

# Plans Review for Fire and Life Safety

PRFLS-Student Manual

*3rd Edition, 3rd Printing-May 2023*



**FEMA**

FEMA/USFA/NFA  
PRFLS-SM  
May 2023  
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Acronyms

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**ACKNOWLEDGMENTS**

The development of any National Fire Academy (NFA) course is a complex process aimed at providing students with the best possible learning opportunity we can deliver.

There are many players in course development, each of whom plays an equally important part in its success. We want to acknowledge their participation and contribution to this effort, and extend our heartfelt thanks for making this quality product.

The following persons participated in the creation of this course:

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### **COURSE GOAL**

1. Understand how building plans examination contributes to the overall community risk-reduction strategy in the built environment.
2. Apply a systematic approach for submitted construction documents in order to verify compliance with applicable codes.
3. Gain knowledge of how to review construction documents, and develop analytical skills to evaluate and verify compliance.
4. Gain an appreciation of the interdependency of various code provisions for construction and life safety.
5. Understand the safety principles and philosophies of the building code to protect the community, occupants and emergency responders.

An additional, non-content-related goal is to foster an environment that encourages discussion, collaborations and sharing of ideas, which provides students with an opportunity to build a professional network that can be beneficial when returning to their jobs.

### **AUDIENCE, SCOPE AND COURSE PURPOSE**

The target audience for the “Plans Review for Fire and Life Safety” (PRFLS) course is building and fire code officials who are responsible for reviewing and approving submitted construction plan documents. Such officials include fire inspectors, deputy fire marshals, fire plans examiners, building officials, building plans examiners and building inspectors with at least one year of on-the-job experience.

Prior to the course, students should be familiar with building and fire codes and understand fire protection principles, fire behavior and the legal aspects of code enforcement. They should possess the ability to identify fire and building code discrepancies, read and interpret the codes, and communicate the discrepancies to the receiving party at a basic level. The students should also have a conceptual understanding of the role of fire and building codes in protecting the community and its occupants.

This course will teach the student the **process** of analyzing submitted construction documents to verify compliance with applicable building and fire code requirements. The student will gain insight into multiple communication strategies that can be used with the submitting applicant.

Subjects addressed in the course include:

- Site plans review for emergency access and water supply.
- Review of architectural and structural drawings for construction requirements, means of egress and fire-resistive compartmentalization.
- Evaluation of integration with heating, ventilating, and air conditioning (HVAC) systems into the fire and life safety strategy.
- Evaluation of integration with electrical systems (e.g., exit illumination and emergency power supplies) into the fire and life safety strategy.
- Assessment of the need for built-in fire and life safety systems.

**GRADING METHODOLOGY**

The PRFLS course will employ multiple types of assessments, including a final examination. Various formats will be used in the assessments and provide a mimic of your responsibilities in the field.

**Ungraded Class Component — Discussion Questions**

Discussion questions will provide students with opportunities to share ideas, explore options, and recall or apply information presented. Due to the nature of discussion flexibility, these will be difficult for an instructor to assess and therefore will be ungraded.

**Graded Assessment Overview:**

<b>Assessments</b>	<b>Percentage of total grade</b>
Participation in group activities	10%
Individual activities	20%
Cumulative project	30%
Final examination	40%
<b>Total</b>	<b>100%</b>

<b>Final Numerical Score</b>	<b>Letter Grade</b>
100 – 90	A
89 – 80	B
79 – 70	C
69 or below	F

**Participation in Group Activities**

Group activities will engage students in collaborative efforts to complete job-related tasks. After an activity, where specified, each group must choose a representative to present the group’s answer and discuss their findings with the rest of the class. Instead of assessing individual contributions during an activity, which would be difficult and time-consuming, the instructor(s) will award participation points to the representative for each group at the end of an activity. Therefore, each student **must** take at least one turn as a representative for their group to receive a participation grade. The instructor(s) should explain at the beginning of the course that participation in group activities will be counted as 10% of the total grade.

**Individual Activities**

To ensure that students will be active participants in the course (rather than just passive members of a group), some activities will include a component that students must complete individually and turn in to the instructor(s). These individual activities will be worth 20% of the total grade. The individual activities that contribute to this percentage are the activity worksheets and Plans Review Checklist completion. Worksheets and sections of the checklist are completed each day, so instructors should plan to check for completion daily.

### **Cumulative Project and Final Examination**

The final assessment will be used to assess cumulative student mastery of the learning objectives taught within the course. It will be comprised of two parts: a cumulative project and a final examination.

- The cumulative project will be a multipart submittal letter in response to a set of submitted construction plan documents for review. The students will complete sections of the letter as part of various unit activities. All sections of the submittal letter must be completed by the last unit and turned in before the final examination. This will be counted as 30% of the total grade.
- The final examination will be a 20-question, multiple-choice, practical examination based on the Canterbury submitted plan documents to measure each learning objective at the appropriate level of learning. This will be counted as 40% of the total grade.

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**SCHEDULE**

<b>TIME</b>	<b>DAY 1</b>	<b>DAY 2</b>
8:00 – 9:15	Introduction	Unit 2: Site Plans: Emergency Access and Water Supply (cont'd)  Activity 2.1: Fire Apparatus Access Roads
9:15 – 9:25	<i>Break</i>	<i>Break</i>
9:25 – 10:15	Introduction (cont'd)	Unit 2: Site Plans: Emergency Access and Water Supply (cont'd)  Activity 2.2: Water Supply Evaluation
10:15 – 10:25	<i>Break</i>	<i>Break</i>
10:25 – 12:00	Unit 1: Code Analysis Information  Activity 1.1: Evaluating a Code Permit Submittal	Unit 2: Site Plans: Emergency Access and Water Supply (cont'd)  Activity 2.3: Site Plan Evaluation Practice
12:00 – 1:00	<i>Lunch Break</i>	<i>Lunch Break</i>
1:00 – 2:30	Unit 1: Code Analysis Information (cont'd)  Activity 1.2: Identification and Communication of Deficiencies	Unit 3: Architectural Features: Fire Protection  Activity 3.1: Occupancy Separations
2:30 – 2:45	<i>Break</i>	<i>Break</i>
2:45 – 4:00	Unit 2: Site Plans: Emergency Access and Water Supply	Unit 3: Architectural Features: Fire Protection (cont'd)  Activity 3.2: Area and Height

Note: This schedule is subject to modification by the instructors and approved by the training specialist.

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>TIME</b>	<b>DAY 3</b>	<b>DAY 4</b>
8:00 – 9:00	Unit 3: Architectural Features: Fire Protection (cont'd) Activity 3.3: Fire Walls	Unit 4: Architectural Features: Life Safety
9:00 – 9:10	<i>Break</i>	<i>Break</i>
9:10 – 10:40	Activity 3.3: Fire Walls (cont'd) Unit 3: Architectural Features: Fire Protection (cont'd)	Unit 4: Architectural Features: Life Safety (cont'd)
10:40 – 10:50	<i>Break</i>	<i>Break</i>
10:50 – 12:00	Unit 3: Architectural Features: Fire Protection (cont'd)	Unit 4: Architectural Features: Life Safety (cont'd) Activity 4.1: Means of Egress
12:00 – 1:00	<i>Lunch Break</i>	<i>Lunch Break</i>
1:00 – 2:30	Unit 3: Architectural Features: Fire Protection (cont'd) Activity 3.4: Fire-Resistance Ratings and Setbacks	Unit 4: Architectural Features: Life Safety (cont'd) Activity 4.2: Interior Finishes
2:30 – 2:40	<i>Break</i>	<i>Break</i>
2:40 – 4:00	Activity 3.4: Fire-Resistance Ratings and Setbacks (cont'd)	Unit 4: Architectural Features: Life Safety (cont'd) Activity 4.3: Life Safety and Fire Protection Concepts

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>TIME</b>	<b>DAY 5</b>	<b>DAY 6</b>
8:00 – 9:00	Unit 5: Electrical Systems	Unit 7: Fire Protection System Requirements (cont'd)
9:00 – 9:10	<i>Break</i>	
9:10 – 10:20	Unit 5: Electrical Systems (cont'd)	Unit 7: Fire Protection System Requirements (cont'd) Activity 7.2: Passive and Active Fire Protection Systems
10:20 – 10:30	<i>Break</i>	<i>Break</i>
10:30 – 12:00	Unit 5: Electrical Systems (cont'd) Activity 5.1: Electrical Requirements Unit 6: Mechanical Systems	Turn in Completed Plans Review Checklist Turn in Final Project — Submittal Letter Final Examination (90 minutes)
12:00 – 1:00	<i>Lunch Break</i>	
1:00 – 2:15	Unit 6: Mechanical Systems (cont'd) Activity 6.1: Mechanical Systems	Course Evaluation and Graduation
2:15 – 2:30	<i>Break</i>	
2:30 – 4:00	Unit 7: Fire Protection System Requirements Activity 7.1: Active Fire Sprinkler Systems Course Review	

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# FIREFIGHTER CODE OF ETHICS

## Background

The Fire Service is a noble calling, one which is founded on mutual respect and trust between firefighters and the citizens they serve. To ensure the continuing integrity of the Fire Service, the highest standards of ethical conduct must be maintained at all times.

Developed in response to the publication of the Fire Service Reputation Management White Paper, the purpose of this National Firefighter Code of Ethics is to establish criteria that encourages fire service personnel to promote a culture of ethical integrity and high standards of professionalism in our field. The broad scope of this recommended Code of Ethics is intended to mitigate and negate situations that may result in embarrassment and waning of public support for what has historically been a highly respected profession.

Ethics comes from the Greek word ethos, meaning character. Character is not necessarily defined by how a person behaves when conditions are optimal and life is good. It is easy to take the high road when the path is paved and obstacles are few or non-existent. Character is also defined by decisions made under pressure, when no one is looking, when the road contains land mines, and the way is obscured. As members of the Fire Service, we share a responsibility to project an ethical character of professionalism, integrity, compassion, loyalty and honesty in all that we do, all of the time.

We need to accept this ethics challenge and be truly willing to maintain a culture that is consistent with the expectations outlined in this document. By doing so, we can create a legacy that validates and sustains the distinguished Fire Service institution, and at the same time ensure that we leave the Fire Service in better condition than when we arrived.



# FIREFIGHTER CODE OF ETHICS

**I understand that I have the responsibility to conduct myself in a manner that reflects proper ethical behavior and integrity. In so doing, I will help foster a continuing positive public perception of the fire service. Therefore, I pledge the following...**

- Always conduct myself, on and off duty, in a manner that reflects positively on myself, my department and the fire service in general.
- Accept responsibility for my actions and for the consequences of my actions.
- Support the concept of fairness and the value of diverse thoughts and opinions.
- Avoid situations that would adversely affect the credibility or public perception of the fire service profession.
- Be truthful and honest at all times and report instances of cheating or other dishonest acts that compromise the integrity of the fire service.
- Conduct my personal affairs in a manner that does not improperly influence the performance of my duties, or bring discredit to my organization.
- Be respectful and conscious of each member's safety and welfare.
- Recognize that I serve in a position of public trust that requires stewardship in the honest and efficient use of publicly owned resources, including uniforms, facilities, vehicles and equipment and that these are protected from misuse and theft.
- Exercise professionalism, competence, respect and loyalty in the performance of my duties and use information, confidential or otherwise, gained by virtue of my position, only to benefit those I am entrusted to serve.
- Avoid financial investments, outside employment, outside business interests or activities that conflict with or are enhanced by my official position or have the potential to create the perception of impropriety.
- Never propose or accept personal rewards, special privileges, benefits, advancement, honors or gifts that may create a conflict of interest, or the appearance thereof.
- Never engage in activities involving alcohol or other substance use or abuse that can impair my mental state or the performance of my duties and compromise safety.
- Never discriminate on the basis of race, religion, color, creed, age, marital status, national origin, ancestry, gender, sexual preference, medical condition or handicap.
- Never harass, intimidate or threaten fellow members of the service or the public and stop or report the actions of other firefighters who engage in such behaviors.
- Responsibly use social networking, electronic communications, or other media technology opportunities in a manner that does not discredit, dishonor or embarrass my organization, the fire service and the public. I also understand that failure to resolve or report inappropriate use of this media equates to condoning this behavior.

**Developed by the National Society of Executive Fire Officers**

**CUMULATIVE PROJECT SUBMITTAL LETTER GRADING RUBRIC**

Plans Review Letter: Each student can earn 30 points with the submittal of a plans review letter that contains at least 15 requests for clarification regarding the submitted plans. The letter is graded on its professional quality and completeness.

<b>Criteria</b>	<b>Excellent 6 points</b>	<b>Acceptable 5 points</b>	<b>Developing 4 points</b>	<b>Deficient 3 points</b>	<b>Points</b>
<b>Number of Questions</b>	The letter contains at least the required number of questions.	The letter is missing no more than three of the required questions.	The letter is missing no more than five of the required questions.	The letter is missing more than five of the required questions.	
<b>Sentences</b>	Sentences are complete and well-constructed. Most words are spelled correctly.	Most sentences are complete and well-constructed, and a few words are spelled incorrectly.	Most sentences are complete, but several words are spelled incorrectly.	Many fragment and/or run-on sentences, and many words are spelled incorrectly.	
<b>Ideas</b>	Ideas are clearly expressed and well-organized. Sentences are easy to understand.	Ideas are organized and expressed in a clear manner, but the wording could be improved.	Ideas are organized to a degree but not very clear. It takes multiple readings to figure out several sentences.	Ideas are not organized, and most sentences are very difficult to understand.	
<b>Content Accuracy</b>	Each request for clarification contains the discrepancy, code requirement, code section, and requested correction.	Most of the requests for clarification contain the discrepancy, code requirement, code section, and requested correction.	Half of the requests for clarification are missing the discrepancy, code requirement, code section, or requested correction.	Most of the requests for clarification are missing the discrepancy, code requirement, code section, or requested correction.	
<b>Letter Format</b>	Letter contains the heading (agency name and address, date), name and address of receiver, subject line, salutation, body of letter, closing, and signature.	Letter contains all but one or two of the parts of a business letter: the heading (agency name and address, date), name and address of receiver, subject line, salutation, body of letter, closing, and signature.	Letter contains most of the parts of a business letter: the heading (agency name and address, date), name and address of receiver, subject line, salutation, body of letter, closing, and signature.	Letter contains at least half of the parts of a business letter: the heading (agency name and address, date), name and address of receiver, subject line, salutation, body of letter, closing, and signature.	
<b>Total Points</b>					

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## A Student Guide to End-of-course Evaluations

**Say What You Mean ...**

### Ten Things You Can Do to Improve the National Fire Academy

The National Fire Academy takes its course evaluations very seriously. Your comments and suggestions enable us to improve your learning experience.

Unfortunately, we often get end-of-course comments like these that are vague and, therefore, not actionable. We know you are trying to keep your answers short, but the more specific you can be, the better we can respond.



Actual quotes from student evaluations:	Examples of specific, actionable comments that would help us improve the course:
1 "Update the materials."	<ul style="list-style-type: none"> <li>The (ABC) fire video is out-of-date because of the dangerous tactics it demonstrates. The available (XYZ) video shows current practices.</li> <li>The student manual references building codes that are 12 years old.</li> </ul>
2 "We want an advanced class in (fill in the blank)."	<ul style="list-style-type: none"> <li>We would like a class that enables us to calculate energy transfer rates resulting from exposure fires.</li> <li>We would like a class that provides one-on-one workplace harassment counseling practice exercises.</li> </ul>
3 "More activities."	<ul style="list-style-type: none"> <li>An activity where students can physically measure the area of sprinkler coverage would improve understanding of the concept.</li> <li>Not all students were able to fill all ICS positions in the exercises. Add more exercises so all students can participate.</li> </ul>
4 "A longer course."	<ul style="list-style-type: none"> <li>The class should be increased by one hour per day to enable all students to participate in exercises.</li> <li>The class should be increased by two days so that all group presentations can be peer evaluated and have written abstracts.</li> </ul>
5 "Readable plans."	<ul style="list-style-type: none"> <li>The plans should be enlarged to 11 by 17 and provided with an accurate scale.</li> <li>My plan set was blurry, which caused the dotted lines to be interpreted as solid lines.</li> </ul>
6 "Better student guide organization," "manual did not coincide with slides."	<ul style="list-style-type: none"> <li>The slide sequence in Unit 4 did not align with the content in the student manual from slides 4-16 through 4-21.</li> <li>The instructor added slides in Unit 4 that were not in my student manual.</li> </ul>
7 "Dry in spots."	<ul style="list-style-type: none"> <li>The instructor/activity should have used student group activities rather than lecture to explain Maslow's Hierarchy.</li> <li>Create a pre-course reading on symbiotic personal relationships rather than trying to lecture on them in class.</li> </ul>
8 "More visual aids."	<ul style="list-style-type: none"> <li>The text description of V-patterns did not provide three-dimensional views. More photographs or drawings would help me imagine the pattern.</li> <li>There was a video clip on NBC News (date) that summarized the topic very well.</li> </ul>
9 "Re-evaluate pre-course assignments."	<ul style="list-style-type: none"> <li>The pre-course assignments were not discussed or referenced in class. Either connect them to the course content or delete them.</li> <li>The pre-course assignments on ICS could be reduced to a one-page job aid rather than a 25-page reading.</li> </ul>
10 "A better understanding of NIMS."	<ul style="list-style-type: none"> <li>The instructor did not explain the connection between NIMS and ICS.</li> <li>The student manual needs an illustrated guide to NIMS.</li> </ul>

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# **UNIT 1: CODE ANALYSIS INFORMATION**

## **TERMINAL OBJECTIVE**

*The students will be able to:*



- 1.1 *Evaluate if the code analysis shown in submitted plan documents, in conjunction with related building code, contains the required information to perform an adequate plans review process.*

## **ENABLING OBJECTIVES**

*The students will be able to:*

- 1.1 *Determine if the provided code analysis in the submitted plan documents contains the required information to complete an adequate plans review.*
  - 1.2 *Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the code analysis information.*
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**UNIT 1:  
CODE ANALYSIS  
INFORMATION**

Slide 1-1

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**I. OBJECTIVES**

**TERMINAL OBJECTIVE**

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Evaluate if the code analysis shown in submitted plan documents, in conjunction with related building code, contains the required information to perform an adequate plans review process.

Slide 1-2

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**ENABLING OBJECTIVES**

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- Determine if the provided code analysis in the submitted plan documents contains the required information to complete an adequate plans review.
- Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the code analysis information.

Slide 1-3

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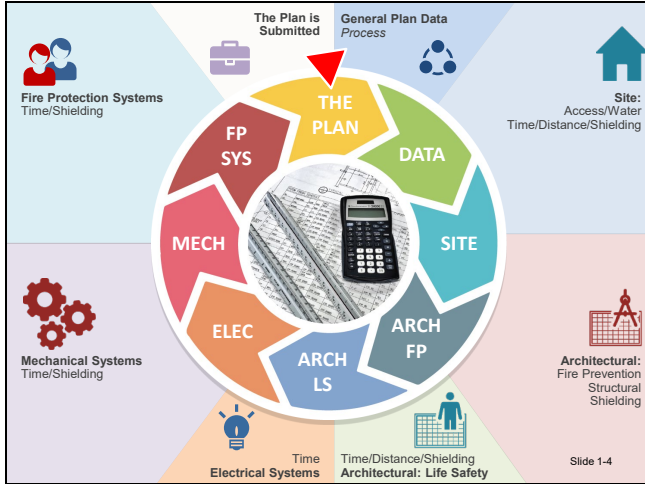
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# CODE ANALYSIS INFORMATION



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## Why do we do plans review?

Slide 1-5

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## WHY

One reason is to keep these situations from occurring.

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II. DOCUMENT NAVIGATION

**REASONS**

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- “What you see is what you get” — drawings represent what will be built.
- **Competent** plans review identifies deficiencies **before** construction — eliminates rework, time loss, cost overruns.

Slide 1-7

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- A. What will be covered?
1. Construction drawings and submittal documents are representative of what will be constructed at the site.
    - a. A competent plans review identifies any deficiencies **before** they become issues in the field and helps ensure that the project complies with code.
    - b. Mistakes in plans review lead to confusion, rework, loss of time, overrun costs and loss of credibility on the part of designers and code officials.

**REASONS (cont'd)**

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- Codes: Specifications for building and fire help ensure safe environment.
- For people, property, the environment and the community.
- Common language to use for communication among all involved.

Slide 1-8

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2. Building and fire codes help to ensure that the building provides a safe environment for people, property, the environment and the community. They establish:
  - a. A standard for using building materials and methods of construction.

- b. Minimum levels of protection for the building, occupants and emergency responders.
  3. Navigation of submittal plans and a common language to use for communication.
- B. Understanding construction documents, walkthrough.
  1. Structure of plan set overview: what plans look and feel like, what to look for and where.
  2. What is a construction document?
    - a. The course emphasis is hands-on from beginning to end — practical application of on-the-job tasks.
    - b. Students will learn applied nomenclature and function throughout the course.

**IN THIS UNIT:  
READING PLANS**

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- Views:
  - Plan.
  - Section.
  - Elevation.
- Details.
- Dimensions.
- Scaling.

Slide 1-9

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**IN THIS UNIT:  
READING PLANS (cont'd)**

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- Typical.
- Legend/Symbols.
- Abbreviations.
- Wall/Partition types.
- Schedules.
- Specifications.

Slide 1-10

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3. Quick overview of submitted plan documents. Will help with:

- a. An introduction to nomenclature.
- b. What appears in submittal plan documents.

C. Reading plans.

1. Common terminology enables efficient and accurate communication between the plans examiner, inspector, designer and contractor.

**PLAN VIEW**

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- Looking down at the horizontal plane.
- Basic building layout.
- Locations of partitions, doors, windows, stairs, built-in cabinets and plumbing fixtures.
- Dark lines = solid features.
- Dashed lines = above the plane features.

Slide 1-11

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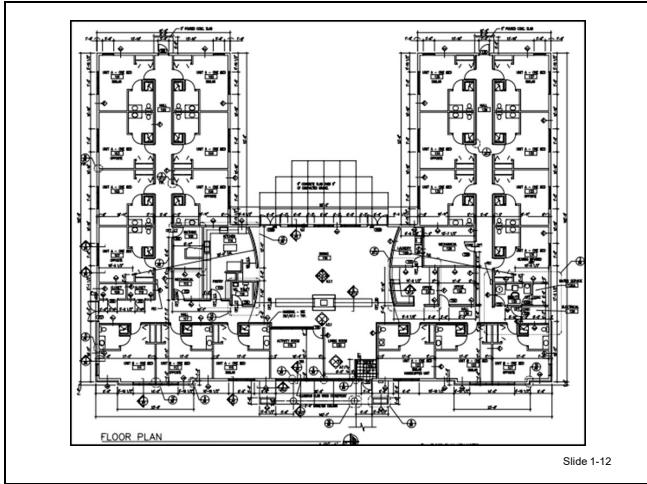
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2. Plan view.

- a. Looking at the floor on the horizontal plane, plan view shows the basic layout of the building at one foot off the floor.
- b. Shows:
  - Spatial arrangement of buildings, rooms, corridors and spaces.
  - Locations of partitions, doors, windows, stairs, built-in cabinets and plumbing fixtures.
  - Dark lines typically show locations of solid features one foot off the floor. Dashed or light lines show features that are above the plane.



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### SECTION VIEW

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- Right angle cutaways to the plan view.
- Shows features not clearly represented on a plan or elevation view alone.

Slide 1-13

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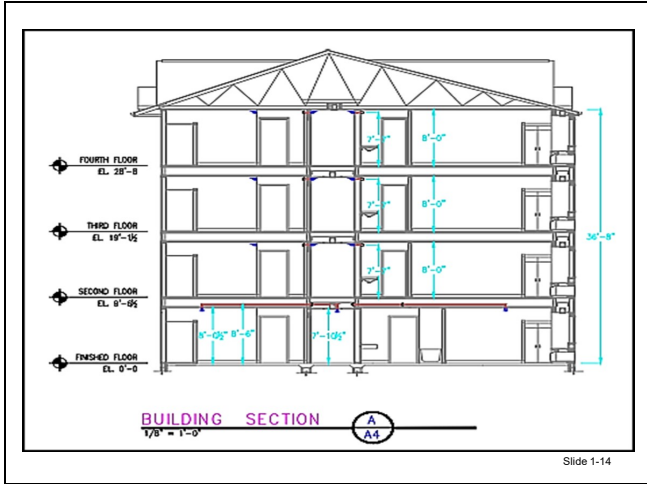
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3. Section view.
  - a. Right angle cutaway or a slice through the structure. An imaginary plane cut through the structure.
  - b. Shows features that cannot be clearly represented on a plan or elevation view alone.

CODE ANALYSIS INFORMATION




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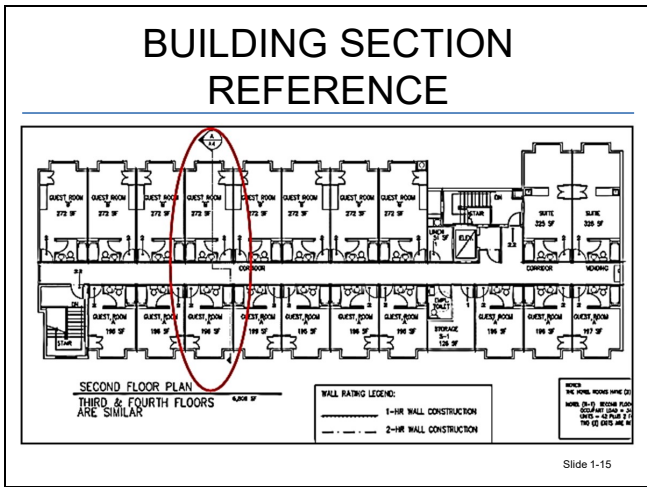
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- c. Section typically referenced on plan view with section number and sheet number, such as 2/A5.
- d. Section view can be a cutaway of the entire building, such as this view of a four-story building.




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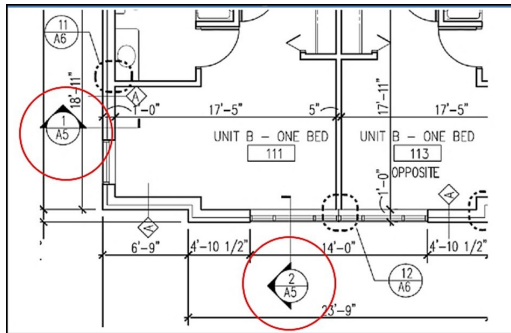
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4. Section reference.

### SECTION REFERENCE ON PLAN



Slide 1-16

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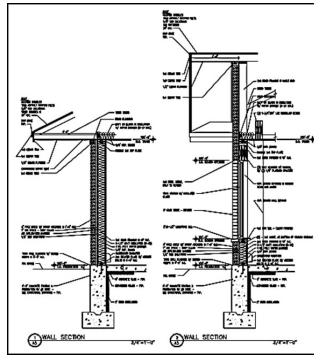
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### WALL SECTION



Slide 1-17

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- 5. Wall sections show construction **details of a vertical element** that cannot be shown on plan view due to the amount of information.
  - a. Cross sections of wall from foundation to roof.
  - b. Show how the wall is proposed to be constructed, materials to be used and the height of the wall.

## ELEVATION VIEWS

- Vertical views of building outside, special walls or features of interior surfaces.
- Labeled with compass direction or face.
- May be called **views**.

Slide 1-18

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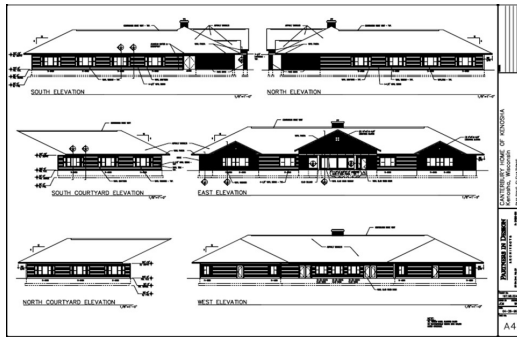
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6. Elevation views.

- a. Vertical views of the outside of the building, special walls, or features of interior surfaces labeled with compass direction or face.
- b. Outside elevations are also called **views**.

## ELEVATION VIEWS (cont'd)



Slide 1-19

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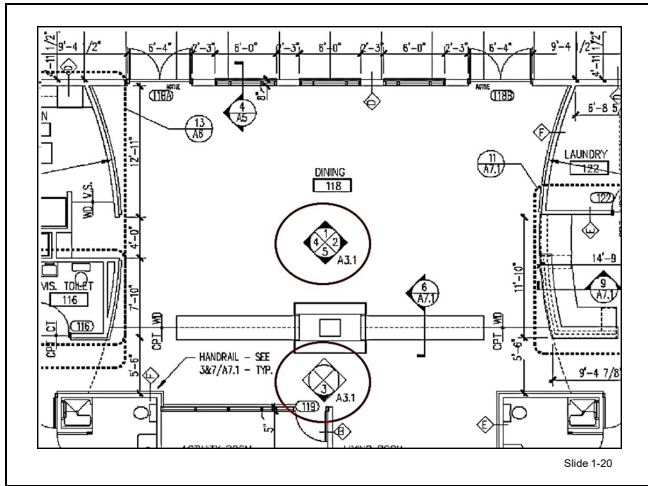
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Slide 1-20

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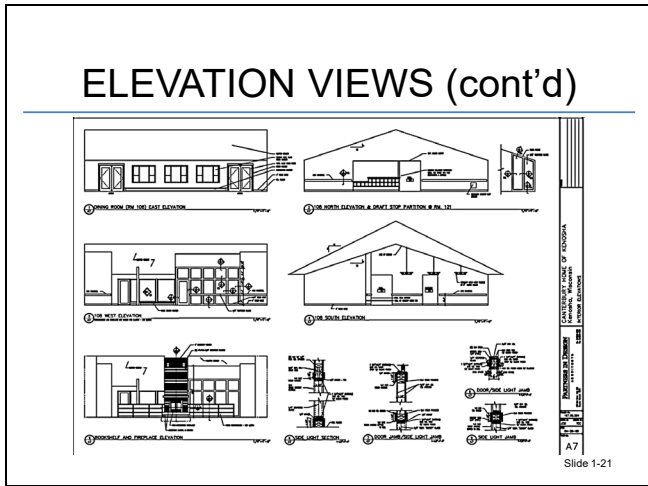
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Slide 1-21

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**DETAILS**

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- Enhanced and enlarged views.
- May be horizontal or vertical, inside or outside, surface, or at a cutting plane.

Slide 1-22

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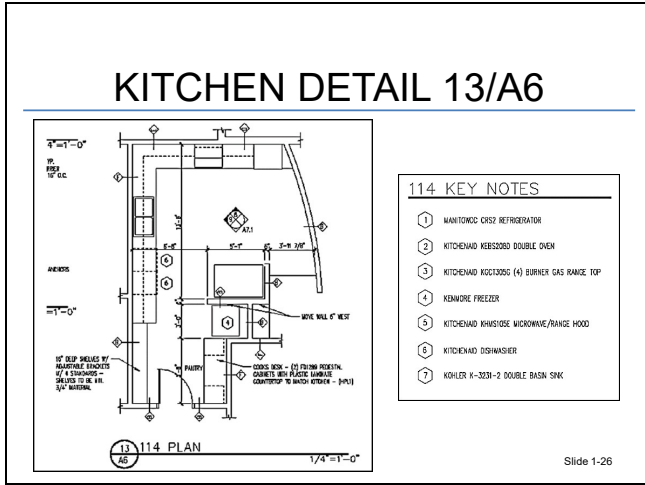
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- D. Details.
1. Enhanced and enlarged views show details of construction.



4. Kitchen.



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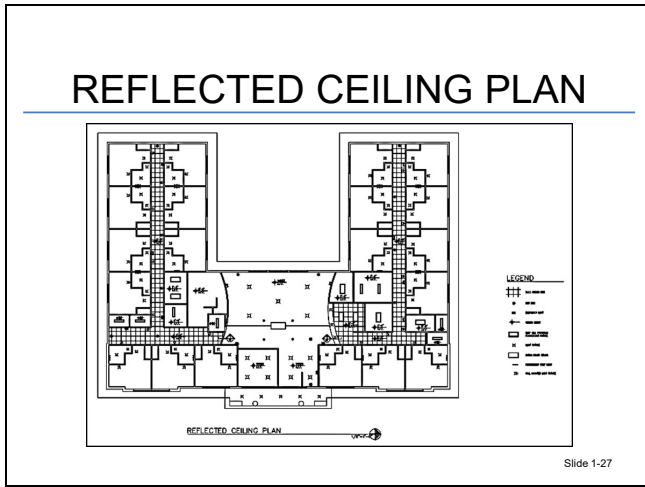
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5. Kitchen detail.



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6. Reflected ceiling plan (RCP). Often contains details:
- a. Ceiling finish.
  - b. Exit signs, emergency lights.
  - c. Normal light fixtures, etc.

## DIMENSIONS

- Generally in feet and inches.
- If even feet, inches as zero; e.g., 14 feet, 0 inches.
- Take precedence over scaling.
- Read from bottom and right of drawing.
- Arrows, dots or slash marks at ends of dimension lines.

Slide 1-28

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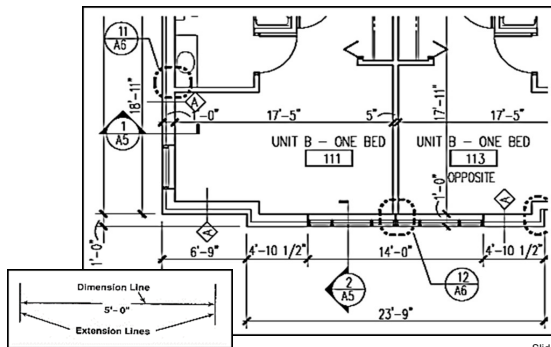
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### E. Dimensions.

1. Generally shown in feet and inches. If shown in even feet, inches will be zero.
2. Stated dimensions take precedence over scaling due to potential errors in reproduction.
3. Read from bottom and right of drawing.
4. Arrows, dots or slashes at ends of dimension lines.

## DIMENSIONS EXAMPLE



Slide 1-29

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**SCALING**

- Scales — rulers used to read drawings — may vary from page to page and on a single page.
- Most important factor: choosing the correct scale.

**SITE PLAN**

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SCALE: 1" = 30'-0"

SCALE 1/32" = 1'-0"

Slide 1-30

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- F.     Scaling.
1.     Provides the ability to reduce real-world dimensions to paper size.
  2.     Scales are rulers used when reading drawings.
    - a.     The most important factor is choosing the right scale.
    - b.     Scales may vary from page to page, as well as on a single page.

**NOT TO SCALE**

- Not to scale (NTS).
- Notes:
  - Photocopies rarely have same proportion in both directions.
  - Some drawings produced intentionally with only critical dimensions given.
- NTS drawings should **never** be used as scaled drawings.

Slide 1-31

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3.     Not to scale (NTS).
  - a.     A typical photocopier rarely copies the same proportion in both directions, which is the reason why photocopies are not accurate to use.
  - b.     Some drawings are intentionally produced with only critical dimensions given.

4. NTS drawings should **never** be used as scaled drawings.

**TYPICAL**

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- Term found on working drawings.
- Feature or design that will be repeated throughout the building.

Slide 1-32

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G. Typical.








1. Term found on working drawings.
2. A feature or design that will be duplicated. For example, if every sleeping room is the same, they may not show them all.

**LEGEND/SYMBOLS**

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- No standard set; often unique to each trade.
- Explains meaning of specific symbols used on drawings.
- May appear on a single sheet.

SYMBOLS LEGEND

	<small>SMOKE DETECTOR</small>
	<small>HEAT DETECTOR</small>
	<small>OCCUPANT NOTIFICATION HORN/ADA STROBE MOUNT AT +84"</small>
	<small>OCCUPANT NOTIFICATION HORN MOUNT AT +84"</small>
	<small>DOOR HOLDER</small>
	<small>WALL MOUNTED EXIT LIGHT MOUNTED ABOVE DOOR</small>
	<small>EMERGENCY LIGHT, MOUNTED ON WALL AT +84"</small>

Slide 1-33

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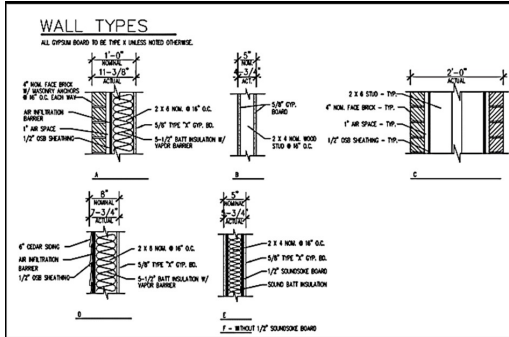
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H. Legends and symbols.

1. Nonstandard. Depends on designer, architectural firm, region or discipline.
2. Legend identifies the symbols used on the drawings, and it may appear on a single sheet.



## WALL AND PARTITION TYPES EXAMPLES



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## SCHEDULES

- Charts containing repetitive information.
- Doors, windows, interior finishes.
- Basic group of building components or treatments.
- May contain references to other lists, details, schedules or specifications.

Slide 1-37

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### K. Schedules.

1. Charts containing repetitive information; for example, doors, windows and interior finishes.
2. Basic group of building components or treatments. May contain references to other lists, details, schedules or specifications.

## SCHEDULE EXAMPLES

The image shows two architectural schedule examples. The top one is a 'DOOR SCHEDULE' with columns for 'DOOR', 'FINISH', 'HARDWARE', 'DETAILS', and 'REMARKS'. Below the table is a detail drawing of a door. The bottom one is a 'WINDOW SCHEDULE' with columns for 'FRAME', 'GLAZING TYPE', and 'REMARKS'. Below the table is a detail drawing of a window.

Slide 1-38

## SPECIFICATIONS

- Contains more detailed information about construction methods and materials.
- Divided into 50 sections (divisions).
- Provides specifications for fire protection systems and equipment.

Slide 1-39

### L. Specifications Manual.

1. Contains more detailed information about construction methods and materials.
2. Architect's or engineer's list of materials and methods specific to that project.
3. Divided into 50 sections in Master Format. Construction Specifications Institute (CSI) now has 50 sections, but most construction trades are still using the 16-section CSI Master Format.
4. Provides specifications for fire protection systems and equipment.
5. On small projects, such information may be provided as notes on drawings.
6. Cutsheets may still be necessary to determine code compliance.

III. SUBMITTED CONSTRUCTION PLAN DOCUMENTS REQUIREMENTS

**PLAN SUBMITTAL  
REQUIREMENTS**

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- When required by code official, state/local jurisdiction.
- Know state and local laws/regulations.
- Regulation gives authority to accept/reject plans.

Slide 1-40

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- A. When construction drawings are required by a code official, state/local jurisdiction.
1. Each state has its own laws regarding development. Local regulations may also specify when plans are required.
  2. Important to know local rules.
    - a. When and how plans are required, number of sets, etc.
    - b. If required to be prepared by registered professional.
  3. Regulation gives the authority to accept/reject plans.

Know it exists and where to find it (e.g., 2015 International Building Code (IBC) 105.3.1, 2015 International Fire Code (IFC) 105.2.1.)
  4. Depends on jurisdiction.
  5. Depends on scope and size of project.

## ELECTRONIC MEDIA

- Permitted when approved by code official.
- Code official must have compatible software and printer.
- Most often used as method to archive as-built drawings.

Slide 1-41

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### B. Electronic media.

#### 1. Format.

- a. Two or more copies.
- b. Know if electronic media may or may not be used for plan submittal.
  - Permitted when approved by code official.
  - Code official must have compatible software and printer.
  - Most often used as a method to archive as-built drawings.

## REQUIRED PLAN INFORMATION

- Dimensioned, oriented (North arrow).
- Clarity: Location, nature and extent of work to be done.
- Code compliance detail.
- Means of egress.
- Exterior wall envelope.
- Fire-resistance information.
- Site plan.

Slide 1-42

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#### 2. Information required on plans.

- a. Show dimensions.
- b. Be of sufficient clarity.

- c. Show detail that will comply with code.
  - Identify all occupied and unoccupied spaces.
  - Number of occupants on all floors, rooms and spaces.
- d. Show means of egress.
- e. Show exterior wall envelope.
- f. Provide fire-resistive and penetration protection information.
- g. Site plan.
  - Scale size and location of new construction and existing structures.
  - Distances from lot lines.
  - Existing and proposed grades.
  - Flood hazard and floodway designations.
- h. Plans may be required to be prepared by a registered design professional if mandated by the jurisdiction's statutes or ordinances.

**CODE ANALYSIS**

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- Basis of the building design.
- Code official has authority to require analysis for each plan set.
- Information needed determined by code official.

Slide 1-43

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- 3. Code analysis.
  - a. Is the basis of the design: why the building was designed the way it was.
  - b. Within the authority of the code official to require each set of plans to include a code analysis.

- c. The authority to promulgate rules, regulations, etc., for enforcement of code provisions.
- d. Format of code analysis is up to the code official.
  - Code official may specify information and amount of detail to include in the code analysis to complete a review for code compliance.

**CODE ANALYSIS  
INFORMATION**

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- Occupancy classification.
- Occupant load calculations.
- Construction type.
- Egress requirements.
- Area and height calculations.
- Fire protection systems.
- Zoning requirements.
- Codes and edition used for design.

Slide 1-44

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- e. Level of detail information on code analysis:
  - Occupancy classification.
  - Occupant loading calculations.
  - Construction type.
  - Egress requirements.
  - Area and height calculations.
  - Any code allowances or modifications taken.
  - Fire alarm requirements.
  - Fire sprinkler requirements.
  - Zoning information.
  - Codes and edition used for design.

### CODE ANALYSIS EXAMPLE

- Retail building.
- Building designed for possible nonseparated mixed use:
  - Group M; Group B; Group A-2 or A-3.
  - Type V-B; 6,000 square feet; 1 story.
  - Fire Protection: National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems*.

Slide 1-45

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f. Code analysis **example**.

### CODE ANALYSIS EXAMPLE (cont'd)

- Allowable area and height (IBC Tables 504.3, 504.4, 506.2):
  - Group A-2 or A-3 the most restrictive.
  - Allowable area: 24,000 square feet; Actual 6,000 square feet.
  - Allowable stories: 2; Actual: 1.
  - Allowable height: 60 feet; Actual: 16 feet.

Slide 1-46

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### CODE ANALYSIS EXAMPLE (cont'd)

- Calculated Occupant Load:
  - Retail Space #1:  $1,200 \text{ ft}^2 / 15 \text{ ft}^2$  per person = 80 occupants.
  - Retail Space #2:  $2,400 \text{ ft}^2 / 15 \text{ ft}^2$  per person = 160 occupants.
  - Retail Space #3: Same as #2.
  - Actual occupant loads will be less based on tenant improvements.

Slide 1-47

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**CODE ANALYSIS EXAMPLE**  
**(cont'd)**

- Egress Width:
  - Retail Space #1: 0.2 inch x 80 occupants = 16 inches or 1 exit width; 2 exits required based on occupant load greater than 50.
  - Retail Space #2: 0.2 inch x 160 occupants = 32 inches or 1 exit width, 2 exits required based on occupant load greater than 50.
  - Retail Space #3: Same as #2.

Slide 1-48

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## Example Code Analysis

### Building Designed for Possible Nonseparated Mixed Use:

- Group M; Group B; Group A-2 or A-3.
- Type VB; 6,000 square feet; 1 story.
- Fire Protection: National Fire Protection Association (NFPA) 13, *Standard for the Installation of Sprinkler Systems*.

### Allowable Area and Height (IBC Tables 504.3, 504.4, 506.2):

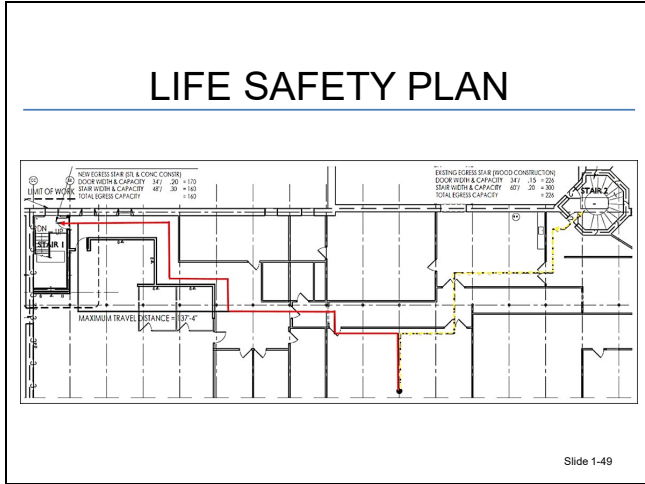
- Group A-2 or A-3 is the most restrictive.
- Allowable area: 24,000 square feet; Actual 6,000 square feet.
- Allowable stories: 2; Actual: 1.
- Allowable height: 60 feet; Actual: 16 feet.

### Calculated Occupant Load:

- Retail Space #1:  $1,200 \text{ ft}^2 / 15 \text{ ft}^2 \text{ per person} = 80 \text{ occupants}$ .
- Retail Space #2:  $2,400 \text{ ft}^2 / 15 \text{ ft}^2 \text{ per person} = 160 \text{ occupants}$ .
- Retail Space #3: Same as #2.
- Actual occupant loads will be less based on tenant improvements.

### Egress Width:

- Retail Space #1:  $0.2 \text{ inch} \times 80 \text{ occupants} = 16 \text{ inches}$  or 1 exit width; 2 exits required based on occupant load greater than 50.
- Retail Space #2:  $0.2 \text{ inch} \times 160 \text{ occupants} = 32 \text{ inches}$  or 1 exit width, 2 exits required based on occupant load greater than 50.
- Retail Space #3: Same as #2.



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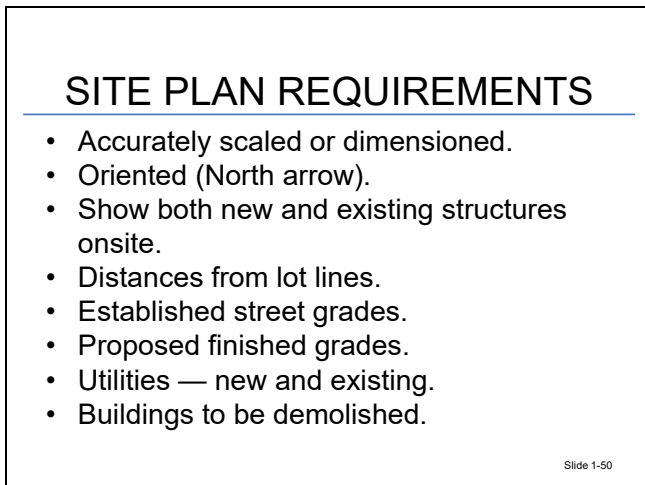
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g. Life Safety Plan.

- Usually a separate sheet.
  - Designer indicates what they designed.
  - Exiting plan of each floor to show measurement of common path of travel, travel distance and remoteness between exits.
  - Fire-resistance-rated construction due to occupancy separations, distance from property lines or construction type.



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4. Requirements for site plans.

- a. Drawn to scale.

- b. Orientation of building on-site with a North arrow.
- c. Show location of all structures on-site.
- d. Show distances from lot lines.
- e. Show established and proposed grades.
- f. Show new and existing utilities.
- g. Show any buildings to be demolished.

**IV. OTHER SUBMITTAL ISSUES**

**ADDENDA/CHANGE ORDERS**

- Changes from the original, approved plans.
- Must be submitted for review and approval.
- Often marked on revised plan with a cloud.

Slide 1-51

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- A. Addenda/Change orders.
  - 1. Changes from original plans.
    - a. Addenda typically occur before a contract is awarded and changes are made to plans.
    - b. Change orders occur after a contract is awarded or construction has commenced, and the contractor is required to change construction materials, methods or design.
    - c. A change is often marked on a revised plan with a cloud.
    - d. A change order alters the contract.
  - 2. Must be submitted for review and approval.

## PHASED APPROVALS

- Fast track.
- Subject to approval of code official:
  - Adequate information must be provided.
  - Permit holder proceeds at own risk.



Slide 1-52

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### B. Phased approvals.

1. Building may be approved for the foundation only until the final building permit is approved, or the building may be approved in several phases.
2. Also known as **fast track**.
3. Subject to the approval of the code official.  
  
Adequate information must be provided.
4. The permit holder proceeds at their own risk.
  - a. Proceeds without assurance that the permit for the entire structure will be granted.
  - b. Have the owner sign a statement that a phased approach is at their own risk.

## DEFERRED SUBMITTALS

- Subject to approval of code official.
- Deferred items may not be installed until submittal and approval.
- Must be stated on permit documents.

Slide 1-53

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- C. Deferred submittals.
  - 1. Subject to the approval of the code official.
  - 2. Items subject to deferred submittal should not be installed until their design and submittal documents have been reviewed and approved.
  - 3. Often used for fire protection systems.
  - 4. Example:
    - a. Mechanical and plumbing systems are typically design-bid systems, which means the contractor who wins the contract will design the system.
    - b. A building is in the design phase for several years. The owner may not put a building to bid for its construction until the building permit is approved.
      - The mechanical and plumbing contractor will design the systems and obtain their own permits for the work.
    - c. Be sure permit documents clearly state the systems that will be installed under deferred submittals.

**FIRE PROTECTION  
SYSTEM PLANS**

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- Submitted and approved prior to start of system installation.
- Contain all information required by appropriate codes and the NFPA standards.
- Fire code requires plan submittal to fire code official.

Slide 1-54

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- D. Fire protection system plans.
  - 1. Submitted prior to the start of any system installation.
  - 2. Contain all information required by appropriate codes and NFPA documents.

3. Plan submittal to the fire code official is required by the fire code.

**APPROVED PERMIT DOCUMENTS**

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- One set of reviewed documents, plus addenda, must be kept on job site.
- Required; open to inspection by code official at all times.



Slide 1-55

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- E. Approved permit documents.

One set of reviewed documents, including addenda, must be kept on the job site at all times.

**ALTERNATE METHODS AND MATERIALS**

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- Codes allow alternate ways to satisfy code compliance.
- Code official must be satisfied that alternates are equivalent in life safety and fire protection.
- If not approved, reasons need to be in writing.

Slide 1-56

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- F. Alternate methods and materials.

1. Codes allow the code official to entertain alternative methods and materials or alternative, equivalent ways to satisfy code requirements in quality, strength, effectiveness, fire resistance, durability and safety.
2. An application for alternative methods and materials must come from the applicant and should be accompanied by supporting documentation.
3. If not approved, the code official is required to respond in writing with reasons why the proposal was not approved.

V. CODE OFFICIAL RESPONSIBILITIES

**CODE OFFICIAL  
RESPONSIBILITIES**

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Responsibilities established in administrative codes:

- Examine.
- Stamp.
- Retain at least one set.
- Inspect premises.
- Enforce compliance.

Slide 1-57

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- A. Code official. Authority.
- B. Building official. The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative.
- C. Fire code official. The fire chief or other designated authority charged with the administration and enforcement of the code, or a duly authorized representative.
- D. Responsibilities:
  - 1. Examine plans or cause them to be examined.
  - 2. Stamp reviewed drawings.
  - 3. Retain at least one set of review materials for a period required by law.
  - 4. Inspect premises for which a permit is issued.
  - 5. Enforce compliance with code provisions.

**VALIDITY OF PERMIT**

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- Plan review is **not** a warranty.
- Permit issuance not a license to ignore or violate any code provisions.
- Noncomplying conditions **must** be corrected.

Slide 1-58

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E. Reminder:

Plans review is **not** a warranty.

1. A permit does not allow side-stepping or violating any code provisions.
2. All work must be in compliance.
3. Noncomplying conditions noted during site inspections must be corrected, regardless of whether or not they were noted during the review process.

**VI. SUMMARY**

**FEDERAL EMERGENCY MANAGEMENT AGENCY**  
**FEMA**

**U.S. Fire Administration**

## SUMMARY

- Document navigation.
- Submitted construction plan document requirements.
- Other submittal issues.
- Code official responsibilities.

Slide 1-59

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Did you get the answer to the question posed at the beginning of this unit, "Why do we do plans review?"

Slide 1-60

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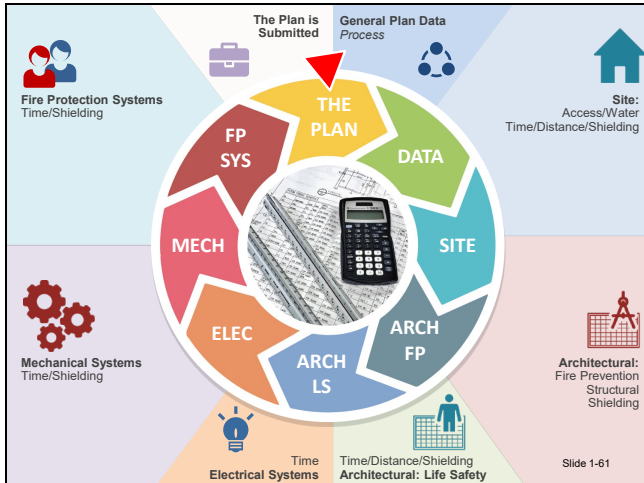
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The first step in the plans review process is to determine if the plan submittal contains the information required to complete a review. Next, we will compile a list and a letter to the permit submitter.

Any burning questions?

Slide 1-62

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## ACTIVITY 1.1

### Evaluating a Code Permit Submittal

#### Purpose

Evaluate a permit submittal to determine if the required information is provided.

#### Directions

1. Work in your table groups for 30 minutes.
2. Review the submitted plan documents and list at least **five** items on an easel pad that **do not** appear on the plans, which prevent you from completing a review on this project.
3. Using your code, identify the applicable section that refers to the missing items (example: Address numbers: IFC 505.1).
4. Select a group representative to report and be prepared to discuss your findings with the rest of the class when called upon by the instructor.

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## ACTIVITY 1.2

### Identification and Communication of Deficiencies

#### Purpose

Communicate the deficiencies of the plans to the applicant and designers in a plans review submittal letter.

#### Directions

1. Work in your table groups for 30 minutes.
2. You will begin a course project to develop a plans review submittal letter that will identify the discrepancies preventing approval of the building permit for the submitted plan documents. Discrepancies include items that are missing and items that do not show compliance with the applicable codes.
  - a. The plans review submittal letter is to be addressed to the applicant, designer(s) and the owner of the project, based on the plans as presented.
  - b. Write questions to the submitter, asking for direction and clarification for one or more discrepancies, depending on instructions. **Your questions must be in complete sentences in order to get credit. See the grading rubric in Appendix: Cumulative Project Submittal Letter Grading Rubric of this unit, which outlines how your submittal letter project will be graded.**
  - c. You will add to the letter in several subsequent unit activities, according to instructions. This course project will be submitted at the end of Unit 7: Fire Protection System Requirements, and will constitute 30% of your final grade.
3. Pull out the submittal letter template from your SM Appendix A: Canterbury Submittal Letter Template for this unit, which you will use for the letter. **Remember to keep this with your course materials since you will be adding to it throughout the course and turning it in at the end of the course.**
4. Using your code and the submitted plan documents, identify the code section that refers to the discrepancies.
5. Each member of your table group will write at least two questions to the submitter in their letter, providing direction for clarification regarding a topic covered in this unit.
6. Write your two questions in the provided letter template, put your name on it, and save this document to be used in future activities.

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# **APPENDIX**

## **CUMULATIVE PROJECT SUBMITTAL LETTER GRADING RUBRIC**

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## CUMULATIVE PROJECT SUBMITTAL LETTER GRADING RUBRIC

Instructor(s): \_\_\_\_\_

Student name: \_\_\_\_\_

CRITERIA	4	3	2	1
<b>Content Accuracy</b>	The letter contains at least the required number of questions.	The letter is missing no more than one of the required questions.	The letter is missing more than one of the required questions.	The letter does not contain any of the required questions.
<b>Sentences</b>	Sentences are complete and well-constructed. Most words are spelled correctly.	Most sentences are complete and well-constructed, and a few words are spelled incorrectly.	Most sentences are complete, but several words are spelled incorrectly.	There are many fragment and/or run-on sentences, and many words are spelled incorrectly.
<b>Ideas</b>	Ideas are clearly expressed and well-organized. Sentences are easy to understand.	Ideas are organized and expressed in a clear manner, but the wording could be improved.	Ideas are organized to a degree but not very clear. It takes multiple readings to figure out several sentences.	Ideas are not organized, and most sentences are very difficult to understand.

UNIT	CONTENT ACCURACY	SENTENCES	IDEAS	AVERAGE
Unit 1				
Unit 2				
Unit 3				
Unit 4				
Unit 5				
Unit 6				
Unit 7				
<b>Total</b>				

<b>Additional Points for Turning in Final Project</b>	<b>2</b>
<b>Cumulative Score</b>	<b>/30</b>

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## **UNIT 2: SITE PLANS: EMERGENCY ACCESS AND WATER SUPPLY**

### **TERMINAL OBJECTIVE**

*The students will be able to:*



- 2.1 *Evaluate contractor submitted plan documents in conjunction with applicable building code requirements to determine if the information shown complies with fire protection feature requirements for fire department access, water flow and special hazards.*

### **ENABLING OBJECTIVES**

*The students will be able to:*

- 2.1 *Evaluate civil (site) submitted plan documents for compliance with requirements for fire department access, water flow requirements and the presence of special hazards.*
  - 2.2 *Compose requests for clarification in business-letter format to the applicant and the professional designer regarding identified deficiencies noted during the plans review of the emergency access and water supply information.*
-

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 FEMA  U.S. Fire Administration

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**UNIT 2:  
SITE PLANS: EMERGENCY  
ACCESS AND WATER  
SUPPLY**

Slide 2-1

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**I. OBJECTIVES**

**TERMINAL OBJECTIVE**

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Evaluate contractor submitted plan documents in conjunction with applicable building code requirements to determine if the information shown complies with fire protection feature requirements for fire department access, water flow and special hazards.

Slide 2-2

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**ENABLING OBJECTIVES**

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- Evaluate civil (site) submitted plan documents for compliance with fire department access, water flow requirements and the presence of special hazards.

Slide 2-3

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## ENABLING OBJECTIVES (cont'd)

- Compose requests for clarification in business-letter format to the applicant and the professional designer regarding identified deficiencies noted during the plans review of the emergency access and water supply information.

Slide 2-4

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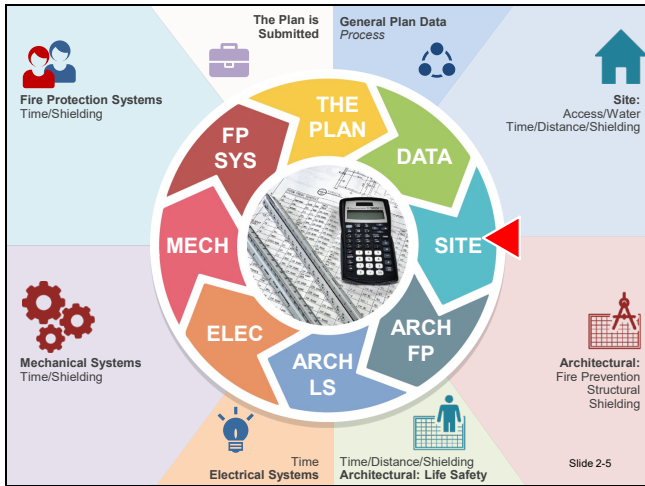
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Why is this topic important?

Slide 2-6

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## WHY?

So situations like these might not occur:



Slide 2-7

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## NOW VERSUS LATER



Slide 2-8

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- A. Reviewers should be involved in **preplanning** meetings and land use process. Sooner is better than later.

Examples:

1. State and local governments have specific land use vesting rights, and fire departments need to be involved in the planning stage to ensure that adequate infrastructure is provided for emergency response.
  - a. Storm water regulations encourage low impact development, meaning fewer impervious surfaces.
  - b. While fire departments want wider roads to maneuver apparatus, storm water engineers want narrower road surfaces so that less water goes into storm water systems.
  - c. Planners want more open space for quality of life, and clustered residential housing developments may be encouraged with fewer roads to serve each house.


2. Developers may propose projects in areas that are not served by a water utility that can supply water flow. As these projects gain land use approval and vesting rights, fire departments may find themselves in a difficult confrontation with developers after they have gained approval to go forward with the permit process, only to find that they must either redesign the project or abandon the plans entirely.
3. Fire departments have an opportunity to address issues of public safety during any land use activity and are encouraged to do so. Be as specific as possible with project requirements based on what is shown.
4. Many jurisdictions have a development permit that is used for installing infrastructure such as utilities, parking lots, sidewalks, etc. Fire departments should get involved in the review of the development permits, which may be administered by their public works department or planning department, so that fire apparatus access and water supply requirements can be reviewed and approved.

**COURSE THEME**

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Three E's of fire prevention and life safety:

- Engineering.
- Education.
- Enforcement.



Slide 2-9

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- B. The course theme is the three E's of fire prevention and life safety: Engineering, Education and Enforcement. The five E's are a combination of the original three E's — **Education, Engineering and Enforcement** — noted by President Truman at the President's Conference on Fire Prevention in 1947. Two additional E's — **Economic Incentive and Emergency Response** — were added by the National Fire Academy (NFA) due to their importance in community risk reduction. For the purpose of this course, we will focus on the original three.

## II. FIRE APPARATUS ACCESS ROAD REQUIREMENTS

### FIRE APPARATUS ACCESS ROADS



Slide 2-10

### GENERAL REQUIREMENTS

- Access roadways — widths, turning radii, grades and turnarounds noted.
- Physical barriers or obstructions identified.
  - Overhead obstructions.
  - Landscaping.
  - Grade slopes.



Slide 2-11

#### A. General requirements.

1. Access roadways with widths, turning radii, grades and turnarounds that are capable of handling all sizes and configurations of local fire apparatus.
2. To control and limit physical barriers or obstructions:
  - a. Overhead obstructions.
  - b. Landscape growth that could affect access in later years.
  - c. Grade slopes around a building site that would affect firefighting operations.

## FIRE APPARATUS ACCESS ROAD

- “Road that provides fire apparatus access from a fire station to a facility, building or portion thereof” (IFC Section 202).
- Generic term including:
  - Fire lanes.
  - Public, private streets.
  - Parking lot lanes.
  - Access roadways.



Slide 2-12

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### B. Fire apparatus access road.

A road that provides fire apparatus access.

1. From a fire station to a facility, building or portion thereof.
2. Includes fire lanes, public streets, private streets, parking lots and access roadways.

## FIRE LANE

- Roadway or other passageway to allow fire apparatus passage.
- Not necessarily intended for other traffic.



Slide 2-13

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### C. Fire lane.

1. A roadway or other passageway to allow the passage of fire apparatus.
2. Not necessarily intended for other vehicular traffic.

## ACCESS DURING CONSTRUCTION

- Fire department access roads and water supply serviceability prior to and during time of construction.
- Approved alternative methods of protection permitted.
- Adequate on-site fire protection required.



Slide 2-14

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D. Access requirements during construction.

1. Fire department access roads must be installed and made serviceable prior to and during the time of construction.
  - a. Crushed rock on asphalt-treated base.
  - b. Temporary asphalt without final lift.
2. Approved alternative methods of protection are permitted.
  - a. Adequate on-site fire protection.
  - b. Water supply with firehose.
  - c. Temporary standpipes (horizontal and vertical).

## REQUIREMENTS

- Apply to every new facility, building or portion of building.
- Varies by model code.
- Measured in actual travel route.

Slide 2-15

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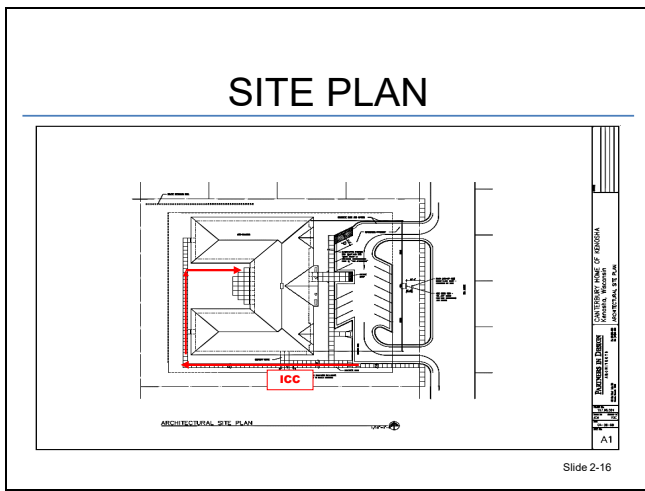
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E. Basic access requirements.

1. Applies to every new facility, building or portion of the building.
2. Varies by model code.
  - a. Extends to within 150 feet of all portions of the facility.
  - b. All portions of the exterior wall of the first story of a building or to within 50 feet of an exterior door providing access to the interior.
3. Measured by actual travel route.
4. Example of why review is important.



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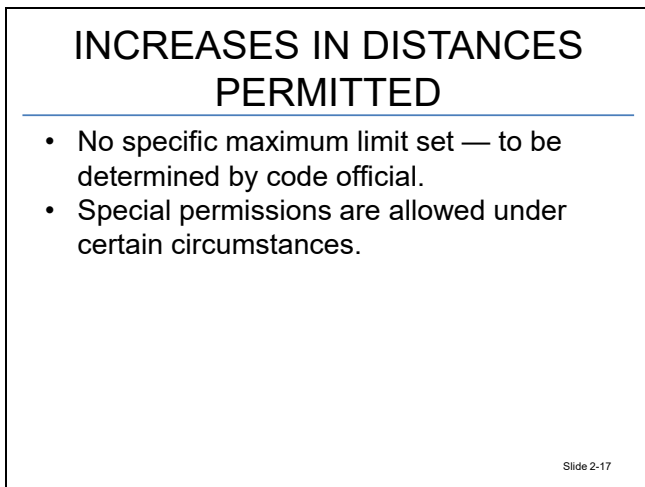
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- F. Increase criteria.
1. Increases in length permitted.
  2. No specific maximum limit set — to be determined by the code official.

- a. Permitted when the building is protected throughout by automatic sprinklers.
- b. Permitted when roads cannot be installed due to location on property, topography, non-negotiable grades or other similar conditions **and** an alternative means of fire protection is provided.

**ADDITIONAL ACCESS**

- Code official may require more than one fire apparatus access road.
- Specific circumstances.



Slide 2-18

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- G. Additional access can be required.
  - 1. A code official may require more than one emergency apparatus access road. For example:
    - a. Shopping centers.
    - b. Industrial complexes.
    - c. Apartment complexes.
    - d. Large, single-family residential developments.
  - 2. Applicable when there is potential for:
    - a. Impairment of a single road by vehicle congestion.
    - b. Condition of terrain, climate or other factors that could limit access.

## DIMENSIONS

- Not less than 20 feet wide — based on assumption that apparatus is 8 feet wide.
- Unobstructed vertical clearance — some codes permit reduction of vertical height.

Slide 2-19

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### H. Dimensions for access.

1. Not less than 20 feet in width.
  - a. Based on the idea that apparatus is about 8 feet wide.
  - b. Allows an engine to work at a hydrant with the ability for another vehicle to pass.
2. Unobstructed vertical clearance not less than 13 feet 6 inches.
3. Some codes permit reduction of vertical height.
  - a. Reduction must not impair access.
  - b. Is marked by approved signs.

## 20-FOOT WIDTH

Example of 20-foot width:



Photo courtesy of Shaun Kurry, Skuared Photographic

Slide 2-20

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## AERIAL ACCESS REQUIREMENTS

- Where aerial apparatus access needed.
- Minimum 26 feet wide.
- Between 15 to 30 feet from building.



Slide 2-21

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### I. Special requirements where aerial access is needed.

Not specifically addressed in codes, but consider:

1. Buildings over 30 feet above the lowest level of fire department access.
2. Minimum width of 26 feet.
3. Minimum of 15 feet and maximum of 30 feet away from the building.

Allows proper ladder positioning, optimal climbing angle.

4. Parallel to one entire side having access doors or windows to the interior.

## 26-FOOT WIDTH

Example of 26-foot width:



Photo courtesy of Shaun Kurry, Skuared Photographic

Slide 2-22

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## INCREASED WIDTH PROVISIONS

A code official may require an increase in minimum access widths when the minimums are inadequate for fire or rescue operations.

Slide 2-23

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### J. Increased width provisions.

A code official may require an increase in minimum access widths when the minimums are inadequate for fire or rescue operations.

## ROADWAY SURFACE

- Support loads of heaviest emergency apparatus — local requirements.
- All-weather driving capabilities.



Slide 2-24

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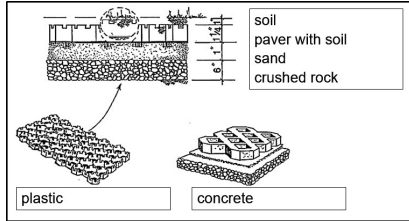
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### K. Roadway surface requirements.

1. Must be able to support the load of the heaviest emergency apparatus.
2. Consider requiring engineer-drawn and stamped plans.
3. Local requirements must be established based on apparatus weight and configurations.
4. All-weather driving capabilities.

### TURF BLOCKS

- Sod is placed in and over turf paving.
- Area must be clearly identified for fire department access.



Slide 2-25

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- L. Turf blocks.
  - 1. Create an all-weather surface.
  - 2. Example: turf blocks.

### TURNING RADII

Established by local needs.

- Inside and outside.
- Front and rear.




Photo courtesy of Shaun Kurry, Skuared Photographic

Slide 2-26

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- M. Turning radius requirements are established by local needs.
  - 1. Consider inside- and outside-turning radii.
  - 2. Front and rear overhangs — aerial tips or platforms.
  - 3. Computer programs.

### DEAD-END ROADS

Roads greater than 150 feet in length — approved turnaround for fire apparatus required.

Slide 2-27

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N. Dead-end roads.

Roads that are more than 150 feet in length must be provided with approved turnarounds for fire apparatus.

### WHY TURNAROUNDS?

Safety purposes to minimize backing incidents.

- Backing of apparatus is dangerous.
- May be impractical or impossible.

Slide 2-28

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O. Turnarounds.

1. For safety purposes to minimize backing accidents.
  - a. Backing of apparatus on a fireground can be dangerous.
  - b. Backing during an incident may be impractical or impossible.

## ACCEPTABLE TURNAROUND REQUIREMENTS

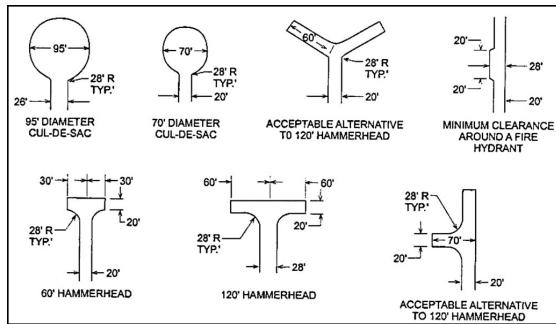
- Cul-de-sac.
- Hammerhead.
- T.
- Y.

Length (feet)	Width (feet)	Turnarounds Required
0-150	20	None required
151-500	20	120 feet hammerhead, 60 feet Y or 96 feet diameter cul-de-sac in accordance with Figure D103.1
501-750	26	120 feet hammerhead, 60 feet Y or 96 feet diameter cul-de-sac in accordance with Figure D103.1
Over 750		Special approval required

Slide 2-29

- c. Acceptable configurations for turnarounds. See requirements on Slide 2-29.

## TURNAROUND EXAMPLES



Slide 2-30

2. Turnaround examples (see Slide 2-30):

- Cul-de-sac.
- Hammerhead.
- T.
- Y.
- Local option.

## OVERHEAD OBSTRUCTIONS

Minimum vertical clearance of 13 feet 6 inches.

- Trees.
- Utility lines.



Slide 2-31

P. Overhead obstructions.

1. Minimum vertical clearance of 13 feet 6 inches.
2. Tree growth may not be an immediate problem, but it should be anticipated.
3. Utility lines.

## OVERHEAD OBSTRUCTIONS (cont'd)

- Pedestrian and vehicle bridges.
- Parking garages.
- Tunnels.



Slide 2-32

4. Pedestrian and vehicle bridges.
5. Parking garages.
6. Tunnels.

## CANTERBURY TODAY



Slide 2-33

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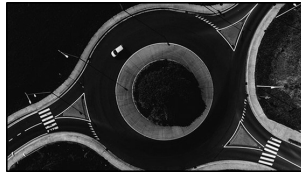
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## TRAFFIC CIRCLES/ ROUNDBABOUTS



Slide 2-34

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- Q. Traffic circles/roundabouts/calming devices.
1. May be located on public streets or on private property.
  2. Must have adequate turning-radius provisions.
  3. Be aware of current public works projects that propose roundabouts or calming devices; provide input on turning radii of fire apparatus and the impact of calming devices to impede emergency response.

**BARRIERS**

- Bollards.
- Lane dividers — Jersey walls.



Slide 2-35

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R. Barriers.

1. May be located on public streets or on private property which can affect access.
2. Must have adequate turning-radius provisions.
3. Due to security concerns, facilities have installed physical barriers that can affect emergency response.
4. Divided roadways can delay emergency response depending on the width of the roadway and any obstructions.

**BRIDGES AND ELEVATED SURFACES**

- Must be designed to carry fire apparatus load.
- Clear marking for surfaces **not** intended for fire department access.



Slide 2-36

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S. Bridges and elevated surfaces.


1. Must be designed to carry a fire apparatus load.

2. If an elevated surface **is not** intended for fire department access, it must be marked clearly.

**GRADE**

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- Within limits established by code official, local ordinance or fire code.
- Maximum grade.
- Designer may give various grade types.
- Can be calculated using contour lines on site plan.



Slide 2-37

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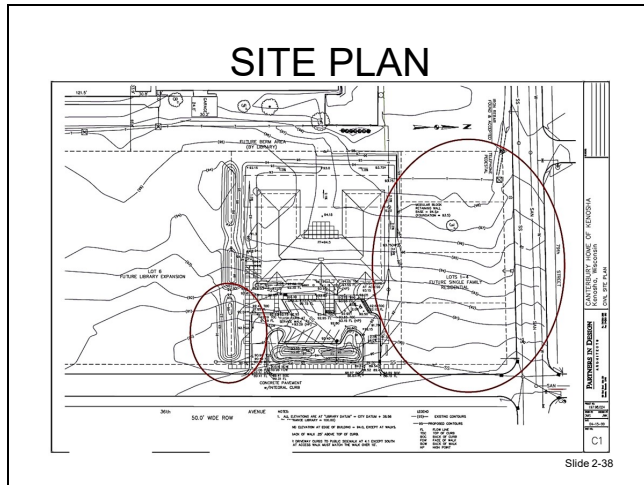
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T. Grade requirements.

1. Within limits established by a code official, local ordinance or fire code.
2. Generally, the maximum grade is not more than 10% for asphalt and 14% for a concrete surface.
3. The designer may give grade as:
  - a. Tangent (slope degrees).
  - b. Gradient.
  - c. Percent.
4. Can be calculated using contour lines on the site plan.
5. Be careful to ensure that all parties agree on the method: a 10-degree slope is not the same as a 10% slope.
6. Example of grade:
  - a. Contour lines represent the elevation of slopes and structures on site plans.
  - b. Civil drawings show the existing site elevations before improvements and the proposed finished site elevations, including:
    - Finished floor level of structures (buildings, storm water ponds, retaining walls and other improvements).

- Finished elevations of sidewalks, driveways and utilities.



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**COMPUTING GRADE SLOPE**

- Slope (decimal) = rise/run.
- Gradient (ratio) = 1: run/rise or 1: horizontal/vertical(H/V).
- Slope (percentage) = 100 x slope or (100) rise/run.
- Slope expressed as an angle in degrees = (rise/run) x (180/π).

The slide is labeled "Slide 2-40" in the bottom right corner.

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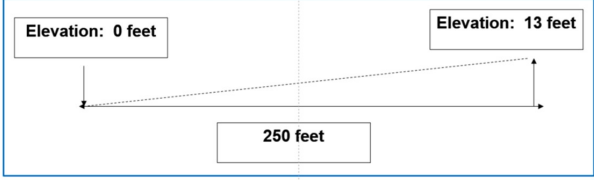
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U. How to determine grade slope.

Can be calculated using contour lines on the site plan.

**EXAMPLE:  
SLOPE AS A FACTOR**

- Slope as a decimal = rise/run.
- Given a 13-foot elevation change over a 250-foot long road.
  - $13/250 = .052$ .



The diagram shows a horizontal line representing a road of 250 feet. A vertical dashed line is drawn at the midpoint. A dotted line rises from the left end to the right end, representing a 13-foot elevation change. Labels indicate 'Elevation: 0 feet' at the start and 'Elevation: 13 feet' at the end. The horizontal distance is labeled '250 feet'. A small text 'Slide 2-41' is at the bottom right.

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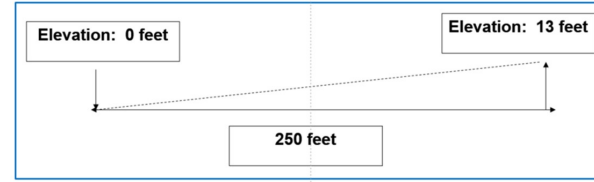
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1. Slope as a factor (decimal) = rise/run or vertical/horizontal.

**EXAMPLE: SLOPE AS GRADIENT**

- Gradient as a ratio = 1 unit in run/rise or 1:H/V.
- Gradient = 1: (250/13).
- Gradient = 1: 19.23.
- Elevation rises 1 foot for every 19.23 feet of run.



The diagram is identical to the one for 'SLOPE AS A FACTOR', showing a 250-foot road with a 13-foot elevation change. Labels indicate 'Elevation: 0 feet' and 'Elevation: 13 feet' and '250 feet'. A small text 'Slide 2-42' is at the bottom right.

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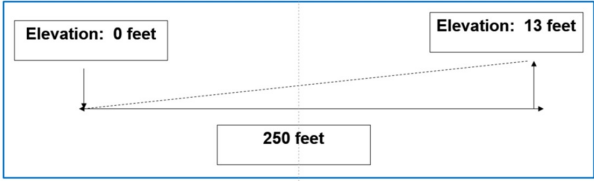
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2. Slope as gradient or ratio = 1 unit in run/rise or 1:H/V.

- a.  $1:250/13 = 1:19.23$ .
- b. Gradient as a ratio = 1 unit in run/rise of 1:H/V.
- c. Gradient =  $1:(250/13)$ .
- d. Gradient = 1:19.23.
- e. Elevation rises 1 foot for every 19.23 feet of run.

**EXAMPLE:  
SLOPE IN DEGREES**

- Slope expressed as an angle in degrees.
- Slope = (rise/run) x (180/π).
- Slope = (13/250) x (180/3.14) = 2.98 degrees.



The diagram shows a right-angled triangle representing a slope. The vertical side (rise) is labeled 'Elevation: 13 feet' with a double-headed arrow. The horizontal side (run) is labeled '250 feet' with a double-headed arrow. The hypotenuse represents the slope. The starting point is labeled 'Elevation: 0 feet'. A dashed vertical line extends from the top of the run to the top of the rise. The text 'Slide 2-43' is in the bottom right corner.

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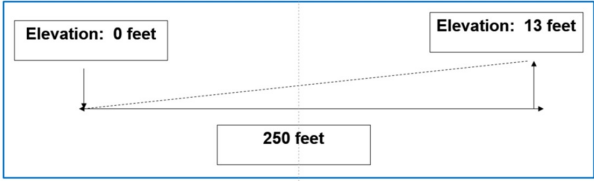
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- f. Slope as an angle in degrees.
- Slope = (rise/run) x (180/π).
  - Slope = (13/250) x (180/3.14) = 2.98 degrees.

**EXAMPLE:  
SLOPE AS PERCENTAGE**

- Slope percentage = 100(rise/run).
- Slope = 100(13/250) = 5.2%.



The diagram is identical to the one in Slide 2-43, showing a rise of 13 feet over a run of 250 feet. The text 'Slide 2-44' is in the bottom right corner.

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3. Slope as percentage is 100 x slope degrees or (100)rise/run.

## SPEAK THE SAME LANGUAGE

A 13-foot elevation increase over 250 feet of distance:

- Slope as a factor = 0.052 degrees.
- Slope ratio/gradient = 1:19.23.
- Slope percentage = 5.2%.
- Slope angle in degrees = 2.98 degrees.



Slide 2-45

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### 4. Speak the same language:

A 13-foot elevation over a distance of 250 feet can be identified as:

- a. Slope = 0.052.
- b. Slope ratio of 1:19.23.
- c. Slope percentage of 5.2%.
- d. Slope angle of 2.98 degrees.

## MARKING REQUIREMENTS

- To identify and prohibit obstruction.
- Signs when required by code official and/or code requirements.
- Local requirements for:
  - Striping.
  - Lettering.
  - Color.
  - Wording.

Slide 2-46

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### V. Marking requirements.

1. Marked in order to identify and/or prohibit obstruction.
2. Signs when required by a code official and/or code requirements.

- 3. Striping — local requirements.
- 4. Lettering — local requirements.
- 5. Color, wording and design of striping or lettering are local requirements.

**TYPICAL SIGNAGE**

- Typical can vary by locale.
- Fire lane and parking enforcement vary by jurisdiction.

Slide 2-47

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- 6. Signage.
  - a. Some typical, **but can vary by locale.**
    - Minimum dimensions of 12 inches wide by 18 inches high.
    - Red letters on white background.
    - 20- to 26-foot roadway — posted on both sides.
    - Greater than 26 feet — posted on one side.
  - b. Fire lane and parking enforcement vary by jurisdiction.



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## SECURITY GATES

When provided, must be maintained and have approved means of emergency access.



Slide 2-49

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- W. Security gates, when provided, must be maintained and have an approved means of emergency access.

## FIRE PROTECTION EQUIPMENT ACCESS

- Fire department connections and hydrants — connection on street side of building, unless otherwise approved by code official.
- Motor vehicle impact protection for hydrants where needed.

Slide 2-50

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- X. Access to all fire department equipment.
1. Fire department connections and hydrants.
    - a. Minimum 3-foot clearance.
    - b. No obstructions, including landscaping.

### HYDRANT ACCESS

Anywhere.



Slide 2-51

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2. Fire department connection must be on the street side of the building, unless otherwise approved by a code official.

### HYDRANT PROTECTION



Slide 2-52

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3. Motor vehicle impact protection for hydrants where appropriate, to avoid hydrant damage.
4. View example plans for emergency vehicle access provisions.

## ACTIVITY 2.1

### Fire Apparatus Access Roads

#### Purpose

Determine fire apparatus access requirements for new construction, plus identify and communicate deficiencies in the submitted plan documents.

#### Directions

1. Work in your table groups for 30 minutes.
2. Using the code and the submitted plan documents, complete the **Shown** column of the Plans Review Checklist, Section A (2) found in Student Manual Appendix B: Job Aid: Plans Review Checklist.

Note: You will need to keep this checklist to use for several future activities before turning it in for a grade.

3. Your group should select a representative to report and be prepared to discuss your findings with the rest of the class.

Note: Each student must take turns at being the representative for their group during the course as this will count as part of your final grade.

4. Work individually to generate one question that you would ask the applicant to request clarification regarding fire apparatus access roads, and add it to your submittal letter template found in SM Appendix A: Canterbury Submittal Letter Template.

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III. WATER SUPPLY AND HYDRANT REQUIREMENTS

**WATER SUPPLY AND  
HYDRANT REQUIREMENTS**

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Slide 2-54

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Is there adequate water supply for what the plans designate?

- A. Water supply.
1. Vital to keep a building fire from spreading to adjacent buildings.
  2. Intended to be adequate to extinguish a fire within a building when firefighters get adequate notification.
  3. Also to protect exposures, meaning other buildings and vital infrastructure in the community.
  4. Intended to be a mitigation measure to protect the public and the community from the impact of a conflagration.

**REFERENCE STANDARDS**

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- NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting.*
- International Fire Code (IFC) and National Fire Protection Association (NFPA) 1, *Fire Code.*
- Insurance Services Office.
- Iowa State University.
- NFPA 13, *Standard for the Installation of Sprinkler Systems.*

Slide 2-55

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B. Reference standards.



1. National Fire Protection Association (NFPA) 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting*.
2. IFC and NFPA 1, *Fire Code*.
3. Insurance Services Office.
4. Iowa State University formula.
5. Illinois Institute of Technology formula.
6. NFPA 13, *Standard for the Installation of Sprinkler Systems*.
7. NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*.
8. NFPA 291, *Recommended Practice for Fire Flow Testing and Marking of Hydrants*.

**REASONS FOR  
WATER SUPPLY TESTING**

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To verify a reliable water supply for:

- Manual firefighting.
- Fire protection systems.



Slide 2-56

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- C. Establishing the purpose of water supply testing.
1. Water supply is determined by the locally adopted code or standard.
  2. Verify reliable water supply for:
    - a. Manual firefighting operations.
    - b. Fixed fire protection systems.

## RELIABLE WATER SUPPLY

**Volume** and **pressure** must be adequate for fire control and suppression — determined from water supply test data.



Slide 2-57

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D. What constitutes a reliable water supply?

1. **Volume** and **pressure** must be adequate for fire control and suppression — determined from water supply test data.
2. Adjustments are permitted.

## PERMITTED WATER SUPPLY ADJUSTMENTS

- Daily and seasonal fluctuations.
- Possible interruption by emergency or weather conditions.
- Large, simultaneous industrial use.
- Future demand on the water supply system.
- Other.

Slide 2-58

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3. Adjustments permitted to water supply test data:
  - a. Daily and seasonal fluctuations.
  - b. Possible interruption by emergency (electrical failure), flood or ice conditions.
  - c. Large, simultaneous industrial or commercial use.
  - d. Future demand on water supply system.

e. Any other condition that could affect water supply.

**WATER SUPPLY ADEQUACY**

- Multiple approaches.
- No one way is correct.

Slide 2-59

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E. Multiple approaches to water supply adequacy.

1. No one way is correct.

**ZONING CODE APPROACH**

- Generally based on:
  - Neighborhood zoning designation.
  - Solely minimum main size.
- No minimum flow rate.
- May not consider building size or construction type differences.

Slide 2-60

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2. Traditional zoning code approach.

a. Mainly based on zoning designation.

b. Generally, solely based upon minimum main size.

c. Generally, no minimum flow rate.

d. Requirements do not consider differences in building size or construction type.

## FIRE CODE APPROACH

- Approved water supply capable of providing required flow.
- Testing witnessed by fire code official.
- Requirements determined by an approved method.
- Specifics provided in appendices.

Slide 2-61

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3. Fire code approach.

- a. Approved water supply is capable of providing required water flow.
- b. Testing is witnessed or performed by the fire code official.
- c. Requirements are determined by an approved method.
- d. Specifics are provided in the following appendices.
  - IFC Appendix III-A.
  - NFPA 1 Annex H.

## APPENDIX TABLE

- Employs construction type and fire flow area.
  - Minimum flow rate at 20 pounds per square inch (psi).
  - Minimum duration.
- Flow rate for manual fire suppression.

MINIMUM REQUIRED FIRE FLOW AND FLOW DURATION FOR BUILDINGS

<small>FIRE AREA (square feet)</small>					<small>FIRE FLOW (gallons per minute)</small>	<small>FLOW DURATION (minutes)</small>
<small>Type IA and IB*</small>	<small>Type IA and IBA*</small>	<small>Type IV and V-A*</small>	<small>Type IIB and IIB*</small>	<small>Type V-B*</small>		
0-22,700	0-12,700	0-4,200	0-4,800	0-3,600	1,500	2
22,701-30,200	12,701-17,000	4,201-10,900	4,801-7,900	3,601-4,800	1,750	
30,201-38,700	17,001-21,800	10,901-12,900	7,901-9,800	4,801-6,200	2,000	
38,701-48,300	21,801-24,200	12,901-17,400	9,801-12,600	6,201-7,700	2,250	
48,301-58,000	24,201-33,200	17,401-21,300	12,601-15,400	7,701-9,400	2,500	
58,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9,401-11,300	2,750	3
70,901-83,700	39,701-47,100	25,501-30,100	18,401-21,800	11,301-13,400	3,000	
83,701-97,700	47,101-54,000	30,101-35,200	21,801-25,900	13,401-15,000	3,250	
97,701-122,700	54,001-63,400	35,201-40,800	25,901-29,300	15,001-18,000	3,500	
122,701-128,700	63,401-72,400	40,801-46,400	29,301-33,500	18,001-20,000	3,750	

Slide 2-62

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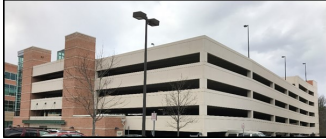

4. Using Table B105.1(2) in IFC Appendix B, Fire-Flow Requirements for Buildings (<https://codes.iccsafe.org/public/document/IFC2012/appendix-b-fire-flow-requirements-for-buildings>), show how a building of Type IIIB construction would have water supply requirements based on the fire flow calculation area of the building.

- a. Construction type and fire flow calculation area.
- b. Minimum flow rate at 20 pounds per square inch (psi), up to 8,000 gallons per minute (gpm).
- c. Minimum duration of two to four hours.
- d. This is the flow rate for manual fire suppression; it does not address requirements for fire protection systems.

**FIRE FLOW CALCULATION  
AREA**

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- Total area of all floors and space under projections.
- Open parking garages: single largest floor.



Slide 2-63

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- 5. How much area is used to determine the water supply area? Calculated area is determined by:
  - a. Total area of all floors and the space under projections.
    - For fire-resistive construction, the three largest successive floors.
  - b. Open parking garages — the single largest floor.
  - c. Fire flow calculation area differs from building area in that the eaves are counted for fire flow but are not counted in building area, unless they are a usable area.

### MODIFICATIONS

- Code official may reduce supply rate for specific conditions.
- May increase water supply requirements in areas susceptible to conflagration.

Slide 2-64

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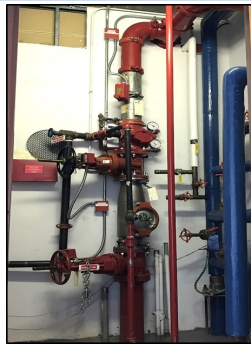
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6. Modifications to tabular (table) flow rates.
  - a. A code official may reduce the required fire flow for isolated buildings, or for groups of buildings in rural areas or small communities, when the fire flow requirements are impractical.
  - b. A code official may increase the fire flow requirements by 100% in areas susceptible to high fire danger or conflagration.
  - c. A fire code official is authorized to use NFPA 1142 or the *International Wildland-Urban Interface Code* in areas with no water supply.

### SPRINKLER MODIFICATIONS

- Up to 75% reduction of table limits.
- Never less than 1,500 gallons per minute (gpm)\*.
  - \*NFPA 1 not less than 1,000 gpm.
- 1,500 gpm with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, system.



Slide 2-65

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7. Automatic sprinkler and construction modifications.
  - a. NFPA 13 or NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, and certain types of fire-resistant construction up to 75% reduction of table limits.

- Depends upon specific code provisions and sprinkler system coverage.
- b. Never less than 1,000 gpm for NFPA 13 system or 1,500 gpm for NFPA 13R system.
  - \*NFPA 1 not less than 1,000 gpm.
- c. All nondwelling structures and one- and two-family dwellings more than 3,600 square feet.

### ONE- AND TWO-FAMILY DWELLINGS

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- Not exceeding 3,600 square feet — minimum flow of 1,000 gpm.
- If over 3,600 square feet, comply with table flow rates.



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- 8. One- and two-family dwelling flow requirements.
  - a. Not exceeding 3,600 square feet.
    - Minimum flow of 1,000 gpm.
    - Reduction of 50% with approved automatic sprinklers.
  - b. If over 3,600 square feet, comply with table flow rates.

### OTHER METHODS

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- Insurance Services Office.
- NFPA 1142.

Slide 2-67

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F. Other methods for determining water supply adequacy.

1. Insurance Services Office.
2. NFPA 1142.

### WATER DELIVERY METHOD CONSIDERATIONS

- Public/Private.
- Requirements.
- Spacing.
- Code requirements.
- Local requirements.
- Zoning ordinances.

Slide 2-68

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G. Water delivery method considerations:

1. Public/Private.
2. Requirements.
3. Spacing.
4. Code requirements.
5. Local requirements.
6. Zoning ordinances.

### HYDRANT CONSIDERATIONS

- Public/Private.
- Configuration.
- Spacing.



Slide 2-69

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H. Fire hydrants.

1. Hydrants may be supplied by public or private water sources.
  - a. Located where they can be employed for optimum tactical applications.
  - b. A code official has authority to designate hydrant locations.

**HYDRANT SPACING  
ZONING CODE APPROACH**

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- Based on zoning designation.
- No correlation to necessary flow rates.
- May not consider differences in building size or construction type.

Slide 2-70

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2. Two spacing approaches: traditional zoning code approach.
  - a. Hydrant spacing is based on zoning designation.
    - No correlation to necessary flow rates.
    - Requirements may not consider differences in building size or construction type.

**HYDRANT SPACING  
MODEL CODE APPROACH**

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- On-site hydrants distance.
- Number and spacing.



Slide 2-71

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- b. Spacing: model code requirements.
  - On-site hydrants are required when any portion of the building is more than 400 feet from a public hydrant.
  - Increased to 600 feet if the building is sprinklered.
  - Number and spacing is based on fire flow.

NUMBER AND DISTRIBUTION OF FIRE HYDRANTS			
FIRE-FLOW REQUIREMENT (gpm)	MINIMUM NUMBER OF HYDRANTS	AVERAGE SPACING BETWEEN HYDRANTS <sup>a, b, c</sup> (feet)	MAXIMUM DISTANCE FROM ANY POINT ON STREET OR ROAD FRONTAGE TO A HYDRANT <sup>d</sup>
1,750 or less	1	500	250
2,000-2,250	2	450	225
2,500	3	450	225
3,000	3	400	225
3,500-4,000	4	350	210
4,500-5,000	5	300	180
5,500	6	300	180
6,000	6	250	150
6,500-7,000	7	250	150
7,500 or more	8 or more	200	120

For SI: 1 foot = 304.8 mm, 1 gallon per minute = 3.785 L/m.  
 a. Reduce by 100 feet for dead-end streets or roads.  
 b. Where streets are provided with median dividers which can be crossed by firefighter pulling hoses, or where arterial streets are provided with four or more traffic lanes and have a traffic count of more than 30,000 vehicles per day, hydrant spacing shall average 500 feet on each side of the street and be arranged on an alternating basis up to a fire-flow requirement of 7,000 gallons per minute and 400 feet for higher fire-flow requirements.  
 c. Where new water mains are extended along streets where hydrants are not needed for protection of structures or similar fire problems, fire hydrants shall be provided at spacing not to exceed 1,000 feet to provide for transportation hazards.  
 d. Reduce by 50 feet for dead-end streets or roads.  
 e. One hydrant for each 1,000 gallons per minute or fraction thereof.

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3. Determining spacing and distribution.

Details provided in a code appendix table.

- a. Average spacing.
- b. Furthest distance on access road to hydrant.
- c. Spacing reductions based on dead ends.
  - If the distance from hydrants to water-based system fire department connections is not specified.
  - Is left up to the code official.

### MODIFICATIONS ALLOWED

- Situations when a code official is authorized to accept deficiency.
- Deficiency is in the spacing.

Slide 2-73

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#### I. Modifications to tabular requirements.

1. A code official is authorized to accept a deficiency of up to 10%.

When existing hydrants provide all or a portion of the required hydrant service.

2. Deficiency is in spacing — not in number or flow rate.

### HYDRANT LOCATION EXAMPLE



Slide 2-74

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- J. Example: Lack of nearby hydrants; took half an hour before water could be supplied. What started as a small fire resulted in a total home loss.

## ACTIVITY 2.2

### Water Supply Evaluation

#### Purpose

Determine minimum fire flow requirements for a given structure as depicted in submitted plan documents. Review documents for code compliance and request clarification of missing or inadequate information via formal correspondence.

#### Directions

1. Work in your table groups for 30 minutes.
2. Using your code book and the submitted plan documents, determine the following:
  - a. Required fire flow for the proposed project.  

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  - b. Once you have determined the flow, use the code approach to provide the minimum number of hydrants required, as well as the spacing.  

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3. Using the submitted plan documents, complete Section A (1) of the Plans Review Checklist found in SM Appendix B.
4. Select a representative to report and be prepared to discuss your findings with the rest of the class.
5. Work individually for 10 minutes to generate one question regarding missing or inadequate fire flow information to add to the submittal letter template requesting clarification from the applicant which can be found in SM Appendix A.


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IV. OTHER SITE PLAN CONSIDERATIONS

**OTHER SITE PLAN CONSIDERATIONS**

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- Storage or use.
- Flammable or combustible liquids.
- Combustible materials.
- Liquefied petroleum (LP) gas fuel tanks.
- Hazardous materials.



Slide 2-76

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- A. Storage of flammable or combustible liquids.
- B. Storage of combustible materials.  
Trash or recycling enclosures.
- C. Liquefied petroleum (LP) gas fuel tanks.
- D. Storage of hazardous materials.

**CANTERBURY TODAY (cont'd)**

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V. SUMMARY



**SUMMARY**

- Fire apparatus access road requirements.
- Water supply and hydrant requirements.
- Other site plan considerations.

Slide 2-78

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- Why is the review of the site plan important?
- What is the intent of fire apparatus and water supply requirements, etc.?

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Any burning questions?

Slide 2-80

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## ACTIVITY 2.3

### Site Plan Evaluation Practice

#### Purpose

Evaluate civil (site) drawings to determine compliance with requirements for fire department access, water flow requirements and the presence of special hazards. Identify and communicate deficiencies in the submitted plan documents.

#### Directions

1. Work in your table groups for 30 minutes to complete the Activity 2.3 Worksheet.
2. At the end of the activity, you will have about 15 minutes to explain and discuss your answers with the rest of the class.
3. You will work individually to generate two questions regarding requirements for fire department access, water flow requirements and the presence of special hazards. These questions will be added to the submittal letter template requesting clarification from the applicant, which can be found in SM Appendix A.

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**ACTIVITY 2.3 (cont'd)**

**Worksheet**

1. What is the final maximum percent grade on 79th Street, from 36th Avenue to the western edge of the project property line?

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2. What is the total length of the 6-inch water service from the tee on 79th Street to where it enters the building?

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3. What is the linear spacing between the fire hydrants on the site plan?

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4. How many new fire hydrants will be added as part of this project?

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5. Who is going to connect the 6-inch water service to the City's water main?

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6. What is the distance between the trash enclosure and the nearest exterior wall?

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7. What is the distance from the exterior wall to the north property line?

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## REFERENCE

ICC. (2015). *International fire code*. Washington, DC: Author.

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**APPENDIX A**

**UPDATED CODE ANALYSIS**

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## Updated Code Analysis

Partners in Design architects  
Mytown, State, USA  
111-222-3344 AnytimeArchitec@business.com

(Yesterday's date)

Plans Review for Fire and Life Safety Student  
NFA/FEMA South Seton Ave.  
Emmitsburg, MD  
21727

Dear Plans Review for Fire and Life Safety Student,

In response to your requested information, the following updated code analysis information is submitted as a revision to the permit under review for Canterbury Home of Kenosha at 7924 36<sup>th</sup> Ave., Kenosha, WI.

Canterbury Home is an assisted living facility that accepts clients who may or may not require limited verbal or physical assistance while responding to an emergency situation to complete building evacuation. If the clients deteriorate to a state where more assistance is needed, the client is required to move to a facility that will better suit the needs of the client.

Occupancy: I-1, Condition 2  
Construction: Type VA, Sprinklered  
Fire Protection Systems: NFPA 13 Automatic Fire Sprinkler System  
Codes Used: 2015 IBC, IFC  
Allowable Building Area: 42,000 ft<sup>2</sup>, Actual: 11,910 ft<sup>2</sup>  
Fire Flow Calculation Area: 14,280 ft<sup>2</sup>  
Allowable Height: 50', Actual: 20'  
Allowable Stories: 3, Actual: 1  
Calculated Occupant Load:  $11,616 \text{ ft}^2 \div 120 \text{ ft}^2 \text{ gross} = 97 \text{ occupants}$   
Egress width and number of exits:  $97 \text{ persons} \times 0.2' \text{/person} = 10'' = 1 \text{ exit width}$   
Travel distance allowed: 250'  
Common path of travel allowed: 75' and 10 people  
Two exits required, 6 exits provided

Sincerely,

Partners in Design architects

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# **APPENDIX B**

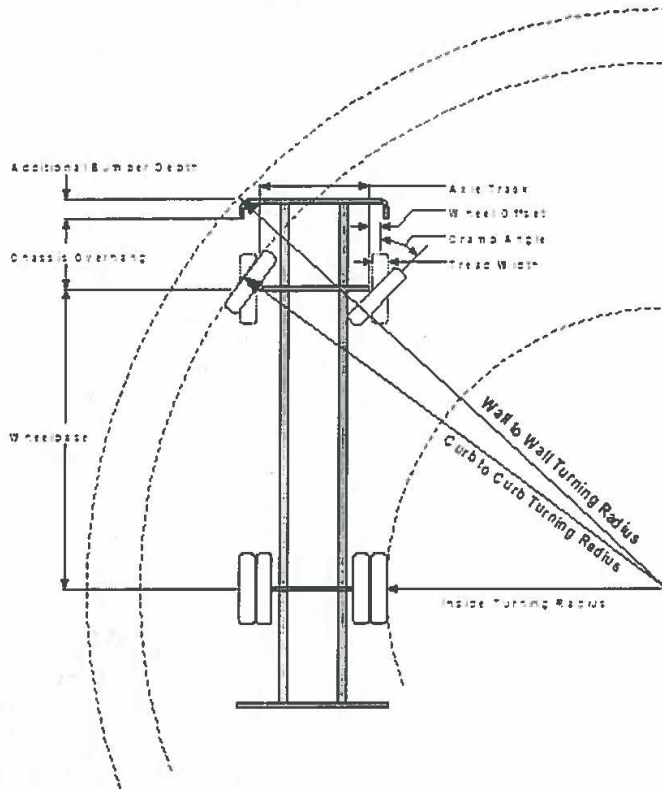
## **TURNING PERFORMANCE ANALYSIS**

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Turning Performance Analysis

8/11/2007



Parameters:

Inside Cramp Angle:	33.00 °
Axle Track:	83.11 in.
Wheel Offset:	5.25 in.
Tread Width:	17.70 in.
Chassis Overhang:	65.99 in.
Additional Bumper Depth:	19.00 in.
Front Overhang:	149.60 in.
Wheelbase:	254.00 in.

Calculated Turning Radii:

Inside Turn:	31 ft. 5 in.
Curb to Curb:	46 ft. 0 in.
Wall to Wall:	52 ft. 10 in.

Comments:

Aerial Application

**NASHUA TOWER I**

Components	PRIDE #	Description
Front Axle	0000295	Axle, Front, Meritor FL-941, 21,000 lb
Front Tires	0001647	Tires, Michelin, 425/65R22.50 20 ply XTE2, Hiway Rib
Chassis	0060024	Lance-2000 Chassis, Aerials/Tankers/HDR Tandem 48K
Front Bumper	0012245	Bumper, 19" extended - all chassis'
Aerial Device	0022160	Aerial, 100' Pierce Platform

Notes:

Actual Inside Cramp Angle may be less due to highly specialized options.

Curb to Curb turning radius calculated for a 9.00 inch curb.



Turning Performance Analysis

8/11/2007

**Definitions:**

Inside Cramp Angle	Maximum turning angle of the front inside tire.
Axle Track	King-pin to king-pin distance of the front axle.
Wheel Offset	Offset from the center-line of the wheel to the king-pin.
Tread Width	Width of the tire tread.
Chassis Overhang bumper depth.	Distance from the center-line of the front axle to the front edge of the cab. This does not include the bumper depth.
Additional Bumper Depth	Depth that the bumper assembly adds to the front overhang.
Wheelbase	Distance between the center lines of the vehicle's front and rear axles.
Inside Turning Radius	Radius of the smallest circle around which the vehicle can turn.
Curb to Curb Turning Radius	Radius of the smallest circle inside of which the vehicle's tires can turn. This measurement assumes a curb height of 9 inches.
Wall to Wall Turning Radius	Radius of the smallest circle inside of which the entire vehicle can turn. This measurement takes into account any front overhang due to the chassis, bumper extensions and/or aerial devices.

# **UNIT 3: ARCHITECTURAL FEATURES: FIRE PROTECTION**

## **TERMINAL OBJECTIVE**

*The students will be able to:*



- 3.1 *Conclude if the information shown in the submitted plan documents, in conjunction with applicable building code requirements, complies with architectural fire protection feature requirements (for area, height, separation, assembly, resistance and bearing construction).*

## **ENABLING OBJECTIVES**

*The students will be able to:*

- 3.1 *Decide if submitted plan documents comply with applicable area and height requirements.*
  - 3.2 *Evaluate submitted plan documents for compliance with separated and nonseparated uses and hazard requirements.*
  - 3.3 *Determine the differences between bearing and nonbearing structural elements, and identify such on architectural and structural drawings.*
  - 3.4 *Conclude whether architectural and structural submitted plan documents comply with requirements for fire-resistance rated construction.*
  - 3.5 *Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the architectural fire protection information.*
  - 3.6 *Verify the occupancy classification with the characteristics of a code specified use.*
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**UNIT 3:  
ARCHITECTURAL FEATURES:  
FIRE PROTECTION**

Slide 3-1

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**I. OBJECTIVES**

**TERMINAL OBJECTIVE**

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Conclude if the information shown in the submitted plan documents, in conjunction with applicable building code requirements, complies with architectural fire protection feature requirements (for area, height, separation, assembly, resistance and bearing construction).

Slide 3-2

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**ENABLING OBJECTIVES**

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- Decide if submitted plan documents comply with applicable area and height requirements.
- Evaluate submitted plan documents for compliance with separated and nonseparated uses and hazard requirements.

Slide 3-3

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## ENABLING OBJECTIVES (cont'd)

- Determine the differences between bearing and nonbearing structural elements, and identify such on architectural and structural drawings.
- Conclude whether architectural and structural submitted plan documents comply with requirements for fire-resistance rated construction.

Slide 3-4

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## ENABLING OBJECTIVES (cont'd)

- Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the architectural fire protection information.
- Verify the occupancy classification with the characteristics of a code specified use.

Slide 3-5

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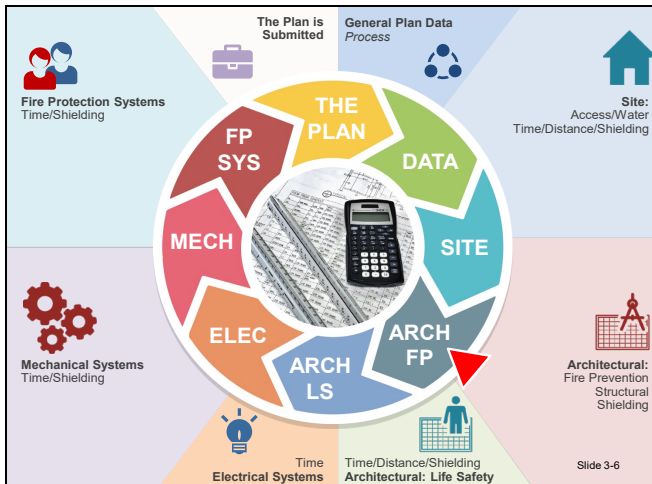
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Why is this information important?

Slide 3-7

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WHY?

- So situations like these might not occur:



Slide 3-8

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- A. The beginning of the unit answers why we are reviewing the plans for the occupancy, construction, and area and height.
- B. Real life examples:
  1. Kmart Fire.
  2. Beverly Hills Supper Club.

## WHY? (cont'd)

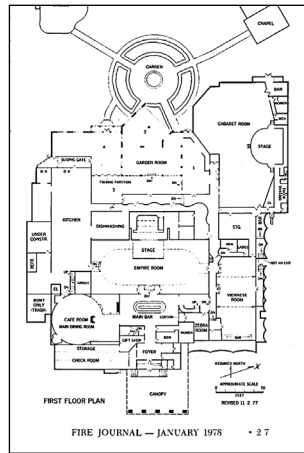
- Beverly Hills Supper Club — Case Study.



No. 1 nightspot still glistened with glamour after shedding gambling  
**PLEASURE PALACE WAS CREME DE LA CREME**

Slide 3-9

Supper Club floor plan.



Slide 3-10

Supper Club during and after the fire.




Slide 3-11

**COURSE THEME**

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Three E's of fire prevention and life safety:

- Engineering.
- Education.
- Enforcement.



Slide 3-12

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- C. Course theme: three E's of fire prevention and life safety:
1. Engineering.
  2. Education.
  3. Enforcement.

**II. ARCHITECTURAL FEATURES**

**ARCHITECTURAL FEATURES**

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- Passive fire protection.
- Foundation for reviewing other drawings.
- Major revisions to architectural drawings may affect the other drawings.
- Work with designer during concept stage to eliminate/avoid problems.

Slide 3-13

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- A. Important points.
1. Passive fire protection for life safety.
  2. Building construction is going to protect various factors:
    - a. Occupants.

- b. Emergency responders.
  - c. Building and contents.
  - d. Community.
3. Architectural drawings are the foundation for the review of other drawings — heating, ventilating, and air conditioning (HVAC); electrical; plumbing; and fire protection systems.
- B. Any major revisions to architectural drawings will affect other drawings.
- C. Working with the designer during the concept stage can help eliminate/avoid problems.

**III. OCCUPANCY CLASSIFICATIONS**

**OCCUPANCY  
CLASSIFICATIONS**

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- Occupancy classes are the foundation of accurate code compliance.
- Should be included in code analysis information.

Slide 3-14

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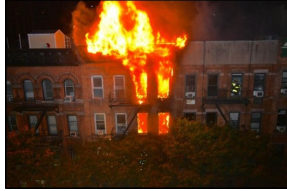
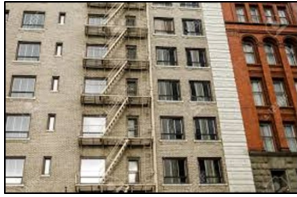
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- A. Establishing occupancy classification.
- 1. First step in designing a building or during plans review, and the foundation of the code process.
  - 2. Is the basis of design for code compliance.

## OCCUPANCY SEPARATION



Slide 3-15

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3. Occupancy classification drives the:
  - a. Type of construction.
  - b. Size of the building.
  - c. Built-in fire protection.
  
- B. Goal of plans review is to mitigate hazard risks of the occupancy and to protect the surrounding community.
  
- C. Code considers the characteristics of occupancy type when determining allowable area and height.

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- Why are there different occupancy groups?
  - On what are the occupancy groups based?

Slide 3-16

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- Does your code cover all conceivable types of occupancies?
- What do you do if your code does not cover a new type of occupancy?

Slide 3-17

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1. Occupancy classification should be included in code analysis information.
2. Some buildings are constructed as a shell building, which means a specific tenant has not been identified. A separate permit application will be submitted later, and the tenant will have a code analysis to show code compliance.

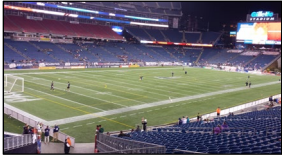
D. Basic classifications.

Model codes identify 10 major classifications of occupancies, each of which has particular characteristics.

### ASSEMBLY

Gathering of 50 or more people within a room or space:

- Civic.
- Social/Religious.
- Recreation.
- Food/Drink consumption.
- Awaiting transportation.



Slide 3-18

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1. Assembly: gathering of 50 or more people for the following purposes:
  - a. Civic.
  - b. Social or religious functions (churches).

- c. Recreation (gymnasiums).
- d. Food or drink consumption.
- e. Awaiting transportation.

**BUSINESS**

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Transaction of business rendering professional services or food or drink consumption that is not classified as assembly.



Slide 3-19

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- 2. Business.
  - a. Transaction of business rendering professional services or food or drink consumption.
  - b. Not classified as assembly (less than 50 people occupant load).

**EDUCATIONAL**

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- Six or more people for educational purposes through 12th grade.
- Day care.



Slide 3-20

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- 3. Educational.
  - a. Six or more people at any time for educational purposes through 12th grade.

- Religious education rooms and auditoriums accessory to churches with occupancy load less than 100 are Group A-3 occupancies.
- b. Day care with more than five children older than 2 1/2 years.
  - Day care with five or fewer children is considered part of the main occupancy.
  - Day care with five or fewer children in a residence is considered part of the residence and covered under the International Residential Code (IRC).

**INSTITUTIONAL:  
UNRESTRAINED**

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- Medical or other treatment or care of people with physical or mental illness — sleeping facilities provided.
- Assisted living facilities.
- Drug and alcohol centers.
- Nursing homes.
- Day care centers.

Slide 3-21

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- 4. Institutional.
  - a. Unrestrained.
    - Medical or other treatment or care of people suffering from physical or mental illness.
      - Sleeping facilities are provided.
    - Assisted living facilities.
    - Drug and alcohol centers.
    - Nursing homes.
    - Day care centers.

**INSTITUTIONAL: RESTRAINED/  
DETENTION AND CORRECTIONAL**

Facility housing occupants under some degree of restraint or security, i.e., jails and prisons.



Slide 3-22

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- b. Restrained/Detention and correctional.
  - Facility housing occupants under some degree of restraint or security, such as jails and prisons.

**RESIDENTIAL**

Sleeping accommodations for normal residential purposes.



Slide 3-23

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- 5. Residential.
  - a. Sleeping accommodations for normal residential purposes not classified as Group I.
  - b. IRC scope:
    - Includes one- and two-family dwellings and townhouses up to three stories in height and with separate means of egress, as well as their accessory structures.

- Residence that does not meet the scope of the IRC to be constructed under auspices of the International Building Code (IBC).

**MERCANTILE**

Stores, markets and buildings used for the display and sale of merchandise.



Slide 3-24

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- 6. Mercantile.
  - a. Stores, markets.
  - b. Buildings used for the display and sale of merchandise.

**FACTORY/INDUSTRIAL**

Factories, processing, assembling, mixing, packaging, finishing, decorating or repairing.



Slide 3-25

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- 7. Factory/Industrial.

Factories, processing, assembling, mixing, packaging, finishing, decorating or repairing.

**HIGH HAZARD**

- Physical or health hazard — manufacturing, processing, generation or storage of materials.
- Hazardous classification.



Slide 3-26

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8. High hazard.
  - a. Use that involves manufacturing, processing, generation or storage of materials that constitute a physical or health hazard.
  - b. Classified as hazardous if:
    - Quantity of hazardous material exceeds maximum allowable quantity in code table.
  - c. Allowances given for:
    - Sprinklers or control areas.
  - d. Increases given for:
    - Storage arrangement.
    - Process use.

**STORAGE**

Storage or sheltering of goods, merchandise, products, vehicles or animals.



Slide 3-27

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9. Storage.

Storage or sheltering of goods, merchandise, products, vehicles or animals.

**UTILITY/MISCELLANEOUS**

- Agricultural buildings, barns, carports, greenhouses, private garages, sheds, tanks, towers, fences over 6 feet and retaining walls.
- Must be in accordance with fire and life hazards incidental to the occupancy.

Slide 3-28

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10. Utility and miscellaneous.

- a. Agricultural buildings, barns, carports, greenhouses, private garages, sheds, tanks, towers, fences over 6 feet and retaining walls.
- b. Must be constructed, equipped and maintained in accordance with fire and life hazards incidental to the occupancy.

**SPECIFIC USES**

- Most use groups are subcategorized — reflects life safety and fire protection characteristics.
- Assemblies — A-1 through A-5.



Slide 3-29

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E. Further subcategorized to better reflect fire and life hazards.

- 1. Most of the use groups are subcategorized.

Reflects life safety and fire protection characteristics.


- 2. Assembly category has five subcategories:
  - a. A-1: production and viewing of performing arts.
  - b. A-2: food and/or drink consumption.
  - c. A-3: worship, amusement, assembly, other uses.
  - d. A-4: viewing of indoor sporting events and activities with spectator seating.
  - e. A-5: participation in, or viewing, outdoor activities.
  
- F. Each of these subcategories represents a different set of characteristics for use of the occupancy that can affect life safety factors of the occupancy, such as:
  - 1. Density of population, configuration of exits, recognition and use of exits, quantity and combustibility of furnishings, awareness of occupants, ratio of staff to visitors, etc.
  - 2. These factors relate to risk analysis of the occupancy and drive code requirements for the protection of occupants and emergency responders.

**MIXED OCCUPANCIES**

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Two methods used to address buildings that contained mixed uses:

- Separated uses.
- Nonseparated uses.



Slide 3-30

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- G. Mixed occupancies.
  - 1. Two methods used to address buildings that contain mixed uses:
    - a. Separated uses.
    - b. Nonseparated uses.

## SEPARATED USE

- Individual occupancies evaluated based on use, and physically separated by fire-resistant construction.
  - Separation may be vertical, horizontal or both.
  - Each area must comply with height restrictions.
- Must meet Unity Formula.

Slide 3-31

### 2. Separated use.

- a. Occupancies of different use groups are physically separated by fire-resistant construction.
  - Vertical.
  - Horizontal.
  - Both.
- b. Refer to separation table in building code (IBC Table 508.4).
- c. Separated occupancies must comply with height limits.
  - Example: Building is two stories of Type VB construction (unprotected wood frame), unsprinklered, contains a Group B business office and a recreation room classified as a Group A-3 assembly. Group B occupancy is allowed on either story; Group A-3 is only allowed on the first story.
- d. Area of separated uses must show compliance with the Unity Formula.
- e. Ratio of actual floor areas to allowable areas shows combined occupancies will not exceed what is allowed for the building.

EXAMPLE: H-2 TO F-1

OCCUPANCY	REQUIRED SEPARATION OF OCCUPANCIES (HOURS)																			
	A <sup>a</sup> , E		I				R <sup>a</sup>		F-2, S-2 <sup>d</sup> , U <sup>d</sup>				B <sup>a</sup> , F-1, M <sup>a</sup> , 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 <sup>a</sup> , E <sup>a</sup>	N	N	1	2	1	2	N	1	1	2	NP	NP	3	1	2	3 <sup>a</sup>				
I	—	—	N	N	1	NP	1	2	1	2	NP	NP	3	NP	2	NP				
R <sup>d</sup>	—	—	—	—	N	N	1	2	1	2	NP	NP	3	NP	2	NP				
F-2, S-2 <sup>d</sup> , U <sup>d</sup>	—	—	—	—	—	—	N	N	1	2	NP	NP	3	1	2	3 <sup>a</sup>				
B <sup>a</sup> , F-1, M <sup>a</sup> , S-1	—	—	—	—	—	—	—	—	N	N	NP	NP	2	3	1	2 <sup>a</sup>				
H-1	—	—	—	—	—	—	—	—	—	—	N	NP	NP	NP	NP	NP				
H-2	—	—	—	—	—	—	—	—	—	—	—	N	NP	NP	1	NP				
H-3, H-4, H-5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP				

Slide 3-32

H. Example of separated uses: Determine the separation required between Group H-2 and Group F-1 in a nonsprinklered building (2015 IBC Table 508.4).

1. Find row with Group F-1.
2. Find intersecting (nonsprinklered) column with Group H-2.

Required separation is three hours.

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## ACTIVITY 3.1

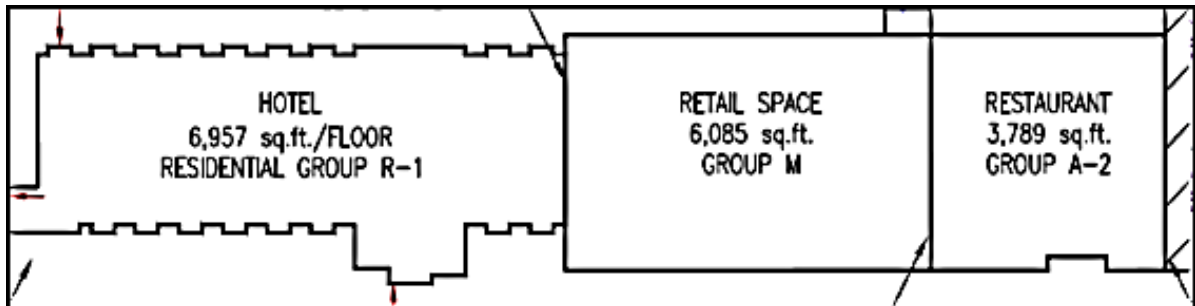
### Occupancy Separations

#### Purpose

Determine the proper fire-rated separations for mixed occupancies.

#### Directions

1. Work at your table groups in teams of two for 30 minutes.
2. Using your code book and the given mixed-use plan graphic, determine the proper fire-rated mixed occupancy separations between:
  - a. The hotel and retail spaces.
  - b. The retail and assembly areas.
3. Assume for the purposes of this activity that:
  - a. It is a single building.
  - b. The building is designed using separated uses.
  - c. The building is protected with a fire sprinkler system throughout.



4. Write your answers to the following questions and be prepared to explain your answers.

a. What is the required fire-resistance rating of the wall to separate the hotel from the retail space?

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b. What is the required fire-resistance rating of the wall between the retail space and the restaurant?

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c. What type of fire-resistance separation is required between occupancies (fire wall, fire barrier, fire partition or horizontal assembly)?

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d. For the first question, if the hotel is protected by a fire sprinkler system designed to National Fire Protection Association (NFPA) 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, is the answer the same?

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III. OCCUPANCY CLASSIFICATIONS (cont'd)

### UNITY FORMULA

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- Formula:
 
$$(a_1 \div A_1) + (a_2 \div A_2) \leq 1$$
- Where:
  - a = actual area of each occupancy.
  - A = allowable area for each occupancy.

Slide 3-35

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I. The Unity Formula (2015 IBC 508.4.2).

1. Unity Formula is used for multioccupancy stories that are separated uses:

Ratio of actual floor areas divided by allowable areas must not exceed 1.

a. a = actual area of each occupancy in the building.

b. A= allowable area of each occupancy from the allowable area and height table.

$$\frac{\text{Actual Area}}{\text{Allowable Area}} + \frac{\text{Actual Area}}{\text{Allowable Area}} + \frac{\text{Actual Area}}{\text{Allowable Area}} \leq 1$$

### UNITY FORMULA: EXAMPLE

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- Building containing a mixed occupancy of **assembly** and **business**.
- Assembly area contains 3,000 square feet ( $a_1$ ).
  - Area table permits maximum 5,500 square feet in assembly ( $A_1$ ).
- Business area contains 5,000 square feet ( $a_2$ ).
  - Area table permits maximum 9,000 square feet in business ( $A_2$ ).

Slide 3-36

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2. Example:

a. A building with a separated, mixed-occupancy of assembly (A-1) and business uses 8,000 square feet of total building area.

- Assembly occupancy is 3,000 square feet.
- Business occupancy is 5,000 square feet.

b.  $(a_1 \div A_1) + (a_2 \div A_2) \leq 1$

- $a_1 = 3,000 \text{ ft}^2, A_1 = 5,500 \text{ ft}^2; a_2 = 5,000 \text{ ft}^2, A_2 = 9,000 \text{ ft}^2.$

**USING THE FORMULA**

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$$(a_1 \div A_1) + (a_2 \div A_2)$$
$$(3,000 \div 5,500) + (5,000 \div 9,000) \leq 1$$
$$0.55 + 0.56 = 1.11$$
$$1.11 > 1$$

Ratio is greater than 1, therefore not acceptable.

Slide 3-37

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c. Test:  $(3,000 \div 5,500) + (5,000 \div 9,000) \leq 1$

$$0.55 + 0.56 = 1.11$$

$$1.11 > 1$$

- Ratio result is greater than 1; therefore mixed-occupancy is not acceptable. The designer will need to redesign the building.

**NONSEPARATED USES**

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- Each occupancy classified.
- Occupancy requirements apply to each portion of the building.
- Sprinkler requirements apply to the entire building.

Slide 3-38

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- 3. Nonseparated uses (IBC 508.3):
  - a. Each occupancy is classified, and requirements of code apply to **each** portion of the building based on the occupancy classification of the space.
  - b. Sprinkler requirements in IBC Chapter 9 apply to the entire building.

**NONSEPARATED USES  
(cont'd)**

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- Allowable building area and height determined by most restrictive occupancy.
- Separate Groups H-2, H-3, H-4 and H-5.
- Separate residential.

Slide 3-39

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- c. Allowable building area and height are determined by the **most restrictive occupancy** in the building.
- d. Groups H-2, H-3, H-4 and H-5 are required to be separated from other uses.
- e. Dwelling units and sleeping rooms are required to be separated from each other and other occupancies contiguous to them. See Chapter 4 for detailed requirements for special occupancies (IBC 420).

- 4. Nonseparated use buildings are designed so any of the uses can use the building separately (does not use Unity Formula).
  - a. Must meet all construction and fire protection requirements of the most restrictive occupancy class.

**NONSEPARATED USES:  
EXAMPLE 1**

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- A nonseparated mixed-use Group A-1 and Group B, Type VB, sprinklered.
- A-2 allowed 18,000 square feet and two stories.
- B allowed 27,000 square feet and three stories.
- Group A-2 is most restrictive and building is limited to 18,000 square feet per story and two stories.

Slide 3-40

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- b. Example: A nonseparated mixed-use Group A-2 and Group B, Type VB, sprinklered.
  - A-2 allowed 18,000 square feet per story and two stories.
  - B allowed 27,000 square feet per story and three stories.
  - Group A-2 is most restrictive and building is limited to 18,000 square feet per story and two stories.

**NONSEPARATED USES:  
EXAMPLE 2**

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- Proposed nonseparated mixed-use Group S-1 and Group H-1, Type VB, sprinklered.
- H-1 not allowed in Type VB and is only allowed in detached building (International Building Code (IBC) 415.7).
- Occupancies not allowed in mixed-use.
  - H-1 allowed 7,500 square feet and one story in Type VB.
  - S-1 allowed two stories and 36,000 square feet.

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- c. Example: Proposed nonseparated mixed-use Group S-1 (moderate hazard storage) and Group H-1 (detonation hazard), sprinklered.
  - Group H-1 is required to be in a detached building per IBC 415.7. Group H-1 is not allowed in Type VB construction per Table 506.2
  - Occupancies not allowed in mixed use building.
  - Group S-1 has a tabular height of 60 feet and two stories in sprinklered, Type VB building and a tabular area of 36,000 square feet.

**ACCESSORY USE**

- Ancillary to main occupancy or portion thereof — administrative offices for mercantile.
- Floor area does **not** exceed 10% of story on which they are located.
- Must meet tabular limits — no height or area modifications permitted.

Slide 3-42

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- J. Accessory use (within main occupancy).
  - 1. An occupancy that qualifies as an accessory use does not have to be separated from the main occupancy. (Exceptions for Group H are dwelling units and sleeping rooms — see below.)
    - a. Must be ancillary to the main occupancy or a portion thereof. Accessory use would not exist if not for the main occupancy.
      - Example: administrative offices for mercantile.
    - b. Floor area cannot exceed 10% of the story on which they are located.
    - c. Must meet tabular limits.
      - No area modifications permitted.
    - d. Groups H-2, H-3, H-4 and H-5 shall be separated from other occupancies.

- e. Groups I-1, R-1, R-2 and R-3 dwelling and sleeping units shall be separated from other dwelling or sleeping units and from contiguous occupancies.

**SPECIFIC ACCESSORY USES**

- Assembly rooms less than 750 square feet.
- Kitchens associated with dining rooms.
- Assembly areas in educational — must comply with assembly egress requirements.
- Religious education rooms and auditoriums less than 100 occupant load.

Slide 3-43

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- 2. Specific accessory uses identified in code occupancies definitions:
  - a. Assembly rooms less than 750 square feet.
  - b. Kitchens associated with dining rooms.
  - c. Assembly areas in educational facilities (theaters, gymnasiums, cafeterias) identified as accessory use to the main occupancy, but must comply with assembly egress requirements.
  - d. Religious education rooms and auditoriums with an occupant load of less than 100 people.

**INCIDENTAL USES**

- Ancillary functions that pose a greater level of risk to the occupancy.
  - Refer to IBC Table 509.
  - Maintain occupancy class of overall occupancy.
- Specific separations or fire sprinklers required.

Slide 3-44

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K. Incidental uses.

1. Defined in 2012; ancillary functions that generally pose a greater risk level to the occupancy and listed in IBC Table 509.
  - a. Refer to Table 509 in IBC.
    - Example: boiler room — needed for building operations, but not normally occupied.
  - b. Incidental uses maintain overall occupancy class. Incidental use is not given an occupancy classification.
2. Specific separations or fire sprinklers required.

In some conditions, reductions may be permitted when sprinklered and construction is capable of resisting smoke.

**NATIONAL FIRE PROTECTION  
ASSOCIATION 101, *LIFE SAFETY CODE*®**

- Hazardous areas in each occupancy chapter.
- Separation.
- Sprinkler protection.
- Combination.

Slide 3-45

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3. NFPA 101, *Life Safety Code*®; covers requirements within each occupancy chapter. Applies to federally licensed occupancies such as I-2 (hospitals and nursing homes).
  - a. Requirements for hazardous areas in each occupancy chapter.
  - b. Separation.
  - c. Sprinkler protection and construction that is capable of resisting passage of smoke.
  - d. Combination of both physical separation and sprinkler protection.

IV. CONSTRUCTION TYPE

**CONSTRUCTION TYPE**

- Construction classification limits allowable height and area by occupancy type.
- Designer must indicate construction type on drawings.
- Construction type criteria are established in the building codes and National Fire Protection Association (NFPA) 220, *Standard on Types of Building Construction*.

Slide 3-46

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A. General.

1. The second basic factor that building code considers for determining allowable area and height.
2. Building codes recognize the importance of resiliency of buildings to protect occupants. As human life risk becomes higher, building is required to be more fire-resistant and resilient.
  - a. As a building gets larger, the occupant load increases and the life safety factor is greater. Codes require a higher level of construction to protect occupants and emergency responders during an event.
  - b. Community resiliency to respond after a major regional event enables the community to sustain its vitality and recover as a community. Building codes establish a minimum level of design criteria, e.g., the wind speed and snow load buildings must withstand to protect occupants and emergency responders.
  - c. By establishing a minimum strength and fire-resistive level, building codes help reduce the impact on public services when citizens can continue to live, work and perform other functions of life after an event.
3. The designer must indicate construction type on drawings.
  - a. If no construction type is indicated on the plans, **ask** the plans submitter.

- b. Construction type criteria are established in various building codes and NFPA 220, *Standard on Types of Building Construction*.

### CONSTRUCTION TYPE (cont'd)

- Building code specifies type of materials and fire-resistance ratings for building Types I to IV.

Slide 3-47

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- B. Construction types per building codes.
  - 1. Building code specifies the type of materials and fire-resistance ratings for different building construction types.
  - 2. Building code specifies fire-resistance ratings for structural frame, bearing walls, exterior walls, floor construction and roof construction.

### CONSTRUCTION TYPE (cont'd)

- Construction type for the building is based on:
  - Occupancy classification.
  - Occupant load.
  - Area and height.

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION									
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V		
		A	B	A	B	A	B		A	B	
A-1	NS	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500	
	S1	UL	UL	62,000	34,000	56,000	34,000	60,000	46,000	22,000	
	SM	UL	UL	46,500	25,500	42,000	25,500	45,000	34,500	16,500	
A-2	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000	
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000	
	SM	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000	

Slide 3-48

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- 3. Construction type for the building is based on:
  - a. Occupancy classification.
  - b. Occupant load.
  - c. Area and height.

C. Types are described in building codes (IBC Chapter 6).

**TYPE I**

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- Contains only noncombustible materials.
- Fire-resistance ratings of two or three hours.



Slide 3-49

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1. Type I.
  - a. Contains only noncombustible materials.
  - b. Fire-resistance rating of structural frame and bearing walls is three hours in Type IA and two hours in Type IB.
  - c. Generally this type of construction is used for high-rise buildings and high-risk occupancies (e.g., hospitals and prisons).

**TYPE II**

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- Contains only noncombustible materials.
- Limited or no fire-resistance ratings.



Slide 3-50

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2. Type II.
  - a. Contains only noncombustible materials.
  - b. Fire-resistance rating of structural frame and bearing walls is one hour in Type IIA and zero hours in Type IIB.

- c. May be pre-engineered metal buildings and are common as industrial buildings.

**TYPE III**

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- Exterior walls are noncombustible; interior walls, floors and roofs may be combustible materials.
- Limited or no fire-resistance ratings.



Slide 3-51

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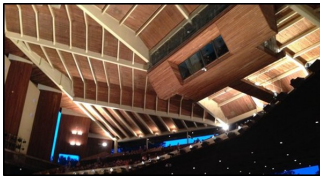
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- 3. Type III.
  - a. Exterior walls are noncombustible, typically concrete or masonry. Fire-retardant treated wood may be used in exterior wall assemblies with rating of two hours or less.
    - Interior walls, floors and roofs may be combustible materials.
  - b. Fire-resistance rating of structural frame is one hour and bearing walls is two hours in Type IIIA and zero hours in Type IIIB.

**TYPE IV**

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Heavy timber: Fire resistance comes from physical sizes (mass) of construction elements.



Slide 3-52

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- 4. Type IV.

- a. Heavy timber: Fire resistance comes from physical sizes (mass) of construction elements.
  - Minimum size of wood columns is 6 inches by 8 inches, floor framing is 6 inches by 10 inches, and roof framing is 6 inches by 8 inches.
- b. Exterior walls required to be noncombustible, but may have fire-retardant treated wood.

**TYPE V**

- Any material permitted by code — traditionally, wood frame.
- Limited or no fire-resistance ratings.



Slide 3-53

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- 5. Type V.
  - a. Any material permitted by code.
    - Traditionally, wood frame.
  - b. Fire-resistance rating of structural frame and bearing walls is one hour in Type VA and zero hours in Type VB.

**FIRE-RESISTANCE RATINGS**

Based upon various elements including:

- Exterior walls.
- Interior walls.
- Supporting structure.
- Bearing and nonbearing elements.
- Floor/Ceiling and roof/ceiling assemblies.

Slide 3-54

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D. Fire-resistance ratings.

1. Based upon various elements that include exterior walls, interior walls, supporting structure, bearing and nonbearing elements, and floor/ceiling and roof/ceiling assemblies.
2. Building code specifies fire-resistance ratings for structural frame, bearing walls, exterior walls, floor construction and roof construction for each type of construction.

### CONSTRUCTION-TYPE TABLE

FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (hours)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Structural frame including columns, girders, trusses	3	2	1	0	1	0	HT	1	0
Bearing walls									
Exterior	3	2	1	0	2	2	2	1	0
Interior	3	2	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions									
Exterior			See Exterior Wall Separation Distance Table						
Interior			See Exterior Wall Separation Distance Table						
Floor construction including supporting beams and joists	2	2	1	0	1	0	HT	1	0
Roof construction including supporting beams and joists	1½	1	1	0	1	0	HT	1	0

Slide 3-55

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3. Set forth in tables in building codes (IBC Table 601).
4. Must meet all elements listed in the table to achieve rating.
5. May choose a lower rating for future design freedom (i.e., VB, IIB).

### MIXED-CONSTRUCTION TYPES

- Building required to comply **only** with minimum requirements based on occupancy.
- Small, one-story office may choose to include fire-resistive elements, but only Type VB construction is enforced.

Slide 3-56

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E. Mixed-construction types.

1. When more than one type of construction is represented, building elements do not have to conform to a higher type of construction if the requirements of occupancy are met with a lower type of construction.
2. When more than one type of construction is present, the most restrictive requirements of area and height for occupancy must be met unless they are separated by appropriate fire-resistance rated construction to create separate buildings.

For example, code allows a wood-frame Type VA residential mixed-use building constructed on top of a Type IA parking garage with a three-hour fire-resistance rated horizontal separation, and each use is considered a separate building.


3. Addressed by IBC in Chapter 5 for area and height, and Chapter 7 for fire walls (IBC 706.1 and Table 706.4 for fire walls).

**V. BEARING AND NONBEARING STRUCTURAL ELEMENTS**

**BEARING ELEMENT**

Element that supports any load in addition to its own weight.

- Wall.
- Beam.
- Girder.
- Column.



Slide 3-57

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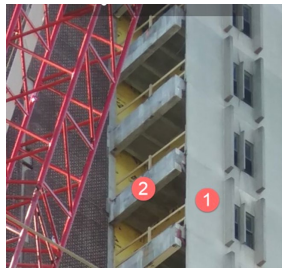
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- A. Bearing.
  1. Any element that supports a vertical gravity load from another element (e.g., wall, floor or roof structure).
  2. Carries load to ground.

## NONBEARING ELEMENT

Element that supports no load other than its own weight and moderate loads, such as wiring, ducts, etc.



Wall supports no structural load

Slide 3-58

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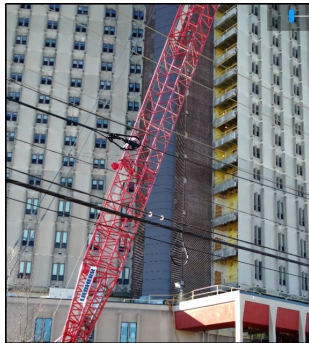
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B. Nonbearing.

Element carries only its own weight and small items like wiring, ducts, wind, etc.

## LOAD BEARING?



Slide 3-59

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## COMPARISON



Slide 3-60

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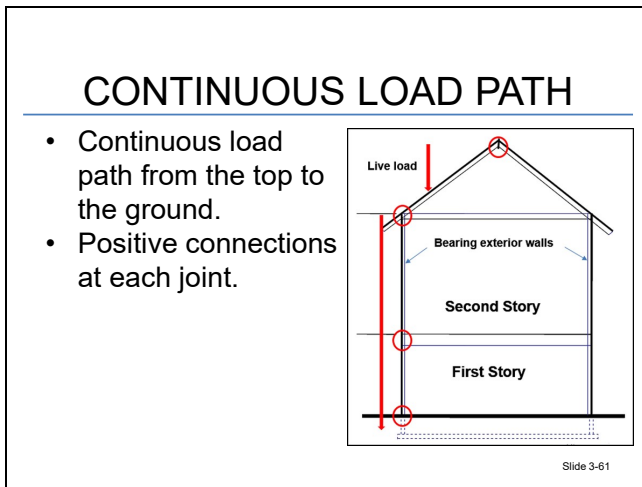
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C. Comparison example.

1. Structural frame of building.
2. Columns supporting weight of floor and roof trusses above.
3. Roof will bear dead loads (roofing materials) and live loads (maintenance personnel, snow, rain, standing water).
4. Floor will bear dead loads (flooring materials or loads from above) and live loads (people, furniture, etc.).
5. Slide 3-59 example shows a tilt-up panel being attached to the structural frame, floor sheathing and interior partition wall which does not have any load bearing except its own weight.



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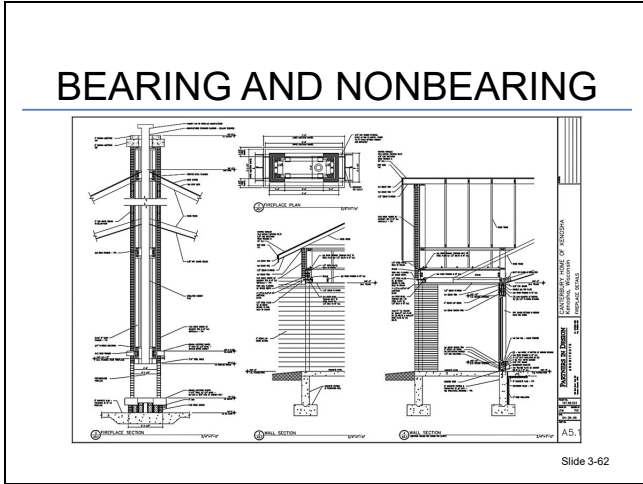
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D. Continuous load path.

Following the load path will help determine the bearing elements of a building.

1. If roof rafters/trusses rest on a wall or a wall supports floor joists, that wall is bearing extra loads and is a bearing wall.
2. The load path must in some way be transferred through the structure and all the way to the ground through a foundation or footing.



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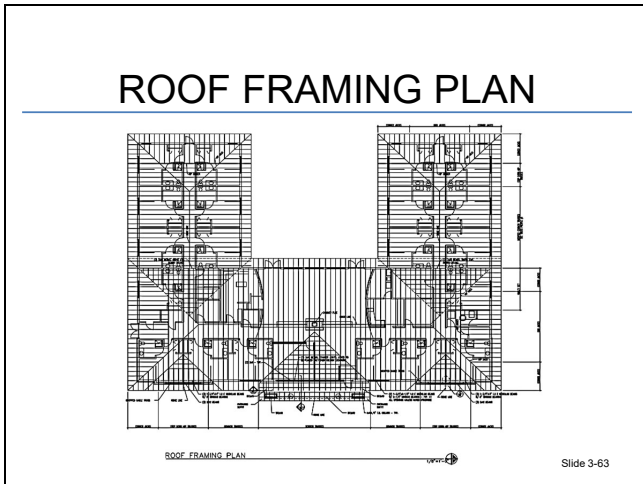
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E. Trusses.

Load bearing walls.

1. Roof framing plan also shows that walls are bearing because of the way the gables are framed.
2. Truss section views show trusses resting on walls in both directions; therefore, all walls are bearing.



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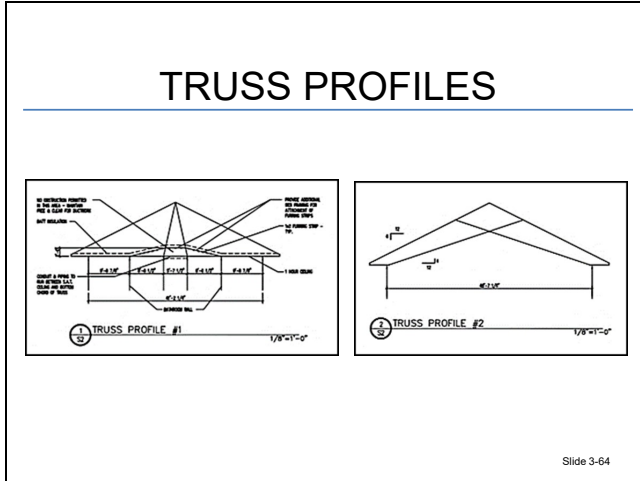
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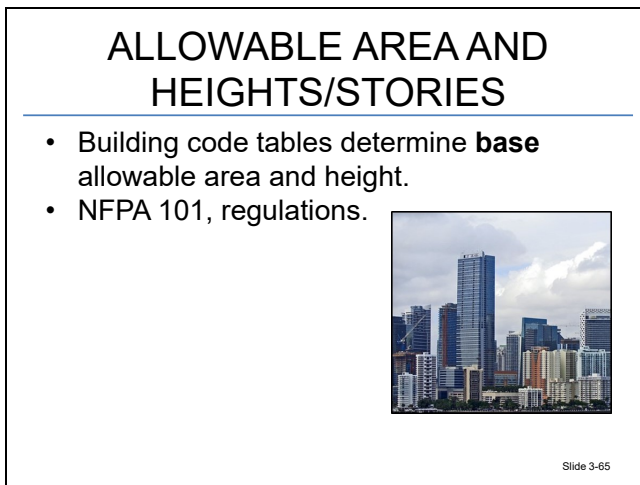
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**VI. ALLOWABLE AREA AND HEIGHTS/STORIES**

- A. Building codes protect individuals and the community.
- B. Protection for building occupants and community is accomplished by limiting the size of occupancy in combustible buildings.
- C. Occupancies with higher life safety factors have more limitations.
- D. Assemblies with a higher density of occupants are limited to buildings of smaller size and lower height than a business building that has a lower density of occupants.
- E. As building construction type becomes more fire-resistant, a building may be larger to house a specific occupancy.

Important: This is one of several reasons why an occupancy in a new or an existing building needs to have a code analysis **before** occupancy moves in and opens for business.




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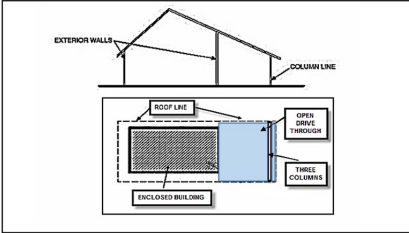
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- F. Allowable areas and heights.
  - 1. Building code tables determine/establish base values.
    - a. Allowable area.
    - b. Allowable height.
  - 2. Occupancy classification and construction type limit areas and heights.
  - 3. NFPA 101 regulates where occupancy can be located in relation to the level of exit discharge.

**BUILDING AREA**

- Area within surrounding exterior walls, **including** areas under projections or floor above.



The diagram illustrates the definition of building area. It shows a cross-section of a building with a gabled roof. Labels include 'EXTERIOR WALLS' pointing to the outer walls, 'ROOF LINE' pointing to the top edge of the roof, and 'COLUMN LINE' pointing to the vertical line of the columns. Below this, a floor plan shows an 'ENCLOSED BUILDING' with a shaded area representing the building area. This area includes the main building footprint and extends to include the area under an 'OPEN DRIVE THROUGH' supported by 'THREE COLUMNS'.

Slide 3-66

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- G. Building area.
  - 1. Defined in building codes as the area within surrounding exterior walls but vent shafts and courtyards may be excluded. Includes the area under the front entry.

**BUILDING AREA EXAMPLE**



A photograph of a modern building with a large glass entrance. The building has a white exterior and a dark roof. The entrance is a covered walkway supported by columns. The area under the entrance is shaded in the diagram above, illustrating the building area.

Slide 3-67

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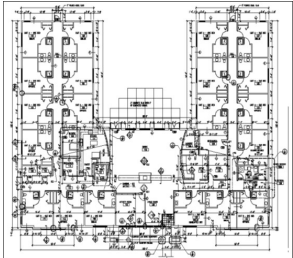
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2. Typically seen as the **footprint** of the building.
  - a. If there are no exterior walls, building area is the area beneath all projections (e.g., roofs, canopies).
  - b. Example shown in Slide 3-65 could be a bank with a drive-through canopy for customer transactions, as exemplified in Slide 3-66.
  - c. Building area includes the area within the exterior walls of the bank building and the area beneath the drive-through canopy to the edges of the roof.

### BUILDING AREA (cont'd)

- Used for calculating allowable building area.



Slide 3-68

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3. Building area is used for calculating the allowable building area.  
  
For the Canterbury Home, building area is the area of the building plus the area of the front entry.

### ALLOWABLE AREA

TABLE 506.2<sup>a</sup>  
ALLOWABLE AREA FACTOR (A, 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-1	NS	UL	UL	15,500	8,500	14,000	8,500	15,000	11,500	5,500		
	S1	UL	UL	62,000	34,000	56,000	34,000	60,000	46,000	22,000		
	SM	UL	UL	46,500	25,500	42,000	25,500	45,000	34,500	16,500		
A-2	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000		
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000		
	SM	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000		
A-3	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000		
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000		
	SM	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000		
A-4	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000		
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000		
	SM	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000		
	NS											

Slide 3-69

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H. Allowable Area Factor (IBC Table 506.2).

1. The Allowable Area Factor Table gives the allowable tabular values that will be used in formulas to calculate the maximum allowable area of a building based on the occupancy, type of construction and presence of an automatic fire sprinkler system.

Prior to the IBC 2015 edition, tabular allowable area and allowable height were combined into one table.

2. Use the nonsprinklered line in IBC Table 506.2 to show the base allowable area with no sprinklers. Comparing tabular allowable areas in Group A-2 occupancy, assembly occupancy for dining and drinking is allowed to be larger as construction becomes more fire resistive.
3. Type VB, unprotected wood frame and assembly occupancy, has a tabular area of 6,000 square feet, but if the construction type changed to Type IIB or IIIB (greater resilience to fire), the size of the building can be increased to 9,500 square feet.
4. If construction type increases to Type VA, one-hour protected wood-frame construction, tabular area can be increased to 11,500 square feet.

**VII. HEIGHT**

**HEIGHT**

- Vertical distance from grade plane to the average height of highest roof surfaces.
- Towers, spires, steeples and other roof structures exempt from height.

Slide 3-70

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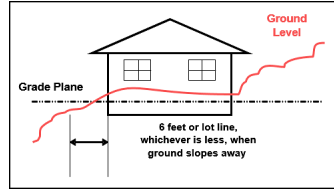
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- A. Defined in building codes as the vertical distance from the grade plane to the average height of the highest roof surfaces.

Towers, spires, steeples and other roof structures are not generally included in the building height.

## GRADE PLANE

- Average finished ground level.
- Or, lowest points between exterior wall and lot line or 6 feet when ground slopes away.



Slide 3-71

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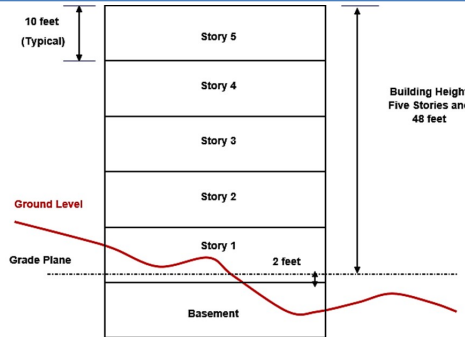
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- B. Grade plane is a reference plane to establish height. It represents the average finished grade at the exterior walls.
1. When grade slopes away from exterior walls, the reference plane is established with the lowest point between the exterior wall and the lot line.
  2. If the lot line is more than 6 feet from the wall, the grade plane is a point measured 6 feet from the exterior wall.

## BUILDING HEIGHT



Slide 3-72

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3. Building height example.

### 2015 INTERNATIONAL BUILDING CODE ALLOWABLE HEIGHT

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION									
		TYPE I		TYPE II		TYPE III		TYPE IV HT	TYPE V		
		A	B	A	B	A	B		A	B	
A, B, E, F, M, S, U	NS <sup>b</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
H-1, H-2, H-3, H-5	NS <sup>c,4</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
H-4	NS <sup>c,4</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
I-1 Condition 1, I-3	NS <sup>c,4</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
I-1 Condition 2, I-2	NS <sup>c,4</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
I-4	NS <sup>c,4</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
R	NS <sup>c,4</sup>	UL	160	65	55	65	55	65	50	40	
	S13R	60	60	60	60	60	60	60	60	60	
	S	UL	180	85	75	85	75	85	70	60	

Slide 3-73

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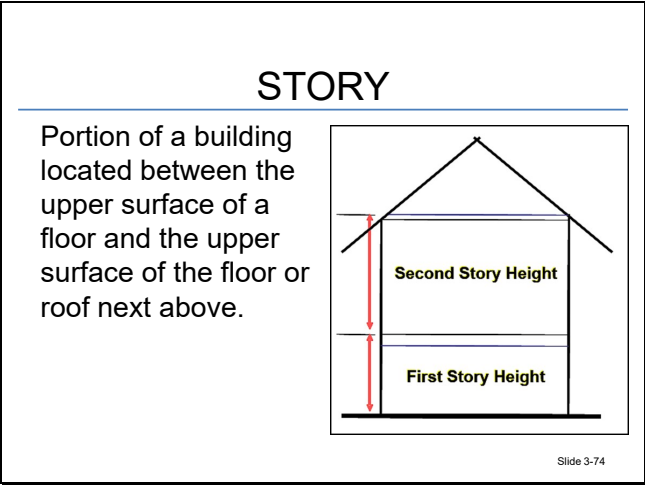
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C. Allowable height table.

Example: Use the nonsprinklered line in IBC Table 504.3 to show the base allowable area with no sprinklers. Using the same occupancy in the allowable area example, a Group A-2 occupancy is limited to 40 feet in height when construction is VB, but increase the construction type to Type VA, and the building can be 50 feet in height, or increase the construction type to IIB or IIIB, and the height can be increased to 55 feet.

VIII. STORY




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- A. The portion of a building between the upper surface of a floor and the upper surface of the floor or roof above.
- B. Accurate description and interpretation of a story is important to verify height limits.

## BASEMENT OR STORY?

Considered a story if finished floor is:

- Entirely above grade plane.
- Is greater than 6 feet above grade plane.
- Is greater than 12 feet above finished ground level at any point.



Slide 3-75

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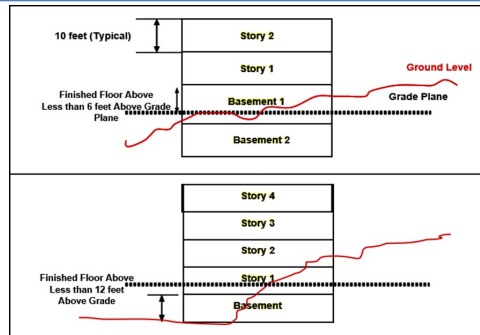
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### C. Basement compared to story.

1. A basement is considered a story if the finished floor level is:
  - a. Entirely above the grade plane.
  - b. More than 6 feet above the grade plane.
  - c. More than 12 feet above the finished ground at any point.
2. Basements are not included in story limits.
3. Rearranging the grade plane or finished grade may enable a designer to maximize the overall size of a building, without exceeding height limits.
4. Grade will be established at final inspection. Jurisdiction can require a licensed surveyor to prepare documentation providing proof that the finished building complies with the given design.

## BASEMENT OR STORY? (cont'd)



Slide 3-76

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- a. The definition of a basement has varied over the history of building codes.
- b. When reviewing an existing building, a basement may have been classified under a previous code and may not qualify as a basement if it were constructed today.

**ALLOWABLE STORIES**

TABLE 604.4\*\*  
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE

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-1	NS	UL	5	3	2	3	2	3	2	1	
	S	UL	6	4	3	4	3	4	3	2	
A-2	NS	UL	11	3	2	3	2	3	2	1	
	S	UL	12	4	3	4	3	4	3	2	
A-3	NS	UL	11	3	2	3	2	3	2	1	
	S	UL	12	4	3	4	3	4	3	2	
A-4	NS	UL	11	3	2	3	2	3	2	1	
	S	UL	12	4	3	4	3	4	3	2	
A-5	NS	UL	UL	UL	UL	UL	UL	UL	UL	UL	
	S	UL	UL	UL	UL	UL	UL	UL	UL	UL	
B	NS	UL	11	5	3	5	3	5	3	2	
	S	UL	12	6	4	6	4	6	4	3	
E	NS	UL	5	3	2	3	2	3	1	1	
	S	UL	6	4	3	4	3	4	2	2	

Slide 3-77

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- 5. Number of stories is based on occupancy and construction type.
  - a. In addition to the height of a building, code also limits the number of stories based on the occupancy and type of construction.
  - b. Group A-2 occupancy in previous examples can be one story if the designer uses Type VB construction. Increasing the construction to Type VA, IIB or IIIB will allow the occupancy to be constructed of two stories or be on the second story of the building.

**MEZZANINES**

Intermediate level **between** floor and ceiling of a story. Not included in story limits if all conditions met.

- Minimum ceiling height 7 feet above and below.
- Mezzanine area may not be more than one-third of floor area.

Slide 3-78

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D. Mezzanines: intermediate levels between the floor and ceiling of a story. Not included in building area or number of stories if all conditions are met.

1. Minimum ceiling height of 7 feet above and below.



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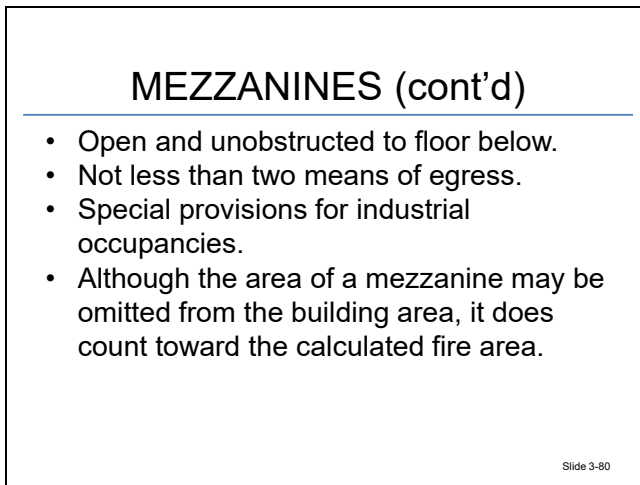
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2. The area of a mezzanine may not be more than one-third of the floor area.



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3. Open and unobstructed to the floor below (exceptions).
4. Not less than two means of egress (exceptions).
5. Special provisions for industrial occupancies.
6. Although the area of a mezzanine may be omitted from the building area, it does count toward the calculated fire area.

**IX. AREA AND HEIGHT MODIFICATIONS**

**AREA AND HEIGHT MODIFICATIONS**

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- Automatic sprinkler protection.
- Accessible street frontage — clearance on one or more sides of building.
- Occupancy specific.
- Unlimited area in certain conditions.

Slide 3-81

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- A. Area and height may be increased by one of the following methods:
1. Automatic sprinkler protection throughout the building or an accessible street frontage, which refers to a clear frontage on one or more sides of the building.
  2. Unlimited-area buildings:
    - a. Low hazard occupancies with sprinklers and adequate clearance on all sides.
    - b. Fully fire-resistive construction (Type IA).

**ALTERNATIVE APPROACH**

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- Two buildings on same property may be considered one building for purposes of allowable area and height.
- Height of each building and aggregate area cannot exceed table limits.
- If they have different occupancy classifications or construction types, most restrictive applies.

Slide 3-82

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- B. Alternative approach.

1. The aggregate area of two or more buildings on the same property may be considered one building for area and height calculations.
2. Height and area cannot exceed table limits.
3. If buildings have different occupancy classifications or different construction types, the area will be that allowed for the most restrictive occupancy or construction.

**AREA MODIFICATIONS**

- Formula to calculate allowable area of building above grade plane.
- $A_a = [A_t + (NS \times I_f)] \times S_a$ .
  - $A_a$  = allowable area (square feet).
  - $A_t$  = tabular area factor (NS, S1, S13R or SM, value as applicable).

Slide 3-83

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C. Area modification formula.

1. Formula used to calculate the maximum allowable area of a building using a fire sprinkler system and clear frontage around a building.

2.  $A_a = [A_t + (NS \times I_f)] \times S_a$ .

Where:

- a.  $A_a$  = allowable area per story (square feet).
- b.  $A_t$  = tabular area factor per story (square feet). NS, S1, S13R or SM value, as applicable in accordance with IBC Table 506.2.

**AREA MODIFICATIONS**  
**(cont'd)**

- NS = tabular allowable area factor for nonsprinklered building.
- $I_f$  = area factor increase due to frontage, as calculated.
- $S_a$  = number of stories not to exceed three.
- No story may exceed area when  $S_a = 1$ .

Slide 3-84

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- c. NS = tabular allowable area factor in accordance with IBC Table 506.2 for nonsprinklered building (regardless of whether the building is sprinklered).
- d.  $I_f$  = area factor increase due to frontage.
- e.  $S_a$  = number of stories (up to three; four if sprinklered and separated uses).
- f. No story may exceed area when  $S_a = 1$ .

D. Sprinkler modification.

- 1. IBC Table 506.2 gives area increases based on full protection in the building with an automatic fire sprinkler system. The tabular area is represented by the term  $A_t$  in the allowable area formula, and the table footnotes describe the terms NS, S1, S13R or SM used to differentiate a building as being fully protected and as being either one story or multiple stories above grade.

**FOOTNOTES TO INTERNATIONAL  
BUILDING CODE TABLE 506.2**

- NS — buildings not equipped throughout with an automatic sprinkler system.
- S1 — buildings a maximum of one story above grade plane, equipped with an automatic sprinkler system installed per IBC 903.3.1.1.

Slide 3-85

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Footnotes to the table explain nomenclature in the table:

- a. NS — buildings not equipped throughout with an automatic sprinkler system.
- b. S1 — buildings a maximum of one story above the grade plane, equipped with an automatic sprinkler system installed per IBC 903.3.1.1 (NFPA 13, *Standard for the Installation of Sprinkler Systems*).

**FOOTNOTES TO INTERNATIONAL BUILDING CODE TABLE 506.2 (cont'd)**

- SM — buildings two or more stories above grade plane, equipped with an automatic sprinkler system installed per IBC 903.3.1.1.
- S13R — buildings equipped with an automatic sprinkler system installed per IBC 903.3.1.2.

Slide 3-86

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- c. SM — buildings two or more stories above the grade plane, equipped with an automatic sprinkler system installed per IBC 903.3.1.1 (NFPA 13).
- d. S13R — buildings equipped with an automatic sprinkler system installed per IBC 903.3.1.2 (NFPA 13R).

**SPRINKLER MODIFICATION**

TABLE 506.2-<sup>a</sup>  
ALLOWABLE AREA FACTOR (A, 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	A	B	A	B
A-1	NS	UL	UL	15,500	8,500	14,000	8,500	15,000	11,200	6,000	6,000
	S1	UL	UL	62,000	34,000	56,000	34,000	60,000	46,000	23,000	23,000
	SM	UL	UL	46,500	25,500	42,000	25,500	45,000	34,500	16,500	16,500
A-2	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000	24,000
	SM	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000	18,000
A-3	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000	24,000
	SM	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000	18,000
A-4	NS	UL	UL	15,500	9,500	14,000	9,500	15,000	11,500	6,000	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	60,000	46,000	24,000	24,000
	SM	UL	UL	46,500	28,500	42,000	28,500	45,000	34,500	18,000	18,000
A-5	NS										
	S1	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL
	SM										
B	NS	UL	UL	37,500	23,000	28,500	19,000	36,000	18,000	9,000	9,000
	S1	UL	UL	150,000	92,000	114,000	76,000	144,000	72,000	36,000	36,000
	SM	UL	UL	112,500	69,000	85,500	57,000	108,000	54,000	27,000	27,000

Slide 3-87

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2. Given a one-story Group B occupancy of Type VB construction, use IBC Table 506.2 to find the cell that intersects Group B and S1 with Type VB construction to see that 36,000 square feet is the tabular allowable area.

**SPRINKLER INCREASE**

Increase only for automatic sprinkler per NFPA 13, *Standard for the Installation of Sprinkler Systems*.

- 300% increase for one-story buildings.
- 200% increase for multistory buildings.

R-1	NS <sup>a,b</sup>			24,000	16,000	24,000	16,000	20,500	12,000	7,000
	S13R	UL	UL							
	S1	UL	UL	96,000	64,000	96,000	64,000	82,000	48,000	28,000
	SM	UL	UL	72,000	48,000	72,000	48,000	61,500	36,000	21,000
R-2	NS <sup>a,b</sup>			24,000	16,000	24,000	16,000	20,500	12,000	7,000
	S13R	UL	UL							
	S1	UL	UL	96,000	64,000	96,000	64,000	82,000	48,000	28,000
	SM	UL	UL	72,000	48,000	72,000	48,000	61,500	36,000	21,000

Slide 3-88

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3. The area increase allowance for an automatic fire sprinkler is only allowed when the system complies with NFPA 13.
- a. A one-story building is allowed a 300% increase on top of the basic tabular area allowed with no sprinklers.
  - b. A multistory building is allowed a 200% increase.
  - c. Note how Group R-1 and R-2 occupancies have the same tabular area for a building considered to be nonsprinklered as a building provided with a system designed to NFPA 13R. The NFPA 13R system is provided for the life safety of the occupants only, does not provide the same level of protection, and is not intended to prevent a fire from spreading from the building of origin.

**AREA MODIFICATIONS**  
(cont'd)

- Frontage increase where building has more than 25% of perimeter fronting on street or unoccupied space at least 20 feet wide.

Slide 3-89

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- E. Area modifications for frontage increase.
  - 1. Frontage increases are permitted when a building has more than 25% of its perimeter fronting a street or unoccupied space at least 20 feet wide that has access to a public way.

**FRONTAGE**

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Measurement of open spaces from the building to:

- The closest interior lot lines.
- Exterior face of an opposing building located on the same lot, as applicable.
- Where the building fronts on a public way, the entire width of the public way shall be used.

Slide 3-90

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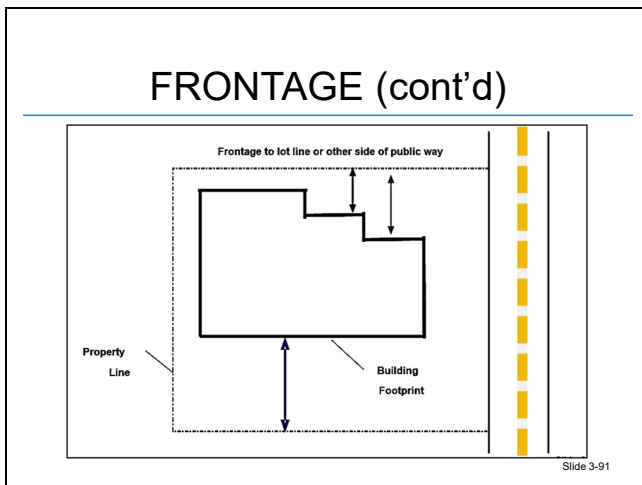
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- 2. Frontage.
  - a. Measurement of open spaces can be yards or public way.
  - b. Yards measured from the building perimeter in all directions to:
    - The closest interior lot lines.
    - The exterior face of an opposing building located on the same lot, as applicable.
  - c. Where the building fronts on a public way, the entire width of the public way shall be used.



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3. Frontage increase formula.

Variables of frontage increase formula.

### FRONTAGE INCREASE

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

Where:

- $I_f$  = area increase (in percent).
- F = building perimeter with not less than 20 feet clearance.
- P = total building perimeter.
- W = minimum clearance width.
  - W must be at least 20 feet and the quantity W/30 cannot exceed 1.

Slide 3-92

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### FRONTAGE INCREASE EXAMPLE

- $I_f = [F/P - 0.25]W/30$ .
- Given all sides have frontage of at least 30 feet and building is 50 feet by 100 feet.
- $I_f = [300/300 - 0.25]30/30$ .
- $I_f = 0.75$ .
- Tabular area is 9,000 square feet.
- $(9,000 \text{ ft}^2)(0.75) = 6,750 \text{ ft}^2$ .

B

D

Slide 3-93

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4. Frontage increase example:

- a. Given a building with dimensions of 50 feet by 100 feet, frontage of 30 feet on all four sides of the building, and the tabular area is 9,000 square feet:
- b. Using the formula for frontage increase:  $I_f = [F/P - 0.25]W/30$ 
  - $I_f = [300/300 - 0.25]30/30$ .
  - $I_f = 0.75$ .
  - Tabular area is 9,000  $\text{ft}^2$ .

-  $(9,000 \text{ ft}^2)(0.75) = 6,750 \text{ ft}^2$ .

### WHEN W VARIES

Use weighted average formula in formula calculations.

Slide 3-94

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5. Variable frontage width: When frontage width varies, the weighted average clearance formula must be used to establish the **W** variable.

### WEIGHTED AVERAGE

$$W = \frac{(L1 \times w1) + (L2 \times w2) + (L3 \times w3) \dots}{F}$$

- W (width: weighted average) = calculated width of public way or open space (feet).
- Ln = length of a portion of the exterior perimeter wall.
- wn = width (>20 feet) of a public way or open space associated with that portion of the exterior perimeter wall.
- F = building perimeter that fronts on a public way or open space having a width of 20 feet or more.

Slide 3-95

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- a. Weighted average. If the frontage on each side of the building is different, the following formula is used for a weighted average that is then used in the frontage increase formula:

$$W = \frac{(L1 \times w1) + (L2 \times w2) + (L3 \times w3) \dots}{F}$$

- b. W (width: weighted average) = calculated width of a public way or open space (feet).
- c. Ln = length of a portion of the exterior perimeter wall.

- d.  $w_n$  = width (> 20 feet) of a public way or open space associated with that portion of the exterior perimeter wall.
- e.  $F$  = building perimeter that fronts on a public way or open space having a width of 20 feet or more.

### VARYING CLEARANCE EXAMPLE

- Building 100 feet by 100 feet.
- Assume clearances:
  - Side A = 25 feet.
  - Side B = 20 feet.
  - Side C = 30 feet.
  - Side D = 10 feet.

The diagram shows a solid square representing a 100-foot by 100-foot building. It is surrounded by a larger dashed square representing the clearance zone. The four sides of the dashed square are labeled: 'A' at the bottom, 'B' on the left, 'C' at the top, and 'D' on the right.

Slide 3-96

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6. Varying clearance example:

- a. A building of 100 feet by 100 feet has clearances between 10 feet and 30 feet on four sides of building.
  - Side A = 25 feet.
  - Side B = 20 feet.
  - Side C = 30 feet.
  - Side D = 10 feet.

### VARYING CLEARANCE EXAMPLE (cont'd)

$$W = \frac{(L1 \times w1) + (L2 \times w2) + (L3 \times w3)}{F}$$

- $W = \frac{(100 \times 25) + (100 \times 20) + (100 \times 30)}{300}$
- $W = 25$  feet
- $I_f = [300/400 - 0.25]25/30$
- $I_f = 0.417$

The diagram shows a solid square representing a 100-foot by 100-foot building. It is surrounded by a larger dashed square representing the clearance zone. The four sides of the dashed square are labeled: 'A' at the bottom, 'B' on the left, 'C' at the top, and 'D' on the right.

Slide 3-97

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- b. Plug in the values of each side that count toward frontage (Side D is < 20 feet and cannot be used):

$$W = \frac{(L1 \times w1) + (L2 \times w2) + (L3 \times w3)}{F}$$

$$W = \frac{(100 \times 25) + (100 \times 20) + (100 \times 30)}{300}$$

- W = 25 feet.
- $I_f = [300/400 - 0.25]25/30$ .
- $I_f = 0.417$ .
- The building can be increased by a factor of 0.417 times the allowable area.

**IF WEIGHTED AVERAGE IS NOT USED ...**

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- Building 100 feet x 100 feet.
- Assume clearances:
  - Side A = 25 feet.
  - Side B = 20 feet.
  - Side C = 30 feet.
  - Side D = 10 feet.
- Clearance would be limited to 20 feet.
  - $I_f = [F/P - 0.25]W/30$ .
  - $I_f = [300/400 - 0.25]20/30$ .
  - $I_f = 0.333$ .

The diagram shows a solid square representing a 100-foot by 100-foot building. It is surrounded by a dashed square representing a 30-foot clearance. The sides of the dashed square are labeled: A (bottom, 25 feet), B (left, 20 feet), C (top, 30 feet), and D (right, 10 feet).

Slide 3-98

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- c. Instead of using the weighted average, the designer can use the smallest frontage measurement between 20 feet and 30 feet.

Example: the same building (100 feet by 100 feet) and the same clearances as before. Clearance would be limited to 20 feet.

- $I_f = [F/P - 0.25]W/30$ .
- $I_f = [300/400 - 0.25]20/30$ .
- $I_f = 0.333$ .
- The building can be increased by a factor of 0.333 times the allowable area.

### ALLOWABLE INCREASES

May employ automatic sprinklers and frontage to compound results.



Slide 3-99

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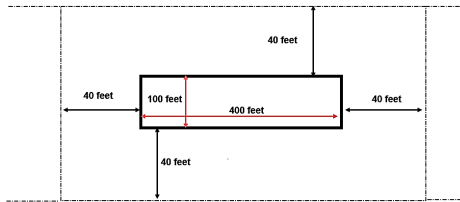
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- F. Compounded area increases.
  - 1. When complete automatic sprinkler protection is provided, and adequate clearances exist, both values may be used to compound allowable increases.

### ALLOWABLE INCREASES EXAMPLE

- One-story office (Group B):
- Unprotected wood-frame construction (Type VB).
  - 40,000 square feet, fully sprinklered.



Slide 3-100

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- 2. Example:
  - a. A one-story office (Group B) of unprotected wood-frame construction (Type VB), 40,000 square feet and fully sprinklered.
  - b. The building has 40 feet of clearance on all sides.



e. Frontage increase.

$$A_f = (0.75)(9,000 \text{ ft}^2) = 6,750 \text{ ft}^2.$$

**ALLOWABLE AREA INCREASE**

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

- $A_t = 36,000$  square feet,  $NS = 9,000$  square feet,  $I_f = 0.75$ .
- $A_a = 36,000 \text{ ft}^2 + (9,000 \text{ ft}^2 \times 0.75)$ .
- $A_a = 42,750$  square feet for one story.
- Maximum allowable area for Group B building Type VB with NFPA 13 sprinkler system.
- Proposed building is 40,000 square feet and complies.

Slide 3-103

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f. By inserting all variables, the calculation results in an allowable area of 42,750 square feet; therefore, 40,000 square feet in the example is within allowable limits based on sprinkler protection and setbacks.

- $A_a = [A_t + (NS \times I_f)]$ .
- $A_t = 36,000 \text{ ft}^2$ ,  $NS = 9,000 \text{ ft}^2$ ,  $I_f = 0.75$ .
- $A_t = 36,000 \text{ ft}^2 + (9,000 \text{ ft}^2 \times 0.75)$ .
- $A_a = 42,750 \text{ ft}^2$  for one story.
- Maximum allowable area for Group B, Type VB with NFPA 13 sprinkler system.

**TOTAL PERMITTED AREA**

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- Tabular area with no increases: 9,000 square feet.
- Frontage only: 15,750 square feet.
- Tabular area with sprinklers: 36,000 square feet.
- Frontage and sprinklers: 42,750 square feet.

Slide 3-104

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- g. The maximum allowable areas for the example would be different depending upon options selected:
  - Tabular area with no increases = 9,000 square feet.
  - Area with frontage only = 15,750 square feet.
  - Tabular area with sprinklers only = 36,000 square feet.
  - Compounded area = 42,750 square feet.

**HEIGHT MODIFICATIONS**

- Automatic sprinkler protection (NFPA 13) increase of one story and 20 feet.
- In Group R (NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*) increase of one story and 20 feet.
- Sprinkler increase restricted in certain occupancies, such as Group H.

Slide 3-105

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- G. Height modifications.
  - 1. Sprinklers can increase the building height by one story and 20 feet.
  - 2. In Group R occupancies, can increase the height by one story and 20 feet using a NFPA 13R design sprinkler system.

Cannot exceed four stories or 60 feet.
  - 3. Sprinkler increase is restricted in some occupancies, such as Group H.

## ALLOWABLE HEIGHT

**TABLE 504.3\*  
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE**

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, B, E, F, M, S, U	NS <sup>2</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
H-1, H-2, H-3, H-5	NS <sup>2,4</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
H-4	NS <sup>2,4</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
I-1 Condition 1, I-3	NS <sup>2,4</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
I-1 Condition 2, I-2	NS <sup>2,4,5</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
I-4	NS <sup>2,4</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	
R	NS <sup>2,3</sup>	UL	160	65	55	65	55	65	50	40	
	S	UL	180	85	75	85	75	85	70	60	

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- IBC Table 504.3 is used to determine the allowable height of a building based on occupancy, type of construction and fire sprinkler protection.

## ALLOWABLE STORIES

**TABLE 504.4\*\*  
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE**

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-1	NS	UL	5	3	2	3	2	3	2	1	
	S	UL	6	4	3	4	3	4	3	2	
A-2	NS	UL	11	3	2	3	2	3	2	1	
	S	UL	12	4	3	4	3	4	3	2	
A-3	NS	UL	11	3	2	3	2	3	2	1	
	S	UL	12	4	3	4	3	4	3	2	
A-4	NS	UL	11	3	2	3	2	3	2	1	
	S	UL	12	4	3	4	3	4	3	2	
A-5	NS	UL	UL	UL	UL	UL	UL	UL	UL	UL	
	S	UL	UL	UL	UL	UL	UL	UL	UL	UL	
B	NS	UL	11	5	3	5	3	5	3	2	
	S	UL	12	6	4	6	4	6	4	3	
E	NS	UL	5	3	2	3	2	3	1	1	
	S	UL	6	4	3	4	3	4	2	2	

Slide 3-107

- IBC Table 504.4 is used to determine the number of allowable stories based on occupancy, type of construction and installation of a fire sprinkler system.

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## ACTIVITY 3.2

### Area and Height

#### Purpose

Determine the maximum allowable areas and heights of a structure.

#### Directions

1. Work at your table groups in teams of two for 30 minutes.
2. Using your code and the provided submitted plan documents, complete the Plans Review Checklist, Section B (1), (2) and (4) found in the Student Manual (SM) Appendix B: Job Aid: Plans Review Checklist.
3. Using the revised code analysis found in Unit 2: Site Plans: Emergency Access and Water Supply, Appendix A: Updated Code Analysis, verify if the **maximum** allowable area and heights are compliant. You will need to use the formula for allowable area as well as the formulas for frontage increase and weighted average to complete this step.
4. Be prepared to explain your answers.
5. Work individually to generate at least one question you would ask the applicant to request clarification regarding area and height, and add it to your submittal letter template found in SM Appendix A: Canterbury Submittal Letter Template.

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**X. COMPARTMENTATION**

- A. Compartmentation is related to the three primary goals of fire safety concepts.
  - 1. Life safety.
  - 2. Property conservation.
  - 3. Operational continuity.
- B. Passive or active protection?

**FIRE AREA**

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- The aggregate floor area enclosed and bounded by fire walls, fire barriers, and exterior walls and horizontal assemblies of a building.
- Employed as a sprinkler option for some areas and occupancies.

Slide 3-109

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- C. Fire area is a fire safety concept to break a building into separate compartments. Fire area can either be an entire building or portions of a building separated by fire-rated construction.
  - 1. Fire area: the aggregate floor area enclosed and bounded by fire walls, fire barriers, and exterior walls and horizontal assemblies of a building.

Areas of a building not provided with surrounding walls shall be included in the fire area if areas are included within the horizontal projection of the roof or the floor above.
  - 2. In most occupancies, fire sprinklers are required based on the size of the fire area. A building may have multiple fire areas before sprinklers are required.
    - a. Fire areas are separated by fire barriers or horizontal assemblies with a fire-resistance rating specified by code requirements.
      - For example, commercial parking garages used for storing commercial trucks or buses where the fire area exceeds 5,000 square feet require sprinklers.


- b. A 20,000 square-foot commercial parking garage could have four fire areas of 5,000 square feet separated by two-hour fire barriers and not require sprinklers.

**FIRE WALL**

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A fire-resistant wall:

- Has protective openings, restricts fire spread.
- Extends continuously from foundation to or through the roof.
- Creates structural independence.



Slide 3-110

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D. Fire walls are used to define separate buildings, or to allow a building to be constructed closer to the property line or another building (IBC 706).

1. A fire wall is a fire-resistant-rated wall, having protective openings when required.
2. Restricts the spread of fire.
3. Extends continuously from the foundation to or through the roof.
4. Has sufficient structural **independence** under fire conditions to allow the collapse of construction on either side without the collapse of the wall.
5. May be designed and constructed in accordance with NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*.
6. A building separated by fire walls may have each section considered as a separate building. Fire walls are sometimes used to make a larger structure or separate an addition of different construction.

Example: A business office building of 18,000 square feet could be separated by a three-hour fire wall into two separate buildings of 9,000 square feet, each of Type VB construction to comply with the allowable area.

**PARTY WALL**

- Fire wall on a lot line between adjacent buildings, used for joint service between two buildings.
- No openings.
- Creates separate buildings.



Slide 3-111

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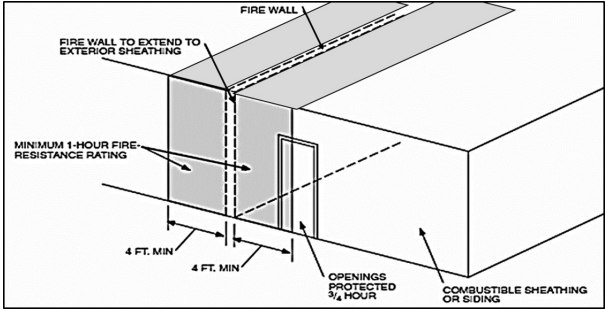
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7. Party wall (IBC 706.1.1).
- a. A fire wall on an interior lot line, used for joint service between two buildings.
  - b. No openings allowed in a party wall due to distance to property line.
  - c. Constitutes separate buildings, although they may be under the same roof.

**HORIZONTAL CONTINUITY**



Slide 3-112

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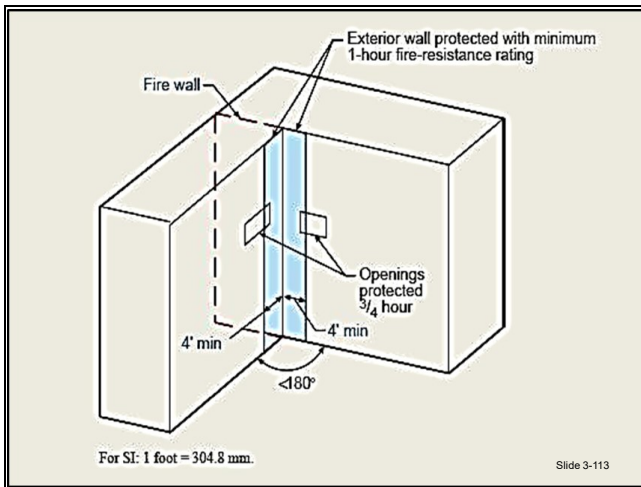
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8. Horizontal continuity ensures that fire will not extend from one side of the building to the other. A fire wall must meet one of the following conditions:
- a. A fire wall is continuous from exterior wall to exterior wall and extends at least 18 inches beyond the exterior surface of the exterior walls.

- b. A fire wall terminates at the interior surface of combustible exterior sheathing or siding, provided that the exterior wall has a fire-resistance rating of at least one hour for a horizontal distance of at least 4 feet on both sides of the fire wall.
  - Any openings in exterior walls are protected by three-fourths-hour opening protectives.
- c. A fire wall terminates at the interior surface of noncombustible exterior sheathing, exterior siding or other noncombustible exterior finishes, provided that sheathing, siding or other exterior noncombustible finish extends a horizontal distance of at least 4 feet on both sides of the fire wall.
- d. A fire wall terminates at the interior surface of noncombustible exterior sheathing where the building on each side of the fire wall is protected by an automatic sprinkler system.



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- 9. Vertical continuity in the form of a parapet above the roof ensures that a fire will not extend from one side of the fire wall to the other.
  - a. A fire wall typically extends 30 inches above both adjacent sides of the roof.
  - b. A parapet is not required for walls of two hours or less provided that the roof is protected on both sides of the fire wall with fire-resistive construction and Class B roof covering.
- 10. Preventing the spread of fire through static provisions of building code involves the construction of fire walls and other types of fire-resistive construction to prevent the spread of fire and its products of combustion from one fire area to another.

Code establishes fire-resistive construction first, then adds other fire protection methods as the building gets larger or the occupancy becomes more susceptible to hazards.

**XI. EXTERIOR WALLS**

**EXTERIOR WALLS**

- Building codes establish the fire-resistance rating of exterior walls.
- Openings are regulated.



Slide 3-114

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- A. Building code sets forth the fire-resistance rating of exterior walls.
- B. Ratings depend upon construction type, occupancy and distance to the property line or another building.
- C. Area and type of openings are regulated.
  - 1. No openings are allowed within 3 feet of the interior property line.
  - 2. Percentage of openings allowed in an exterior wall increases as distance from the property line increases.
  - 3. Slide 3-113 shows two buildings constructed adjacent to each other. Each wall is on the property line and has a fire wall with no openings.

## EXTERIOR WALL FIRE SEPARATION DISTANCE

- Fire separation distance.
  - Distance measured from the building face to one of the following:
    - Lot line.
    - Centerline.
    - An imaginary line.
  - Distance measured at right angles from the face of the wall.

Slide 3-115

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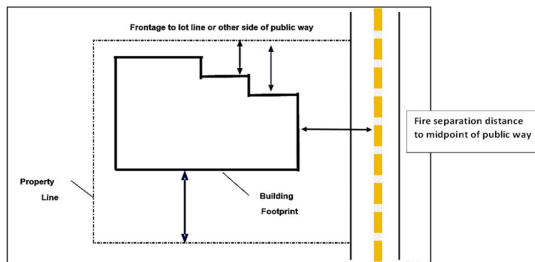
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D. Fire separation distance.

1. The distance measured from the building face to one of following:
  - a. The closest interior **lot line**.
  - b. The centerline of a **street, alley or public way**.
  - c. An imaginary line between **two buildings on the lot**.
2. Distance shall be measured at right angles from the face of the wall.

## EXTERIOR WALL FIRE SEPARATION DISTANCE (cont'd)

- Measured to lot line or midpoint of public way.



Slide 3-116

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E. The measurement of fire separation distance is very similar to the measurement used for frontage increase.

Fire separation distance is measured to the midpoint of a public way and frontage is measured to the far side of a public way.

## EXTERIOR WALL RATINGS

- Based on **construction type**.

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame <sup>a</sup> (see Section 202)	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	HT	1	0
Bearing walls									
Exterior <sup>a, f</sup>	3	2	1	0	2	2	2	1	0
Interior	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	1/HT	1	0
Nonbearing walls and partitions	See Table 602								
Exterior	See Table 602								
Nonbearing walls and partitions							See Section 602.4.6		
Interior <sup>d</sup>	0	0	0	0	0	0		0	0
Floor construction and associated secondary members (see Section 202)	2	2	1	0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1 1/2 <sup>b</sup>	1 <sup>b, e</sup>	1 <sup>b, e</sup>	0 <sup>e</sup>	1 <sup>b, e</sup>	0	HT	1 <sup>b, e</sup>	0

Slide 3-117

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- F. The rating for an exterior wall is determined by either construction type or fire separation distance.
- The construction type table specifies ratings of structural elements of a building. The second row in the table specifies ratings for bearing walls.
  - The following row tells the user to go to IBC Table 602 for the fire separation distance for nonbearing exterior walls.

## EXTERIOR WALL RATINGS (cont'd)

- Based on **fire separation distance, construction type and occupancy group**.

FIRE SEPARATION DISTANCE <sup>a</sup> X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP <sup>b</sup>	OCCUPANCY GROUP F-1, M, S-1 <sup>c</sup>	OCCUPANCY GROUP A, B, E, F-2, I, R, S-2, U
X < 5 <sup>b</sup>	All	3	2	1
5 ≤ X < 10	IA	3	2	1
	Others	2	1	1
10 ≤ X < 30	IA, IB	2	1	1 <sup>c</sup>
	IB, VB	1	0	0
	Others	1	1	1 <sup>c</sup>
X ≥ 30	All	0	0	0

Slide 3-118

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- G. The table for exterior wall protection is **based on fire separation distance, construction type and occupancy group**.

Example: Group A occupancy is to be built of Type VA construction, and a nonbearing wall is located 15 feet from the property line. According to the table, the exterior wall is required to be constructed with a fire-resistance rating of at least one hour.

## FIRE WALL ON PROPERTY LINE

Two buildings on property line can have one shared party wall or two separate fire walls.

**TABLE 706.4  
FIRE WALL FIRE-RESISTANCE RATINGS**

GROUP	FIRE-RESISTANCE RATING (hours)
A, B, E, H-4, I, R-1, R-2, U	3 <sup>a</sup>
F-1, H-3 <sup>b</sup> , H-5, M, S-1	3
H-1, H-2	4 <sup>b</sup>
F-2, S-2, R-3, R-4	2

a. In Type II or V construction, walls shall be permitted to have a 2-hour fire-resistance rating.  
b. For Group H-1, H-2 or H-3 buildings, also see Sections 415.7 and 415.8.

Slide 3-119

### H. Fire wall on a property line.

When two buildings are constructed up to the property line, fire protection can be provided with either:

1. A fire wall on each building with the fire-resistance rating specified in IBC Table 602.
2. A party wall may be shared between the buildings with the fire-resistance rating specified in IBC Table 706.4.

## OPENINGS IN EXTERIOR WALLS

Openings limited in exterior walls depending on protected versus unprotected openings, sprinkler system, fire separation distance.

**MAXIMUM AREA OF EXTERIOR WALL OPENINGS BASED ON  
FIRE SEPARATION DISTANCE AND DEGREE OF OPENING PROTECTION**

FIRE SEPARATION DISTANCE (ft) <sup>a</sup>	DEGREE OF OPENING PROTECTION		ALLOWABLE AREA <sup>a</sup>
0 to less than 3 <sup>b,c</sup>	Unprotected, Nonsprinklered (UP, NS)		Not Permitted <sup>d</sup>
	Unprotected, Sprinklered (UP, S)		Not Permitted <sup>d</sup>
	Protected (P)		Not Permitted <sup>d</sup>
3 to less than 5 <sup>d,e</sup>	Unprotected, Nonsprinklered (UP, NS)		Not Permitted
	Unprotected, Sprinklered (UP, S)		15%
	Protected (P)		15%
5 to less than 10 <sup>f,g</sup>	Unprotected, Nonsprinklered (UP, NS)		10% <sup>h</sup>
	Unprotected, Sprinklered (UP, S)		25%

Slide 3-120


### I. Openings in exterior walls are regulated when the fire separation distance is less than 30 feet (IBC Table 705.8).

1. The area of the openings may be increased when the fire separation distance is greater.
2. The area of the protected openings may be more than unprotected openings.

3. The area of the openings may be increased when the building is sprinklered.
4. If a wall is not required to be rated otherwise, openings may be unprotected and unlimited.

### EXTERIOR WALL RATINGS (cont'd)

- Fire separation distance measured to midpoint of right of way (IBC Table 602).
- Rating of exterior bearing wall (IBC Table 601).
- Wall openings (IBC Table 705.8).



Slide 3-121

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5. A building protected by a sprinkler system may use a water curtain to protect openings. (Only an NFPA 13 system.)
6. The first story wall of a street-facing building having 15 feet fire separation distance may have unlimited protected openings.
7. The area of the openings is calculated per wall per story.
8. Slide 3-120 shows two buildings separated by an alley with a width of 10 feet. Each wall is on the property line and has a fire wall with protected openings

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### ACTIVITY 3.3

#### Fire Walls

##### Purpose

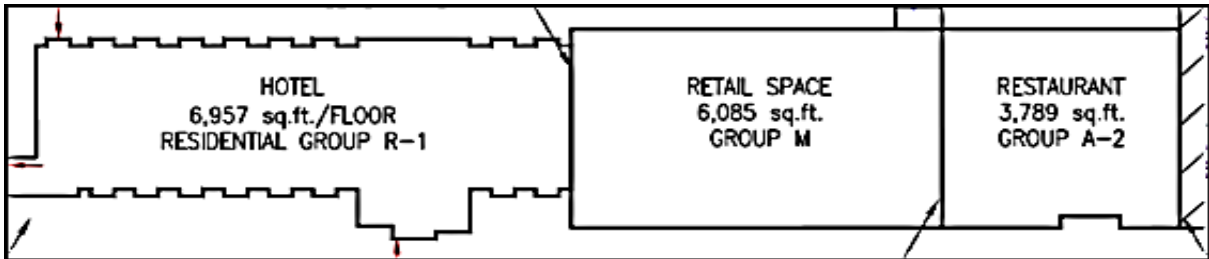
Determine the proper fire wall separations.

##### Directions

Work at your table groups in teams of two.

##### Part 1

1. You will have 15 minutes to complete Part 1.
2. Using your code and the example plan graphic shown here (same from Activity 3.1), determine the proper fire wall rating to separate the project into three separate buildings (hotel, retail and assembly). The three buildings are to be built of Type VB construction.



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3. Be prepared to explain your answers.

**Part 2**

1. Work for 30 minutes on Part 2 to review the **Canterbury** submitted plan documents for the exterior wall protection and complete the following.

2. Measure the fire separation distance on each side of the building, and answer the following questions:

a. For the given occupancy and construction type, what is the minimum fire separation distance that will not require fire-resistance rated walls?

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b. Which, if any, of the exterior walls have fire separation distance that requires fire-resistance rated walls?

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c. For the given type of construction, which exterior walls are required to have fire-resistance construction, and what is the required rating?

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3. Work individually to generate at least three questions to add to the submittal letter template requesting clarification from the applicant, which can be found in SM Appendix A.

a. What information will be required from the designer regarding the exterior walls?

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- b. What information will be required in the building construction drawings to support the type of construction?

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**XII. FIRE-RESISTANCE RATED ASSEMBLIES**

**FIRE BARRIERS**

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- Wall intended to restrict fire spread.
- Used in:
  - Shaft enclosures, interior exits or exit passageways.
  - Horizontal exits, atriums.
  - Incidental use and control areas.
  - Occupancy separations.
  - Fire area separations.

Slide 3-124

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- A. Fire barriers.
1. Fire-resistant wall assembly designed to restrict fire spread.  
Collapse design not included.
  2. Wall extends from the top of the slab or floor/ceiling assembly below to the underside of the floor or roof sheathing, slab, or deck above.
  3. Supporting construction to be fire-resistance rated except for nonrated construction.
  4. Used for:
    - a. Shaft enclosures.
    - b. Interior exit stairways and ramps.
    - c. Exit passageways.
    - d. Horizontal exits.
    - e. Atriums.
    - f. Incidental use.
    - g. Control areas.
    - h. Separated occupancies.
    - i. Separating occupancies into fire areas (e.g., for sprinkler purposes).

## FIRE PARTITIONS

- A fire-resistive wall designed to separate occupancies/tenants/corridors.
- Wall extends from slab top to deck, unless floor/ceiling or roof/ceiling is fire-rated.

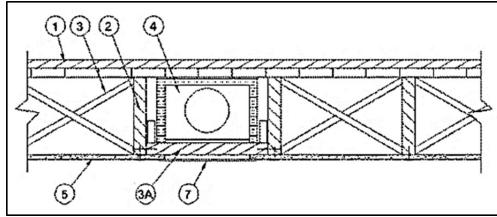
Slide 3-125

B. Fire partitions.

1. A fire-resistive wall designed to separate occupancies/tenants/corridors.
2. Wall extends from the top of the slab or floor/ceiling assembly below to:
  - a. The underside of the floor or roof sheathing, slab, or deck above, or fire-resistance rated floor/ceiling or roof/ceiling if fire rated.
  - b. Nonrated construction may have fireblocking or draft stops instead.
3. Supporting construction to be fire-resistance rated except for certain instances.
4. Used for:
  - a. Tenant spaces in mall buildings.
  - b. Corridors.
  - c. Elevator lobby separation.
  - d. Egress balcony separation.
  - e. Separation between dwelling units or sleeping rooms and their contiguous spaces.

## HORIZONTAL ASSEMBLIES

Floor or floor/ceiling assembly intended to prevent vertical fire spread.



Slide 3-126

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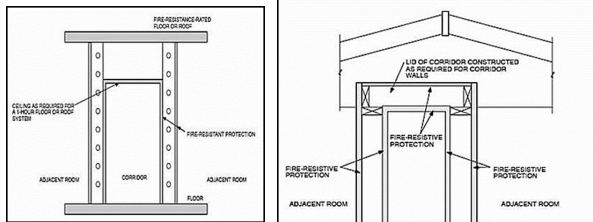
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### C. Horizontal assemblies.

1. A fire-resistance rated floor or **roof assembly** of materials designed to restrict the vertical spread of fire in which continuity is maintained.
2. Used for:
  - a. Occupancy separation.
  - b. Separating fire areas.
  - c. Dwelling unit and sleeping room separation.
  - d. Smoke compartments.
  - e. Incidental use areas.
  - f. Fire-resistance rated construction (e.g., Type VA requires floor assembly of one hour).

## CORRIDOR CONSTRUCTION



Slide 3-127

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D. Corridor construction.

1. Exit access corridors are required to have either a half-hour or one-hour separation, depending on occupancy and number of occupants.
2. A corridor is not considered an exit passageway or exit; it is part of exit access.
3. A rated corridor may extend through the rated floor or roof deck above, or to a corridor ceiling of materials as required as part of a one-hour floor or roof assembly. Walls extend through to a rated floor or roof, or to a ceiling assembly constructed as required for a corridor wall.

**SMOKE BARRIER/PARTITION**

- A continuous membrane designed to restrict the movement of smoke.
- One-hour fire rated.
- Examples: health care, correctional, educational.

Slide 3-128

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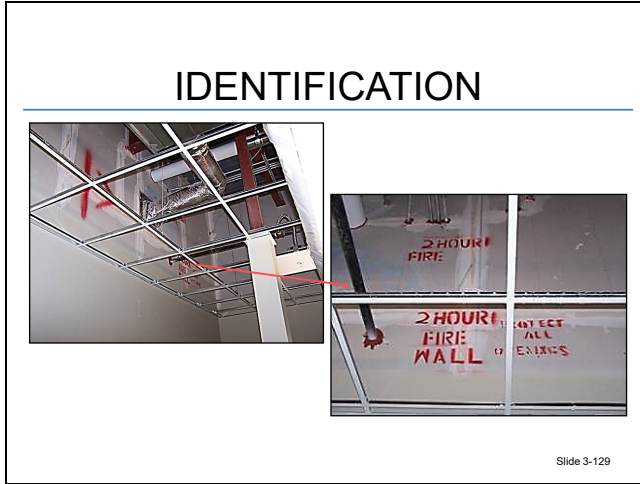
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E. Smoke barrier or partition.

1. A continuous membrane, either vertical or horizontal, such as a wall, floor or ceiling assembly that is designed to restrict movement of smoke.
2. Continuous from outside wall to outside wall when used to separate smoke compartments. Terminates at fire barrier when used to enclose an area of refuge or elevator lobby.
3. Continuity required from the top of the foundation or floor/ceiling below to the floor or roof deck above.
4. Supporting construction rated except for nonrated construction.
5. One-hour fire rated.
6. Examples of use include health care, correctional and educational occupancies where walls are used to separate smoke compartments or to create areas of refuge.



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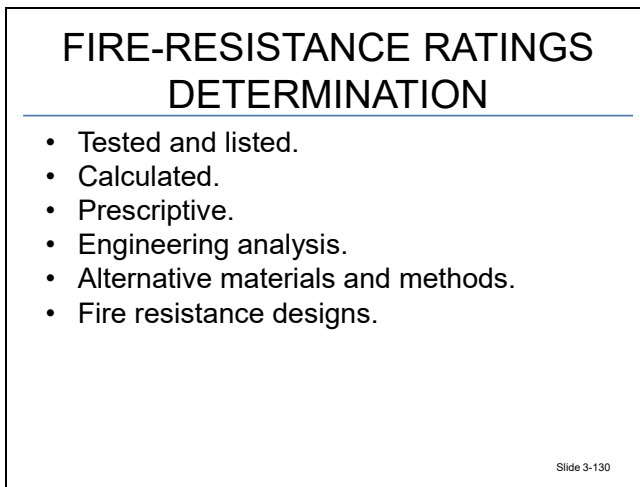
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F. Marking and identification of fire-resistance rated walls.

1. An accessible concealed floor, floor/ceiling or **attic** space, or wall required to have protected openings or penetrations shall be effectively and permanently identified with signs or stenciling in the concealed space.
2. Be located within 15 feet of each end wall and at intervals not exceeding 30 feet horizontally along the wall or partition.
3. Lettering at least 3 inches high in a contrasting color stating “FIRE AND/OR SMOKE BARRIER — PROTECT ALL OPENINGS” or other wording.



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G. Fire-resistance ratings determination:

1. Tested and listed.
2. Calculated.

3. Prescriptive.
4. Engineering analysis.
5. Alternative materials and methods.
6. Fire resistance designs.

**TESTED AND LISTED**

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- ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*.
- Underwriters Laboratories (UL) 263, *Standard for Fire Tests of Building Construction and Materials*.
- Provides testing and acceptance criteria.

Slide 3-131

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H. Tested and listed, or by accepted method.

1. ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*.
2. UL 263, *Standard for Fire Tests of Building Construction and Materials*.
3. Both documents provide testing and acceptance criteria to list assemblies.
4. Assemblies may be generic or proprietary with specific products.

**CALCULATED FIRE RESISTANCE**

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- Procedures where a specific material's or combination of materials' fire resistance is established by calculations.
- Procedures contained in building code.
- Steel assemblies calculated according to American Society of Civil Engineers (ASCE) 29, *Standard Calculation Methods for Structural Fire Protection*.

Slide 3-132

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- I. Calculated fire resistance.
  - 1. Procedures where fire resistance of a specific material or combination of materials is established by calculations.
  - 2. Procedures contained in building code.
    - a. For example, 5/8 inch, Type X gypsum wall board worth 40 minutes, wood studs spaced 16 inches on center worth 20 minutes, and mineral wool insulation inside wood studs worth 15 minutes.
    - b. A designer could show a calculated fire resistance of a fire barrier of 115 minutes on plans by following instructions in the code.
  - 3. Calculated fire resistance of steel assemblies permitted in accordance with Chapter 5 of American Society of Civil Engineers (ASCE) 29, *Standard Calculation Methods for Structural Fire Protection*.

**PRESCRIPTIVE FIRE  
RESISTANCE**

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Prescriptive details of fire-resistance rated building elements, components or assemblies.

Slide 3-133

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- J. Prescriptive fire resistance.
  - 1. Building code contains prescriptive details of fire-resistance rated building elements, components or assemblies.

## PRESCRIPTIVE ASSEMBLIES

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>a</sup> (inches)			
			4 hour	2 hour	1 hour	1/2 hour
1. Brick of clay or shale	1-1.1	Solid brick of clay or shale <sup>b</sup>	6	4.9	3.8	2.7
	1-1.2	Hollow brick, not filled.	5.0	4.3	3.4	2.3
	1-1.3	Hollow brick unit wall, grove or filled with perlite vermiculite or expanded shale aggregate.	6.6	5.5	4.4	3.0
	1-2.1	4" nominal thick units at least 75 percent solid backed with a hat-shaped metal furring channel 1/4" thick formed from 0.021" sheet metal attached to the brick wall on 24" centers with approved fasteners, and 1/2" Type X gypsum wallboard attached to the metal furring strips with 1"-long Type 3 screws spaced 8" on center.	—	—	3 <sup>c</sup>	—
2. Combination of clay brick and load-bearing hollow clay tile	2-1.1	4" solid brick and 4" tile (at least 40 percent solid).	—	8	—	—
	2-1.2	4" solid brick and 8" tile (at least 40 percent solid).	12	—	—	—
3. Concrete masonry units	3-1.1 <sup>d</sup>	Expanded slag or perlite.	4.7	4.0	3.2	2.1
	3-1.2 <sup>e</sup>	Expanded clay, shale or slate.	5.1	4.4	3.6	2.6
	3-1.3 <sup>f</sup>	Limestone, clinker or air-cooled slag.	5.9	5.0	4.0	2.7
4. Solid concrete <sup>g</sup>	4-1.1	Calcareous or siliceous gravel.	6.2	5.3	4.2	2.8
		Siliceous aggregate concrete.	7.0	6.2	5.0	3.5
		Carbonate aggregate concrete.	6.6	5.7	4.6	3.2
		Sand-lightweight concrete.	5.4	4.6	3.8	2.7
		Lightweight concrete.	5.1	4.4	3.6	2.5

Slide 3-134

- Several tables contain descriptions of specific methods to protect structural members and specific rated assemblies.

## ENGINEERING ANALYSIS

- Based on comparison of building element designs having fire-resistance ratings.
- ASTM E119.

Slide 3-135

- Engineering analysis.

Based on comparison of building element designs having fire-resistance ratings, determined by test procedures in ASTM E119.

### ALTERNATIVE MATERIALS AND METHODS

- Complies with the intent of the code.
- The material, method or work is for the purpose intended.
- Equivalent in quality, strength, effectiveness, fire resistance, durability and safety.
- Building official shall respond in writing, stating reasons if not approved.

Slide 3-136

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L. Alternative materials and methods.

1. Proposed design complies with the intent of the provisions of their code.
2. Material, method or work is for the purpose intended.
3. Equivalent of the code in quality, strength, effectiveness, fire resistance, durability and safety.
4. If it is not approved, the building official shall respond in writing, stating reasons why the alternative was not approved.

### FIRE-RESISTANCE DESIGNS

- Certified by approved agency.
- Designs documented in approved sources.
- Gypsum Association, *Fire Resistance and Sound Control Design Manual*.
- American Wood Council.

Slide 3-137

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M. Fire-resistance designs are certified by an approved agency, and the designs are documented in approved sources.

1. Gypsum Association, *Fire Resistance and Sound Control Design Manual*.
2. American Wood Council.

## SUPPORT FOR FIRE-RATED ASSEMBLIES

Must be supported by construction at least equal to the rating of the assembly.

Slide 3-138

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N. Support for fire-rated assemblies.

In most circumstances, fire-resistance rated assemblies are required to be supported by construction equal to the rating of the assembly.

### XIII. OPENINGS AND PENETRATIONS

## OPENINGS AND PENETRATIONS

Protect openings and penetrations of fire-rated assemblies.

- Doors and windows.
- Shafts.
- Ducts.
- Utilities.
- Electrical cables and wiring.

Slide 3-139

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A. Background:

1. Fire-resistance rated buildings need openings and penetrations for access:
  - a. Into and through the building.
  - b. To mechanical, plumbing, electrical and other systems.
2. To maintain building fire protection:

Openings and penetrations must be protected by sealing in or some other way.

**OPENING PROTECTION**

TABLE 716.5  
OPENING FIRE PROTECTION ASSEMBLIES, RATINGS AND MARKINGS

TYPE OF ASSEMBLY	REQUIRED WALL ASSEMBLY RATING (hours)	MINIMUM FIRE DOOR AND SHUTTER ASSEMBLY RATING (hours)	DOOR VISION PANEL SIZE*	FIRE-RATED GLAZING MARKING DOOR VISION PANEL*	MINIMUM SIDELIGHT/TRANSOM ASSEMBLY RATING (hours)		FIRE-RATED GLAZING MARKING SIDELIGHT/TRANSOM PANEL	
					Fire protection	Fire resistance	Fire protection	Fire resistance
Fire walls and fire barriers having a required fire-resistance rating greater than 1 hour	4	3	See Note b	D-H-W-240	Not Permitted	4	Not Permitted	W-240
	3	3 <sup>1</sup> / <sub>2</sub>	See Note b	D-H-W-180	Not Permitted	3	Not Permitted	W-180
	2	1 <sup>1</sup> / <sub>2</sub>	100 sq. in.	≤100 sq. in. = D-H-90 >100 sq. in. = D-H-W-90	Not Permitted	2	Not Permitted	W-120
	1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub>	100 sq. in.	≤100 sq. in. = D-H-90 >100 sq. in. = D-H-W-90	Not Permitted	1 <sup>1</sup> / <sub>2</sub>	Not Permitted	W-90
Enclosures for shafts, interior exit stairways and interior exit ramps.	2	1 <sup>1</sup> / <sub>2</sub>	100 sq. in.	≤100 sq. in. = D-H-90 > 100 sq. in. = D-H-T-W-90	Not Permitted	2	Not Permitted	W-120
Horizontal exits in fire walls*	4	3	100 sq. in.	≤100 sq. in. = D-H-180 > 100 sq. in. = D-H-W-240	Not Permitted	4	Not Permitted	W-240
	3	3 <sup>1</sup> / <sub>2</sub>	100 sq. in.	≤100 sq. in. = D-H-180 > 100 sq. in. = D-H-W-180	Not Permitted	3	Not Permitted	W-180

Slide 3-140

B. Opening protection requirements are dependent on the type of fire-resistance rated assembly and rating (IBC Table 716.5).

1. Look in the first column for appropriate fire-rated assembly.
2. Look in the second column for rating.
3. Follow the row across to the type of opening protective to find the needed assembly rating.

**FIRE DOOR ASSEMBLIES**

- Listed components installed in correct fashion.
  - Door label will indicate class and hourly rating.
    - Traditional rating of doors was by Class A to E.
  - Frame label may only indicate that it is a rated fire door frame.

Slide 3-141

C. Fire door assemblies.

1. Fire door rating may be lower than the wall rating in which it is located.
  - a. This is because the fuel load in a room is typically located away from the door.

- b. If an existing fire door is no longer needed and items are placed against the door, it should be replaced with construction equivalent to the wall assembly.
- 2. Listed components include door, frame, hardware and door closer:
  - a. Door label will indicate class and hourly rating.
  - b. Frame label may indicate only that it is a rated fire door frame — most metal frames are interchangeable.

**FIRE DOOR ASSEMBLIES**  
(cont'd)

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- All doors required to be rated must be self-closing and self-latching.
- Some codes permit rated doors to be connected to hold-open devices connected to the fire alarm system.
- Door schedule must specify class and/or hourly rating.

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- 3. All doors required to be rated must be self-closing and self-latching.
- 4. Some codes permit rated doors to be connected to hold-open devices linked to the fire alarm system.
- 5. Door schedule must specify class and/or hourly rating.

**FIRE DOOR CLASSES**

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Class rating: Traditional method.

- A: fire walls and in walls that divide a single building into fire areas.
- B: enclosures of vertical openings or two-hour horizontal fire-rated separations.



Slide 3-143

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- 6. Fire door classes, traditional method.
  - a. Class A: fire walls and in walls that divide a single building into fire areas.
  - b. Class B: enclosures of vertical openings or two-hour horizontal fire-rated separations.

**FIRE DOOR CLASSES (cont'd)**

- C: walls or partitions between rooms and corridors rated at one hour or less.
- D: exterior walls subject to severe fire exposure.
- E: exterior walls subject to moderate or light fire exposure.



Slide 3-144

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- c. Class C: walls or partitions between rooms and corridors rated at one hour or less.
- d. Class D: exterior walls subject to severe fire exposure from outside the building.
- e. Class E: exterior walls subject to moderate or light fire exposure from outside the building.

**FIRE DOOR RATINGS**

- NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, now uses fire protection rating of fire doors.
  - Hourly designation indicates duration of fire test exposure.
- Fire protection rating determines the use of the door.

Slide 3-145

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- 7. Fire door ratings.

- a. NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, now uses the fire protection rating of fire doors.
- b. Hourly designation indicates the duration of fire test exposure.
- c. Fire protection rating determines the use of the door.

### DOOR RATING IN ASSEMBLY

Wall Rating	Door and Frame Rating	Description and Use
1/2 hour, 1 hour	1/2 hour, 1/3 hour	Where smoke and draft control is primary consideration; protection between habitable space and corridor or across corridors where smoke barrier is required.
1 hour	3/4 hour	Exterior wall has the potential to be exposed to moderate to light fire from the exterior of the building.
2 hour	1 1/2 hour	Potential for severe fire exposure from the exterior of the building.
1 hour	3/4 hour	For use where there are openings in corridors or room partitions.
1 hour	1 hour	Assemblies divide occupancies in a building.
2 hours	1 1/2 hours	Enclosures of vertical communication or egress through buildings, such as stairwells and elevator shafts.
4 hours	3 hours	Walls that separate buildings or that divide a large building into smaller fire areas.

Slide 3-146

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Wall Rating	Door and Frame Rating	Description and Use
1/2 hour, 1 hour	1/2 hour, 1/3 hour	Where smoke and draft control is the primary consideration; protection between habitable space and a corridor or across corridors where smoke barrier is required.
1 hour	3/4 hour	Exterior wall that has the potential to be exposed to moderate to light fire from the exterior of the building.
2 hour	1 1/2 hour	Potential for severe fire exposure from the exterior of the building.
1 hour	3/4 hour	For use where there are openings in corridors or room partitions.
1 hour	1 hour	Assemblies divide occupancies in a building.
2 hours	1 1/2 hours	Enclosures of vertical communication or egress through buildings, such as stairwells and elevator shafts.
4 hours	3 hours	Walls that separate buildings or that divide a large building into smaller fire areas.

## FIRE DOOR HARDWARE

All fire doors must be equipped with proper rating and hardware.



Slide 3-147

### 8. Fire door hardware

- a. All fire doors must be equipped with proper rating and hardware.
- b. May be either **builders' hardware** or **fire exit hardware**.
  - Hinges and pivots.
  - Door bolts.
  - Locks or latches.
  - Exit devices.
  - Door closers, protection plates.
  - Astragals.
  - Gasketing.

## DOOR LABEL FOR HARDWARE

- Door is manufactured for fire exit hardware.
- Do not put fire exit hardware on any fire door.




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9. Door label for hardware.

Fire doors are not all designed to have fire exit hardware installed. The door has not been tested with the fire exit hardware, and the interior of the door may not have the structural stability to support the fastening of the fire exit hardware.

**PENETRATIONS**

- Fire-rated wall and smoke-barrier penetrations must be sealed properly.
- Sealing methods and exceptions.



Slide 3-149

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D. Penetrations of fire-resistant rated walls and horizontal assemblies.

1. Building codes provide requirements for protecting membrane penetrations and through penetrations.
2. Membrane penetration is through one side of the assembly. Through penetration goes entirely through the assembly.
3. Fire-rated wall and smoke-barrier penetrations must be sealed properly.

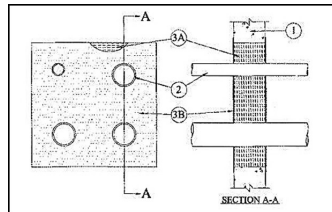
The sealing method must be a listed through-penetration firestop system.

4. Membrane-penetration firestop system and through-penetration firestop system are listed assemblies.
  - a. The product is not the listed assembly; the use of the product is in a listed assembly.
  - b. T-Rating is the time period that **penetration firestop system** limits maximum temperature rise to 325 F (163 C) above its initial temperature through penetration on the nonfire side when tested in accordance with ASTM E814, *Standard Test Method for Fire Tests of Penetration Firestop Systems*, or UL 1479, *Standard for Fire Tests of Penetration Firestops*.

- c. F-Rating is the time period that a **through-penetration firestop system** limits the spread of fire through penetration when tested in accordance with ASTM E814 or UL 1479.
- d. T-Rating is required for penetrations through a wall, while both T-Rating and F-Rating are required when penetrating a horizontal assembly. Some exceptions apply.
  - Exceptions provided for:
    - Metal piping in concrete or masonry walls.
    - Electrical boxes.
    - Other specific conditions.

**INFORMATION REQUIRED**

Plans must indicate how structural and fire-resistance integrity will be maintained where a penetration occurs.



Slide 3-150

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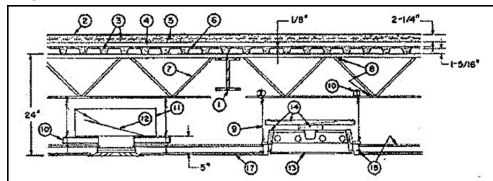
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**FIRE-RESISTIVE CONSTRUCTION**

Assemblies: Combination of components that, when designed and installed correctly, provide a specific degree of fire-resistance rating.



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E. Structural and fire-resistance integrity information required.

1. Information is required on plans, but many architects will request a deferred submittal from the contractor.
2. Indicates how structural and fire-resistance integrity will be maintained where a penetration of a required fire-resistant wall, floor or partition will be made for electrical, gas, mechanical, plumbing, and communication conduits, pipes and systems.

The sealing method must be a listed through-penetration firestop system.

- a. T-Rating for amount of time during the test.
  - b. F-Rating for flame.
3. Exceptions provided for metal piping in concrete or masonry walls.
  4. Exceptions provided for electrical boxes.
  5. Other exceptions may be provided.

**XIV. DRAFTSTOPPING**

**DRAFTSTOPPING**

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A material, device or construction installed to restrict air movement within open spaces of concealed areas.

- Crawlspace.
- Floor/Ceiling assemblies.
- Roof/Ceiling assemblies.
- Attics.

Slide 3-152

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- A. A material, device or construction installed to restrict the movement of air within the open spaces of concealed areas of building components.
  1. Crawl spaces, floor/ceiling assemblies, roof/ceiling assemblies and attics.
  2. Draftstopping will generally provide about 15 minutes of fire resistance.

### TYPICAL SPACING

- Every 3,000 square feet in attic space.
- Every 1,000 square feet in floor/ceiling space.
- In multifamily residential — in line with each tenant separation.
- None required if attic sprinklered.

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B. Typical spacing.

1. Every 3,000 square feet in attic space.
2. Every 1,000 square feet in floor/ceiling space.
3. In multifamily residential — in line with each tenant separation or every two dwelling units.
4. If attic is sprinklered, none required.

(Old rule was every 9,000 square feet with sprinkler protection in attic.)

## XV. FIRESTOPPING (BLOCKING)

### FIRESTOPPING (BLOCKING)

Barriers installed to resist the movement of flame and gases to other areas of a building through small, concealed passages in building components, such as floors, walls and stairs.

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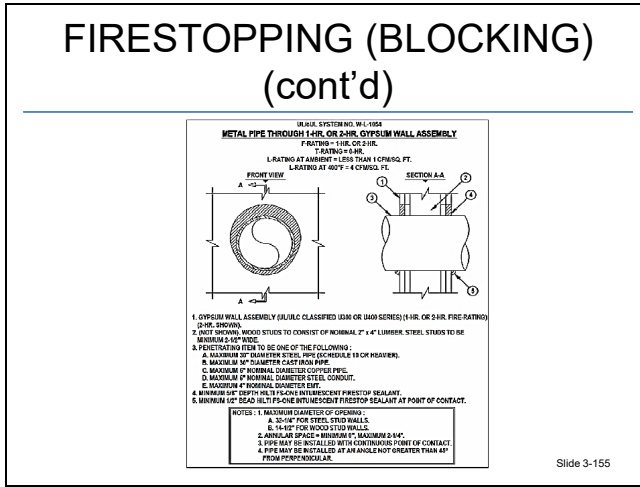
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A. Firestopping.

Barriers installed to resist the movement of flame and gases to other areas of a building through small, concealed passages in building components, such as floors, walls and stairs.




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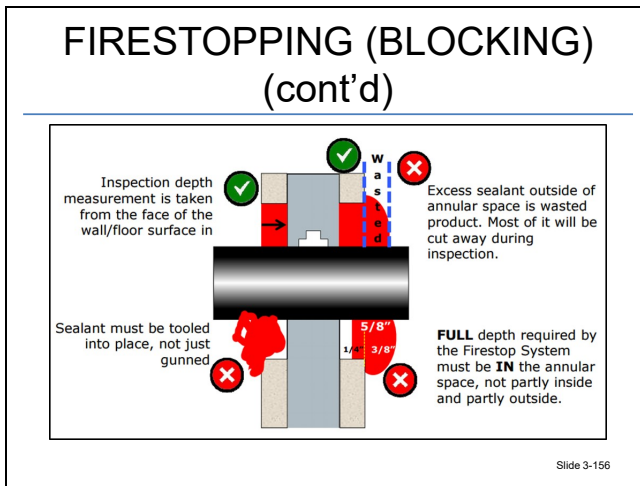
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**B. Requirements.**

Fireblocking is required in combustible construction to cut off draft openings vertically and horizontally between floors, between a top story and attic, and every 10 feet in walls, soffits, drop ceilings and stairs.




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- C. Approved materials include lumber, wood structural panel, gypsum board and mineral wool.**
1. Firestop **products** have no rating. Only firestop **systems** have a rating.
  2. More information on firestopping in the Appendix of this unit.

**XVI. SUMMARY**

 **FEMA**  **SUMMARY**

- Architectural features.
- Occupancy classifications.
- Construction type.
- Bearing and nonbearing structural elements.
- Allowable area and heights/stories.
- Height.

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 **FEMA**  **SUMMARY (cont'd)**

- Story.
- Area and height modifications.
- Compartmentation.
- Exterior walls.
- Fire-resistance rated assemblies.
- Openings and penetrations.
- Draftstopping.
- Firestopping.

Slide 3-158

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Did you get the answer to the question, "Why is this information important?"

Slide 3-159

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Any burning questions?

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## ACTIVITY 3.4

### Fire-Resistance Ratings and Setbacks

#### Purpose

Determine the proper fire rating for exterior walls and various building elements. Identify and compare differences among building code requirements that establish fire-resistance requirements based on fire separation distance and exterior wall protection based on construction.

#### Directions

Complete **both parts** of the activity as instructed below.

#### Part 1

1. Working in pairs, use the provided plan graphic following the activity instructions to answer the following questions. Assume that the walls in the questions below are bearing.

- a. What is the minimum required fire-resistance rating (in hours) of Wall A?

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- b. What is the minimum required fire-resistance rating (in hours) of Wall B?

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- c. What is the minimum required fire-resistance rating (in hours) of Wall C?

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**ARCHITECTURAL FEATURES: FIRE PROTECTION**

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d. Is Wall E required to have the same fire-resistance rating along its entire length?

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e. What is the amount (percentage of wall area) of protected openings permitted in Wall F?

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f. What is the minimum required fire-resistance rating (in hours) of Wall G?

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g. What is the amount (percentage of wall area) of unprotected openings permitted in Wall G?

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2. The developer wants to erect a new building on this site as Building Three. It will consist of mixed-use, Group B and Group A, Division 2 occupancies, and the construction will be Type IIA. Assume nonbearing walls in both buildings for the following questions.

a. What is the minimum fire-resistance rating (in hours) of Wall H?

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- b. What is the amount (percentage of wall area) of unprotected openings permitted in Wall H?

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- c. What is the lowest permitted fire resistance (in hours) of Wall I opposite Wall D?

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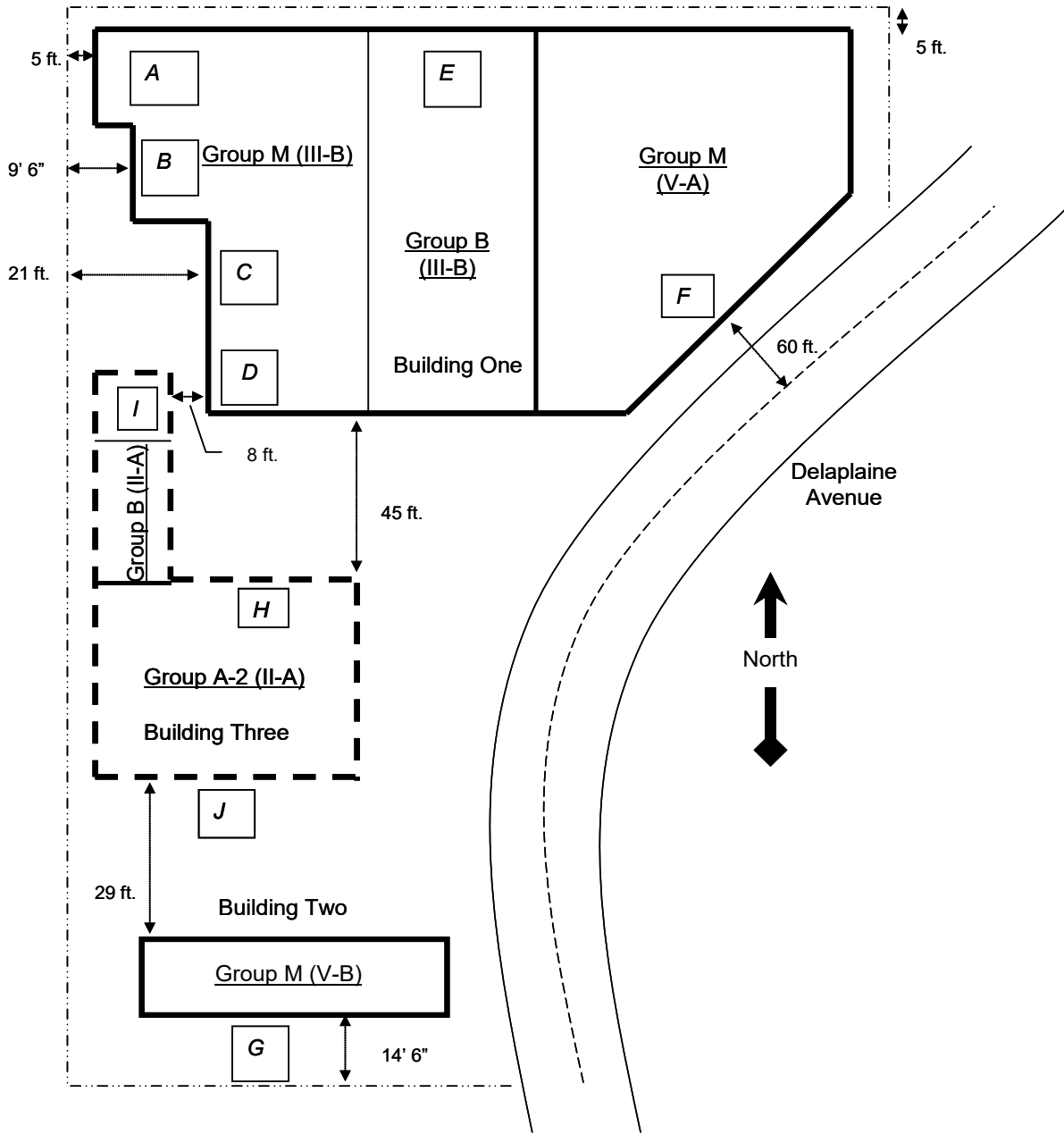
**Part 2**

- 1. Use your code and the Canterbury submitted plan documents to determine the proper fire resistance of all exterior walls.
- 2. Complete the Plans Review Check List, Section B (3) found in SM Appendix B.

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ACTIVITY 3.4 (cont'd)

Fire-Resistance Ratings and Setbacks



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## REFERENCE

ICC. (2015). *International building code*. Washington, DC: Author.

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# **APPENDIX**

## **BASIC FIRESTOP INSTALLER GUIDES**

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# Basic Firestop Installer Guides



This set of installer guides is intended to provide very basic information to help GCs, and mechanical, electrical, plumbing and sprinkler contractors understand the fundamentals of firestopping in compliance with the International Building Code (IBC).

The most critical concept to understand about firestopping is that the IBC requires that all penetrations in fire-resistive barriers be “*protected by an approved firestop system installed as tested*”. No mention is made of caulks, putty, pillows, bricks, mineral wool or other materials or products. The IBC requires **systems**.

Contrary to what many think, firestop products have no rating. There is no such thing as a 1 or 2-hour caulk, putty, pillow or other firestop product. Only firestop systems have a rating.



VeriCon is an independent inspection, training and consulting firm providing services for the passive fire protection disciplines of firestopping, barriers, dampers, doors & glazing.

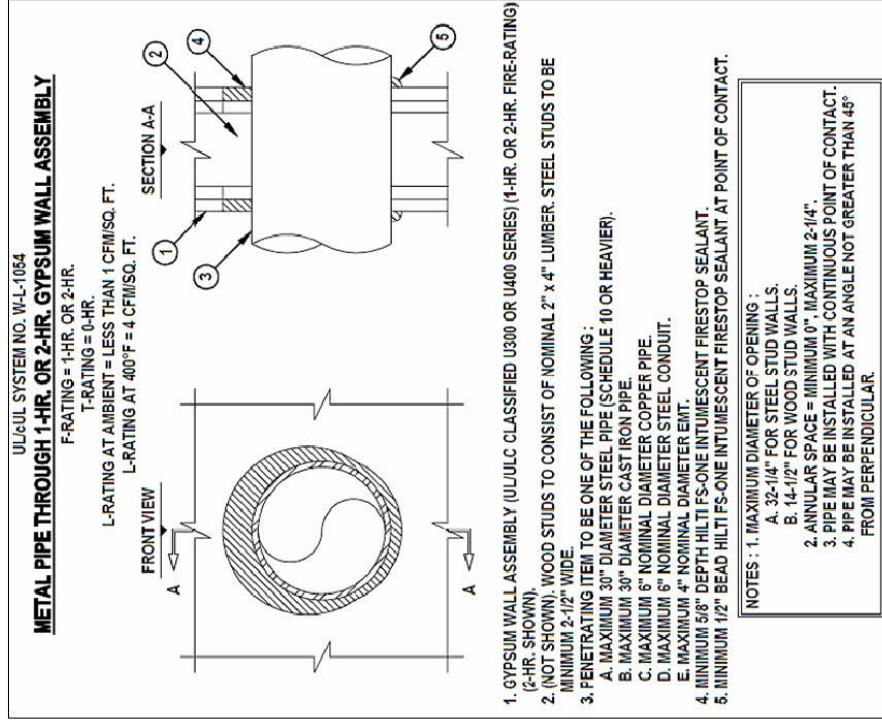
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# 1. Start with a System

All firestop products must be installed in conformance to listed firestop system. A system is similar to a cake recipe. You can use all the right ingredients but end up with a bad cake if you don't follow the recipe exactly.

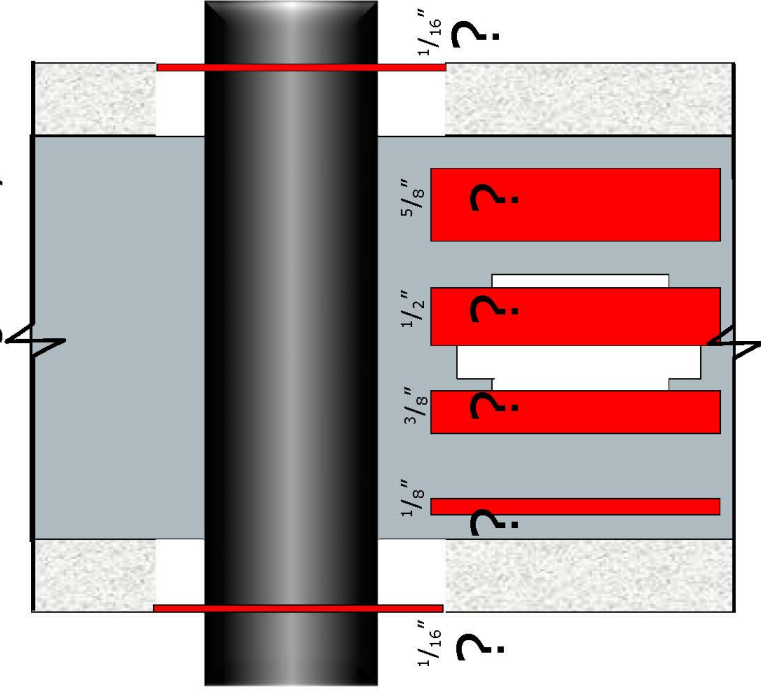
If you are not carefully following a system you are just smearing "red stuff" around. The installation **will** fail inspection and **will** fail during a fire.



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## Why Systems Must Be Followed

You just made a 3" hole for a 2" metal pipe in a 1-hour gypsum wall. **The wall now has 0-hour rating.** What are you going to do to restore the rating of the wall? Just putting some "red stuff" around the hole is not enough. Many variables must be dealt with.



- What product(s) can/must be used?
- How much must be installed?
- Where must it be installed?
- What if the pipe is plastic?
- What if it is insulated?
- What if you have cables?
- How big can the hole be?
- Is mineral wool needed?
- Etc., etc.,...

The firestop systems answer all those questions.

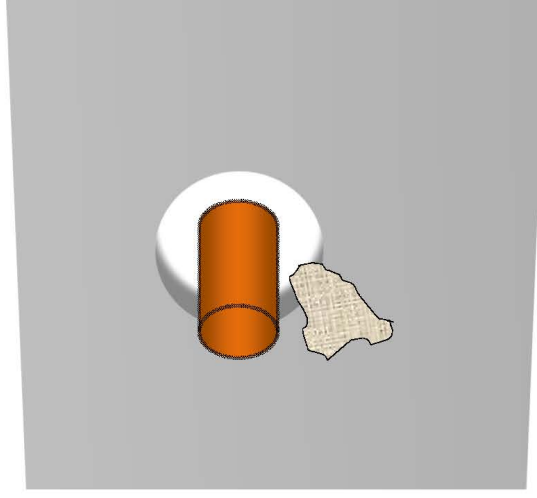
**Systems direct installation.**

**Inspection verifies that the installations conform to the systems.**

## 2. Clean the opening out

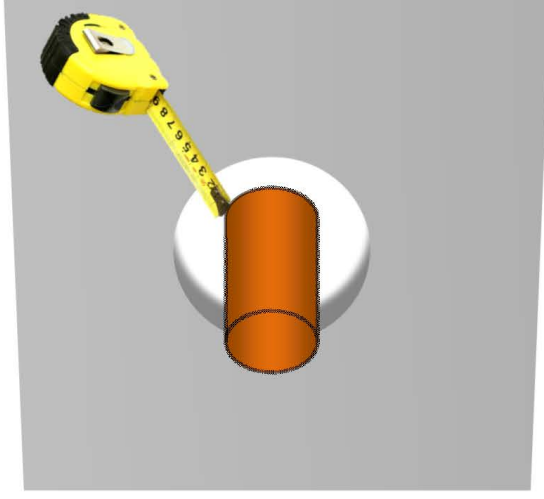
All drywall compound, gypsum dust, concrete dust, loose mortar, etc., must be cleaned out of the opening for two primary reasons;

1. So you can be sure the hole size and annular space are correct. This especially important with drywall compound might get into the opening before it is firestopped.
2. So the sealant can adhere well to the opening and the penetrating item.



### 3. Verify all system details

- Type of barrier
- Type of penetrant(s)
- Hole size maximum
- Penetrant size maximum
- Annular space minimum and maximum
- Sleeve?
- Coupling?
- Angle of penetrant?
- Etc.

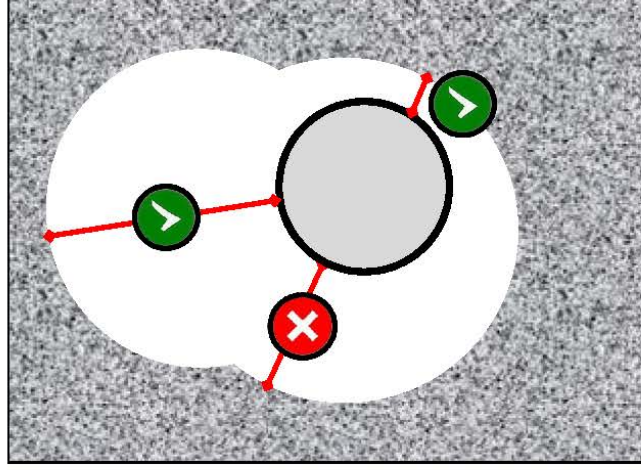


If you do not have a system that matches your field application, find one that does or request an Engineering Judgment (EJ) from the firestop manufacturer. Do **NOT** just install what you think is OK! It will **not** pass inspection, and worse, may fail during a fire.

## Determining Annular Space

The size of the gap between the penetrant and the substrate is called the annular space and is a critical item. The minimum and maximum limits specified in the firestop system must be met.

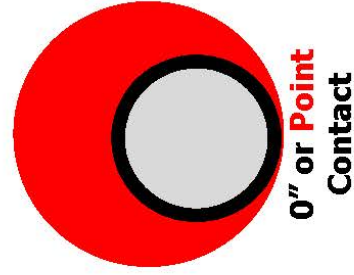
For round openings, measure to the widest and narrowest distance between the penetrant and the edge of the opening.



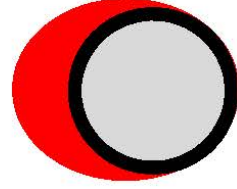
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## Determining Annular Space

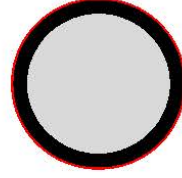
"Point Contact" is when a system allows a penetrant to touch the side of the opening **at a single point**. Many systems will say, "The annular space between the pipe and the periphery of the opening shall be a min of 0 in. (point contact) to a max of X in." This only allows a single point of contact. It does **not** mean the penetrant can touch the opening all the way around which is called "continuous point of contact". Typically, only metallic pipes are allowed to have continuous point of contact. In most cases the system will specifically say that continuous point of contact is allowed.



**0" or Point Contact**

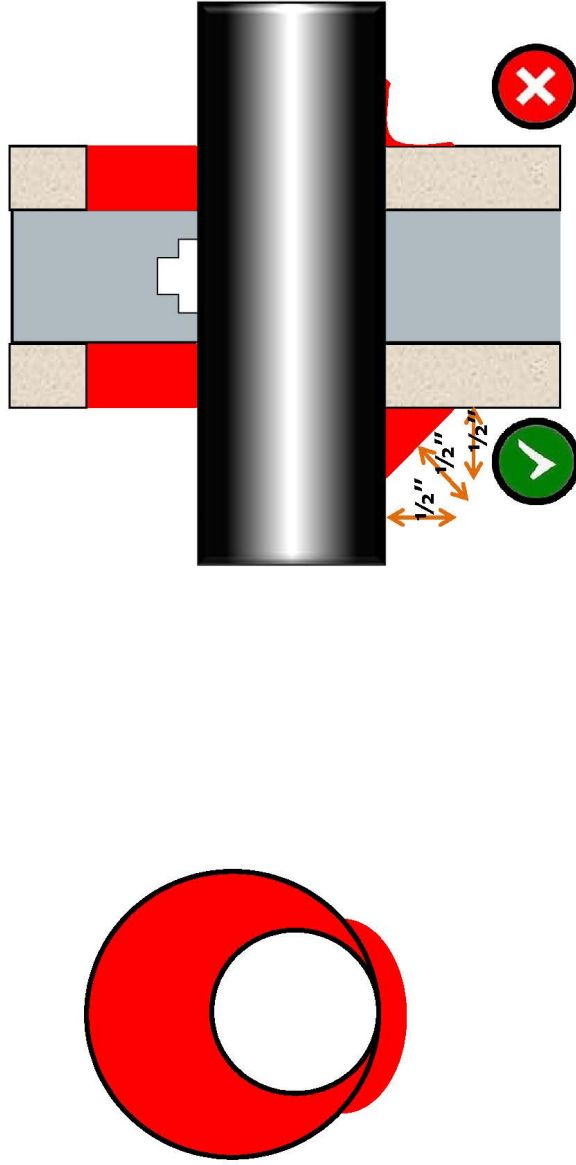


**NOT Point Contact**



**Continuous Point of Contact**

## Crown Bead at Point Contact



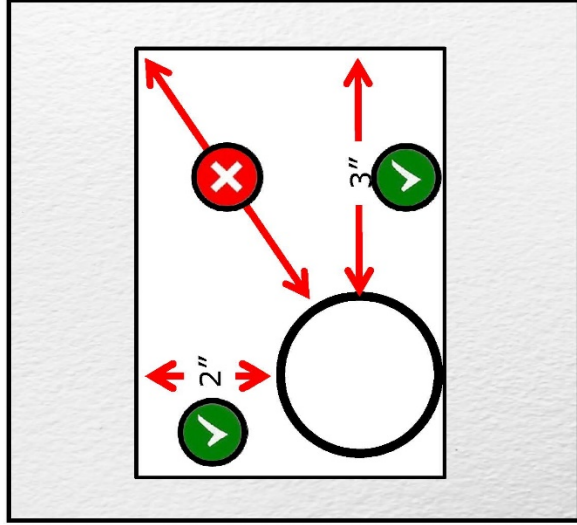
Systems that allow point contact often require a crown bead of a certain depth of sealant where a penetrant touches the rated wall or floor. Crown beads must extend the designated length in three directions; along the penetrant, on the substrate and through the depth in the middle



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## Determining Annular Space

While it is better to close down oversized openings properly, it is not always possible. When you have a square or rectangular openings, measure only to points perpendicular to the penetrant, NOT to diagonal points.



## Installs must meet Annular Space Limits

### UL System C-AJ-1226

Annular space = **0" to 1 7/8"**



4" pipe,  
6" opening  
1" annular space  
on **both** sides



4" pipe,  
6" opening  
2" annular space  
on **one** side



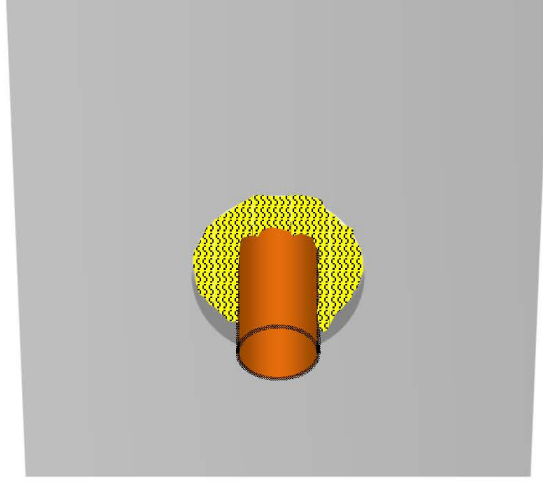
3" pipe,  
6" opening  
1 1/2" annular  
space on **both** sides



3" pipe,  
6" opening  
3" annular space  
on **one** side

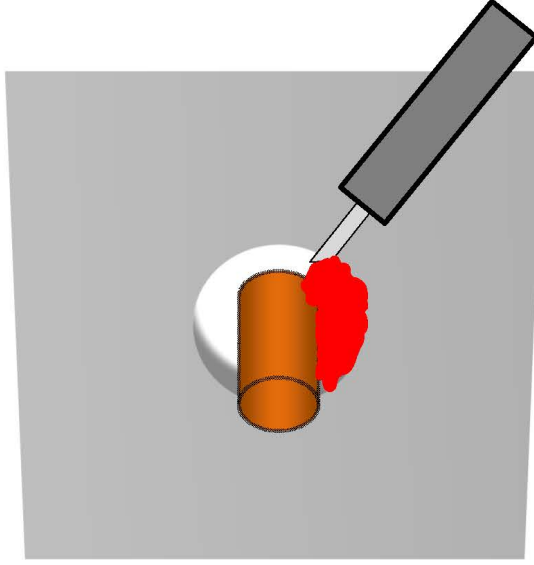
When possible, it is OK to reposition a penetrant in the opening to meet the annular space requirements, BUT, the penetrant must be well supported and not place any load on the firestop materials





#### **4. Install mineral wool if the system requires it**

Mineral wool must be tightly packed as a permanent form. It should not move when you push on it.



## 5. Install sealant.

Sealant must be **IN** the plane of the wall or floor and completely fill the annular space. Firestop material just smeared on the surface or piled up across the face of the opening **will** fail inspection and **will** fail during a fire.



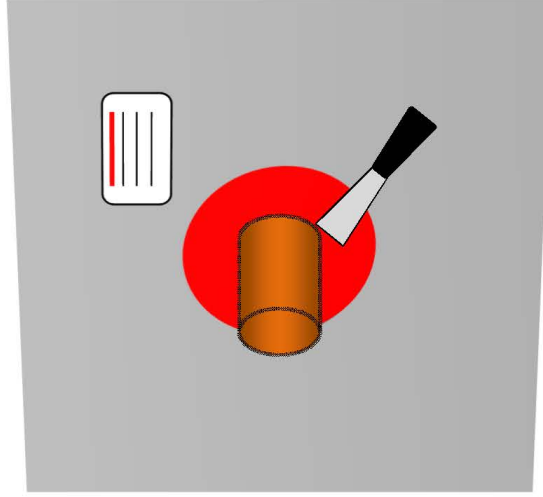
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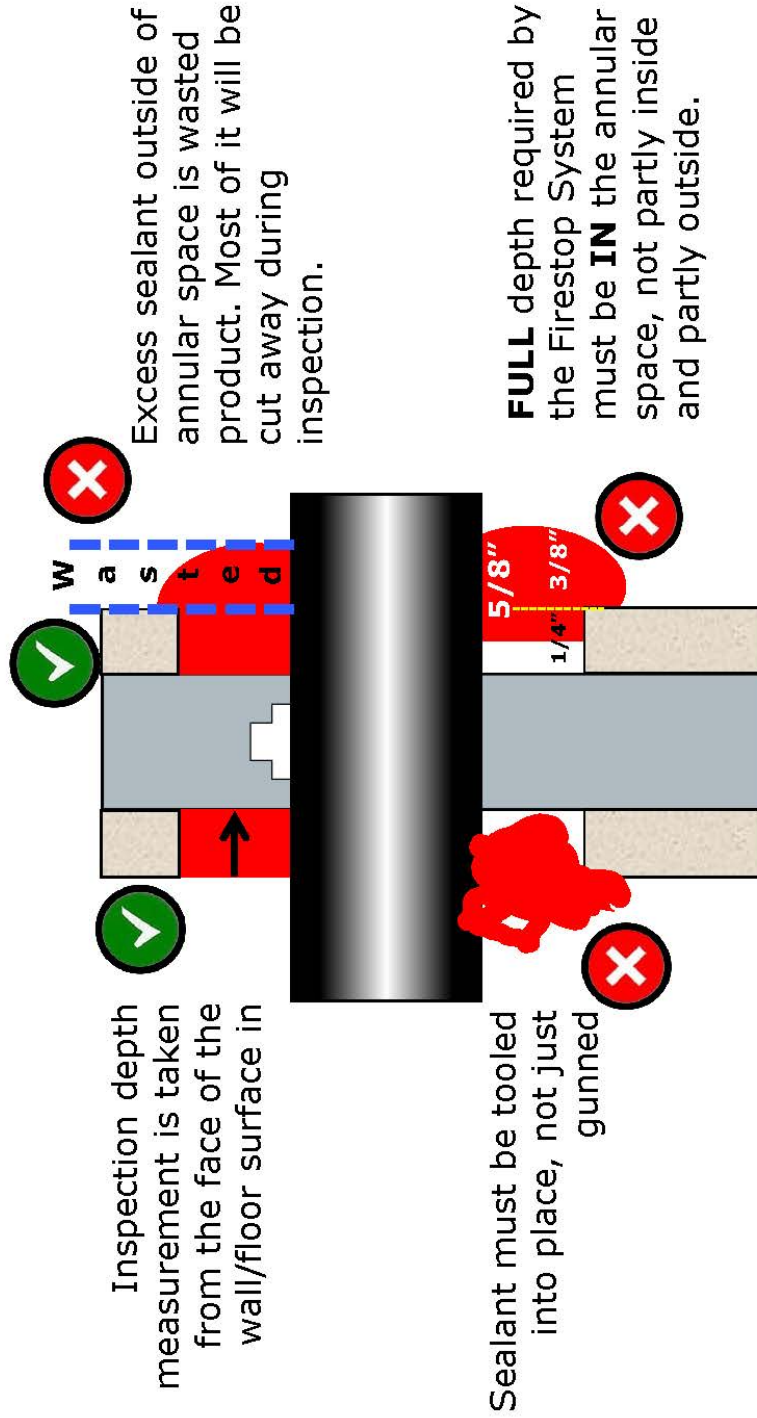


## 6. Tool the sealant. Apply a label if required.

Sealant must be tooled to ensure:

1. Proper depth in the annular space
2. Proper adhesion to the penetrant
3. Proper adhesion to the substrate.
4. Complete coverage of the annular space.





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# **UNIT 4: ARCHITECTURAL FEATURES: LIFE SAFETY**

## **TERMINAL OBJECTIVE**

*The students will be able to:*


- 4.1 *Evaluate information shown in submitted plan documents, in conjunction with applicable building code requirements, for compliance with architectural life safety feature requirements (for occupant load, means of egress, vertical arrangements, interior finishes, and special uses and occupancies).*

## **ENABLING OBJECTIVES**

*The students will be able to:*

- 4.1 *Evaluate if architectural submitted plan documents comply with the requirements for occupant load.*
  - 4.2 *Determine if architectural submitted plan documents comply with the requirements for means of egress.*
  - 4.3 *Determine the building code requirements that establish the provisions for vertical-opening arrangements and protection.*
  - 4.4 *Evaluate architectural submitted plan documents for compliance with the requirements for interior finishes.*
  - 4.5 *Determine the building code applications for special uses and occupancies.*
  - 4.6 *Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the architectural life safety features information.*
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**UNIT 4:  
ARCHITECTURAL FEATURES:  
LIFE SAFETY**

Slide 4-1

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**I. OBJECTIVES**

**TERMINAL OBJECTIVE**

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Evaluate information shown in submitted plan documents, in conjunction with applicable building code requirements, for compliance with architectural life safety feature requirements (for occupant load, means of egress, vertical arrangements, interior finishes, and special uses and occupancies).

Slide 4-2

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**ENABLING OBJECTIVES**

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- Evaluate if architectural submitted plan documents comply with the requirements for occupant load.
- Determine if architectural submitted plan documents comply with the requirements for means of egress.

Slide 4-3

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### ENABLING OBJECTIVES (cont'd)

- Determine the building code requirements that establish the provisions for vertical-opening arrangements and protection.
- Evaluate architectural submitted plan documents for compliance with the requirements for interior finishes.
- Determine the building code applications for special uses and occupancies.

Slide 4-4

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### ENABLING OBJECTIVES (cont'd)

- Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the architectural life safety features information.

Slide 4-5

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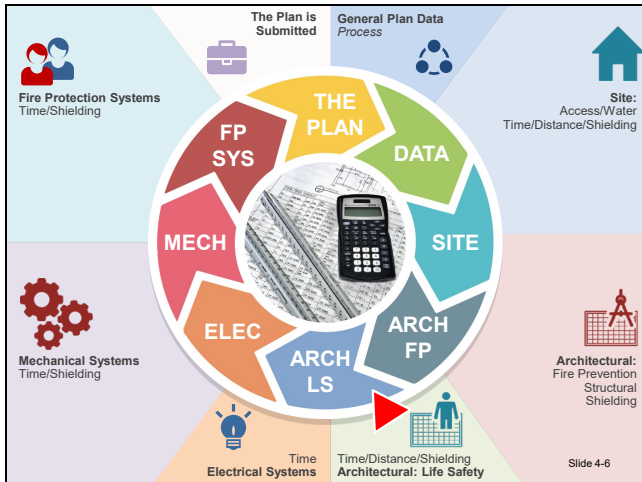
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Slide 4-6

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Why is this information important?  
Why is it important to evaluate plans  
for compliance with occupant load,  
egress and finish requirements?

Slide 4-7

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**WHY?**

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Plans review should eliminate these  
situations:



Slide 4-8

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**WHY? (cont'd)**

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Slide 4-9

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**COURSE THEME**

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Three E's of fire prevention and life safety:

- Engineering.
- Education.
- Enforcement.



Slide 4-10

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Course theme: three E's of fire prevention and life safety: Engineering, Education and Enforcement.

**II. VERIFYING EGRESS REQUIREMENTS**

**MEANS OF EGRESS**

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Slide 4-11

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A. The purpose of means of egress is to provide a safe, protected way from any point in a building to a public way.

### THREE PARTS TO A MEANS OF EGRESS

- Exit access.
- Exit.
- Exit discharge.



Slide 4-12

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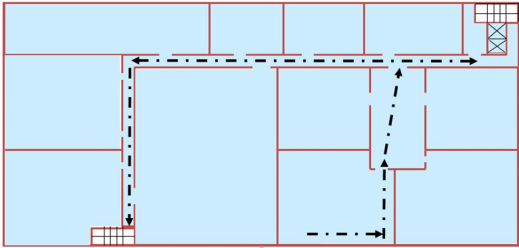
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A means of egress consists of three parts:

1. Exit access (inside the lobby).
2. Exit (the doors).
3. Exit discharge (area outside the doors).

### EXIT ACCESS

The portion of the exit path from any point in a building to an exit.



Slide 4-13

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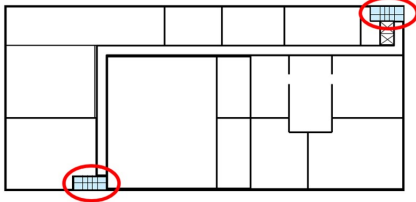
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- B. Exit access includes any exit portion before the actual exit.
1. Rooms.
  2. Doors.
  3. Interior corridors.
  4. Stairs (inside and outside).

- 5. Ramps.
- 6. Courts and yards.

**EXIT**

- Portion that is separated from other spaces of building or structure by construction or equipment.
- **Exit door** versus an **exit**.



Slide 4-14

The diagram shows a floor plan of a building with several rooms. Two specific areas are circled in red: one is a door at the bottom left, and the other is a small rectangular area at the top right, representing an exit.

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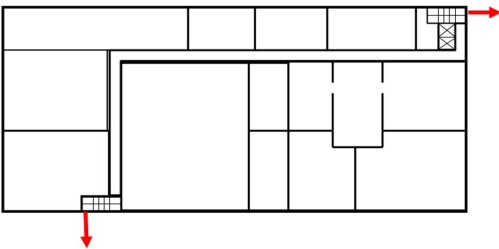
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- C. The exit is the portion between exit access and exit discharge or public way.
  - 1. Exterior exit door is at the level of exit discharge.
  - 2. Horizontal exits.
  - 3. Interior exit stairways and ramps (protected construction).
  - 4. Exit passageways.
  - 5. Exit balconies.
  - 6. Exterior exit stairways and ramps.

**EXIT DISCHARGE**

Portion between termination of an exit and a public way.



Slide 4-15

The diagram shows the same floor plan as Slide 4-14. Red arrows point to the termination of the exit paths: one arrow points down from the door at the bottom left, and another points right from the exit area at the top right.

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D. Exit discharge.

1. Portion between exit termination and a public way.

**PUBLIC WAY**

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- Street.
- Alley.
- Public land.



Slide 4-16

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2. A public way is:

- a. Any street, alley or another similar land parcel essentially open to outside air.
- b. Deeded, dedicated or otherwise permanently appropriated for public use, and having a clear width and height not less than 10 feet.

**III. CHECKLIST TO VERIFY MEANS OF EGRESS**

**MEANS OF EGRESS  
CHECKLIST**

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• Occupancy classification.	• Travel distance.
• Occupant load.	• Capacity of egress.
• Minimum number of exits.	• Doors and hardware.
• Arrangement of exits.	• Special considerations.

Slide 4-17

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A. Means of egress analysis encompasses several criteria. It is critical to address each item before making the determination that an adequate means of egress is provided.

B. Items to consider when making a determination:

1. Occupancy classification.
2. Occupant load.
3. Minimum number of exits.
4. Arrangement of exits.
5. Travel distance.
6. Capacity of egress.
7. Doors and hardware.
8. Special considerations.

**IV. OCCUPANCY CLASSIFICATION**

A. Why occupancy is important when determining exit requirements:

1. Uses of each occupancy and the density of people in a space determine the occupant load.
2. Some occupancies have special exit requirements.

**OCCUPANCY**

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- Exiting provisions based on occupancy.
  - Occupancy is foundation of code requirements.
  - Classification driven by characteristics (e.g., use and density).
- Most restrictive provisions in multiple-use occupancy.

Slide 4-18

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B. Exiting determination is based on occupancy classification.

Before evaluating the means of egress for an occupancy, occupancy classification must be determined.

1. Occupancy classification is based on specific criteria (e.g., the use and density of people in the space, capabilities of occupants, etc.).
  2. Exiting is designed for occupancy use so that occupants can exit in a safe and efficient manner.
- C. Special exiting requirements by some occupancies.
1. Exiting cannot be fully reviewed until occupancy is known.
  2. Some special exiting requirements include hardware type, exit system protection, increased exit system width, etc. Examples:
    - a. Panic hardware is required for assembly, educational and hazardous occupancies.
    - b. Panic hardware is not required for business or mercantile occupancies.
- D. Multiple-use occupancy.
1. If a space is designed for multiple uses, exiting is designed for the occupancy that would be **most restrictive**.
  2. For example, a space in a building designed for retail sales and business uses may be leased for either use. Exiting is based on the use that would net the most occupants in a building, which would be retail sales.

**V. VERIFYING OCCUPANT LOAD**

**OCCUPANT LOAD**

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- Number of persons for which the means of egress of a building or portion of a building is designed.
- Use- and occupancy-driven.

Slide 4-19

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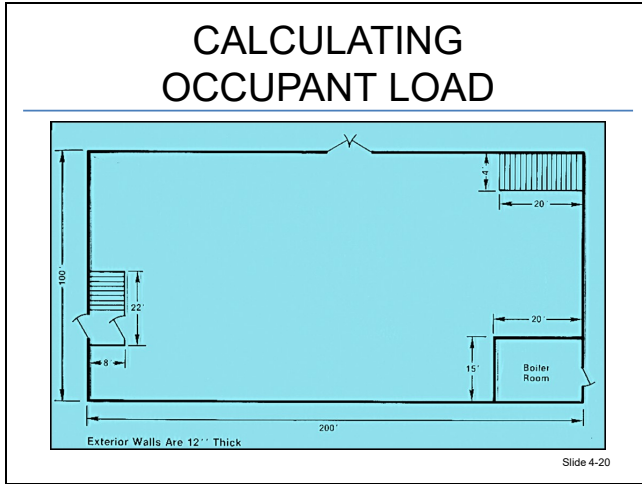
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- A. Occupant load.

1. Number of persons for which the means of egress of a building or portion of a building is designed.
2. Building use and occupancy type drive calculated occupant load.



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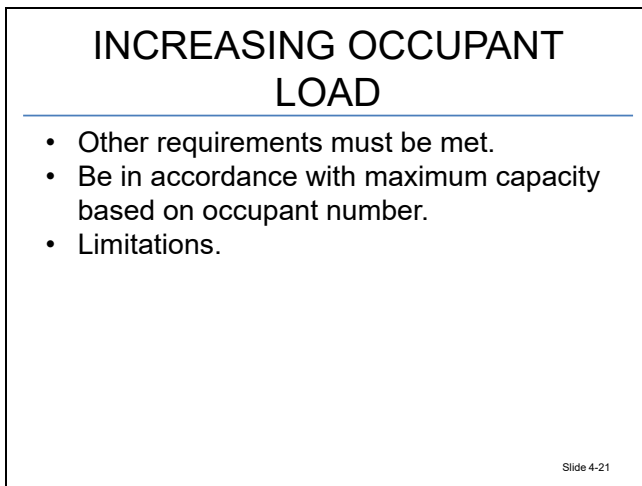
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B. Space use and occupancy affect calculated occupant load.

Example: The space shown in Slide 4-20 could be an assembly use with tables and chairs, a business, or a mercantile.

1. Floor area that the space can support:
  - a. Business use of 194 persons.
  - b. Mercantile use of 325 persons.
  - c. Assembly use of 1,257 persons.
2. Exiting system for this space.



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- C. Increasing occupant load.
  - 1. Requirements — all other requirements must be met.
  - 2. If approved by a building official, may use actual number of persons permitted to occupy a floor area.
  - 3. Must be in accordance with the maximum capacity of exits serving that floor area and all other requirements of the code, based on occupant number.
  - 4. Limitations.
    - a. Cannot exceed egress capacity.
    - b. Density of 7 square feet per person.
    - c. Aisle, seating or fixed equipment plan may be required.
  - 5. A building official can require that a plan be submitted for proposed use and occupancy density to show that an occupant load proposal is reasonable and justifiable.

**OCCUPANT LOAD FACTORS**

- Based on classification, **space function** and how space is used.
- Most occupancies use **gross** square footage; some use **net**.

Slide 4-22

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- D. Occupant load factors.
  - 1. Criteria of occupant load factors.
  - 2. Based on occupancy classification — function.
  - 3. May also be based on the **character** of how the space is used; for example, classrooms in a church Sunday school building.
  - 4. Most occupancies use **gross** square footage as a basis for calculations.

- 5. Some occupancies use **net** square footage.
- 6. Occupant load factor can be found in tables in building and fire codes.

**FACTOR EXAMPLES**

Function of Space	Floor Area per Occupant (ft <sup>2</sup> )
<b>Airport terminal</b>	
Baggage claim	20 gross
Baggage handling	300 gross
Concourse	100 gross
Waiting area	15 gross
<b>Assembly without fixed seats</b>	
Concentrated use (chairs only)	7 net
Standing space	5 net
Nonconcentrated use (tables and chairs)	15 net
<b>Business areas</b>	100 gross
<b>Day care</b>	35 net

Slide 4-23

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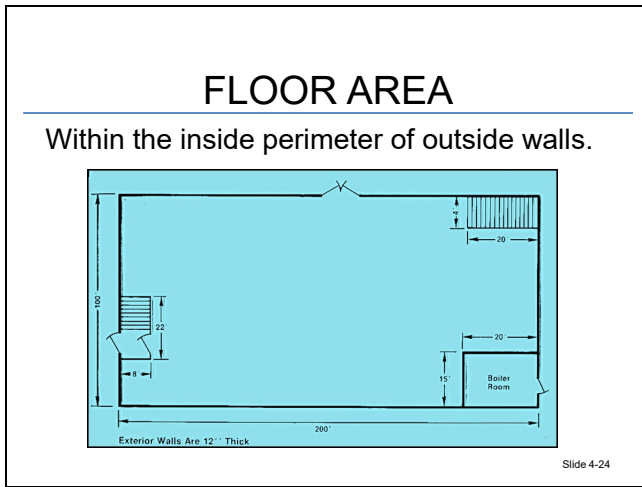
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E. Occupant load factor examples.



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F. Floor area.

- 1. Occupant load uses floor area with occupant load factor to determine the number of persons that will use the exiting system.
- 2. Floor area is the area within the inside perimeter of outside walls.

### GROSS FLOOR AREA

- Floor area within inside perimeter of outside wall of the building.
- No deductions for hallways, closets, stairs, thickness of interior walls, columns, or other features.

Slide 4-25

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3. Gross floor area.
  - a. Floor area within the inside perimeter of the building's outside wall.
  - b. No deductions for hallways, closets, stairs, thickness of interior walls, columns or other features.

### NET FLOOR AREA

- Net floor area is actual occupied area.
- Does not include unoccupied accessory areas.

Slide 4-26

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4. Net floor area.
  - a. Actual occupied area.
  - b. Does not include columns, interior walls or other unoccupied accessory areas.
    - Spaces such as corridors, stairs, closets, thickness of walls, columns, toilet rooms, mechanical rooms or similar areas.

## MIXED-USE BUILDINGS

- Multiple factors may be used in same building.
- Office building with conference rooms.

Slide 4-27

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G. Occupant load in mixed-use buildings:

1. Multiple factors may be used in the same building.
2. Example: An office building with conference rooms.
  - a. Office area would be business use — one person per 100 square feet gross.
  - b. Conference rooms would be assembly use — one person per 15 square feet net.

**TABLE 1004.1.2  
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT**

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR*
Accessory storage areas, mechanical equipment room	300 gross
Agricultural building	300 gross
Aircraft hangars	500 gross
Airport terminal	
Baggage claim	20 gross
Baggage handling	300 gross
Concourse	100 gross
Waiting areas	15 gross
Assembly	
Gaming floors (keno, slots, etc.)	11 gross
Exhibit gallery and museum	30 net
Assembly with fixed seats	See Section 1004.4
Assembly without fixed seats	
Concentrated (chairs only—not fixed)	7 net
Standing space	5 net
Unconcentrated (tables and chairs)	15 net

Slide 4-28

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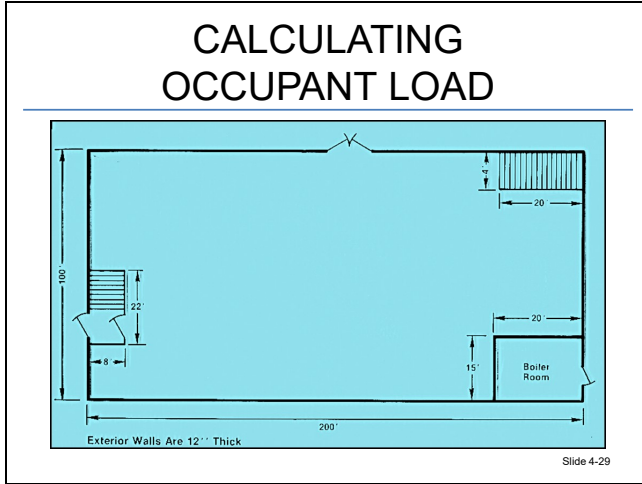
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H. Calculating occupant load example.

1. Using the same space as before, calculate the occupant loads for each use. This building could house:
  - a. An assembly use with tables and chairs.
  - b. A business.
  - c. A mercantile.
2. Building area is 20,000 square feet, and floor area must be determined for each occupancy.

### OCCUPANT LOAD (cont'd)

- Occupant load factors.
 

Assembly with tables and chairs	15 ft <sup>2</sup> net
Business	100 ft <sup>2</sup> gross
Mercantile	60 ft <sup>2</sup> gross
- Computed results:
  - Assembly:  $18,848 \text{ ft}^2 / 15 \text{ ft}^2/\text{person} = 1,257.$
  - Business:  $19,404 \text{ ft}^2 / 100 \text{ ft}^2/\text{person} = 194.$
  - Mercantile:  $19,404 \text{ ft}^2 / 60 \text{ ft}^2/\text{person} = 323.$

Slide 4-30

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Change of use changes the occupant load.

**VI. EXIT QUANTITY**

### EXIT QUANTITY

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- Determined by:
  - Occupancy.
  - Occupant load.
  - Travel distance.
  - Number of stories.
- Two minimum with occupancy-based exceptions.

Slide 4-31

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Number of exits required.

- A. Determined by occupancy, occupant load, travel distance and number of stories.
- B. Minimum of two with exceptions.
  - 1. If occupant load is 501 to 1,000 — minimum of three exits.
  - 2. If occupant load is over 1,000 — minimum of four exits.

### ONE EXIT ALLOWED

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- Stories with one exit.
- Based on occupancy, number of occupants, sprinklers and travel distance.

<small>1006.3.2(2) STORIES WITH ONE EXIT OR ACCESS TO ONE EXIT FOR OTHER OCCUPANCIES</small>			
STORY	OCCUPANCY	MAXIMUM OCCUPANT LOAD PER STORY	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE (ft)
First story above or below grade plane	A, B <sup>1</sup> , E, F <sup>1</sup> , M, U	49	75
	H-2, H-3	3	25
	H-4, H-5, I, R-1, R-2 <sup>1</sup> , R-4	10	75
Second story above grade plane	S <sup>4</sup>	29	75
	B, F, M, S <sup>4</sup>	29	75
Third story above grade plane and higher	NP	NA	NA

Slide 4-32

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- C. When one exit is allowed.
  - 1. Code is intended to be reasonable.

Some spaces or buildings that are small enough, and/or based on occupancy, number of occupants, sprinklers and travel distance, require only one exit.

## ONE EXIT ALLOWED (cont'd)

- Spaces with one exit.

TABLE 1006.2.1  
SPACES WITH ONE EXIT OR EXIT ACCESS DOORWAY

OCCUPANCY	MAXIMUM OCCUPANT LOAD OF SPACE	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE (ft=)		
		Without Sprinkler System		With Sprinkler System
		Occupant Load		
		OL ≤ 30	OL > 30	
A', E, M	49	75	75	75'
B	49	100	75	100'
F	49	75	75	100'
H-1, H-2, H-3	3	NP	NP	25'
H-4, H-5	10	NP	NP	75'
I-1, I-2, I-4	10	NP	NP	75'
I-3	10	NP	NP	100'
R-1	10	NP	NP	75'
R-2	10	NP	NP	125'
R-3*	10	NP	NP	125'
R-4*	10	75	75	125'
S'	29	100	75	100'
U	49	100	75	75'

Slide 4-33

2. When reviewing a plan showing one exit, review the space or building for conditions that may allow one exit.
  - a. International Building Code (IBC) Tables 1006.2.1 and 1006.3.2(2).
  - b. Show conditions that allow one exit for a space or a building.
3. All conditions must be met for an occupancy to require only one exit.

Example: A 3,000-square-foot business building is three stories high. The occupant load is 29 per floor, and travel distance is 75 feet to an exit from anywhere in the space. The first and second stories meet conditions for one exit per the tables indicated, but the third story is required to have a second exit per IBC Table 1006.3.2(2).

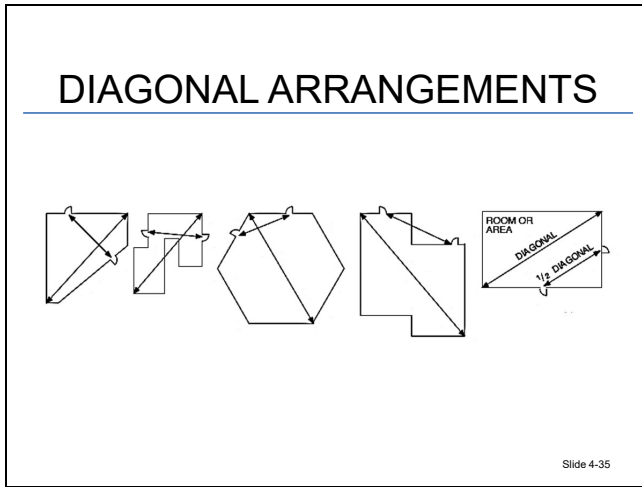
## VII. ARRANGEMENT OF EXITS (IBC 1007.1.1)

### EXIT ARRANGEMENT

- Intent is to provide exits **remote from each other**.
- Separated by at least one-half the diagonal distance of area served.

Slide 4-34

- A. The intent is to provide exits **remote from each other**.
  - 1. If one is blocked by fire or smoke, the other may be used.
  - 2. The phrase “remote as possible or practical” was subjective in earlier codes.
  - 3. Codes now require that exits be separated by at least one-half the diagonal distance of the area served.



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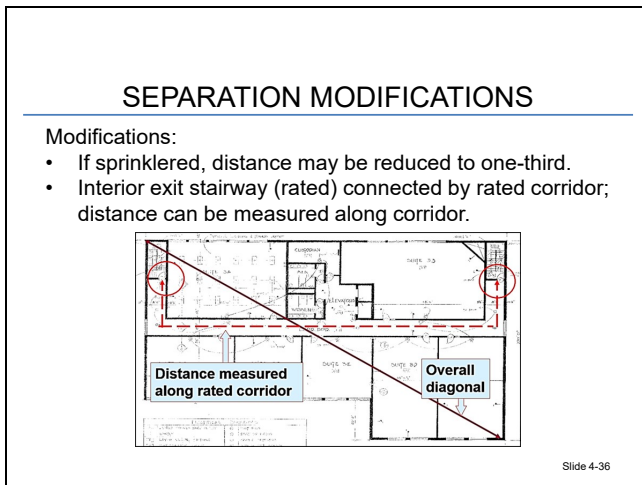
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- B. Buildings and spaces may be different configurations.
  - 1. Diagonal distance is measured at the longest distance between two corners or walls.
  - 2. Two exits are required to be located so that the distance between them is at least one-half the diagonal measurement.



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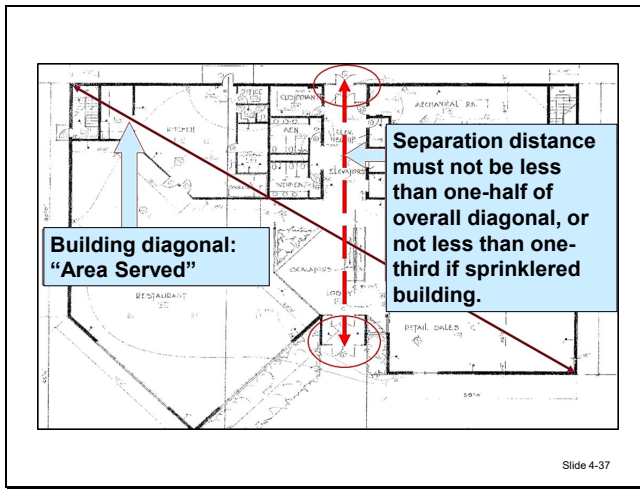
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- C. Exit remoteness may be modified by sprinklers or special conditions.

1. Two exits may be located at least one-third the diagonal distance apart when the building is provided with an automatic sprinkler system.
2. If a building has interior exit stairways or ramps (protected exit) interconnected by a one-hour-rated corridor, the required distance between exits may be measured along the shortest direct line of travel in a corridor.

Example: Building has rated interior exit stairs connected by a one-hour-rated corridor. Measurement between the two exits may be taken along the most direct line of travel in the corridor.



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D. Example (from plans other than the Canterbury Home):

Building's diagonal measurement is shown, and measurement between the two exits meets the remoteness test.

### VIII. TRAVEL DISTANCE (IBC 1017)

**EXIT TRAVEL DISTANCE ALLOWED**

- Measurement of actual distance in exit access from most remote point to exit.
- Measured on walking surface in natural path of travel around obstructions.
- When sprinklered, distance may increase.

Slide 4-38

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- A. Measurement of exit access distance from most remote point to an exit.
  - 1. Measured on walking surface in the natural path of travel.
  - 2. Curves around corners or obstructions with a 1-foot clearance.
  - 3. Ends at the center of a doorway or another point at which an exit begins.
  - 4. Codes allow increase in distance with complete sprinkler protection.

**PER INTERNATIONAL BUILDING CODE**

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“Measured from the most remote point within a story along the natural and unobstructed path of horizontal and vertical egress travel to the entrance to an exit” (International Building Code (IBC) 1017.3).

Slide 4-39

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- B. IBC measurement of exit access travel distance.

“Measured from the most remote point within a story along the natural and unobstructed path of horizontal and vertical egress travel to the entrance to an exit” (IBC 1017.3).

**PER NATIONAL FIRE PROTECTION ASSOCIATION 101, *Life Safety Code*®**

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- Along centerline of natural path of travel, starting from most remote point.
- Around corners or obstructions with 12-inch clearance.
- Terminating either at center of doorway or other point where exit begins.

Slide 4-40

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- C. National Fire Protection Association (NFPA) 101, *Life Safety Code*<sup>®</sup> measurement:
1. Along the centerline of the natural path of travel, starting from the most remote point.  
  
Subject to occupancy.
  2. More specifically:  
  
Measurement curving around corners or obstructions with a 12-inch clearance from corners or obstructions.
  3. Terminating at one of the following:
    - a. Center of a doorway.
    - b. Another point at which an exit begins.

<h3>COMMENTARY</h3>
<ul style="list-style-type: none"><li>• Natural exit path influenced by contents and occupancy of building.</li><li>• Furniture, fixtures, machinery or storage can increase length of travel.</li><li>• Recognize this influence.</li></ul>
<small>Slide 4-41</small>

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- D. Commentary for IBC.
1. Recognizes that the natural exit path is influenced by furnishings or other items in the room, and they can cause the path of travel to increase.
  2. Most room use will not allow occupants to go straight from the furthest corner of a room to a door.  
  
Measuring one foot off the wall around the room perimeter gives the measurement of the travel distance when there are furnishings in the middle of the room.
  3. Important to recognize this influence.

## TRAVEL DISTANCE

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

Slide 4-42

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E. Distance occupants must travel in exit access:

1. Limited and based on occupancy classification and if building is provided with a sprinkler system.
2. Fire and life safety concept:

Sprinkler system will help control a fire and allow occupants more time to evacuate.

## COMMON PATH OF TRAVEL

Distance in exit access before two **separate** and **distinct** exits may be selected.

Slide 4-43

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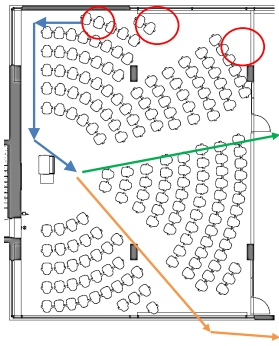
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F. Common path of travel.

1. Portion of exit access that must be traveled before two **separate** and **distinct** paths of travel to two exits are available.
2. Common path of travel is measured in the same manner as travel distance, but terminates at the point where two separate and distinct paths become available.

COMMON PATH OF TRAVEL  
(cont'd)

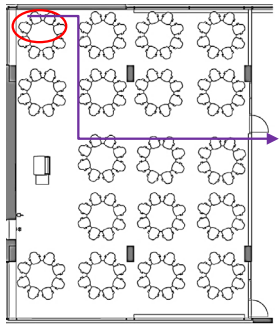


Slide 4-44

G. Examples.

1. What type of occupancy?

COMMON PATH OF TRAVEL  
(cont'd)



Slide 4-45

2. Same room, different arrangement.

COMMON PATH OF TRAVEL  
(cont'd)

TABLE 1006.2.1  
SPACES WITH ONE EXIT OR EXIT ACCESS DOORWAY

OCCUPANCY	MAXIMUM OCCUPANT LOAD OF SPACE	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE (ft/m)		
		Without Sprinkler System (ft/m)		With Sprinkler System (ft/m)
		Occupant Load	Occupant Load	
A, E, M	49	75	75	75 <sup>a</sup>
B	49	100	75	100 <sup>a</sup>
F	49	75	75	100 <sup>a</sup>
H-1, H-2, H-3	3	NP	NP	25 <sup>b</sup>
H-4, H-5	10	NP	NP	75 <sup>b</sup>
I-1, I-2 <sup>c</sup> , I-4	10	NP	NP	75 <sup>b</sup>
I-3	10	NP	NP	100 <sup>b</sup>
R-1	10	NP	NP	75 <sup>b</sup>
R-2	10	NP	NP	125 <sup>b</sup>
R-3 <sup>d</sup>	10	NP	NP	125 <sup>b</sup>
R-4 <sup>e</sup>	10	75	75	125 <sup>b</sup>
S <sup>f</sup>	20	100	75	100 <sup>b</sup>
U	49	100	75	75 <sup>b</sup>

Slide 4-46

3. Table shows when one exit may be allowed.
  - a. Uses common path of travel and occupant load as criteria.
  - b. When the building is provided with an automatic fire sprinkler system, common path of travel can be increased in some occupancies.

**ADJOINING ROOMS**

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- Exit travel can be through adjoining rooms.
- Travel through adjoining hazardous areas not permitted.
- Travel **not** permitted through high hazard area.

Slide 4-47

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- H. Exit travel can be through adjoining rooms in certain situations.
  1. Cumulative occupant load must be added.
    - a. Rooms must not be subject to locking.
    - b. Clear path of travel must be maintained.
  2. Travel through adjoining hazardous areas and high hazard areas is not permitted. Examples:
    - a. A dining room may not exit through the kitchen in a restaurant.
    - b. A business office may not exit through an adjacent garage.
  3. A Group M occupancy **may** exit through its stockroom **when:**
    - a. Stock is of the same hazard classification.
    - b. Up to 50% of exit access is allowed through the stockroom.
    - c. The stockroom is not subject to locking from the egress side.

- d. It has a demarcated, minimum 44-inch-wide aisle, defined by full- or partial-height walls or similar construction, that will maintain required width and lead directly from retail area to exit without obstructions.

### CORRIDORS

- Exit access.
- Rating depends on occupancy, occupant load and sprinkler system.
- Fire partitions and rated ceiling, floor/ceiling or ceiling/roof.

Slide 4-48

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- I. Exit access through corridors.
  - 1. Corridors are fire-resistance rated according to occupancy and the number of occupants using the corridor.
  - 2. When the building is protected by an automatic fire sprinkler system, the corridor rating may be reduced or eliminated.
  - 3. Construction of corridors includes fire partitions for walls and rated ceiling protection.

### CORRIDOR FIRE-RESISTANCE RATING

OCCUPANCY	OCCUPANT LOAD SERVED BY CORRIDOR	REQUIRED FIRE-RESISTANCE RATING (hours)	
		Without sprinkler system	With sprinkler system <sup>a</sup>
H-1, H-2, H-3	All	Not Permitted	1
H-4, H-5	Greater than 30	Not Permitted	1
A, B, E, F, M, S, U	Greater than 30	1	0
R	Greater than 10	Not Permitted	0.5
I-2 <sup>a</sup> , I-4	All	Not Permitted	0
I-1, I-3	All	Not Permitted	1 <sup>b</sup>

Slide 4-49

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- 4. Code for corridor fire-resistance rating.

- a. IBC table describes fire-resistance rating for corridors in occupancies.
- b. Note: Also pay attention to footnotes that direct the user to other sections.

## CORRIDOR WIDTH

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OCCUPANCY	MINIMUM WIDTH (inches)
Any facilities not listed below	44
Access to and utilization of mechanical, plumbing or electrical systems or equipment	24
With an occupant load of less than 50	36
Within a <i>dwelling unit</i>	36
In Group E with a <i>corridor</i> having an occupant load of 100 or more	72
In <i>corridors</i> and areas serving stretcher traffic in ambulatory care facilities	72
Group I-2 in areas where required for bed movement	96

Slide 4-50

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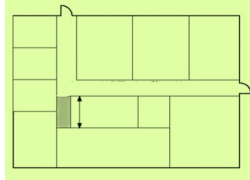
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- 5. Code for minimum corridor width.
  - a. Required to be minimum width depending on the occupancy and number of occupants.
  - b. Most corridors are required to be at least 44 inches wide, but can be reduced to 36 inches if:
    - The corridor is designed for less than 50 persons.
    - It is within a dwelling unit.
  - c. Some occupancies need wider corridors due to the density of occupants, or the use of the occupancy is such that it may be obstructed.
    - For example, an institutional occupancy that has patients who are moved in beds or gurneys.

### DEAD-END CORRIDORS

- Exit travel should be arranged to avoid dead-end corridors.
  - Dead-end corridors could be mistaken for exit access.



Slide 4-51

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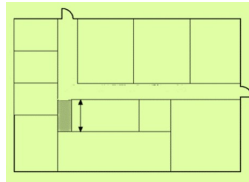
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J. Dead-end corridors (IBC 1020.4).

1. Exit travel should be arranged to avoid dead-end corridors, which could be mistaken for exit travel.

### DEAD-END CORRIDORS (cont'd)

- Codes generally limit distance of dead-end corridors to 20 feet.
- Greater distances are permitted by the IBC based on configuration and occupancy classification.



Slide 4-52

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2. Codes generally limit the distance of dead-end corridors to a maximum of 20 feet.
  - a. Greater distances are permitted by the IBC.
  - b. More distance based on configuration, occupancy classification and sprinkler protection.
    - Group I-3 of Condition 2, 3 or 4 state that a dead end in a **corridor** shall not exceed 50 feet.

- In Groups B, E, F, I-1, M, R-1, R-2, R-4, S and U provided with an **automatic sprinkler system**, length of dead-end corridors may be up to 50 feet.
- Not limited in length where the length of a dead-end corridor is less than 2.5 times the least width of a dead-end corridor.

**IX. EGRESS CAPACITY**

**EGRESS CAPACITY**

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- Required width based on occupant load.
- Exit capacity calculated using the clear opening width.

Slide 4-53

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- A. Defined — number of occupants who can use means of egress system.
  - 1. Capacity determined by occupant load and minimum requirements for egress component (IBC 1005.3).
  - 2. Path of egress includes all components of exit access, exit and exit discharge. Can include doors, corridors, aisles, stairs and ramps.
- B. Egress capacity determined with clear width available for egress.
  - 1. If door opens 180 degrees, use full-width door less door stop (exiting only).
  - 2. If new construction, door must be assumed to be 90 degrees.

Deduct 4 inches from door leaf width to determine clear opening.
  - 3. Continuity of minimum width, or required capacity of means of egress, is required to be maintained along path of egress travel to public way.

### EGRESS CAPACITY FACTORS

- Level travel.
- Stairway travel.
- Special factors for Group H and I occupancies.

Slide 4-54

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C. Egress capacity factors.

Based on characteristics of the occupancy and exiting system.

1. Level travel.
2. Stairway travel.
3. Special factors for Group H and I occupancies.

D. Calculating required exit width:

1. (Occupant load) x (egress capacity factor) = egress width.

### EXAMPLE

- Occupant load: 350 persons.
- Nonsprinklered building.
  - Level travel:  $350 \times 0.2 \text{ inch} = 70 \text{ clear inches}$ .
  - Stairway travel:  $350 \times 0.3 \text{ inch} = 105 \text{ clear inches}$ .
- Sprinklered **and** voice communication building.
  - Level travel:  $350 \times 0.15 \text{ inch} = 52.5 \text{ clear inches}$ .
  - Stairway travel:  $350 \times 0.2 \text{ inch} = 70 \text{ clear inches}$ .

Slide 4-55

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2. Given a building with a calculated occupant load of 350 persons, nonsprinklered:
- a. For level exit components (e.g., a door), an occupant load of 350 persons is multiplied by 0.2 inch per person, for a total of 70 clear inches of exit width divided between exits.
  - b. If an exit involves stairs, the occupant load is multiplied by 0.3 inch per person, for a total of 105 clear inches of exit width on stairs.
  - c. If a building is sprinklered and provided with a voice/alarm communication system, level path of exit through a door is determined by multiplying occupant load of 350 by 0.15 inch per person, for a total of 52.5 clear inches of exit width.
  - d. Clear width of stairway travel in a sprinklered building is determined by multiplying occupant load of 350 by 0.2 inch per person, for a total width of 70 clear inches.
    - Occupant load: 350 persons. Nonsprinklered building.
      - Level travel:  $350 \times 0.2 \text{ inch} = 70 \text{ clear inches}$ .
      - Stairway travel:  $350 \times 0.3 \text{ inch} = 105 \text{ clear inches}$ .
    - Sprinklered and emergency voice/alarm communication building.
      - Level travel:  $350 \times 0.15 \text{ inch} = 52.5 \text{ clear inches}$ .
      - Stairway travel:  $350 \times 0.2 \text{ inch} = 70 \text{ clear inches}$ .
  - e. Existing buildings will vary according to the code under which they were constructed. The 2009 IBC has no allowance for sprinklers.

**X. DOORS**

**DOORS**

Must swing in direction of exit travel when serving:

- High-hazard area.
- Occupant load of 50 or more.
- Group H occupancy.
- Interior exit enclosure.



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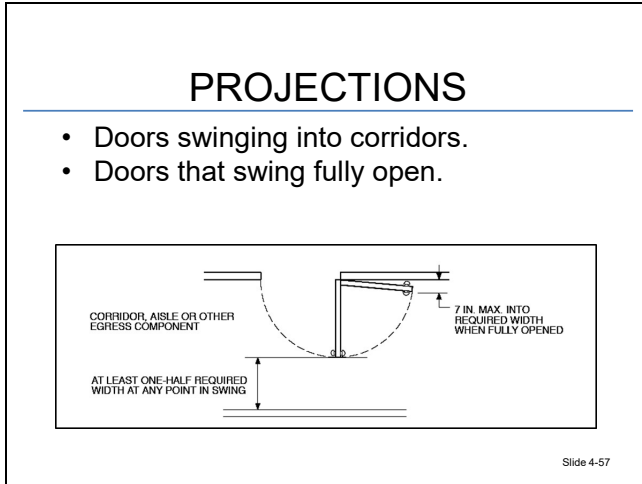
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- A. Doors must swing in the direction of exit travel:
  - 1. When serving a high-hazard area.
  - 2. When occupant load is 50 or more.
  - 3. If in a Group H occupancy.
  - 4. If in an interior exit enclosure.



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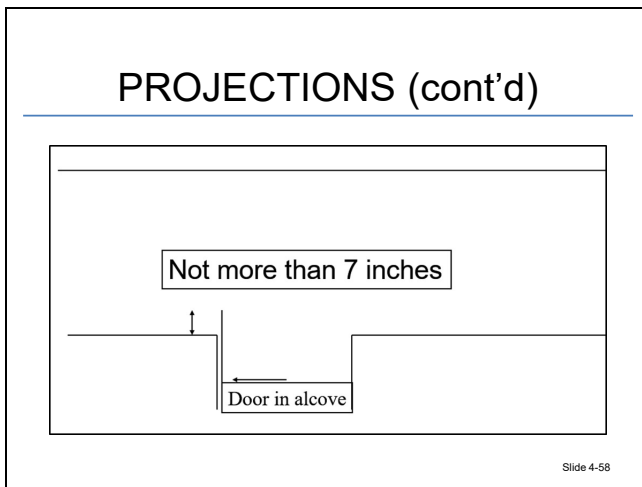
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- B. Projections.
  - 1. Doors swinging into corridors, hallways or stairways may not obstruct more than one-half the required width of the exit path.
  - 2. Doors that swing fully open must not project more than 7 inches from the wall.



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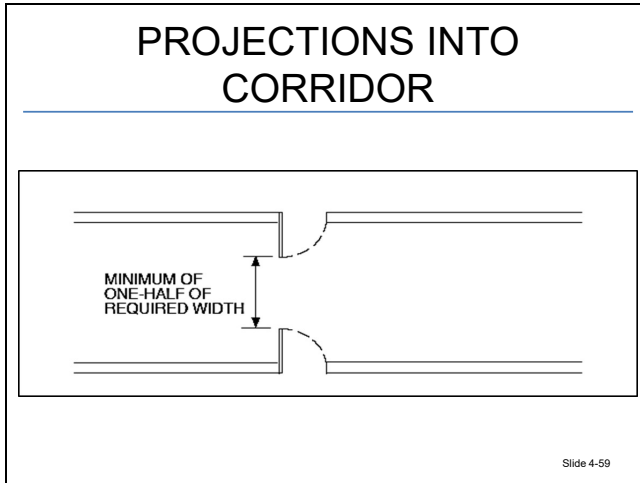
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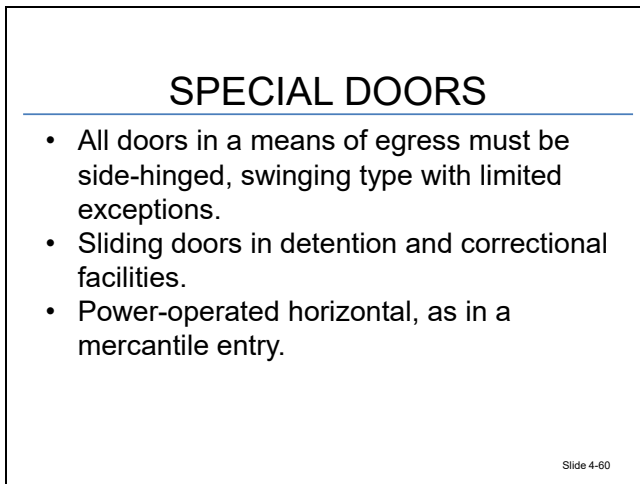
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3. Door type provisions.
  - a. All doors in a means of egress must be side-hinged, swinging type with limited exceptions.
  - b. Special doors.
    - Sliding doors in detention and correctional facilities.
    - Sliding doors in some horizontal exits.
    - Sliding doors and security doors in limited circumstances.

### MINIMUM DOOR SIZE

- In the means of egress, minimum opening for most occupancies is 32 inches.
- Exceptions provided for residential occupancies.
- Special requirements for certain occupancies.

Slide 4-61

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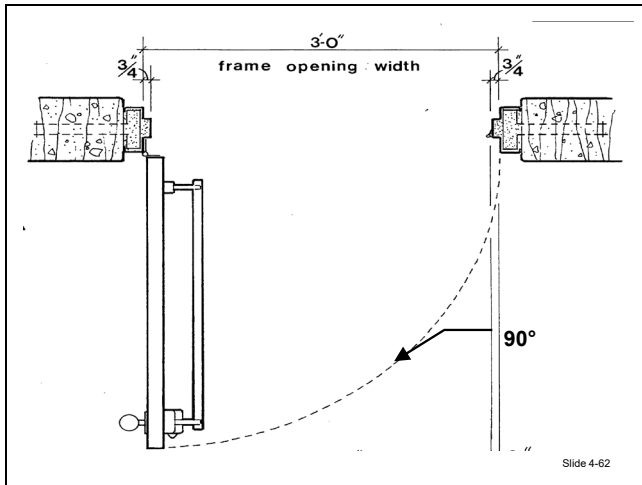
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C. Minimum door size.

1. Based on net clear opening.
2. Applies to doors in means of egress.
3. Minimum opening for most occupancies is 32 inches.
  - a. Exceptions provided for residential occupancies (inside living unit).
  - b. Exceptions provided for existing occupancies.
  - c. Special requirements for certain occupancies, such as health care.



Slide 4-62

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4. Clear width (opening) in path of egress. How to measure:
  - a. If the door opens 180 degrees, then the full width of the door leaf, less doorstop, can be considered.

- b. If the door opens less than 180 degrees, then deduct 4 inches for the door leaf width.

**PANIC HARDWARE**

- Only permit **locking** or **latching** device on egress doors.
  - Groups A and E, 50 or more occupant load.
  - Group H occupancies.
- May be installed as an option on any door (that is not a fire-rated door assembly).



Slide 4-63

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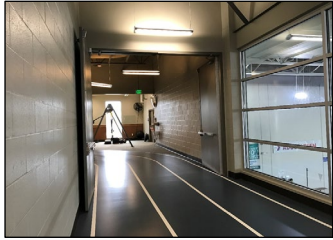
D. Panic hardware/fire exit hardware.

- 1. Panic-type hardware required in Groups A and E that have an occupant load of 50 or more.

Main entrance of Group A occupancies may have key-locking hardware per IBC Section 1010.1.9.3.

- 2. Group H occupancies.
- 3. Electrical rooms that have equipment rated at 1,200 amperes or more.
- 4. May be installed as an option on any door.
- 5. Fire-rated door assemblies that require panic hardware must have fire exit hardware because it will positively latch when closed and is tested for the specific use.

Can listed panic hardware be installed on a fire-rated door assembly?



Slide 4-64

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## SPECIAL LOCKING DEVICES

Delay-releasing hardware:

- Opening delayed 15 to 60 seconds.
- Permitted only in certain occupancies.
- Require complete sprinkler/detection systems.
- Audible alarm at door.
- Unlock upon fire alarm activation or power loss controlling the lock or lock mechanism.
- Requires instructional signage at door.

Slide 4-66

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## DELAYED EGRESS DOORS EXAMPLE



Slide 4-67

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- E. Special locking devices — delay-releasing hardware.
1. Opening delayed for 15 to 60 seconds after panic bar depressed.
  2. Permitted only in certain occupancies.
  3. Require complete sprinkler and/or detection systems.
  4. Audible alarm at door.
  5. Open upon activation of fire alarm or loss of power controlling the lock or lock mechanism.
  6. Requires instructional signage at door.

## LOCKING DEVICES

- All doors in means of egress must be arranged to be readily opened from egress side whenever building is occupied.
- Locks, if provided, shall not require use of a key, tool, special knowledge or effort for operation from inside building.

Slide 4-68

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F. Exit door latching/locking devices.

1. All doors in means of egress must be arranged to be readily opened from the egress side whenever the building is occupied.
2. Thirty-four inches to 48 inches above finished floor.
3. Locks, if provided, shall not require use of a key, tool, special knowledge or effort for operation from inside of the building.

## LOCKING DEVICES (cont'd)



Slide 4-69

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**EXCEPTIONS**

- Detention and correctional occupancies.
- Limited areas in health care occupancies.
- Main entrance/exit door in business and mercantile occupancies.
- Special signage.

Slide 4-70

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- 4. Exceptions.
  - a. Detention and correctional occupancies.
  - b. Limited areas in health care occupancies.
  - c. Main entrance/exit door in business and mercantile, storage, factory, and small assembly occupancies.
    - Buildings in occupancy Group A having an **occupant load** of 300 or less; Groups B, F, M and S; and **in places of religious worship**: main door or doors are permitted to be equipped with key-operated locking devices from egress side, provided:
      - Locking device is readily distinguishable as locked.
      - A readily visible, durable sign is posted on egress side or adjacent to door stating: “THIS DOOR TO REMAIN UNLOCKED WHEN THIS SPACE IS OCCUPIED.” Sign shall be in letters 1 inch (25 millimeters) high on a contrasting background.

Language changed from “This door to remain unlocked while building is occupied” in earlier version.

Language was “This door must remain unlocked during business hours” in Legacy codes.
      - Use of key-operated locking device is revocable by **building official** for due cause (IBC Section 1010.1.9.3).

**SPECIAL CONSIDERATIONS**

- Assembly occupancies greater than 300.
- National Fire Protection Association (NFPA) 101 allows for two-thirds of total load for certain places of assembly.

Slide 4-71

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- G. Special considerations — assembly occupancies with an occupant load greater than 300 that have a main exit:
1. Requires main exit to be capable of handling at least 50% of total occupant load.
  2. Main exit is required to front on a street or an open space adjacent to a street.
  3. Remaining exits must handle the other 50% of the occupant load.
  4. If there is no main exit, exits are allowed to be distributed around the building perimeter.
  5. NFPA 101 allows for two-thirds of total load for certain places of assembly.

## ACTIVITY 4.1

### Means of Egress

#### Purpose

Identify proper means of egress elements.

#### Directions

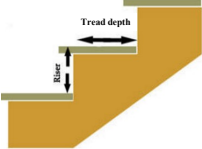
1. Work in your table groups for 30 minutes.
2. Using your code book and the submitted plan documents, complete the Plans Review Checklist, Sections B (5) and (6) found in SM Appendix B: Job Aid: Plans Review Checklist.54
3. You will work individually to generate one question that you would ask the applicant to request clarification regarding means of egress and add it to your submittal letter template found in SM Appendix A: Canterbury Submittal Letter Template.

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XI. MEANS OF EGRESS

**STAIRWAYS**

- Minimum clear width: 44 inches.
- Minimum riser height: 4 inches.
- Maximum riser height: 7 inches.
- Minimum tread depth: 11 inches.
- Consistent dimensions for risers and treads.
- Special exceptions for residential living units.



Slide 4-73

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- A. Stairways (IBC 1011).
1. Process perspective. Look at what information the plans provide.
    - a. Review what is being built.
    - b. Look at code.
    - c. Verify if compliant or not; if not clear, **ask for clarification.**
  2. Requirement-driven egress width formula.
    - a. Minimum clear width of 44 inches.
    - b. Minimum riser height of 4 inches.
    - c. Maximum riser height of 7 inches.
    - d. Minimum tread depth of 11 inches.
  3. Consistent dimensions for risers and treads.
  4. Special exceptions for residential living units.

### HANDRAILS

- On both sides of stairs.
- Between 34 and 38 inches above tread surface.
- Circular cross section at least 1 1/4 inches and not more than 2 inches.

Slide 4-74

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- B. Handrails: Stairs must be provided with handrails on both sides (IBC 1014).
1. Handrails must be between 34 and 38 inches above tread surface.
  2. Handrails must have a circular cross section of at least 1 1/4 inches and not more than 2 inches.

### HANDRAILS (cont'd)

Slide 4-75

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The Americans with Disabilities Act (ADA) requires a cross section of at least 1 1/4 inches and not more than 1 1/2 inches.

3. Handrails must be continuously graspable along the entire length of stair run or ramp run.
4. Handrails must be located at least 1 1/2 inches from the wall.

## INTERMEDIATE RAILS

Where stair is greater than 5 feet wide between handrails.



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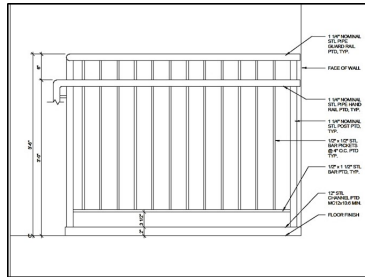
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5. Handrails must return to the wall, guard or walking surface, or be continuous to the handrail of an adjacent stair flight or ramp.
  - a. Where not continuous, must extend 12 inches beyond top riser and one tread depth at the bottom.
  - b. An intermediate handrail must be provided when all portions of the required minimum width of the stair are not within 30 inches of a handrail.

## GUARDS

- Fall protection.
- Specifications.
- Thirty inches above floor or grade.



Slide 4-77

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- C. Guards (IBC 1015).
  1. Required when the walking surface is more than 30 inches above the floor surface or ground below.
  2. The following must have fall protection:
    - a. Sides of unenclosed floor and roof openings.

- b. Open and glazed sides of landings and ramps.
  - c. Balconies or porches that are 30 inches or more above the floor.
3. The top of the guard must be at least 42 inches high.

Intermediate rails or an ornamental pattern with openings must be designed so that a 4-inch sphere cannot pass through.

### RAMPS

- Walking surfaces must be stable, firm and slip-resistant.
- Maximum ramp slope is 1:12.



Slide 4-78

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D. Ramps (IBC 1012).

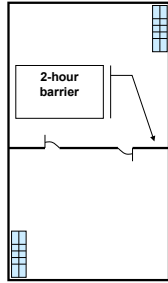
- 1. Walking surfaces must be stable, firm and slip-resistant.
- 2. Maximum slope of ramp is 1:12.

Definition of ramp is a running slope steeper than 1:20 (5% slope).

- 3. Ramps with steeper slopes were permitted in the past, but are being replaced in order to comply with the ADA.
- 4. Handrails are required on both sides when the rise is greater than 6 inches.
- 5. A ramp run may not exceed 30 inches in rise. A landing is required between ramp runs.

### HORIZONTAL EXITS

- Way of passage from one building to area of refuge in another building on approximately the same level.
- Way of passage through or around fire barrier to area of refuge on approximately same level in same building.



Slide 4-79

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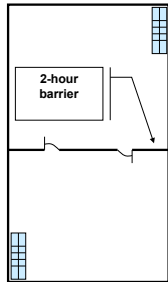
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E. Horizontal exits (IBC 1026).

1. A passage from one building to an area of refuge in another building on approximately the same level.
2. A way of passage through or around a fire barrier to an area of refuge on approximately the same level in the same building.

### HORIZONTAL EXITS (cont'd)

- Must be separated by at least two-hour-rated construction.
- Use limited to no more than 50% of required exits with exceptions for certain occupancies.



Slide 4-80

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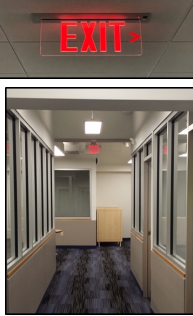
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3. Opposing spaces must be separated by at least two-hour-rated construction.
4. Use limited to no more than 50% of required exits with exceptions for certain occupancies.

**XII. MARKING MEANS OF EGRESS**

**EGRESS MARKING**

- Sign criteria.
- No point in corridor more than 100 feet from sign.
- Six-inch letters on contrasting background.



Slide 4-81

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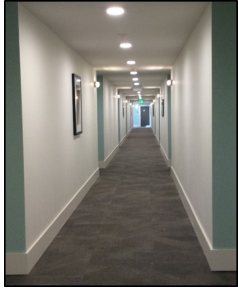

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- A. Egress marking (IBC 1013).
1. Exits and exit access doors are to be marked by an approved exit sign visible from any direction of egress travel.
  2. Exit sign to be provided when the exit or path of travel is not immediately visible.
  3. Exit sign placement. No point in an **exit access corridor** or **exit passageway** should be:
    - a. More than 100 feet (30,480 millimeters).
    - b. Or the listed viewing distance for a sign, whichever is less, from nearest visible exit sign.
  4. Sign placement exceptions:
    - a. Rooms or areas that require only one **exit** or **exit access**.
    - b. Main exterior exit doors or gates obviously and clearly identifiable as exits.
    - c. Occupancies in Group U and individual **sleeping units** or **dwelling units** in Group R-1, R-2 or R-3.
    - d. Dayrooms, sleeping rooms or dormitories in occupancies in Group I-3.
- B. Floor-level exit signs in Group R-1 occupancies (IBC 1013.2).

1. Low-level exit signs provided in all areas serving guest rooms in Group R-1 occupancies.
  2. Bottom of sign located between 10 inches and 12 inches above floor level, flush mounted to door or wall.
- C. Exit sign illumination (IBC 1013.3).
1. Exit signs shall be internally or externally illuminated at all times.
  2. **Exception:** Tactile signs required by IBC Section 1013.4 do not need to be provided with illumination.

**EGRESS ILLUMINATION**

- Normal pathway lighting.
- Emergency lighting.



Slide 4-82

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- D. Egress Illumination (IBC 1008).
- Where is emergency lighting required?
1. All portions of the means of egress.
  2. Exceptions provided (if only one exit).

**TACTILE SIGNS**

- Sign must read "EXIT" (visual characters, raised characters and braille).
- Tactile signs required at each door leading to:
  - Exit stair enclosure.
  - Area of refuge.
  - Exterior area of rescue assistance.
  - Exit stairway or ramp.
  - Exit discharge.



Slide 4-83

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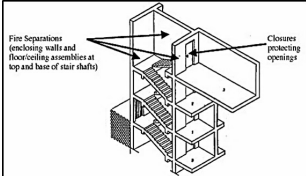
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- E. Tactile sign requirements (IBC 1013.4).
  - 1. A sign stating “EXIT” in visual characters, raised characters and braille complying with International Code Council (ICC) A117.1, *Accessible and Usable Buildings and Facilities*.
  - 2. Tactile signs are required to be provided at each door leading to an:
    - a. Exit stair enclosure.
    - b. Area of refuge.
    - c. Exterior area of rescue assistance.
    - d. Exit stairway or ramp.
    - e. Exit discharge.

**XIII. INTERIOR EXIT STAIRWAY**

**INTERIOR EXIT STAIRWAY**

- If serving four or more stories: two hours.
- If serving three or fewer stories: one hour.
- All door openings must be protected with fire-rated door assemblies.



The diagram shows a cross-section of a stair shaft. Labels include 'Fire Separations (enclosing walls and floor/ceiling assemblies at top and base of stair shafts)' and 'Closures protecting openings'. The shaft is shown with stairs and a door at the top.

Slide 4-84

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- A. Interior exit stairway: protected exit in a fire-resistance-rated shaft (IBC 1023).
  - 1. If it serves or connects four or more stories, enclosure must be at least two hours.
  - 2. If it serves or connects three or fewer stories, enclosure must be at least one hour.
  - 3. All door openings must be protected with fire-rated door assemblies.

### STAIRWAY SIGNS

Signs inside stairway at each landing; visible when door is both open and closed.

- Indicate floor level.
- Terminus of top and bottom of stairway.
- Floor level and direction to exit discharge.
- Level of exit discharge.
- Identify the stairway.

Slide 4-85

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B. Stairway signs (if serving four or more stories).

1. Signs inside stairway at each landing; visible when door is both open and closed.
2. Indicate floor level.
3. Terminus of top and bottom of stairway.

### STAIRWAY SIGN EXAMPLES



Slide 4-86

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4. Floor level and direction to exit discharge.
5. Level of exit discharge.
6. Identify the stairway.

### EGRESS PATH MARKINGS

- Currently only applicable to high rise.
- Self luminous:
  - Treads.
  - Landings.
  - Handrails.
  - Perimeter demarcation.

Slide 4-87

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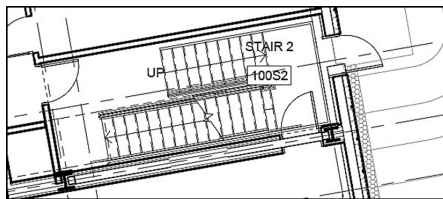
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C. Luminous egress path markings.

1. High-rise buildings of Group A, B, E, I, M and R-1 occupancies.
2. Solid and continuous strip at steps, landings, handrails and walls of interior exit stairs; interior exit ramps; and exit passageways.
3. May be self-luminous or photoluminescent.

### STAIRWAY DISCHARGE

- Directly to the outside.
- Exit passageway.
- Lobbies of certain sizes exceptions.



Slide 4-88

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D. Interior exit stairway discharge.

1. Directly to outside.
2. Exit passageway; extension of stairway enclosure with the same rating and restrictions.
3. Lobbies of certain sizes — 50% may discharge across the level of exit discharge with automatic sprinkler protection.

### STAIRWAY OPENINGS

- Limited to spaces that are normally occupied.
- Storage areas may be enclosed under stairway space.

Slide 4-89

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- E. Openings into stairways.
1. Limited to spaces that are normally occupied — no pipes, conduit or ductwork unless serving stairway enclosure.
  2. Storage areas may be enclosed under stairway space; they must be properly separated and cannot be accessed from inside of the stairway enclosure.

### SMOKEPROOF ENCLOSURES

Stair enclosure designed to protect from smoke infiltration.

- May be internal or external.
- May be pressurized or ventilated.

Slide 4-90

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- F. Smokeproof enclosures — interior exit stairways or exit ramps.
1. For high-rise or underground buildings only.
  2. Stairway or ramp enclosure designed so that movement of products of combustion, which are produced by a fire occurring in any part of a building, is limited.
    - a. May be internal or external.
    - b. May be pressurized or ventilated — natural or mechanical.

**XIV. INTERIOR FINISH AND CONTENTS**

**INTERIOR FINISH IMPACT**

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Example:



Slide 4-91

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- A. Interior finish impact.
  - 1. Examples.

**DVD PRESENTATION**

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**“STATION NIGHTCLUB FIRE”**



Slide 4-92

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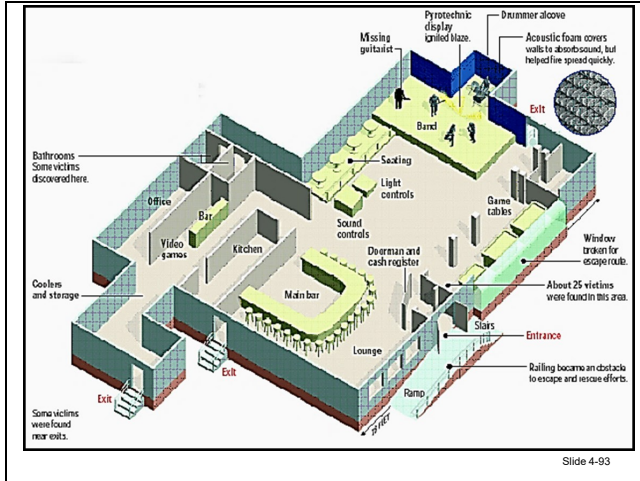
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- 2. “Station Nightclub Fire” video.




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## INTERIOR FINISHES

Exposed surfaces of walls and ceilings.

- Materials less than 1/28 inch in thickness directly applied to surface.
- ASTM E84/NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.
- Steiner Tunnel Test Apparatus.

Slide 4-94

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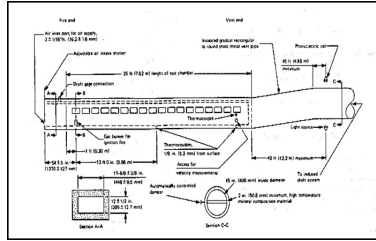
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### B. Interior finishes (IBC Chapter 8).

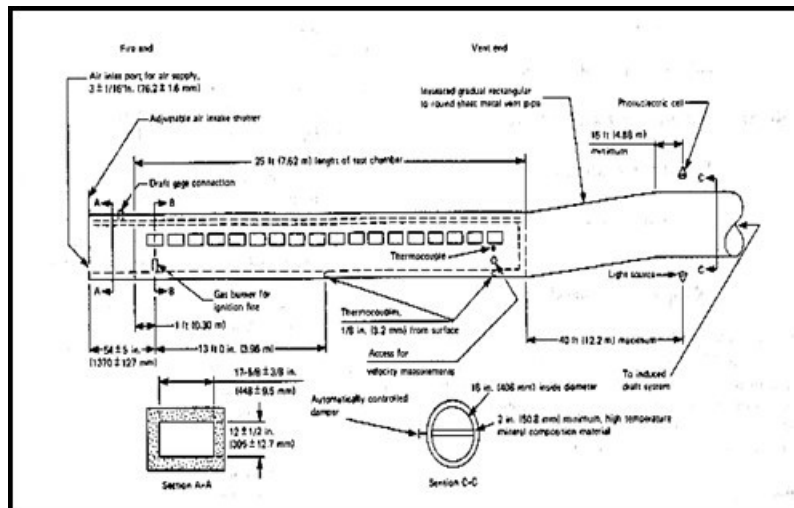
1. Exposed surfaces of walls and ceilings.
2. Interior wainscoting, paneling or other finish applied to walls and ceilings.
3. Materials less than 0.036-inch thickness directly applied to surface are not required to be tested. Note: Excludes paper-covered gypsum wallboard.

# STEINER TUNNEL



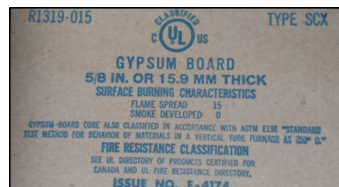
Slide 4-95

4. Tested in accordance with ASTM E84/NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials* (Steiner tunnel apparatus).



# ASTM E84/NATIONAL FIRE PROTECTION ASSOCIATION 255

- Benchmarks (nondimensional).
- Observations benchmarked.
- Smoke obscuration (toxicity not considered).
- Marking.



Slide 4-96

C. ASTM E84/NFPA 255.

1. Two different tests for various contributions to fire spread, i.e., the speed at which flames spread and move across surfaces.
2. Benchmarks (nondimensional).
  - a. Cement board: zero flame spread.
  - b. Red oak: 100 flame spread.
3. Observations made:
  - a. At maximum distance intervals of 2 feet.
  - b. At maximum time intervals of 30 seconds.
  - c. When flame reaches end of specimen.
4. Values are dimensionless numbers.
5. Smoke obscuration (toxicity not considered).

CLASSIFICATIONS			
<b>Class</b>	<b>A</b>	<b>I</b>	<b>0-25</b>
<b>Class</b>	<b>B</b>	<b>II</b>	<b>26-75</b>
<b>Class</b>	<b>C</b>	<b>III</b>	<b>76-200</b>

Smoke developed: maximum of 450 (nondimensional).

Slide 4-97

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6. Classifications (IBC 803.1.1).
  - a. Class A (I) 0-25.
    - Gypsum wallboard has a rating of 15 for flame spread.
  - b. Class B (II) 26-75.
  - c. Class C (III) 76-200.

- d. Smoke developed for all classes: maximum of 450.

**TEXTILE WALL/CEILING MATERIALS**

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- Permitted on walls and ceilings with Class A rating and automatic sprinkler protection.
- NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls.*
- Note that NFPA 265 does not apply to ceilings.

Slide 4-98

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- D. Textile wall and ceiling materials (rating combustibility).
  - 1. Permitted on walls and ceilings with Class A rating and automatic sprinkler protection.
  - 2. Testing in accordance with NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls.*
  - 3. NFPA 265 does not apply to ceilings.

**EXPANDED VINYL WALL OR CEILING COVERINGS**

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- Types of materials.
- NFPA 265 or NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.*

Slide 4-99

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- E. Expanded vinyl wall or ceiling coverings.
  - 1. Materials with:
    - a. Woven textile backing.

- b. Expanded vinyl base coat layer.
  - c. Non-expanded vinyl skin coat.
  - d. Total thickness limited to .055 to .070 inch.
2. Must be tested in accordance with NFPA 265 or NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*.

### INTERIOR WALL AND CEILING FINISH

TABLE 803.11  
INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY\*

GROUP	SPRINKLERED <sup>1</sup>			NONSPRINKLERED		
	Interior exit stairways, interior exit ramps and exit passageways <sup>1,2</sup>	Corridors and enclosure for exit access stairways and exit access ramps	Rooms and enclosed spaces <sup>2</sup>	Interior exit stairways, interior exit ramps and exit passageways <sup>1,2</sup>	Corridors and enclosure for exit access stairways and exit access ramps	Rooms and enclosed spaces <sup>2</sup>
A-1 & A-2	B	B	C	A	A <sup>1</sup>	B <sup>2</sup>
A-3 <sup>3</sup> , A-4, A-5	B	B	C	A	A <sup>1</sup>	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 <sup>4</sup>	A	A	B
I-1	B	C	C	A	B	B
I-2	B	B	B <sup>1,3</sup>	A	A	B
I-3	A	A <sup>1</sup>	C	A	A	B
I-4	B	B	B <sup>1,3</sup>	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		

Slide 4-100

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- F. Interior wall and ceiling finish requirements depend on the occupancy and the presence of an automatic fire sprinkler system (IBC Table 803.11).

### FLOOR FINISHES

- Interior finish of floors, ramps, walking surfaces, stair treads and risers.
- ASTM E648/NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*.
- Applies to where specifically regulated or to an unusual hazard.

Slide 4-101

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- G. Floor finishes.
- 1. Interior finish of floors, ramps, stair treads, risers and walking surfaces.

2. ASTM E648/NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.*

**CRITICAL RADIANT FLUX TEST**

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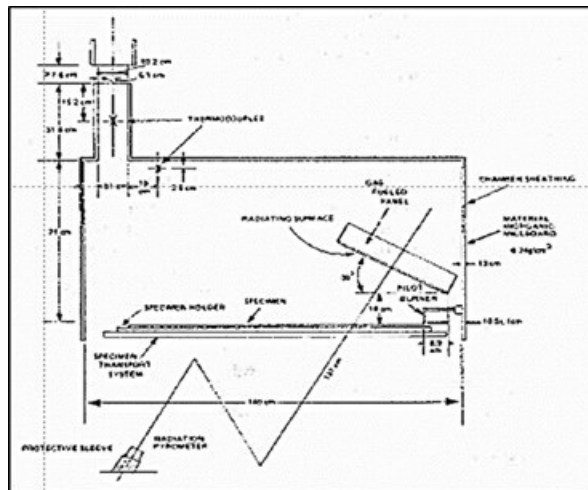
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3. Applies to where specifically regulated or to an unusual hazard.



**CLASSIFICATIONS**

- Minimum critical radiant flux.
  - Heat energy needed to ignite carpet.
- Class I: 0.45 W/cm<sup>2</sup> or greater.
- Class II: 0.22 W/cm<sup>2</sup> up to 0.45 W/cm<sup>2</sup>.
- No correlation with flame-spread ratings developed under E84/NFPA 255.

Slide 4-103

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- 4. Classifications of floor finishes.
  - a. Class I — critical radiant flux of not less than 0.45 W/cm<sup>2</sup>.
  - b. Class II — critical radiant flux of not less than 0.22 W/cm<sup>2</sup> but less than 0.45 W/cm<sup>2</sup>.
  - c. No smoke development rating.
  - d. No correlation with flame-spread ratings developed under ASTM E84/NFPA 255.

**PILL TEST**

- All carpets are regulated by Consumer Product Safety Commission (CPSC), *Standard for the Surface Flammability of Carpets and Rugs*.
  - DOC FF-1 pill test (CPSC 16 Code of Federal Regulations (CFR) Part 1630) or ASTM D2859, *Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials*.
- A methenamine tablet (pill) is placed in center of sample and ignited.

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- 5. Pill test.
  - a. All carpets are regulated by the Consumer Product Safety Commission (CPSC), *Standard for the Surface Flammability of Carpets and Rugs*.
    - DOC FF-1 pill test (CPSC 16 Code of Federal Regulations (CFR) Part 1630) or ASTM D2859, *Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials*.
  - b. Nine-inch square material sample.
  - c. Flat metal plate with an 8-inch hole in the center is placed over the sample.
  - d. A methenamine tablet (pill) is placed in the center of the sample and ignited.

- e. The sample passes if the charred portion does not extend to the side of the hole in the metal plate.
- f. Intended to test for potential of cigarette ignition.

**INTERIOR FLOOR FINISH**

- Groups I-1, I-2 and I-3.
  - Class I; Class II if sprinklered.
- Groups A, B, E, H, I-4, M, R-1, R-2 and S.
  - Class II; Pill test if sprinklered.
- All occupancies.
  - Pill test.

Slide 4-105

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- 6. Interior floor finish requirements depend on the occupancy and the presence of an automatic fire sprinkler system.

**CONTENTS AND FURNISHINGS**

- Objects, goods or products inside a structure for functional, operational or decorative reasons.
- Exclusions.



Slide 4-106

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- H. Contents and furnishings.
  - 1. Objects, goods or products placed inside a structure for functional, operational or decorative reasons.
  - 2. Excludes parts of building structure, building service equipment, and items meeting the definition of interior finish.

**TEST STANDARDS**

- NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.*
- NFPA 260, *Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture.*

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- I. Test standards.
1. NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.*
  2. NFPA 260, *Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture.*

**TEST STANDARDS (cont'd)**

- NFPA 261, *Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes.*
- NFPA 266, *Standard Method of Test for Fire Characteristics of Upholstered Furniture Exposed to Flaming Ignition Source.*

Slide 4-108

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3. NFPA 261, *Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes.*
4. NFPA 266, *Standard Method of Test for Fire Characteristics of Upholstered Furniture Exposed to Flaming Ignition Source.*

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## ACTIVITY 4.2

### Interior Finishes

#### Purpose

Identify proper interior finish requirements.

#### Directions

1. Work in your table groups for 20 minutes.
2. Review the provided cut sheet.
3. Using the submitted plan documents, complete Section B (9) and (10) of the Plans Review Checklist found in SM Appendix B.
4. Work individually to generate one question you would ask the applicant to request clarification regarding interior finishes and add it to your submittal letter template found in SM Appendix A.

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**XV. SPECIAL OCCUPANCIES**

**SPECIAL OCCUPANCIES**

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Have unique or special considerations.

Slide 4-110

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- A. Have unique or special considerations.

Special occupancies covered in IBC Chapter 4.

**COVERED MALLS**

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- Single building enclosing a number of tenants and occupants:
  - Retail stores, drinking and dining, entertainment, passenger terminals, offices, and other similar uses.
  - Two or more tenants have a main entrance into one or more malls.

Slide 4-111

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- B. Covered malls.
  - 1. Single building enclosing a number of tenants and occupants.
    - a. Retail stores, drinking and dining, entertainment, passenger terminals, offices, and other similar uses.
    - b. Two or more tenants have a main entrance into one or more malls.

### COVERED MALLS (cont'd)

- Mall is roofed or has a covered, common pedestrian way within a covered mall.
- Does not include anchor buildings.



Slide 4-112

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2. Mall is roofed or has a covered, common pedestrian way within a covered mall.
3. Large occupant loads.
  - a. Egress obstructions.
  - b. Smoke control challenges.

### ANCHOR BUILDING/STORE

- Exterior perimeter building of a group other than H having direct access to covered mall building.
- Has required means of egress independent of the mall.



Slide 4-113

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4. Definition does not include anchor buildings.
  - a. Exterior perimeter building of a group other than H having direct access to a covered mall building.
  - b. Has required means of egress independent of the mall.

## HIGH-RISE

Buildings having an occupied floor level more than 75 feet above the lowest level of fire department access.



Slide 4-114

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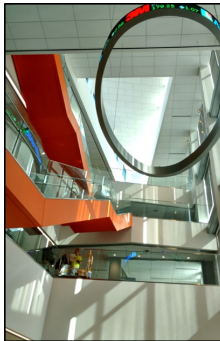
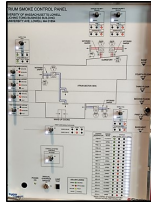
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### C. High-rise building.

1. Buildings having an occupied floor level more than 75 feet above the lowest level of fire department access.
2. High-rises challenge life safety and fire control due to elevation.

## ATRIUMS (ATRIA)

- Opening connecting two or more stories.
- Like a chimney in the building middle.



Slide 4-115

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### D. Atriums (Atria).

1. Opening connecting two or more stories.
2. Does not include enclosed stairways; elevators; hoistways; escalators; plumbing; electrical; heating, ventilating, and air conditioning (HVAC); or other equipment.
3. Essentially, a chimney in the middle of the building.

## UNDERGROUND OR WINDOWLESS

Any floor for human occupancy more than 30 feet below the level of exit discharge.

- Sprinkler protection.
- Smoke control.



Slide 4-116

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E. Underground or windowless buildings.

1. Any floor for human occupancy which is more than 30 feet below the level of exit discharge.
2. Smoke- and heat-removal issues due to lack of openings.
3. Egress and access problems.

## MOTOR VEHICLE-RELATED

- Private garages and carports.
- Parking garages — open and closed.
- Repair garages.
- Motor-fueling facilities.



Slide 4-117

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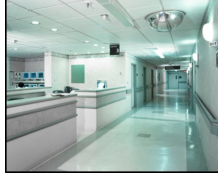
F. Motor vehicle-related — issues related to type and amount of combustibles.

1. Private garages and carports.
2. Parking garages — open and closed.
3. Repair garages.
4. Motor-fueling facilities.

## HEALTH CARE

Hospitals, nursing homes, mental hospitals, detoxification facilities.

- Nurses' stations.
- Mental health treatment areas.
- Gift shops.
- Corridor construction.
- Automatic fire detection.



Slide 4-118

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### G. Health care and detention facilities.

1. Hospitals, nursing homes, mental hospitals, detoxification facilities, jails and reformatories.
2. Patients' inability to self-evacuate.

## SPECIAL AMUSEMENT BUILDINGS

Permanent or temporary building where means of egress is not readily apparent or available due to visual or audio features.

- Haunted houses.
- Amusement park rides.

Slide 4-119

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### H. Special amusement buildings.

1. A building where means of egress is not readily apparent or available due to visual or audio features: haunted houses, amusement park rides.
2. Permanent or temporary.

## AIRCRAFT-RELATED

- Control towers.
- Hangers.
- Heliports/Helistops.



Slide 4-120

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- I. Aircraft-related.
1. Control towers.
  2. Hangers.
  3. Heliports/Helistops.

## COMBUSTIBLE MATERIALS STORAGE

High pile or rack must comply with fire code.



Slide 4-121

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- J. Combustible materials storage.
- A high pile or rack must comply with the fire code.

## HAZARDOUS MATERIALS

- Physical and health hazard materials.
- Control areas.
- Allowable amounts.
- Fire protection systems.
- Emergency controls and alarms.



Slide 4-122

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- K. Hazardous materials — physical and health hazard materials.
1. Control areas.
  2. Exempt quantities.
  3. Architect may not have complete information.

## XVI. SUMMARY



### SUMMARY

- Verifying egress requirements.
- Checklist to verify means of egress.
- Occupancy classification.
- Verifying occupant load.
- Exit quantity.
- Arrangement of exits (IBC 1007.1.1).
- Travel distance (IBC 1017).
- Egress capacity.

Slide 4-123

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 **FEMA**  U.S. Fire Administration

## SUMMARY (cont'd)

- Doors.
- Means of egress.
- Marking means of egress.
- Interior exit stairway.
- Interior finish and contents.
- Special occupancies.

Slide 4-124

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Did you get the questions answered, “Why is this information important?” and “Why is it important to evaluate plans for compliance with occupant load, egress and finish requirements?”

Slide 4-125

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Any burning questions?

Slide 4-126

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## ACTIVITY 4.3

### Life Safety and Fire Protection Concepts

#### Purpose

Explain the building code applications for special uses and occupancies.

#### Directions

1. Work in your table groups.

Note: Special detailed requirements based on use and occupancy or in special structures are intended to address the specific life safety and fire protection requirements unique to these facilities.

For example, the essential life safety and fire protection concepts related to motion picture projection rooms are to **confine the hazard to a single location** and **provide adequate ventilation**.

2. Using your most current code, your table group is to develop a one-page easel pad summary of the key life safety and fire protection concepts that the code addresses within the assigned occupancy type.
3. Choose a representative to present your group's findings to the class when called upon by the instructor.

Table	Occupancy/Use	Key Life Safety and Fire Protection Concepts
1	Covered mall buildings	

ARCHITECTURAL FEATURES: LIFE SAFETY

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2	Stages and platforms	
3	Special amusement buildings	
4	High-rise buildings	

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ARCHITECTURAL FEATURES: LIFE SAFETY

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5	Aircraft-related occupancies	
6	Underground buildings	

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## REFERENCE

ICC. (2015). *International Building Code*. Washington, DC: Author.

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# **APPENDIX**

## **ABSTRACT OF NIST REPORT ON THE STATION NIGHTCLUB FIRE**

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**Report of the Technical Investigation of The Station Nightclub Fire (NIST NCSTAR 2),  
Volume 1 Published: June 30, 2005**

**Author(s)**

**William L. Grosshandler, Nelson P. Bryner, Daniel M. Madrzykowski, K. Kuntz**

**Abstract**

A fire occurred on the night of Feb. 20, 2003, in The Station Nightclub at 211 Cowesett Avenue, West Warwick, Rhode Island. A band that was on the platform that night, during its performance, used pyrotechnics that ignited polyurethane foam insulation lining the walls and ceiling of the platform. The fire spread quickly along the walls and ceiling area over the dance floor. Smoke was visible in the exit doorways in a little more than one minute, and flames were observed breaking through a portion of the roof in less than five minutes. Egress from the nightclub, which was not equipped with sprinklers, was hampered by crowding at the main entrance to the building. One hundred people lost their lives in the fire. On Feb. 27, 2003, under the authority of the National Construction Safety Team (NCST) Act, the National Institute of Standards and Technology (NIST) established a National Construction Safety Team to determine the likely technical cause or causes of the building failure that led to the high number of casualties in that fire. This report documents the procedures, findings, and issues that were raised by the investigation. Volume I contains the main report and Volume II contains appendix material. The investigation concluded that strict adherence to 2003 model codes available at the time of the fire would go a long way to preventing similar tragedies in the future.

**Citation:** National Construction Safety Team Act Reports (NIST NCSTAR) - 2

**NIST Pub Series:** National Construction Safety Team Act Reports (NIST NCSTAR)

**Pub Type:** NIST Pubs

**Report Number:** 2

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# **UNIT 5: ELECTRICAL SYSTEMS**

## **TERMINAL OBJECTIVE**

*The students will be able to:*



- 5.1 *Evaluate information shown in submitted plan documents, in conjunction with applicable building code requirements, for compliance with electrical life safety feature requirements, including illumination and markings.*

## **ENABLING OBJECTIVES**

*The students will be able to:*

- 5.1 *Evaluate the submitted plan documents for compliance with fire protection and life safety systems.*
  - 5.2 *Evaluate the submitted plan documents for compliance with egress illumination and markings.*
  - 5.3 *Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the electrical systems information.*
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## UNIT 5: ELECTRICAL SYSTEMS

Slide 5-1

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### I. OBJECTIVES

### TERMINAL OBJECTIVE

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Evaluate information shown in submitted plan documents, in conjunction with applicable building code requirements, for compliance with electrical life safety feature requirements, including illumination and markings.

Slide 5-2

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### ENABLING OBJECTIVES

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- Evaluate the submitted plan documents for compliance with fire protection and life safety systems.
- Evaluate the submitted plan documents for compliance with egress illumination and markings.

Slide 5-3

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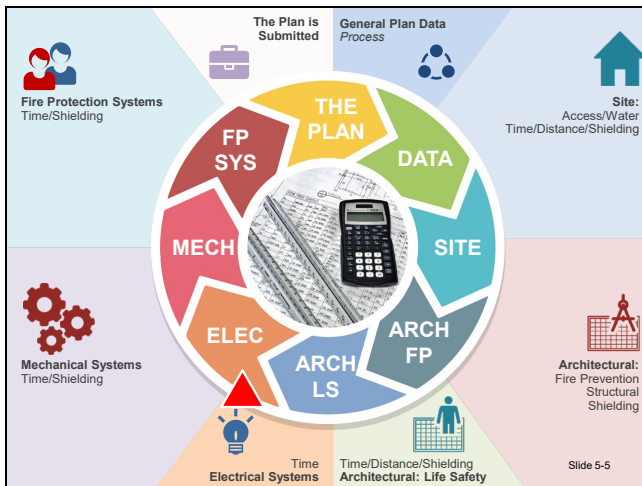
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## ENABLING OBJECTIVES (cont'd)

- Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the electrical systems information.

Slide 5-4



Slide 5-5

Why is reviewing plans for electrical service, power illumination and exit signage important?

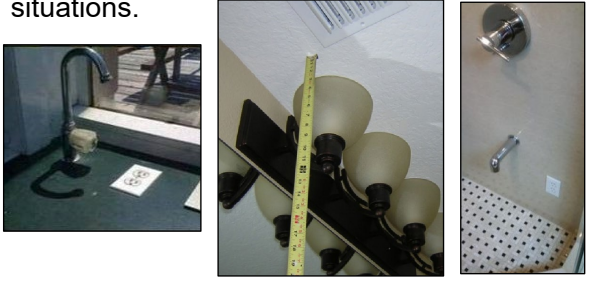
Slide 5-6

- A. The unit focus is on life safety and fire protection fixtures and appliances that require electrical systems (e.g., egress illumination, fire alarm systems, smoke control systems and elevators).

**WHY?**

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Plans review should eliminate these situations.



Slide 5-7

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B. Plans review should eliminate situations like those shown on Slide 5-7.

**COURSE THEME**

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Three E's of fire prevention and life safety:

- Engineering.
- Education.
- Enforcement.



Slide 5-8

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- C. The course theme is the three E's of fire prevention and life safety:
1. Engineering.
  2. Education.
  3. Enforcement.

II. ELECTRICAL PLANS REVIEW

**ELECTRICAL PLANS REVIEW**

- Symbols/Legends.
- Plans may include:
  - Power.
  - Lighting.
  - Fire alarm.
  - Security.
  - Closed-circuit television (CCTV)/telecommunications.

Slide 5-9

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A. This unit covers aspects of National Fire Protection Association (NFPA) 70, *National Electrical Code*<sup>®</sup> (NEC), that are fire and life safety specific.

B. Preparing for electrical plans review.

1. Symbols used on electrical drawing.

a. Not all electrical engineers use the same symbols as architectural drawings.

b. Check the legend for symbol identification.

- The legend will include the type of fixtures and appliances that will be classified as part of an emergency system.

2. Electrical plans will usually include:

a. Power distribution.

b. Preliminary fire alarm, security, and closed-circuit television (CCTV) and telecommunications services.

3. Point-to-point wiring methods are seldom shown.

May be needed to identify zones when required, or to identify the electrical fixtures and appliances that will be served by emergency or standby power systems.

## ELECTRICAL PLANS REVIEW (cont'd)

- One-line drawing.
  - Power distribution diagram.
  - Equipment and conductor ratings and sizes.

Slide 5-10

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4. A one-line drawing demonstrates the power distribution system.
  - a. Ratings and sizes of electrical equipment and circuit conductors.
  - b. Electrically correct distribution of power with respect to current flow from the power source to downstream loads or panel boards.

### III. BUILDING ELECTRICAL SERVICE

## ELECTRICAL SERVICE

- Each building/structure should not be served by more than one service.
- Exceptions for multiple services.



Slide 5-11

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- A. Number of services.
  1. Each building/structure should not be served by more than one service (e.g., conductors and equipment for delivering energy from the electrical supply system to the premises' wiring system).
  2. Exceptions for multiple services.

## SPECIAL EXCEPTIONS

- Where separate service is required for fire pumps and other receptions.
- Multiple-occupancy or large-area buildings by special permission.



Slide 5-12

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### B. Special exceptions.

1. Where separate service is required for the following:
  - a. Fire pumps.
  - b. Emergency.
  - c. Legally required standby.
  - d. Optional standby.
  - e. Parallel power production systems.
2. Multiple-occupancy buildings where there is no space available for one service for all occupancies or a building large enough to require two or more services.

## SPECIAL EXCEPTIONS (cont'd)

- Large capacity requirements.
- When facility requires different voltages, frequencies or phases.

Slide 5-13

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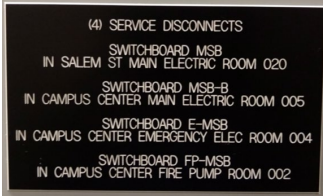
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- 3. Large capacity requirements.
  - a. When high-amperage services are required (more than 2,000 amps).
  - b. When there are needs for different voltages, frequencies or phases.

**REQUIRED WARNING SIGNS**

- Where building or structure has more than one service.
- Permanent plaque.



Slide 5-14

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- C. Required warning signs.
  - 1. Where a building or structure has more than one service.
  - 2. A permanent plaque or directory shall be installed at each service disconnect location denoting all other services.

**SUPPLY SIDE EQUIPMENT**

- Standby power systems.
- Emergency systems.
- Fire pumps.
- Fire and sprinkler alarms.

Slide 5-15

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- D. Equipment permitted on supply side of service disconnects.
  - 1. Standby power systems.
  - 2. Emergency systems.
  - 3. Fire pumps.

4. Fire and sprinkler alarms.
5. Must be provided with a separate disconnecting means and overcurrent protection (circuit breakers).
6. Fire pump feeder is not required to have overcurrent protection, but if provided, must be rated at no less than 150% of locked rotor current.

**IV. EMERGENCY, STANDBY AND SECONDARY POWER**

**ALTERNATIVE POWER**

- Emergency.
- Standby.
- Secondary.



Slide 5-16

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- A. Alternative power:
1. Emergency power systems.
  2. Standby power systems.
  3. Secondary power systems.

**EMERGENCY POWER SYSTEMS**

- Operate required life safety, fire alarm, detection and ventilation systems in event of power failure.
- Power loss could result in loss of human life or serious injury.



Slide 5-17

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- B. Emergency power systems.
  - 1. Power to operate required life safety, fire alarm, detection and ventilation systems in the event of a failure of the primary power.
  - 2. Where interruption of the primary power could result in loss of human life or serious injuries.

**EMERGENCY POWER SYSTEMS (cont'd)**

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- National Fire Protection Association (NFPA) 70, *National Electrical Code*® (NEC), Article 700.
- Automatically online **within 10 seconds**:
  - Fire alarms/communications.
  - Exit illumination and signs.
  - Hazardous materials control systems.
  - Systems in high-rise buildings.

Slide 5-18

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- 3. Installation requirements found in NFPA 70, Article 700.
- 4. Systems legally required by municipal, state, federal or other codes, or by any government agency having jurisdiction.
- 5. Must be online automatically **within 10 seconds**.
- 6. Emergency power loads provided to:
  - a. Fire alarms/communications.
  - b. Exit illumination and signs.
  - c. Hazardous materials control systems.
  - d. Systems in high-rise buildings.
- 7. Minimum duration of 90 minutes.

### LEGALLY REQUIRED STANDBY SYSTEMS

- Operate required building, hazardous materials or ventilation systems in the event of power failure.
- Power loss could create hazards or hamper rescue or firefighting operations.

Slide 5-19

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C. Legally **required** standby systems.

1. A source of automatic electric power of a required capacity and duration to operate required building, hazardous materials or ventilation systems in the event of a failure of the primary power.
2. Loads, when stopped, could create hazards or hamper rescue or firefighting efforts.

### LEGALLY REQUIRED STANDBY SYSTEMS (cont'd)

- NFPA 70, Article 701.
- Automatically online **within 60 seconds**:
- Standby power provided to:
  - Smoke control/management.
  - Elevators for accessible means of egress, fire service access or occupant self-evacuation.
  - Power and lighting for the fire command center.

Slide 5-20

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3. Installation requirements found in NFPA 70, Article 701.
4. Systems required and classified as **required standby** by municipal, state, federal, or other codes or government agency having jurisdiction.
5. Must be online automatically **within 60 seconds**.
6. Standby power provided to:
  - a. Smoke control/management.

- b. Elevators for accessible means of egress, fire service access or occupant self-evacuation.
- c. Power and lighting for the fire command center required by International Building Code (IBC) Section 403.4.6.

**OPTIONAL STANDBY SYSTEMS**

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- NFPA 70, Article 702.
- Protect facilities where life safety does not depend on performance of the system.
- Power loss could cause discomfort, serious interruption of process, damage to product or process, etc.
- Qualified systems.
- No online time limit.

Slide 5-21

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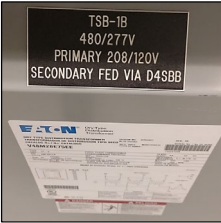
**D. Optional standby systems.**

1. Installation requirements found in NFPA 70, Article 702.
2. Systems intended to protect public or private facilities or property where life safety does not depend on performance of the system.
3. Loads that, when stopped, could cause discomfort, serious interruption of process, damage to product or process, or similar other.
4. Qualified systems.
5. No online time limit — automatic or manual (e.g., elevators).

**SECONDARY POWER**

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- Fire alarm control panels.
- Minimum 24-hour storage capacity.
- Automatically on within 30 seconds.
- No fire alarm signal loss.



Slide 5-22

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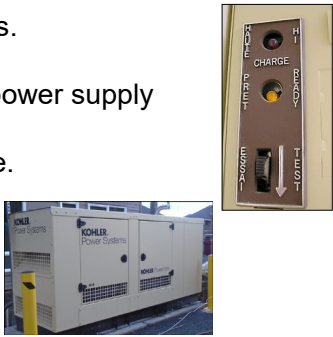
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- E. Secondary power.
  - 1. Term applicable only to fire alarm systems.
  - 2. Minimum 24-hour storage capacity.
  - 3. Battery, generator, uninterruptible power supply (UPS).
  - 4. Automatically on within 30 seconds of power loss.
  - 5. No fire alarm signal loss.

**POWER SOURCES**

- Storage batteries.
- Generator sets.
- Uninterruptible power supply (UPS).
- Separate service.
- Unit equipment.



Slide 5-23

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F. Power sources.

**STORAGE BATTERIES**

- Maintain the total load for a duration of 90 minutes without the voltage applied to the load falling below 87.5% of normal.
- Automotive batteries are not allowed.
- Automatic means of charging.

Slide 5-24

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- 1. Storage batteries.
  - a. Maintain the total load for a duration of 90 minutes without the voltage applied to the load falling below 87.5% of normal.

- b. Automotive batteries are not allowed.
- c. Automatic means of charging.

**GENERATOR SETS**

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- Automatic transfer.
- Fifteen-minute time delay to avoid retransfer in the event of a short-term outage.
- Two-hour fuel supply for a combustion engine.
- May not be solely supplied by public utility gas or be solely dependent on public water system for water cooling unless approved by authority having jurisdiction (AHJ).

Slide 5-25

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- 2. Generator sets.
  - a. Automatic transfer.
  - b. Fifteen-minute time delay to avoid retransfer in the event of a short-term outage.
  - c. Two-hour fuel supply for a combustion engine.
  - d. May not be solely supplied by public utility gas or be solely dependent on public water system for water cooling unless approved by authority having jurisdiction (AHJ).

**UNINTERRUPTIBLE POWER SUPPLY**

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Installed per requirements of storage batteries or generator system.

Slide 5-26

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- 3. UPSs.

Installed per requirements of storage batteries or generator system.

### SEPARATE SERVICE

- Only when allowed.
- Separate overhead service connectors, service drops, underground service conductors or service laterals.
- Sufficiently remote, electrically and physically, from any other service conductors to minimize possibility of simultaneous interruption of supply.

Slide 5-27

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4. Separate service.
  - a. Only when allowed.
  - b. Separate overhead service connectors, service drops, underground service conductors or service laterals.
  - c. Sufficiently remote, electrically and physically, from any other service conductors to minimize the possibility of simultaneous interruption of supply.

### UNIT EQUIPMENT

- Self-contained emergency lighting units.
  - Exit signs.
  - Emergency light packs.
- Maintain total lamp load:
  - 1 1/2 hours without voltage falling below 87.5% of normal battery usage.
  - Or, supply and maintain at least 60% of the initial emergency illumination for at least 1 1/2 hours.

Slide 5-28

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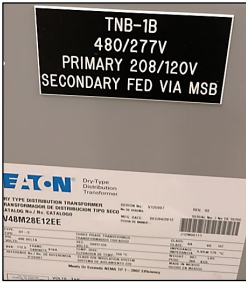
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5. Unit equipment (i.e., self-contained emergency lighting units).
  - a. Exit signs.
  - b. Emergency light packs.
  - c. Maintain total lamp load:

- One and one half hours without voltage falling below 87.5% of normal battery usage.
- Or, supply and maintain at least 60% of the initial emergency illumination for at least 1 1/2 hours.

**SIGNAGE REQUIREMENTS**

- At service entrance and on-site location.
- Legally required for:
  - Emergency power sources.
  - Standby power sources.
  - Optional standby power sources.



Slide 5-29

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G. Signage requirements.

Sign placed at service entrance, indicating type and location of on-site:

1. Legally required emergency power sources.
2. Legally required standby power sources.
3. Optional standby power sources.

**GENERATOR REQUIREMENTS**

- NFPA 110, *Standard for Emergency and Standby Power Systems*.
- NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*.

Slide 5-30

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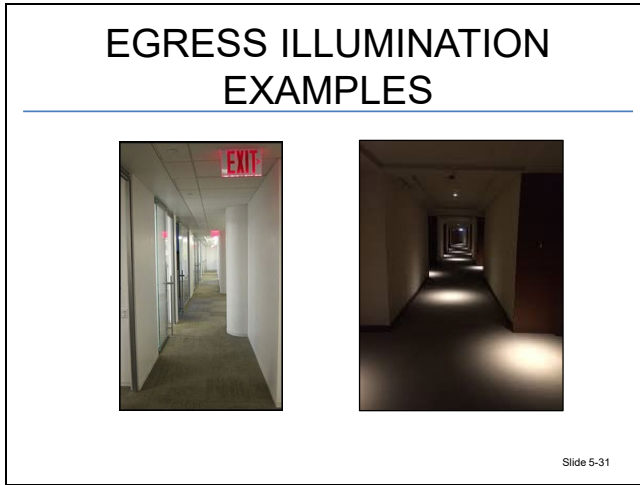
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H. Generator requirements.

1. NFPA 110, *Standard for Emergency and Standby Power Systems*.

2. NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*.
3. If a generator provides secondary power for the fire pump, it must have a minimum eight-hour fuel supply.

**V. EGRESS ILLUMINATION**



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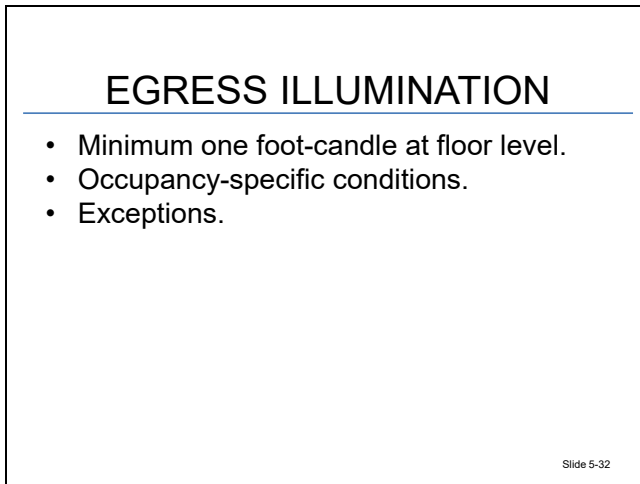
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- A. Egress illumination requirements.
1. Illumination of means of egress is needed to maintain reasonable visibility in nonemergent and emergent conditions.
  2. Exit discharge is included.



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3. Minimum of one foot-candle at walking surface level. Includes:
  - a. Natural, artificial or both.

- b. Normal or emergency.
- 4. Occupancy-specific considerations.
  - a. Auditoriums, theaters or similar occupancies.
  - b. May reduce to two-tenths foot-candle during presentation.
- 5. Light level must return to one foot-candle of illumination upon fire alarm operation.
- 6. Illumination requirement exceptions. None required in:
  - a. Group U occupancies.
  - b. Aisle access ways in Group A occupancies.
  - c. Dwelling units and sleeping units in Groups R-1, R-2 and R-3 occupancies.
  - d. Sleeping units in Group I occupancies.

**FIXTURE COUNT FOR  
NORMAL ILLUMINATION**

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- Plans review provides only baseline.
- On-site inspection and testing required.



Slide 5-33

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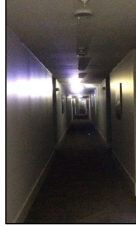
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- B. Number of fixtures required for normal illumination.
  - 1. Plans review provides only baseline.
  - 2. On-site inspection and testing needed to verify illumination levels.

## EMERGENCY LIGHTING REQUIREMENTS

Not less than:

- Average of one foot-candle at floor level.
- One-tenth foot-candle at any point in egress path.
- Ninety-minute duration.
- Average of six-tenths foot-candle.



Slide 5-34

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C. Emergency lighting requirements (IBC 1008.3).

1. Not less than an average of one foot-candle at floor level.
2. Not less than one-tenth foot-candle at any point in means-of-egress path.
3. Duration of not less than 90 minutes.
4. May decline to not less than an average of six-tenths foot-candle, but not less than six-hundredths foot-candle at any point.

## LIGHTING POWER SOURCES

- Unit fixture.
- Generator.
- Storage batteries.

Slide 5-35

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D. Lighting power sources (IBC 1008.3.4).

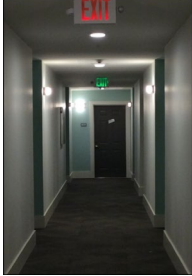
1. Self-contained rechargeable battery (unit fixtures) — ensure that fixture is connected to a lighting circuit serving the area in which the fixture is located.
2. Generator.
3. Storage batteries.

**VI. EXIT SIGNS**

**EXIT SIGNS**

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- Where needed to identify exit path.
- Where not required.
- Internally or externally illuminated, or self-luminous.
- Fixture connected to lighting circuit serving area where fixture is located.



Slide 5-36

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- A. Exits and exit access doors where needed to readily identify the path of exit travel.
- B. Not required at:
  - 1. Obvious main exit doors or gates.
  - 2. Rooms or areas that require only one exit.
  - 3. Group U occupancies or sleeping rooms.
- C. Signs must be illuminated internally or externally, or be self-luminous.

Fixture should be connected to a lighting circuit serving the area in which the fixture is located.

**EXIT SIGN POWER SOURCE**

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Emergency power sources:

- Self-contained rechargeable battery (unit fixtures).
- Generator installed as emergency power.
- Storage batteries.

Slide 5-37

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- D. Exit sign emergency power sources (IBC 1013.6.3).
  - 1. Self-contained rechargeable battery (unit fixtures).
  - 2. Generator.

- 3. Storage batteries.

**VII. SUMMARY**



### SUMMARY

- Electrical plans review.
- Building electrical service.
- Emergency, standby and secondary power.
- Egress illumination.
- Exit signs.

Slide 5-38

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Did you get the answer to the question, "Why is reviewing plans for electrical service, power illumination and exit signage important?"

Slide 5-39

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Any burning questions?

Slide 5-40

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## ACTIVITY 5.1

### Electrical Requirements

#### Purpose

Identify appropriate electrical requirements related to fire and life safety.

#### Directions

1. Work individually in your table groups for 45 minutes.
2. Using the provided plans, complete Section D (1), (2), (4), (5) and (6) of the Plans Review Checklist found in Student Manual (SM) Appendix B: Job Aid: Plans Review Checklist.
3. Identify the deficiencies.
4. Work individually to generate one question regarding electrical service, power, egress power and/or illumination. This question will be added to the submittal letter template requesting clarification from the applicant which is found in SM Appendix A: Canterbury Submittal Letter Template.

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# **UNIT 6: MECHANICAL SYSTEMS**

## **TERMINAL OBJECTIVE**

*The students will be able to:*



- 6.1 *Evaluate if information shown in submitted plan documents complies with mechanical fire and life safety feature requirements, including fire and smoke dampers.*

## **ENABLING OBJECTIVES**

*The students will be able to:*

- 6.1 *Evaluate if the submitted plan documents comply with the code requirements for fire and smoke dampers.*
  - 6.2 *Evaluate if the submitted plan documents comply with the code requirements for smoke detector systems control in air distribution systems.*
  - 6.3 *Evaluate if the submitted plan documents comply with the code requirements for the protection of commercial cooking equipment.*
  - 6.4 *Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the mechanical systems information.*
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**UNIT 6:  
MECHANICAL SYSTEMS**

Slide 6-1

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**I. OBJECTIVES**

**TERMINAL OBJECTIVE**

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Evaluate if information shown in submitted plan documents complies with mechanical fire and life safety feature requirements, including fire and smoke dampers.

Slide 6-2

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**ENABLING OBJECTIVES**

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- Evaluate if the submitted plan documents comply with the code requirements for fire and smoke dampers.
- Evaluate if the submitted plan documents comply with the code requirements for smoke detector systems control in air distribution systems.

Slide 6-3

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## ENABLING OBJECTIVES (cont'd)

- Evaluate if the submitted plan documents comply with the code requirements for the protection of commercial cooking equipment.
- Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the mechanical systems information.

Slide 6-4

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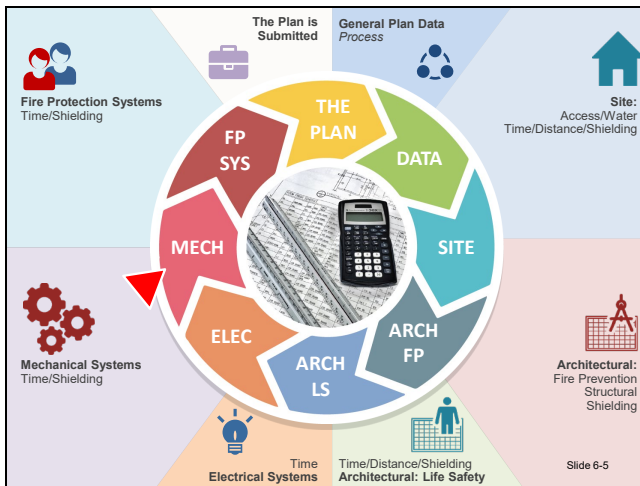
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Why is this information important?

Slide 6-6

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### WHY?

Plans review should eliminate these situations:



Slide 6-7

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A. Examples.

1. The picture on Slide 6-7 shows a ventilation hood over cooking appliances. The hood was extended with **tin foil**, which will do little to contain a fire; the fire suppression system was not modified to cover the appliances.

### WHY? (cont'd)



Slide 6-8

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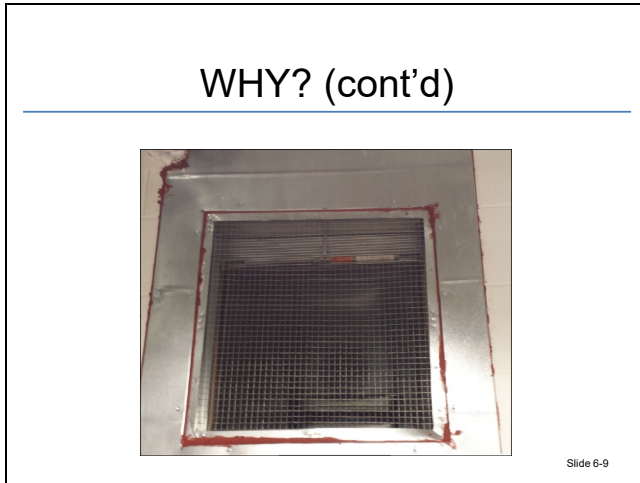
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2. Slide 6-8 shows a duct full of grease that had not been cleaned in several years but passed inspection.

This duct is a fire hazard, as grease provides plenty of fuel for a fire.



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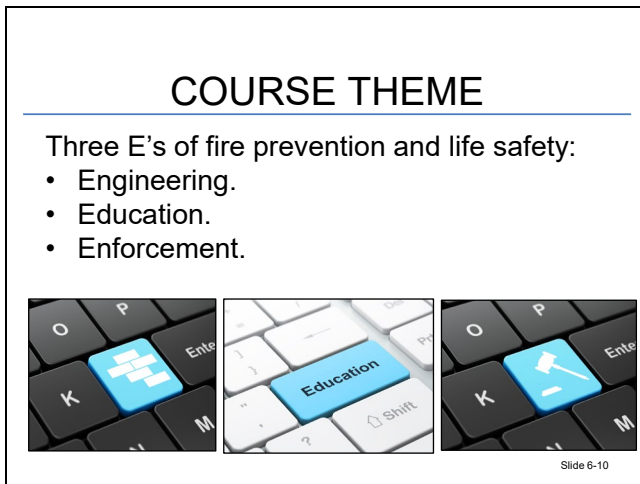
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3. Slide 6-9 shows a damper installed with wire mesh grill that has been fire caulked (should not be fire caulked).

Someone did not follow the manufacturer's instructions on the cut sheet.



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- B. Course theme: three E's of fire prevention and life safety:

1. Engineering.
2. Education.
3. Enforcement.

II. MECHANICAL PLANS REVIEW

**MECHANICAL PLANS REVIEW**

- Symbols/Legends on mechanical drawings.
- May not use same symbols as architectural drawings.
- Check legend for symbol identification.

Slide 6-11

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- A. Preparing for mechanical plans review.
1. Symbols used on mechanical drawings.
  2. Not all mechanical engineers use the same symbols as architectural drawings.
  3. Check the legend for symbol identification.
  4. Mechanical plans usually include:
    - a. Heating, ventilating, and air conditioning (HVAC).
    - b. May show plumbing details.
    - c. Smoke control.
    - d. Sometimes fire protection systems (e.g., sprinkler systems).

**HEATING EQUIPMENT TESTING AND LISTING**

- Approved by Underwriters Laboratories (UL) or American Gas Association (AGA).
- Installation: applicable codes and manufacturer's instructions.
- Instructions should be available for inspections.

Slide 6-12

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- B. Equipment and materials testing and listing requirements.
  - 1. Must be installed according to the requirements.
  - 2. Approved by a testing and listing laboratory; e.g., Underwriters Laboratories (UL) or American Gas Association (AGA).
  - 3. Installation must follow both provisions of applicable codes and the manufacturer's instructions.
  - 4. Instructions should be available to conduct the inspection.

**REVIEW AREAS**

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- System layout.
- Clearances.
- Combustion air.
- Roof vent termination points.
- Dampers.
- Smoke detectors.

Slide 6-13

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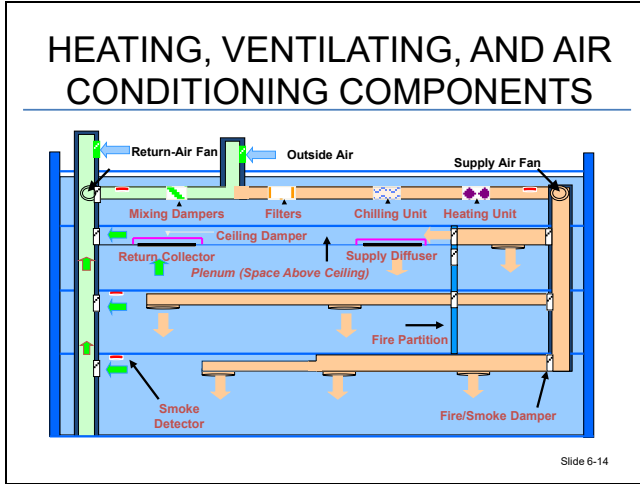
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- C. Review areas.
  - 1. System layout.
  - 2. Clearances from combustibles and intake/exhaust points.
  - 3. Combustion air (fuel-fired appliances need adequate combustion air and make-up air).
  - 4. Roof vent termination points.
  - 5. Dampers.
    - a. Fire.
    - b. Smoke.
  - 6. Smoke detectors.



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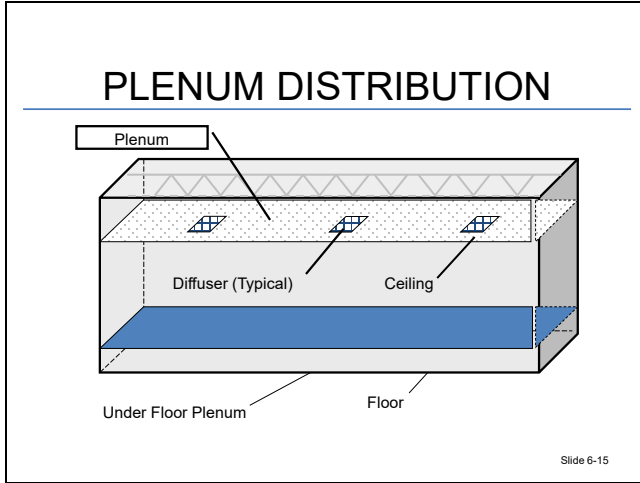
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- D. Identify the various elements of an HVAC system.
1. Schematic of HVAC systems showing both plenum and ducted approaches to moving air.
  2. Typically, the air handling unit is located outside the building to push fresh air into the building.
  3. Air can be conditioned — heated or cooled — either at the air handling unit or by another unit inside or outside the building.
  4. Air is transferred by ducts into a building and can be moved inside the building by ending at a wall, transferred by ducts, or transferred by plenum.
  5. The plenum is the space in and under the floor space or the ceiling and above.
    - a. Ceiling grids supply air from a duct or plenum into a heated or cooled space.
    - b. Ducts return used air back to the air handling unit to be mixed with fresh air to supply the building.
  6. On Slide 6-14, mechanical ducts are shown in orange on the right.
    - a. A duct is enclosed in a shaft if it penetrates floors, or a shaft can be a mechanical chase with no duct.
    - b. In either case, a shaft is rated at one hour if it extends through two to three floors and two hours if it extends through four or more floors.

- c. Penetrations of the fire-rated assembly are protected by fire or fire and smoke dampers. Notice that penetrations at each floor are protected by a fire damper.

III. AIR DISTRIBUTION SYSTEMS



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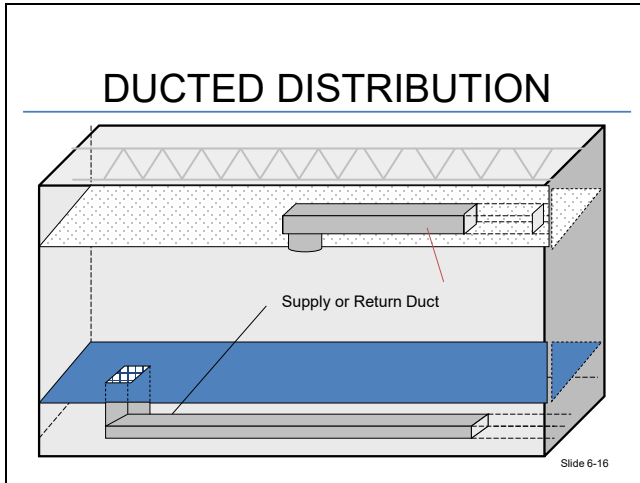
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- A. Plenums.
  - 1. Plenum systems use confined space to circulate air.
    - a. Above the ceiling or below the floor.
    - b. Uninhabited crawl spaces.
    - c. Attics.
    - d. Mechanical equipment rooms.
    - e. Limited to one fire area.
  - 2. Limits on materials exposed within plenums.
    - a. Duct materials.
    - b. Electrical or electronic wiring and equipment.
    - c. Plastic sprinkler pipe only on wet pipe systems.
    - d. Pneumatic tubes.
    - e. Foam plastic insulation.



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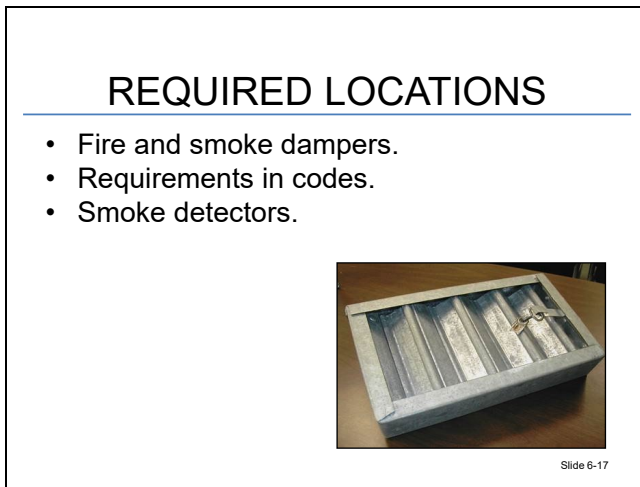
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B. Ducts.

1. Metallic, or nonmetallic (fibrous, plastic or gypsum wallboard).
2. Rigid or flexible.

IV. DAMPERS



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A. Requirements for fire and smoke dampers are in:

1. Building code.
2. Mechanical code.
3. National Fire Protection Association (NFPA) 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

4. NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*.

B. Damper styles.



1. Fire.

- a. Fire dampers.
- b. Fire smoke dampers.
- c. Smoke dampers.

- Can also be known as **leakage-rated dampers**.
- Smoke detector installation in NFPA 72, *National Fire Alarm and Signaling Code*<sup>®</sup>.

### FIRE DAMPER REQUIREMENTS

- Static.
- Dynamic.



Slide 6-18

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2. Air handling system damper requirements.

- a. Static: designed to work with the HVAC shut down — gravity operation.
  - Fire damper closes upon activation and stays closed until reset.
- b. Dynamic: designed to work with the HVAC still operating — coiled spring or mechanical.
  - Dynamic fire dampers will remain closed even if the airflow continues during the fire.

## FIRE DAMPERS

- Required.
  - Penetrations of fire-rated construction.
  - Condition exceptions addressed in the code.
- Access.
  - Maintenance and resetting.
  - Show on plans.

Slide 6-19

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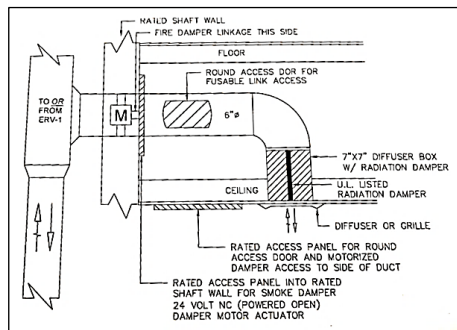
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### C. Fire dampers required.

1. Penetrations of fire-rated construction (e.g., fire walls, fire barriers, fire partitions, horizontal assemblies and rated shafts).

## FIRE DAMPER EXAMPLE



Slide 6-20

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2. All these conditions have specific exceptions addressed in codes.
  - a. Listed penetration assemblies used to maintain the rating of the assembly.
  - b. Ducts as part of a smoke control system.
  - c. One-hour or less rated fire barriers in fully sprinklered building.

## DUCT PENETRATIONS INTO SHAFTS

- Enclosures permitted to be penetrated by ducts and air transfer openings protected with **approved/listed** fire and smoke dampers.
- Some exceptions.

Slide 6-21

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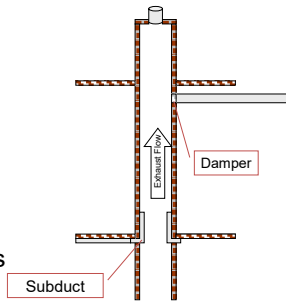
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### D. Shaft enclosures.

1. Enclosures permitted to be penetrated by ducts and air transfer openings shall be protected with **approved** fire and smoke dampers installed in accordance with their listing.
2. Vertical ducts can be installed in a rated shaft or dampered at each floor level (if floor is of rated construction).
3. Penetrations in a rated shaft must be protected by appropriate smoke and fire dampers.
4. These conditions have specific exceptions addressed in codes.

## FIRE DAMPER LOCATIONS

- Shaft enclosures.
- Exceptions for:
  - Exhaust subducts.
  - Listed penetration assemblies.
  - Ducts as part of smoke control system.
  - Sprinklered business and residential.



Slide 6-22

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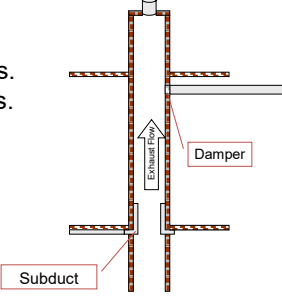
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**FIRE DAMPER LOCATIONS**  
(cont'd)

- Fire partitions.
- Exceptions for:
  - Small diameter ducts.
  - Sprinklered buildings.



The diagram shows a vertical shaft with a subduct at the bottom and a damper in the middle. An arrow labeled 'Exhaust' points upwards from the subduct. The shaft is shown with fire-resistant construction around it.

Slide 6-23

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E. Duct penetrations into shafts **exceptions.**

1. Part of the smoke management system.
2. Penetrations in parking garage exhaust or supply shafts separated from other building shafts by not less than two-hour fire-resistance rated construction.
3. In Groups B and R, occupancies equipped throughout with automatic sprinkler systems in accordance with International Building Code (IBC) Section 903.3.1.1, smoke dampers are not required.
4. At penetrations of shafts where kitchen, clothes dryer, bathroom and toilet room exhaust openings with steel exhaust subducts:
  - a. Having a minimum thickness of 0.0187 inch (0.4712 mm) (No. 26 gauge).
  - b. Extend at least 22 inches (559 mm) vertically, and the exhaust fan at the upper terminus is powered continuously and maintains airflow upward to the outdoors.
  - c. Penetrations are tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or UL 263, *Standard for Fire Tests of Building Construction and Materials*, as part of the fire-resistance rated assembly.

## SMOKE DAMPERS

- Also known as leakage rated.
- Locations required.
- Specific exceptions.
- Exception for steel ducts in single smoke compartment.



Slide 6-24

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F. Smoke dampers required.

1. Can also be known as **leakage rated**.
  - a. Refer to UL “Building Materials Directory” for Class I or II ratings.
  - b. Permitted leakage at various pressures.
2. Required at corridor wall penetrations when smoke and draft doors are required.
3. Smoke barriers.
4. These conditions have specific exceptions addressed in the codes.
  - a. Buildings with smoke control systems.
  - b. Steel ducts not opening into corridor.
  - c. Smoke barriers.
  - d. Steel ducts in single smoke compartment.

## ACCESS AND IDENTIFICATION

- Size.
- Opening.
- Tight-fitting and suitable for duct construction.
- Access points permanently marked.

Slide 6-25

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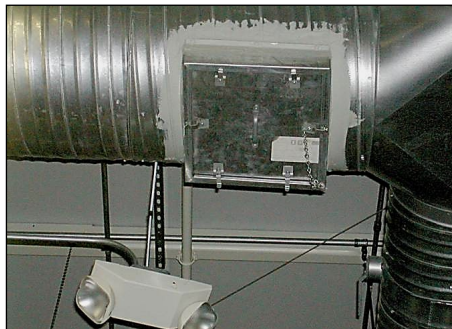
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### G. Damper access and identification requirements.

1. Access to fire and smoke dampers required for maintenance, testing and resetting.
2. Need to look for access on plans.
  - a. Note how damper can be accessed — 80% of issues are access to locations.
  - b. Size — large enough to permit inspection and maintenance.
3. Opening may not reduce fire resistance of the assembly.
4. Tight-fitting and suitable for duct construction.

## ACCESS AND IDENTIFICATION (cont'd)



Slide 6-26

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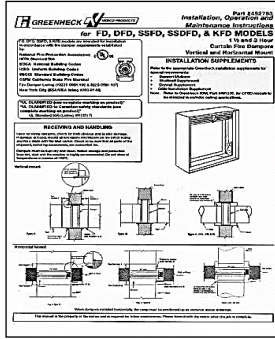
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5. Access points are permanently marked **smoke damper** or **fire damper** in not less than half-inch letters.

## MANUFACTURER'S CUT SHEETS

- Provide additional installation information.
- Should be available for site inspections.



Slide 6-27

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### H. Manufacturer's information.

1. Provide additional installation information and details.
2. Should be made available for site inspections.

## V. SMOKE DETECTION SYSTEMS CONTROL

### SMOKE DETECTION SYSTEMS CONTROL

- Individual return or common return/supply air capacity more than 2,000 cubic feet per minute (cfm).
- Upstream of any filters, exhaust air, or outdoor air connections or decontamination equipment.

Slide 6-28

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### A. HVAC systems control.

1. Individual return-air systems having design capacity of greater than 2,000 cubic feet per minute (cfm).
2. Upstream of any filters, exhaust air, or outdoor air connections or decontamination equipment.

## SMOKE DETECTION SYSTEMS EXCEPTIONS

Not required when:

- System incapable of spreading smoke beyond enclosing walls, floors or ceilings of room or space where smoke is generated.
- Area smoke detection provided for area served by unit.

Slide 6-29

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### 3. Exceptions.

- a. Not required when systems are incapable of spreading smoke beyond enclosing walls, floors or ceilings of a room, or the space where smoke is generated (2015 International Mechanical Code (IMC) Section 606).
- b. Not required when area smoke detection is provided for the area served by the unit.

### 4. Common supply and return systems.

- a. Greater than 2,000 cfm.
- b. Exception permitted for area smoke detection.

## RETURN-AIR RISERS

- Serving two or more floors.
- Any portion of system with capacity greater than 15,000 cfm.
- Smoke detectors at each story.
- Upstream of any connections.

Slide 6-30

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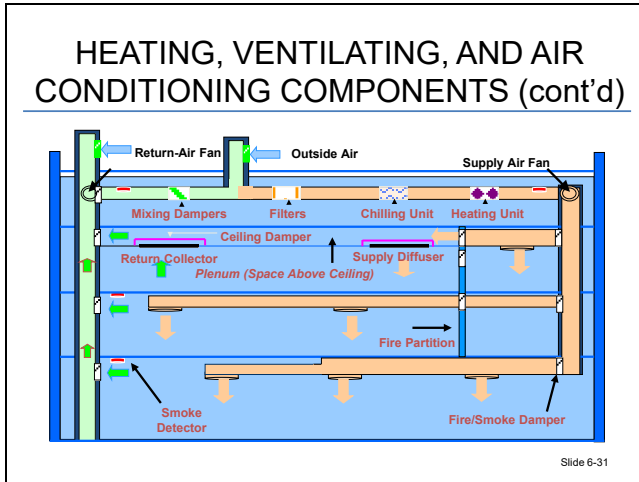
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### B. Return-air risers.

1. Serve two or more floors.
2. Any portion of a system with capacity greater than 15,000 cfm.
3. Smoke detectors at each story.
4. Upstream of any connections.



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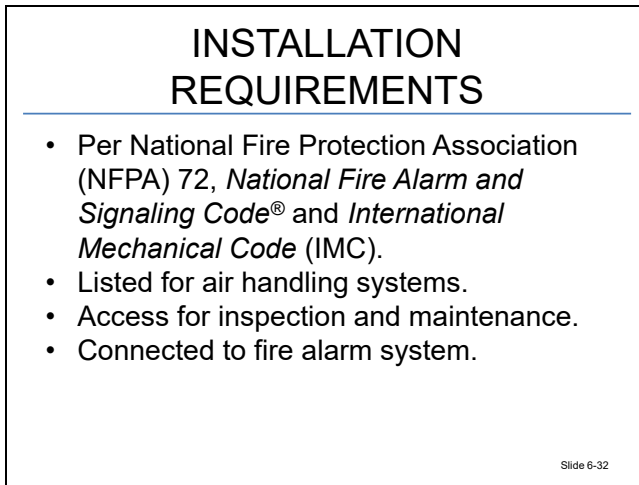
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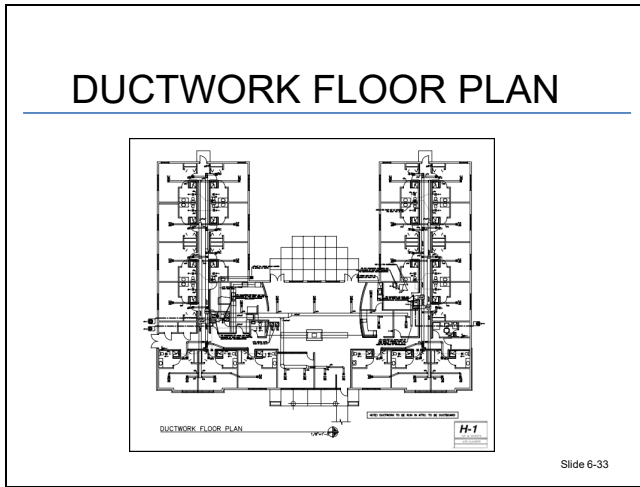
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- C. Duct detector installation requirements.
1. Per NFPA 72 and IMC Section 606.
  2. Listed for air handling systems.
  3. Access for inspection and maintenance.
  4. Connected to fire alarm system.

- a. Activate supervisory signal at a constantly attended location.
- b. A supervisory signal at a constantly attended location is not required where the duct smoke detector activates the building evacuation alarm.
- c. If there is no fire alarm system in the building, visible and audible signals must be at an approved location.



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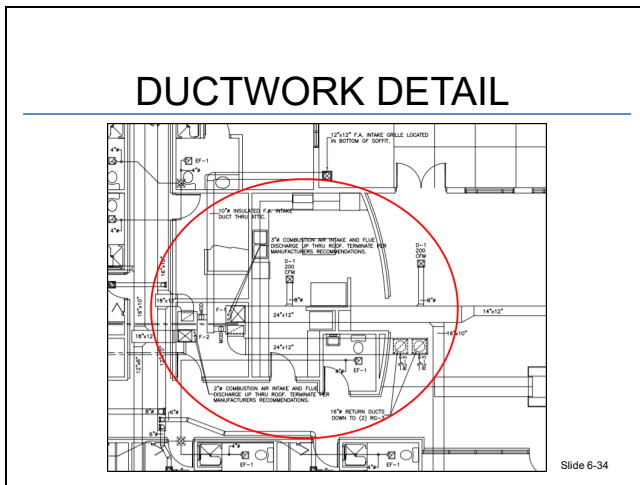
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D. Walkthrough of mechanical plans.



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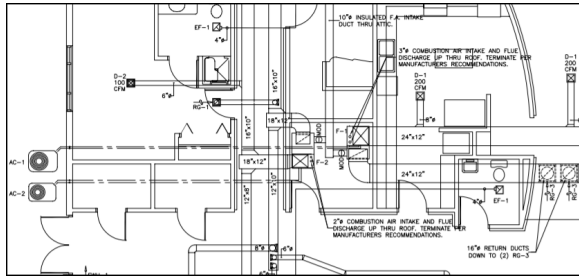
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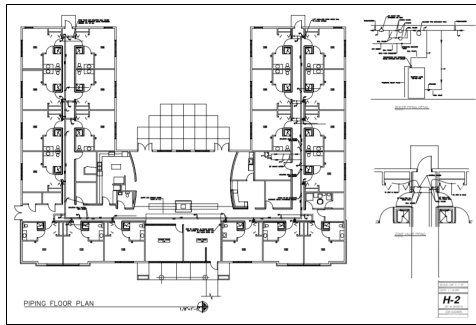
1. Ductwork details.

### DUCTWORK DETAIL (cont'd)



Slide 6-35

### PIPING FLOOR PLAN



Slide 6-36

2. Piping floor plan.

### MECHANICAL SCHEDULES

**EQUIPMENT SCHEDULE**  
1. TO BE CONSULTED BY FIELD REPRESENTATIVE BEFORE CONTRACTOR LOCATES & INSTALLS EQUIPMENT.  
2. TO BE CONSULTED BY FIELD REPRESENTATIVE BEFORE CONTRACTOR LOCATES & INSTALLS EQUIPMENT.

**PIPE SCHEDULE**  
1. TO BE CONSULTED BY FIELD REPRESENTATIVE BEFORE CONTRACTOR LOCATES & INSTALLS EQUIPMENT.  
2. TO BE CONSULTED BY FIELD REPRESENTATIVE BEFORE CONTRACTOR LOCATES & INSTALLS EQUIPMENT.

**DUCTWORK SCHEDULE**  
1. TO BE CONSULTED BY FIELD REPRESENTATIVE BEFORE CONTRACTOR LOCATES & INSTALLS EQUIPMENT.  
2. TO BE CONSULTED BY FIELD REPRESENTATIVE BEFORE CONTRACTOR LOCATES & INSTALLS EQUIPMENT.

**MECHANICAL SCHEDULES**  
1. TO BE CONSULTED BY FIELD REPRESENTATIVE BEFORE CONTRACTOR LOCATES & INSTALLS EQUIPMENT.  
2. TO BE CONSULTED BY FIELD REPRESENTATIVE BEFORE CONTRACTOR LOCATES & INSTALLS EQUIPMENT.

Slide 6-37

3. Mechanical schedule tables.

## PLUMBING SCHEDULES

RECIRCULATION PUMP SCHEDULE									
NO.	DESCRIPTION	UNIT	QTY	MARKING	DATE	BY	CHECKED	APPROVED	REVISIONS
1	RECIRCULATION PUMP	1/2 HP	1						
2	RECIRCULATION PUMP	1/2 HP	1						

HOT WATER HEATER SCHEDULE									
NO.	DESCRIPTION	UNIT	QTY	MARKING	DATE	BY	CHECKED	APPROVED	REVISIONS
1	HOT WATER HEATER	40 GPM	1						

GREASE SEPARATOR SCHEDULE									
NO.	DESCRIPTION	UNIT	QTY	MARKING	DATE	BY	CHECKED	APPROVED	REVISIONS
1	GREASE SEPARATOR	100 GPM	1						

MECHANICAL ABBREVIATIONS									
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION				
—	PIPE	—	VALVE	—	FLANGE				
—	PIPE	—	VALVE	—	FLANGE				
—	PIPE	—	VALVE	—	FLANGE				

MECHANICAL SYMBOLS									
SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION				
—	PIPE	—	VALVE	—	FLANGE				
—	PIPE	—	VALVE	—	FLANGE				
—	PIPE	—	VALVE	—	FLANGE				

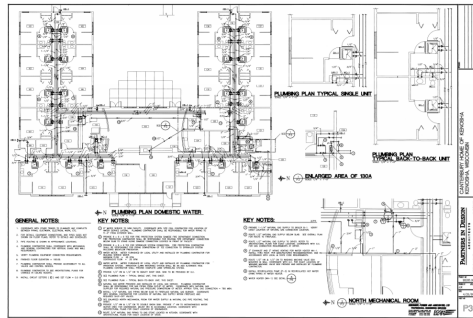
  

DRAWING LIST	
NO.	DESCRIPTION
1	PLUMBING SCHEDULES
2	PLUMBING PLAN

Slide 6-38

4. Plumbing schedules.

## PLUMBING PLAN



Slide 6-39

5. Plumbing plan.

VI. COOKING APPLIANCES



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- A. A Type I hood is required when cooking produces grease or smoke.
  - 1. Protected shaft around duct or other approved means.
  - 2. Liquid-tight, welded seam.
  - 3. Interlocking controls so that the exhaust fan will operate when the appliances are operating.
  - 4. A fire suppression system is required when a Type I hood is required.
  - 5. Exception for electric cooking appliances where an approved testing agency provides documentation that the appliance effluent contains 5 mg/m<sup>3</sup> or less of grease when tested at an exhaust flow rate of 500 cfm (0.236 m<sup>3</sup>/s) in accordance with UL 710B, *Standard for Recirculating Systems*.
  
- B. A Type II hood is required when cooking produces heat and moisture and does not produce grease or smoke.
  - 1. Exception for cooking appliances where heat and moisture loads are incorporated into the HVAC system design or into the design of a separate removal system.

Example — bread-baking oven.
  - 2. If a Type II hood is accepted above a cooking appliance, consider a requirement to post a sign that grease cooking is not allowed.
  
- C. Domestic appliances.

1. Used for commercial purposes: required to be provided with a Type I or II hood per type of cooking.
2. Used for domestic purposes: may be provided with a domestic range hood or downdraft exhaust system.

VII. SUMMARY



**SUMMARY**

- Mechanical plans review.
- Air distribution systems.
- Dampers.
- Smoke detection systems control.
- Cooking appliances.

Slide 6-41

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Did you get the answer to the question, “Why is this information important?”

Slide 6-42

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Any burning questions?

Slide 6-43

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## ACTIVITY 6.1

### Mechanical Systems

#### Purpose

Evaluate architectural, mechanical and electrical drawings to determine compliance with requirements for fire and smoke dampers and combustion air.

#### Directions

1. Work in your table group for 45 minutes.
2. Using the submitted plan documents, complete the Plans Review Checklist, Section C, found in your Student Manual (SM) Appendix B: Job Aid: Plans Review Checklist, for mechanical systems.
3. Work individually to generate two questions regarding mechanical systems. These questions will be added to your submittal letter template requesting clarification from the applicant, which can be found in your SM Appendix A: Canterbury Submittal Letter Template.

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# APPENDIX

# CUT SHEETS

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## Model FSD-212

### APPLICATION

Model FSD-212 is a combination fire smoke damper with 3V style blades. The FSD-212 has been qualified to 2000 fpm (10.2 m/s) and 6 in. wg (1.5 kPa) for operation and dynamic closure in emergency fire smoke situations. Model FSD-212 may be installed vertically (with blades running horizontal) or horizontally and is rated for airflow and leakage in either direction.

### RATINGS

#### UL 555 Fire Resistance Rating

**Fire Rating:** 1½ Hours  
**Dynamic Closure Rating:** Actual limits are size dependent  
**Maximum Velocity:** 2000 fpm (10.2 m/s)  
**Maximum Pressure:** 6 in. wg (1.5 kPa)  
**Maximum Temperature:** 350°F (177°C) - Depending on actuator

#### UL 555S Leakage Rating

**Leakage Class:** II

**Operational Rating:** Actual limits are actuator dependent  
**Maximum Velocity:** 2000 fpm (10.2m/s)  
**Maximum Pressure:** 6 in. wg (1.5 kPa)  
**Maximum Temperature:** 350°F (177°C)-- Depending on actuator

Construction	Standard	Optional
Frame Material	Galvanized steel	-
Frame Material Thickness	16 ga. (1.5mm)	-
Frame Type	5 in. x 1in. (127mm x 25mm) hat channel	-
Blade Material	Galvanized steel	-
Blade Material Thickness	16 ga. (1.5mm)	-
Blade Type	3V	-
Linkage	Plated steel out of airstream, concealed in jamb	-
Axle Bearings	Bronze	304SS
Axle Material	Plated steel	-
Blade Seals	Silicone	-
Jamb Seals	304SS	-
Closure Device	RRL	RRL/OCI, TOR, PRV, or Fusible Link
Closure Temperature	165°F (74°C)	212°F (100°C), 250°F (121°C), 350°F (177°C)

W x H	Minimum Size	Maximum Size		
		Single Section	Multiple Section	
			Horizontal	Vertical
<b>4 in. wg (1 kPa) pressure</b>				
Inches	8 x 6	32 x 50 or 36 x 48	144 x 96	128 x 100
mm	203 x 152	813 x1270 or 914 x 1219	3658 x 2438	3251 x 2540
<b>6 in. wg (1.5 kPa) pressure</b>				
Inches	8 x 6	36 x 48	144 x 48	128 x 48
mm	203 x 152	914 x 1219	3658 x 1219	3251 x 1219

### Combination Fire Smoke Dampers Steel 3-V Blades UL 555S Leakage Class II UL 555 1½ Hour Fire Resistance Rating

Model FSD-212 meets the requirements for fire dampers, smoke dampers and combination fire smoke dampers established by:

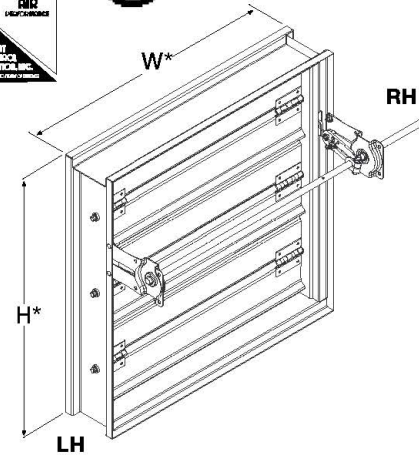
- National Fire Protection Association  
NFPA Standards 80, 90A, 92A, 92B, 101 & 105
- IBC International Building Codes
- CSFM California State Fire Marshal  
Fire Damper Listing (#3225-0981:103)  
Leakage (Smoke) Damper Listing (#3230-0981:104)
- New York City (MEA listing #260-91-M)

"UL CLASSIFIED (see complete marking on product)"

"UL CLASSIFIED to Canadian safety standards (see complete marking on product)"  
Standard 555 & 555S (Listing #R13317)



FM Approvals  
SPECIFICATION TESTED PRODUCT  
(OPTION)



\*W&H dimensions furnished approximately ¼in. (6mm) undersize.  
(Add sleeve thickness for overall sleeved damper dimension)  
Right hand drive is shown. Left hand drive is available upon request.

### FEATURES:

- Frames are constructed with reinforced corners. Low profile head and sill are used on sizes less than 17 in. high (432mm).
- Blades are reinforced with 3 longitudinal structurally designed vee's.

Installation instructions available at [www.greenheck.com](http://www.greenheck.com)

## Options & Pressure Drop Data

## FSD-212

### Options available on FSD-212:

- Actuators: 120V, 24V, 230V, pneumatic
- Factory mounted accessories
  - Retaining angles
  - Quick connect breakaway connections
  - S & drive connections
  - Access doors
- Greenheck test switches (GTS-1, -2, -3, -4)
- Momentary test switch
- POC retaining angles
- RRL/OCI (Open closed indication switches)
- TOR (Temperature limited override)
- Sealed transitions and sleeves
- Security bars
- Smoke detectors
- Transitions: R, C, O

### Pressure Drop Data

This pressure drop testing was conducted in accordance with AMCA Standard 500-D using the three configurations shown. All data has been corrected to represent standard air at a density of .075 lb/ft<sup>3</sup> (1.201 kg/m<sup>3</sup>).

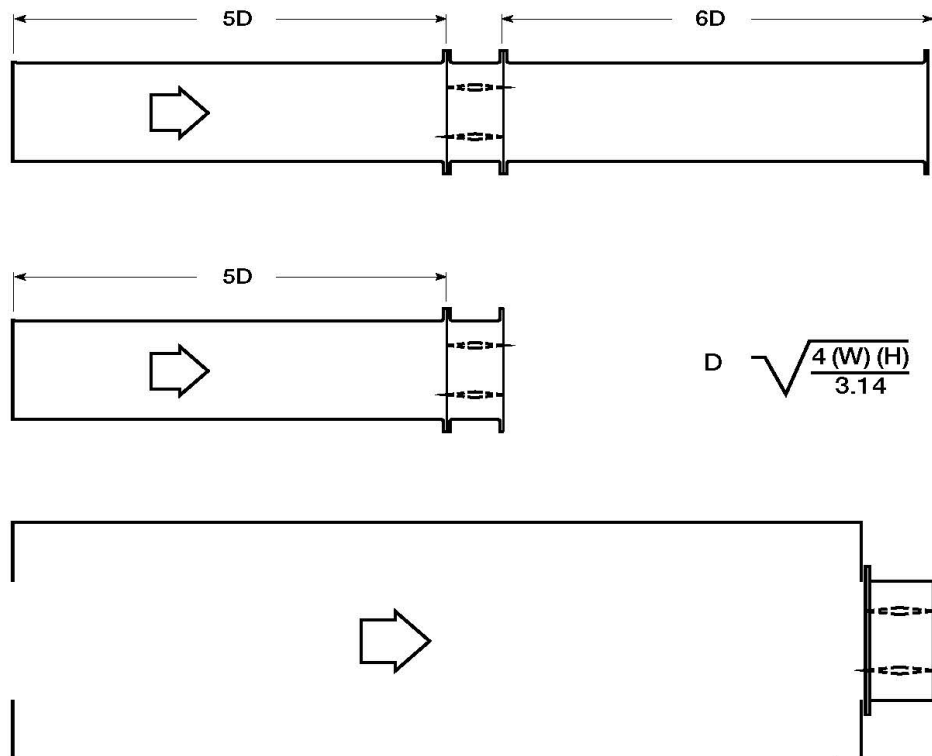
Actual pressure drop found in any HVAC system is a combination of many factors. This pressure drop information along with an analysis of other system influences should be used to estimate actual pressure losses for a damper installed in a given HVAC system.

### AMCA Test Figures

**Figure 5.3** illustrates a fully ducted damper. This configuration has the lowest pressure drop of the three test configurations because entrance and exit losses are minimized by straight duct runs upstream and downstream of the damper.

**Figure 5.2** illustrates a ducted damper exhausting air into an open area. This configuration has a lower pressure drop than Figure 5.5 because entrance losses are minimized by a straight duct run upstream of the damper.

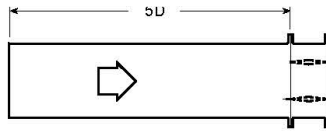
**Figure 5.5** illustrates a plenum mounted damper. This configuration has the highest pressure drop because of extremely high entrance and exit losses due to the sudden changes of area in the system.



# Pressure Drop

# FSD-212

AMCA Figure 5.2



12 in. x 12 in. (305mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.04
1000	0.14
1500	0.31
2000	0.55
2500	0.86
3000	1.24
3500	1.69
4000	2.20

24 in. x 24 in. (610mm x 610mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.02
1000	0.07
1500	0.16
2000	0.29
2500	0.45
3000	0.65
3500	0.89
4000	1.16

36 in. x 36 in. (914mm x 914mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.04
1500	0.09
2000	0.16
2500	0.25
3000	0.36
3500	0.49
4000	0.64

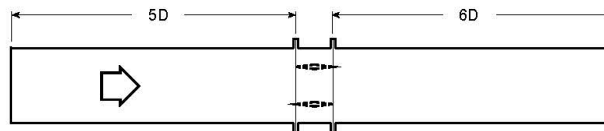
12 in. x 48 in. (305mm x 1219mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.06
1500	0.13
2000	0.23
2500	0.36
3000	0.52
3500	0.70
4000	0.92

48 in. x 12 in. (1219mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.10
1500	0.23
2000	0.41
2500	0.63
3000	0.91
3500	1.24
4000	1.62

AMCA Figure 5.3



12 in. x 12 in. (305mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.02
1000	0.09
1500	0.20
2000	0.36
2500	0.56
3000	0.81
3500	1.10
4000	1.44

24 in. x 24 in. (610mm x 610mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.04
1500	0.09
2000	0.16
2500	0.25
3000	0.35
3500	0.48
4000	0.63

36 in. x 36 in. (914mm x 914mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.03
1500	0.06
2000	0.11
2500	0.17
3000	0.24
3500	0.33
4000	0.42

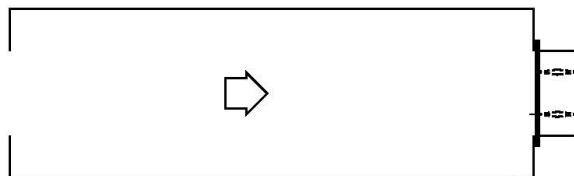
12 in. x 48 in. (305mm x 1219mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.01
1000	0.04
1500	0.10
2000	0.17
2500	0.27
3000	0.39
3500	0.53
4000	0.70

48 in. x 12 in. (1219mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.02
1000	0.07
1500	0.16
2000	0.29
2500	0.45
3000	0.64
3500	0.88
4000	1.14

AMCA Figure 5.5



12 in. x 12 in. (305mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.06
1000	0.22
1500	0.50
2000	0.89
2500	1.39
3000	2.00
3500	2.72
4000	3.55

24 in. x 24 in. (610mm x 610mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.14
1500	0.31
2000	0.54
2500	0.85
3000	1.22
3500	1.66
4000	2.17

36 in. x 36 in. (914mm x 914mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.12
1500	0.26
2000	0.46
2500	0.73
3000	1.05
3500	1.42
4000	1.86

12 in. x 48 in. (305mm x 1219mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.03
1000	0.13
1500	0.30
2000	0.53
2500	0.83
3000	1.19
3500	1.62
4000	2.11

48 in. x 12 in. (1219mm x 305mm)

Velocity (fpm)	Pressure Drop (in. wg)
500	0.04
1000	0.17
1500	0.38
2000	0.67
2500	1.04
3000	1.50
3500	2.05
4000	2.67



Greenheck Fan Corporation certifies that the model FSD-212 shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 511 and comply with the requirements of the AMCA Certified Ratings Programs. The AMCA Certified Ratings Seal applies to air performance ratings only.

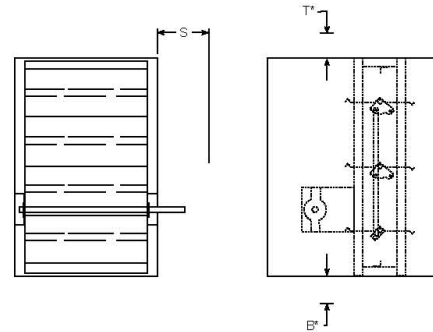
# Application Data

# FSD-212

## Actuators and Accessories Space Envelopes

Externally mounted actuators always require space outside of the damper sleeve. The “S” dimension illustrates the clearance required for various available actuators.

On dampers less than 18 in. (457mm) high, actuators may also require clearances above and/or below the sleeve. “B” and “T” dimensions are **worst** case clearance requirements for some dampers less than 18 in. (457mm) high. All damper sizes under 18 in. (457mm) high do not require these worst case clearances. If space availability above or below the damper sleeve is limited, each damper size should be individually evaluated.



Actuator Type/Model	B*	T*	S	
	With RRL, RRL/OCI, or TOR	With RRL, RRL/OCI, or TOR	PiggyBack	
			No	Yes
120 Volt AC				
FSLF120 (-S) Belimo	3 1/2 in. (89mm)	0	6 in. (152mm)	NA
FSNF120 (-S) Belimo	12 3/4 in. (324mm)	0	6 in. (152mm)	9 in. (229mm)
FSTF120 (-S) Belimo	3 1/2 in. (89mm)	0	6 in. (152mm)	NA
ML4XX Series Honeywell	4 3/4 in. (121mm)	0	6 in. (152mm)	NA
MS4X09 Series Honeywell	4 3/4 in. (121mm)	0	6 in. (152mm)	NA
MS4120 Series Honeywell	12 3/4 in. (324mm)	0	6 in. (152mm)	9 in. (229mm)
GND-22X.1 Siemens	12 3/4 in. (324mm)	0	6 in. (152mm)	NA
24 Volt AC				
FSAF24 (-S) Belimo	12 3/4 in. (324mm)	0	6 in. (152mm)	NA
FSAF24-BAL (-S) Belimo	12 3/4 in. (324mm)	0	6 in. (152mm)	NA
FSLF24 (-S) Belimo	3 1/2 in. (89mm)	0	6 in. (152mm)	NA
FSNF24 (-S) Belimo	12 3/4 in. (324mm)	0	6 in. (152mm)	9 in. (229mm)
ML8XX Series Honeywell	4 3/4 in. (121mm)	0	6 in. (152mm)	NA
MS8X09 Series Honeywell	4 3/4 in. (121mm)	0	6 in. (152mm)	NA
MS8120 Series Honeywell	12 3/4 in. (324mm)	0	6 in. (152mm)	9 in. (229mm)
GND-12X.1 Siemens	12 3/4 in. (324mm)	0	6 in. (152mm)	NA
230 Volt AC				
FSLF230 (-S) Belimo	3 1/2 in. (89mm)	0	6 in. (152mm)	NA
FSNF230 (-S) Belimo	12 3/4 in. (324mm)	0	6 in. (152mm)	9 in. (229mm)
ML4XX Series Honeywell	4 3/4 in. (121mm)	0	6 in. (152mm)	NA
MS4X09 Series Honeywell	4 3/4 in. (121mm)	0	6 in. (152mm)	NA
MS4620 Series Honeywell	12 3/4 in. (324mm)	0	6 in. (152mm)	9 in. (229mm)
GND 321.1 Siemens	12 3/4 in. (324mm)	0	6 in. (152mm)	NA
Pneumatic (25 psi min.)				
331-4551 Siemens	7 1/2 in. (191mm)	0	6 in. (152mm)	NA
331-2976 Siemens	12 3/4 in. (324mm)	0	6 in. (152mm)	NA
331-2856 Siemens	2 1/2 in. (64mm)	0	9 in. (229mm)	NA
MK2-7121 TAC (Invensys)	2 1/2 in. (64mm)	0	9 in. (229mm)	NA

\* For dampers 18 in. (457mm) or more in height these dimensions are 0 in. .

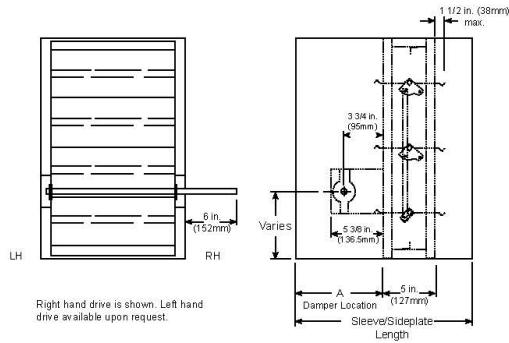
# Application Data

# FSD-212

## Damper Sleeve Dimensional Data

The drawings below and corresponding table show the position of the FSD-212 damper when mounted in a factory sleeve. The standard mounting locations provide enough space for the mounting of actuators, controls and allow space for installation of retaining angles and duct connections.

The standard location of a damper mounted in a factory sleeve ("A" dimension) is shown below. The damper can be positioned at other locations within a range of 6 in. (152mm) to 12 in. (305mm) for the "A" dimension.



in. (mm)	"A" Dimension	
	Standard	Maximum
All Dampers*	7 3/16 (183)	12 (305)
When H is 11 in. (279mm) or less with OCI, RRL, or TOR	12 (305)	12 (305)

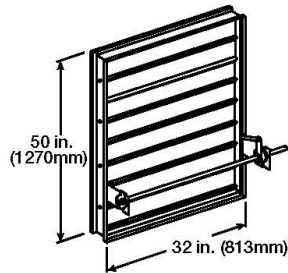
\*With the exception of dampers 10 in. high (254mm) or less.

NOTE: Entire damper frame is not required to be installed within the wall. The damper blades, when closed should be contained within the wall.

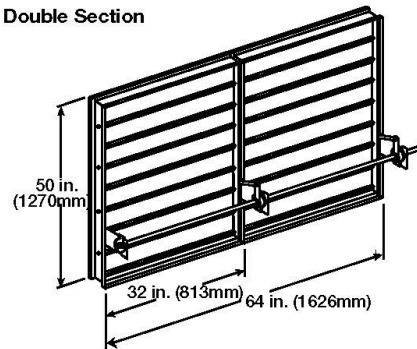
## Damper Sizing Information

Dampers larger than maximum single section size are supplied as a factory assembly of two or more sections of equal size. The following figures show maximum damper section size and assembly configurations for multi-section dampers.

Single Section



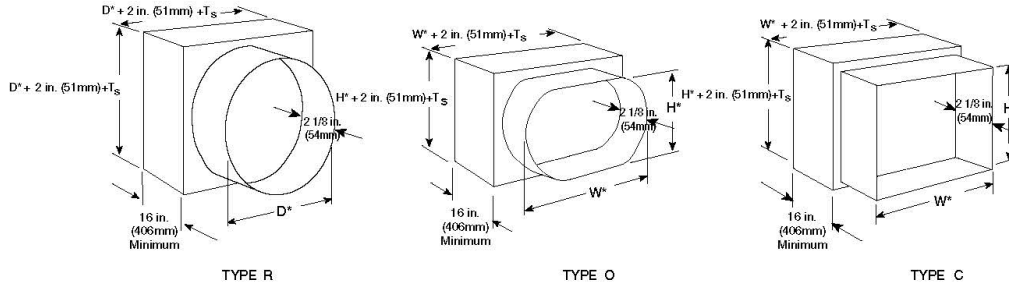
Double Section



# Transitioned Damper Dimensions

# FSD-212

When a fire/smoke damper is being used in conjunction with round or oval ductwork, the FSD-211 can be supplied in a factory sleeve with round or oval transitions on both ends of the sleeve. Dampers should be ordered to the duct dimensions. Drawings below show overall damper size.



\*These dimensions are furnished approximately 1/4 in. (6mm) undersize, except round and oval dimensions which are approximately 1/8 in. (3mm) undersize.

Ts = (2)(Sleeve Thickness)

## Specifications

Combination Fire Smoke Dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules. Dampers shall meet the requirements of NFPA 80, 90A, 92A, 92B, 101 & 105 and further shall be tested, rated and labeled in accordance with the latest edition of UL Standards 555 and 555S. Dampers shall have a UL555 fire rating of 1 1/2 hours and be of low leakage design qualified to UL 555S Leakage Class II.

Each damper/actuator combination shall have a UL555S elevated temperature rating of 250°F (121°C) minimum and shall be operational and dynamic rated to operate at maximum design air flow at its installed location. Each damper shall be supplied with an appropriate actuator installed by the damper manufacturer at the time of damper fabrication. Damper actuator shall be (specifier select one of the following) electric type for 120 (24 or 230) volt operation or pneumatic type for 25 psi minimum (30 psi maximum) operation.

Damper blades shall be 16 ga. (1.5mm) galvanized steel 3V type with three longitudinal grooves for reinforcement. Damper frame shall be galvanized steel formed into a structural hat channel shape with reinforced corners.

Bearings shall be sintered bronze sleeve type rotating in extruded holes in the damper frame. Blade edge seals shall be silicone rubber designed to inflate and provide a tighter seal against leakage as pressure on either side of the damper increases. Jamb seals shall be stainless steel compression type. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow in either direction or pressure on either side of the damper.

The Damper Manufacturer's submittal data shall certify all air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3, and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D. Dampers shall be labeled with the AMCA Air Performance Seal.

Damper must be rated for mounting vertically (with blades running horizontal) or horizontally and be UL 555S rated for leakage and airflow in either direction through the damper. Each damper shall be supplied with a 165°F (74°C) RRL.

The basis of design is Greenheck Model FSD-212.



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FSD-212 Rev 10 January 2015

# **UNIT 7: FIRE PROTECTION SYSTEM REQUIREMENTS**

## **TERMINAL OBJECTIVE**

*The students will be able to:*



- 7.1 *Evaluate submitted plan documents, in conjunction with applicable building code requirements, to determine which type(s) of fire protection and life safety systems (sprinklers, standpipes, fire alarms, smoke or smoke management, and other extinguishing systems) are required.*

## **ENABLING OBJECTIVES**

*The students will be able to:*

- 7.1 *Determine which type of fire protection and life safety systems are required based on the submitted plan documents.*
  - 7.2 *Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the fire protection systems information.*
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**UNIT 7:  
FIRE PROTECTION SYSTEM  
REQUIREMENTS**

Slide 7-1

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**I. OBJECTIVES**

**TERMINAL OBJECTIVE**

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Evaluate submitted plan documents, in conjunction with applicable building code requirements, to determine which type(s) of fire protection and life safety systems (sprinklers, standpipes, fire alarms, smoke or smoke management, and other extinguishing systems) are required.

Slide 7-2

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**ENABLING OBJECTIVES**

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- Determine which type of fire protection and life safety systems are required based on the submitted plan documents.
- Compose requests for clarification in business letter format to the applicant and professional designer regarding identified deficiencies noted during the plans review of the fire protection systems information.

Slide 7-3

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**COURSE THEME**

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Three E's of fire prevention and life safety:

- Engineering.
- Education.
- Enforcement.



Slide 7-7

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B. Course theme: three E's of fire prevention and life safety:

1. Engineering.
2. Education.
3. Enforcement.

C. Fire protection systems help to notify occupants of an emergency or mitigate the hazard of fire, as well as give occupants time to evacuate the building and to perform other mitigating measures. An automatic fire alarm system can give early notification throughout the building and notify emergency responders. A fire sprinkler system can confine a fire to the area of origin and give the occupants time to evacuate the building.

D. The value of a fire sprinkler system is recognized as an effective tool to protect the building and occupants and prevent the fire from spreading. Given the value of a fire sprinkler system, the codes allow greater latitude in the concepts of time, distance and shielding. For example, a sprinklered building may be allowed to have reduced corridor protection as the fire sprinkler system is used to mitigate the shielding quality of the corridor. A sprinklered building is allowed to be larger and taller with the use of the sprinkler system, and the distance to exit a building can be longer.

E. Built-in fire protection can affect the concepts of time, distance and shielding in a building.

**II. PURPOSE OF PLANS REVIEW FOR FIRE PROTECTION**

A. This unit is designed to identify **why** fire protection systems are required by building and fire codes.

## PURPOSE OF FIRE PROTECTION SYSTEMS

Reasons:

- Life safety.
- Fire protection.
- Business continuity.
- Special hazard protection.
- Alternative to other fire protection requirement.



Slide 7-8

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B. Fire protection systems are installed for:

1. Life safety.
2. Fire protection.
3. Business continuity operation.
4. Special hazard protection.
5. As an alternative to other fire protection requirements.

### III. BASIC CODE PROVISIONS

Design conflict code provisions.

## CODE/STANDARD CONFLICTS

If there is a conflict, legally adopted building and fire code requirements take precedence over referenced National Fire Protection Association (NFPA) standards.

Slide 7-9

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- A. If there is a conflict in design or installation criteria among codes, standards or other regulations, requirements of legally adopted building code, fire code or life safety code take precedence over referenced National Fire Protection Association (NFPA) codes and standards (International Building Code (IBC) 102.4.1).
- B. Manufacturer’s installation instructions take precedence.

**IV. SPRINKLER AND STANDPIPE SYSTEMS**

**AUTOMATIC SPRINKLERS**

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By area or occupancy:

- Increase allowable building area or height.
- Alternative to fire apparatus access or limited fire flow.



Slide 7-10

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- A. Sprinkler systems by area or occupancy.
  - 1. Increase allowable building area or height.
    - a. IBC Table 504.3 gives an additional 20 feet in height.
    - b. IBC Table 504.4 gives another story in height.
    - c. IBC Table 506.2 gives an additional 200% (multistory) or 300% (single-story) of allowable area when the building is provided with an automatic fire sprinkler system.
  - 2. Alternative to fire apparatus access or limited fire flow.
    - a. International Fire Code (IFC) 503.1.1, Exception 1.1 allows apparatus access distance to building to be increased when the building is sprinklered.
    - b. IFC 507.5.1, Exception 2 allows spacing from a hydrant to a building to be increased when the building is sprinklered.

- c. IFC Table B105.2 allows fire flow to be reduced to 25% of the tabular amount when the building is sprinklered.
- 3. Provides alternate means of fire protection.
  - a. When fire apparatus access is compromised or extremely difficult.
  - b. As an alternate method or material for other fire protection options.
  - c. When required by insurance underwriters or investors.
- 4. Examples of situations when a fire sprinkler system is required:
  - a. Group A-1 or A-3 occupancy.
    - Fire area size exceeds 12,000 square feet, or fire area has an occupant load of 300 or more.
    - Fire area is located on a floor other than a level of exit discharge serving the assembly occupancies.
    - A fire sprinkler system is to be provided throughout the story containing the Group A-1 or A-3 occupancy fire area and throughout stories from assembly occupancy to exit of level of exit discharge.
  - b. Educational occupancies.
    - More than 12,000 square feet in fire area.
    - Throughout portion of an educational building below exit discharge level.
    - Exception when every classroom has at least one exterior exit door at ground level.
    - More than 20,000 square feet or below exit discharge level.
  - c. Assembly occupancies.
    - Fire area size or occupant load.

## FIRE AREAS

- Fire area between single occupancy.
- Fire area between multiple occupancies.

**TABLE 707.3.10  
FIRE-RESISTANCE RATING REQUIREMENTS FOR  
FIRE BARRIER ASSEMBLIES OR HORIZONTAL  
ASSEMBLIES BETWEEN FIRE AREAS**

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

Slide 7-11

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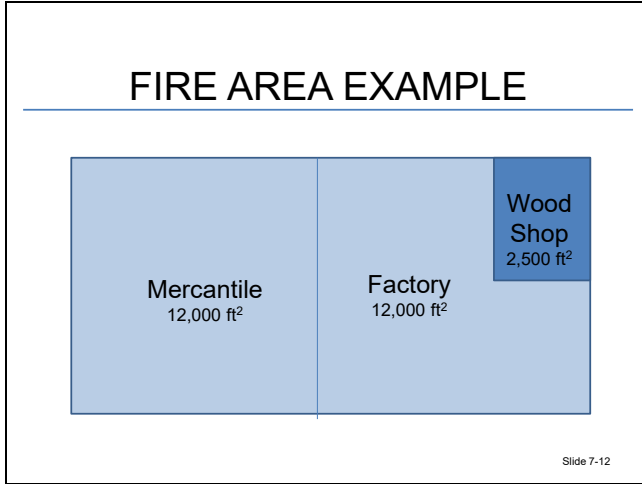
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- B. Definition of fire areas for purposes of IBC Chapter 9.
1. Requirements for sprinkler systems are usually based on the floor area of the fire area of the occupancy.
  2. Fire area is bounded by fire barriers (IBC 707) and/or horizontal assemblies (IBC 711), with a fire rating established by occupancy classification (IBC 707.3.10).
  3. The table is used to separate like occupancies into separate fire areas, or to separate multiple occupancies into separate fire areas.

**TABLE 707.3.10  
FIRE-RESISTANCE RATING REQUIREMENTS FOR  
FIRE BARRIER ASSEMBLIES OR HORIZONTAL  
ASSEMBLIES BETWEEN FIRE AREAS**

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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4. Example:
  - a. A building of 26,500 square feet is proposed to house a business that manufactures household products in 12,000 square feet of the building and sells its product in another 12,000 square feet.
  - b. The business also maintains a wood shop of 2,500 square feet in the manufacturing area.
  - c. The owner needs information for a feasibility study for the project, and the property has limited water supply.
5. Group F-1 is required to be sprinklered when the fire area exceeds 12,000 square feet.
6. Group M is required to be sprinklered when the fire area exceeds 12,000 square feet.
  - a. Woodworking operations having a fire area that exceeds 2,500 square feet are required to be sprinklered.
  - b. Fire area ratings for separating the occupancies result in Group F-1 at three hours, Group M at two hours and the woodworking area (Group F-1) at three hours.
  - c. The highest rating between two occupancies is required.

**FIRE AREA EXAMPLE (cont'd)**

- Fire barrier between Groups F and M.
- Fire barrier between Group F-1 and the woodworking area.

TABLE 707.3.10  
FIRE-RESISTANCE RATING REQUIREMENTS FOR  
FIRE BARRIER ASSEMBLIES OR HORIZONTAL  
ASSEMBLIES BETWEEN FIRE AREAS

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

Slide 7-13

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- d. The fire-resistance rating for a fire barrier between Group F-1 and the woodworking area (Group F-1) is required to be at least three hours.
- e. The rating between Group F-1 and Group M occupancies, and between Group F-1 and the woodworking area, is required to be at least three hours, or to provide an automatic fire sprinkler system throughout the building.

**DESIGN/INSTALLATION  
CRITERIA**

- NFPA 13, *Standard for the Installation of Sprinkler Systems*.
- For applications where **property protection** is the primary objective.

Slide 7-14

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- C. Referenced design and installation standards.
  1. NFPA 13, *Standard for the Installation of Sprinkler Systems*.
    - a. Intended for those applications where:
      - **Property protection** is the primary objective.

- Life safety is the objective in nonresidential occupancies or high-rise residential occupancies.
- b. Used as a construction substitution for area, height or fire-resistive construction.
  - IBC allows a one-story height increase in residential construction when an NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, design is employed.
  - Corridor rating may decrease to a half-hour when a residential building is provided with an NFPA 13 system.
  - **Note:** 2015 IBC no longer allows a one-hour substitution for the interior fire rating of Type VA or IIA building.

<b>DESIGN/INSTALLATION CRITERIA (cont'd)</b>
<ul style="list-style-type: none"><li>• NFPA 13R, <i>Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies</i>.</li><li>• NFPA 13D, <i>Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes</i>.</li></ul>
Slide 7-15

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2. NFPA 13R is intended for those specific residential occupancies where:
  - a. **Life safety** is the primary objective.
  - b. Property protection is not within the scope of the design standard.
3. NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, is intended for those specific residential occupancies where:
  - a. **Life safety** is the primary objective.
  - b. Property protection is not within the scope of the design standard.

## STANDPIPE SYSTEMS

- Determination by height, area or occupancy.
- Difficult hose stream deployment by time or distance.



Slide 7-16

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### D. Standpipe systems.

1. Standpipe system determination is by height, area or occupancy.
2. Why it is required:
  - a. Areas where it is difficult by deployment time or distance to get fire hose streams.
  - b. Examples:
    - Buildings 30 feet above or below fire apparatus access.
    - Nonsprinklered Group A with 1,000 occupants.

## STANDPIPE SYSTEMS (cont'd)

- Where:
  - Covered malls.
  - Stages.
  - Underground buildings.
  - Marinas/Boatyards.
  - Heliports.



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3. Buildings where the highest or lowest story floor level is more than 30 feet above or below the lowest level of fire department vehicle access.

## **FIRE PROTECTION SYSTEM REQUIREMENTS**

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- a. Covered malls.
- b. Stages.
- c. Underground buildings.
- d. Marinas/Boatyards.
- e. Heliports.

**ACTIVITY 7.1**

**Active Fire Sprinkler Systems**

**Purpose**

Research code requirements for active fire sprinkler systems in designated occupancies.

**Directions**

1. Work at your table groups for 20 minutes.
2. Each table group will be assigned two to four occupancies from the list below. You are to research the code for the requirements to provide active fire sprinkler systems (fire sprinklers and standpipes).
  - a. Places of public assembly: Groups A-1 and A-2.

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- b. Places of public assembly: Groups A-3, A-4 and A-5.

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**FIRE PROTECTION SYSTEM REQUIREMENTS**

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c. Educational occupancies.

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d. Factory/Industrial, storage and mercantile.

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e. Hazardous occupancies.

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f. Institutional occupancies.

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**FIRE PROTECTION SYSTEM REQUIREMENTS**

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g. Motor vehicle.

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h. Windowless stories and basements.

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i. Rubbish and linen chutes.

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j. Buildings 55 feet or more in height above the lowest level of fire department vehicle access.

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k. Aircraft hangar.

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l. Covered mall buildings.

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m. Stages.

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n. Underground buildings.

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- o. Helistops and heliports.

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- p. Marinas and boatyards.

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- 3. Report to the class after the allotted time is finished. Reports should take 25 minutes.

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V. FIRE ALARM AND DETECTION SYSTEMS

**FIRE ALARM AND DETECTION**

- For notification, protection or operations.
- Manual systems in occupancies:
  - Assembly.
  - Large business or mercantile.
  - Educational.
  - Institutional.
  - Residential.
  - Special hazard areas.

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- A. Fire alarm and detection systems by occupancy for occupant and staff notification, property protection or fire ground operations.
1. Manual fire alarm systems.
    - a. Assembly occupancies, depending upon occupant load.
      - Emergency voice/alarm in larger occupancies.
    - b. Business and mercantile occupancies.
      - Occupant load of 500 or more.
      - More than 100 feet above or below the level of exit discharge.
    - c. Educational occupancies.
    - d. Factory and industrial occupancies.
      - Two or more stories.
      - Occupant load of 500 or more above or below the level of exit discharge.
    - e. Semiconductor fabrication and organic coating facilities.
    - f. Institutional occupancies.
    - g. Residential occupancies.

- h. Lumber, wood structural panel and veneer mills.
- i. Special hazard storage (e.g., aerosols).

**AUTOMATIC FIRE ALARM AND DETECTION (cont'd)**

- Residential occupancies.
- Special amusement buildings.
- High-rise buildings.
- Institutional occupancies.
- Atriums.
- Special hazard storage.



Slide 7-20

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- 2. Automatic fire detection and alarm.
  - a. Residential occupancies.
  - b. Special amusement buildings.
  - c. High-rise buildings.
  - d. Institutional occupancies.
  - e. Atriums.
  - f. Special hazard storage (e.g., high-piled storage).
- 3. Emergency voice/alarm communications system.
  - a. Group A occupancies with an occupant load of 1,000.
  - b. Group E occupancies with an occupant load greater than 50.
    - Exception for occupancies under 100 if the manual alarm initiates activation of the manual fire alarm system which initiates an **approved** occupant notification signal.
  - c. Special amusement buildings.
  - d. High-rise buildings.

- e. Atriums connecting more than two stories in Groups A, E or M.
- f. Deep underground buildings (greater than 60 feet).
- g. Covered and open malls exceeding 50,000 square feet.
- h. Predominant language of the occupancy.

**CODE REQUIREMENTS**

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- International Building Code (IBC) Chapters 4 and 9.
- International Fire Code (IFC).
- NFPA occupancy chapters and codes.

Slide 7-21

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- 4. Code Requirements.
  - a. IBC Chapters 4 and 9.
  - b. IFC.
  - c. NFPA 101, *Life Safety Code*<sup>®</sup>, and NFPA 5000, *Building Construction and Safety Code*<sup>®</sup>, occupancy chapters.
    - NFPA codes, standards and recommended practices for certain occupancies, processes or hazards.

**DESIGN/INSTALLATION CRITERIA (cont'd)**

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- NFPA 72, *National Fire Alarm and Signaling Code*<sup>®</sup>.
- NFPA 70, *National Electrical Code*<sup>®</sup>.

Slide 7-22

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- B. Referenced design and installation criteria.
  - 1. NFPA 72, *National Fire Alarm and Signaling Code*<sup>®</sup>.
  - 2. NFPA 70, *National Electrical Code*<sup>®</sup>.

**FIRE ALARM SHOP  
DRAWINGS**

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- Submitted for review and approval before installation.
- Code specifies submittal documents.
  - Floor plan, initiating devices, notification devices, specification sheets, etc.

Slide 7-23

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- C. Fire alarm shop drawings submitted for review and approval before installation (IBC and IFC 907.1.1).
  - 1. A floor plan that indicates the use of all rooms.
  - 2. Locations of alarm-initiating devices.
  - 3. Locations of alarm notification appliances, including candela ratings for visible alarm notification appliances.
  - 4. Design minimum audibility level for occupant notification.
  - 5. Location of fire alarm control unit, transponders and notification power supplies.
  - 6. Annunciators.
  - 7. Power connection.
  - 8. Battery calculations.
  - 9. Conductor types and sizes.
  - 10. Voltage drop calculations.


VI. SMOKE MANAGEMENT AND SMOKE CONTROL SYSTEMS

**SMOKE MANAGEMENT  
AND CONTROL**

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By occupancy or special conditions:

- Atrium.
- Covered mall.
- High-rise.
- Underground and windowless.
- Theatrical stages.



Slide 7-24

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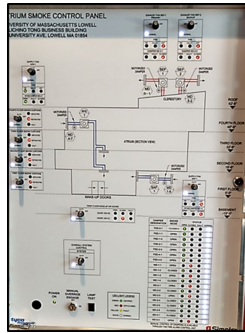
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- A. Smoke control based on occupancy or special conditions.
1. Atrium buildings.
  2. Covered mall buildings.
  3. High-rise buildings — stairway pressurization.
  4. Underground or windowless buildings.
  5. Theatrical stages.

### DESIGN/INSTALLATION CRITERIA (cont'd)

- NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences*, and 92B, *Standard for Smoke Management Systems in Malls, Atria, and Large Spaces*.



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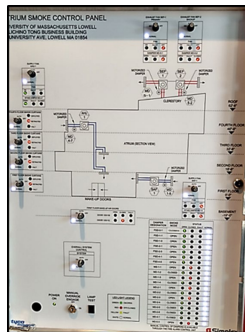
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- B. Referenced design and installation criteria.
1. NFPA 92A, *Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differences*.
  2. NFPA 92B, *Standard for Smoke Management Systems in Malls, Atria, and Large Spaces*.

### DESIGN/INSTALLATION CRITERIA (cont'd)

- International Mechanical Code (IMC), Chapter 5.
- International Building and Fire Codes, Chapter 9.



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3. International Mechanical Code (IMC), Chapter 5. IBC and IFC Chapter 9.

### INTERNATIONAL BUILDING/FIRE CODES

- Very specific criteria for design, installation and acceptance testing.
- Requires a **special inspector**.

Slide 7-27

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4. IBC and IFC.
  - a. Contain very specific criteria for design, installation and acceptance testing.
  - b. Designed and/or evaluated by a professional engineer, and testing criteria is documented.
  - c. Requires coordination of sprinkler, fire alarm and mechanical contractors.
  - d. Requires use of a **special inspector**.

### VII. SPECIAL HAZARDS

#### SPECIAL HAZARDS

- Commercial cooking operations.
- Spray finishing operations.
- Dip tanks.
- Special storage and operations.



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- A. Commercial cooking operations — protected by fire protection systems.

- B. Spray finishing operations — protection of.
- C. Dip tanks.
- D. Special storage and operations.

VIII. SUMMARY



## SUMMARY

- Purpose of plans review for fire protection.
- Basic code provisions.
- Sprinkler and standpipe systems.
- Fire alarm and detection systems.
- Smoke management and smoke control systems.
- Special hazards.

Slide 7-29

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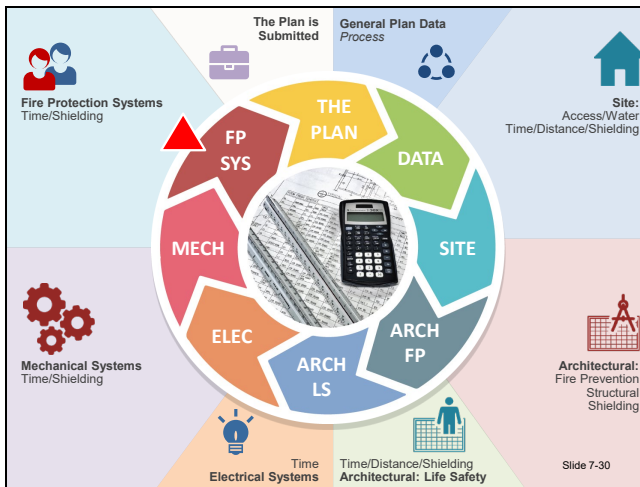
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Did you get the answer to the question, "Why is this information important?"

Slide 7-31

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**IX. END-OF-COURSE WRAP-UP**

Any burning questions?

Slide 7-32

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- A. Questions posed at the beginning of the course.
  - 1. What is the systems approach to fire and life safety?
  - 2. Define passive versus active fire protection.
- B. Do you better understand the theme of the course, the three E's of fire protection and life safety?

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## ACTIVITY 7.2

### Passive and Active Fire Protection Systems

#### Purpose

Determine where and what types of passive and active fire protection systems are required, based on occupancy or construction.

#### Directions

##### Part 1

1. Individually, use your code and the submitted plan documents to identify the **passive** fire protection systems.

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2. Individually, use your code and the submitted plan documents to identify the **active** fire protection systems.

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##### Part 2

1. Work in your table groups.

2. Using your code and the submitted plan documents, complete the Plans Review Checklist, Sections D (7) and E, found in your Student Manual (SM) Appendix B: Job Aid: Plans Review Checklist.
3. A representative from each group will report your group's findings to the class.
4. Work individually to generate one question you would ask the applicant to request clarification regarding passive and active fire protection systems and add it to your submittal letter template found in your SM Appendix A: Canterbury Submittal Letter Template.
5. When completed, turn in the following to your instructor:
  - a. Your individual Plans Review Checklist.
  - b. Your individual submittal letter.

**REFERENCES**

ICC. (2015). *International Building Code*. Washington, DC: Author.

ICC. (2015). *International Fire Code*. Washington, DC: Author.

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# **APPENDIX A**

## **CANTERBURY SUBMITTAL LETTER TEMPLATE**

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\_\_\_\_\_ (Student Name)  
National Fire Academy  
Plans Review for Fire and Life Safety  
16825 S Seton Ave.  
Emmitsburg, MD 21727

\_\_\_\_\_ (Date)

Partners in Design Architects  
600 52nd St., Ste. 220  
Kenosha, WI 53140

Alfred Benesch & Company  
4633 Washington Rd.  
Kenosha, WI 53144

Subject: Canterbury Home of Kenosha Building Permit

Dear Applicant,

Your plans for the building permit referenced above are in the process of being reviewed. Unfortunately, the review cannot be completed until we receive all the information relevant to the project as proposed. This letter reflects only those items that are necessary to continue the Building and Fire Code reviews, and does not contain the findings of the review or note the corrections that may be necessary once the review is completed; nor does it address any needs of any other city division or department.

Please review the following comments, and then follow the re-submittal directions. The code references in the following comments refer to the 2015 editions of the International Building Code (IBC), International Fire Code (IFC) and International Mechanical Code (IMC), unless otherwise noted.

Unit 1: Code Analysis Information

Activity 1.2: Identification and Communication of Deficiencies

- 1) The code referenced in the project title block is not adopted in this jurisdiction. Please change any code references to the codes in effect at this time. (IBC 101.2)
- 2) The building plans are required to be designed by an architect or engineer licensed by the state, and the professional designer is required to stamp and sign the plans. (IBC 107.1)
- 3) The civil drawings are required to be prepared by a surveyor or civil engineer licensed in the state. Please provide civil drawings that have been designed, stamped and signed by a surveyor or civil engineer licensed by the state. (IBC 107.1)

4) \_\_\_\_\_

5) \_\_\_\_\_

Unit 2: Site Plans: Emergency Access and Water Supply  
Activity 2.1: Fire Apparatus Access Roads

1) Apparatus access is required to be \_\_\_\_\_

Activity 2.2: Water Supply Evaluation

1) \_\_\_\_\_

Activity 2.3: Site Plan Evaluation Practice

1) \_\_\_\_\_

2) \_\_\_\_\_

Unit 3: Architectural Features: Fire Protection  
Activity 3.2: Area and Height

1) \_\_\_\_\_

Activity 3.3: Fire Walls

1) \_\_\_\_\_

2) \_\_\_\_\_

3) \_\_\_\_\_

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Unit 4: Architectural Features: Life Safety

Activity 4.1: Means of Egress

1) \_\_\_\_\_

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Activity 4.2: Interior Finishes

1) \_\_\_\_\_

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Unit 5: Electrical Systems

Activity 5.1: Electrical Requirements

1) \_\_\_\_\_

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Unit 6: Mechanical Systems

Activity 6.1: Mechanical Systems

1) \_\_\_\_\_

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2) \_\_\_\_\_

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Unit 7: Fire Protection System Requirements

Activity 7.2: Passive and Active Fire Protection Systems

1) \_\_\_\_\_

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**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

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Please make the required corrections and/or clarifications, and submit two sets of the revised sheets. Please be sure to reference the building permit number to identify the file to which all re-submitted documents belong.

If you have any questions or comments regarding this review, please contact me by email at \_\_\_\_\_ (email) or by telephone at \_\_\_\_\_ (phone).

Sincerely,

# **APPENDIX B**

## **JOB AID: PLANS REVIEW CHECKLIST**

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**Job Aid: Plans Review Checklist**

<b>PLANS REVIEW CHECKLIST</b>
-------------------------------

<b>Project Name</b> Canterbury Home of Kenosha		<b>Project Number</b>	
<b>Project Address</b> 7924 36 <sup>th</sup> Ave., Kenosha, Wisconsin			
		<b>Parcel Number</b> None Given	
<b>Owner</b> Kingston & Associates		<b>Telephone</b>	
<b>Address</b>		<b>Fax</b>	
		<b>Email</b>	
<b>Architect/Designer</b> Partners in Design Architects		<b>Telephone</b> 414-652-2800	
<b>Address</b> 600 52 <sup>nd</sup> St., Suite 220		<b>Fax</b> 414-652-2812	
Kenosha, WI 53140		<b>Email</b>	
<b>Reviewer</b>		<b>Date</b>	
<b>Review Type/Date</b>	<b>Preliminary</b> 2/21/16	<b>Resubmittal</b>	<b>FINAL</b>
<b>APPROVED FOR PERMIT RELEASE by</b>			<b>DATE</b>
<b>Codes/Editions Used for Review</b>	<b>Building</b> 2015 IBC	<b>Fire</b> 2015 IFC	<b>Mechanical</b> 2015 IMC
	<b>Plumbing/Gas</b> 2015 IPC/2015 IFGC	<b>Electrical</b> NEC	<b>Other</b> 2015 IEEC
<b>Notes/Special Conditions</b>			
Plans determined to be incomplete. Letter of review to include all discrepancies noted, including missing items. Occupancy classification on plans doesn't match any classification in 2015 IBC.			
Legal description of parcel not provided. Property lines not identified.			

<b>SECTION A — SITE PLANS</b>			
<b>Site Plan Date:</b> 4/15/99	<b>Sheets</b>		
<b>Stamped and Signed by:</b>			
<b>1. FIRE PROTECTION WATER SUPPLY</b>			
	<b>Yes</b>	<b>No</b>	<b>Capacity</b>
<b>Onsite Storage</b>			
<b>Public Water Main</b>			
<b>Other (specify)</b>			
<b>Fire Flow Test Data</b>			
<b>Location</b>	<b>Date</b>	<b>Time</b>	
<b>Performed by</b>			
<b>Static Pressure in psi</b>	<b>Pitot Pressure in psi</b>	<b>Residual Pressure in psi</b>	
<b>Number of Outlets</b>	<b>Outlets Size(s)</b>	<b>Available Flow at 20 psi</b>	
<b>Required Fire Flow at 20 psi</b>			
<b>(See Also Section E: Standpipe and Sprinkler Systems)</b>			<b>GPM</b>
<b>Fire Protection Systems</b>			
<b>Notes/Special Considerations</b>			

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>2. FIRE DEPARTMENT ACCESS</b>		
	<b>Shown</b>	<b>Required</b>
<b>Public Street Width</b>		20'
<b>Onsite Street/Fire Lane Width</b>		20'
<b>All-Weather Surface</b>		Yes
<b>Overhead Clearance</b>		13'6"
<b>Turning Radii (inside)</b>		As approved by code official
<b>Turning Radii (outside)</b>		As approved by code official
<b>Dead-end Lengths</b>		150'
<b>Turnarounds</b>		150'
<b>Access Grades</b>		≤10% (IFC D103.2) or as approved by fire code official (IFC 503.2.7)
<b>Bridges/Culverts</b>		
<b>Gate Access</b>		
<b>Walkways</b>		Required exterior doors and openings shall be maintained readily accessible for emergency access by the fire department. Approved walkway to exterior openings when required by fire code official. (IFC 504.1)
<b>Maximum Distance Between Building Exterior and Access Roadway</b>		150'
<b>Number of Hydrants</b>		1 or 2 depending on reduction approval
<b>Hydrant(s) Spacing</b>		450' or 500' depending on reduction approval
<b>Distance of Hydrant(s) to Building</b>		
<b>Distance of Hydrant(s) to Fire Department Connection</b>		Authority Having Jurisdiction (AHJ) approval
<b>Utility Shutoffs</b>		
<b>Notes/Special Considerations</b>		
Access to back of building more than 150'. Parking lot to be considered apparatus access unless distance from street to back of building considered adequate with sprinkler allowance. Turning radius tight and access narrow. One way access subject to AHJ approval.		
<b>3. SITE DEMOLITION/CONSTRUCTION ACCESS CONCERNS</b>		
Property line not designated on the site plan. Need construction entrance and access during construction.		

<b>SECTION B — ARCHITECTURAL/STRUCTURAL PLANS</b>		
Architectural Plan Date:	Sheets:	
Stamped and Signed by:		
Structural Plan Date:	Sheets:	
Stamped and Signed by:		
<b>1. OCCUPANCY CLASSIFICATION</b>		
Select One		
	<b>Assembly</b>	<b>Subclass</b>
	<b>Business</b>	
	<b>Educational</b>	<b>Subclass</b>
	<b>Detention and Correctional</b>	<b>Subclass</b>
	<b>Health Care</b>	<b>Subclass</b>
	<b>Mercantile</b>	
	<b>Storage</b>	<b>Subclass</b>
	<b>Factory/Industrial</b>	<b>Subclass</b>
	<b>Residential</b>	<b>Subclass</b>
	<b>Mixed</b>	
	<b>High Rise</b>	
	<b>Performance Group (ICC Only)</b>	
	<b>Other (Specify)</b>	
<b>Notes/Special Considerations</b>		

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>2. CONSTRUCTION CLASSIFICATION</b>			
Type I	Subclass		
Type II	Subclass		
Type III	Subclass		
Type IV	Subclass		
Type V	Subclass		
Type VI	Subclass		
Mixed (specify)			
Notes/Special Considerations			
<b>3. FIRE-RESISTANCE RATINGS</b>			
	Shown	Required	Design Number(s)
Exterior Walls (bearing)			
Exterior Walls (nonbearing)			
Openings in Exterior Walls			
Columns (supporting other columns or more than one floor)			
Columns (supporting one floor only)			
Columns (supporting roofs only)			
Beams, Girders, Trusses, and Arches (supporting columns or more than one floor)			
Beams, Girders, Trusses, and Arches (supporting one floor only)			
Beams, Girders, Trusses, and Arches (supporting roofs only)			
Floor and Floor/Ceiling Assemblies			
Roof and Roof/Ceiling Assemblies			
Interior Bearing Walls (supporting columns, other than bearing walls, or more than one floor)			
Interior Bearing Walls (supporting one floor only)			

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>Walls of Horizontal Exits</b>			
<b>Interior Bearing Walls (supporting roofs only)</b>			
<b>Party and Firewalls</b>			
<b>Roof Coverings</b>			
<b>Notes/Special Considerations</b>			
<b>4. ALLOWABLE AREA AND HEIGHT</b>			
	<b>Amount</b>		
<b>Floor Area Shown (footprint)</b>			
<b>Height Shown (feet)</b>			
<b>Height Shown (stories)</b>			
<b>Base Area Allowed by Code (&lt;2015); Allowable Area by Code (2015+)</b>			
<b>Maximum Height Allowed by Code (feet)</b>			
<b>Maximum Height Allowed by Code (stories)</b>			
<b>Area Increase Permitted for Automatic Sprinklers (&lt;2015)</b>			
<b>Height Increase Permitted for Automatic Sprinklers</b>			
<b>Area Increase Permitted for Frontage</b>			
<b>Other Increases Permitted (specify)</b>			
	<b>Yes</b>	<b>No</b>	
<b>Total Area is Acceptable</b>			
<b>Total Height is Acceptable</b>			
<b>Notes/Special Considerations</b>			

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>5. OCCUPANT LOAD</b>		
	<b>Amount</b>	
Basement		
First Floor		
Second Floor		
Third Floor		
Fourth Floor		
Fifth Floor		
Sixth Floor		
Seventh Floor		
Eighth Floor		
Ninth Floor		
Tenth Floor		
Special uses or rooms		
<b>Total for Entire Building</b>		
<b>6. MEANS OF EGRESS</b>		
	<b>Shown</b>	<b>Minimum Required</b>
Number of Exits Provided		
Egress Capacity		
	<b>Shown</b>	<b>Maximum Allowed</b>
Travel Distance		
Common Path of Travel Distance		
Dead-End Travel Distance		
	<b>Shown</b>	<b>Required</b>
Direction of Door Swing		
	<b>Yes</b>	<b>No</b>
Exit Separation (1/2 diagonal rule) meets requirements for separation		
Net Clear Opening Acceptable		
Panic Hardware		
	<b>Required</b>	
	<b>Shown</b>	
Locks Acceptable		

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

	Yes	No
Exit Discharge Acceptable		
<b>Interior Stairways</b>		
Stair Width Acceptable		
Maximum Riser Height Acceptable		
Minimum Riser Height Acceptable		
Minimum Tread Depth Acceptable		
Handrails Provided on Each Side		
Guards Provided on Open Sides		
Minimum Height of Handrails and Guardrails is Acceptable		
Maximum Spacing of Intermediate Rails is Acceptable		
Size of Handrail is Acceptable		
Handrail is Graspable Along Entire Length		
Handrail Extensions are Provided		
Space Between Handrail and Wall/Surface is Acceptable		
Proper Landings are Provided		
Adequate Headroom is Provided		
Buildings Over Three Stories have at least One Stairway to Roof		
Buildings Over Three Stories Identification Signs in Each Stairway		
<b>Horizontal Exits</b>		
Door Swing Acceptable		
Adequate Floor Area Provided on Either Side		
<b>Outside Stairs</b>		
Stair Width Acceptable		
Maximum Riser Height Acceptable		
Minimum Riser Height Acceptable		
Minimum Tread Depth Acceptable		
Handrails Provided on Each Side		
Guards Provided on Open Sides		
Minimum Height of Handrails and Guardrails is Acceptable		
Maximum Spacing of Intermediate Rails is Acceptable		
Size of Handrail is Acceptable		
Handrail is Graspable Along Entire Length		
Handrail Extensions are Provided		
Space Between Handrail and Wall/Surface is Acceptable		
Proper Landings are Provided		
Adequate Headroom is Provided		
Proper Separation/Protection is Provided		
<b>Ramps</b>		
Walking Surface Slip Resistant		
Minimum Width Acceptable		
Maximum Slope Acceptable		

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

Edge Protection Provided		
Handrails Provided		
Landings Provided		
Notes/Special Considerations		
<b>7. BUILDING COMPARTMENTALIZATION</b>		
	<b>Yes</b>	<b>No</b>
<b>Fire Separation Assemblies/Occupancy Separations</b>		
Shown		X
Required	X	
Fire-Resistance Rating(s) Required	½, 1	
Design Numbers		Not shown
<b>Separation of Hazardous Areas</b>		
Shown		
Required		
Fire-Resistance Rating(s) Required		
Design Numbers		
<b>Smoke Barriers</b>		
Shown		
Required		
Fire-Resistance Rating(s) Required		
Design Numbers		
<b>Exit Access Corridors</b>		
Shown	X	
Required	X	
Fire-Resistance Rating(s) Required	½, 1 hr	
Design Numbers		Not shown
<b>Exit Passageways</b>		
Shown	N/A	N/A
Required	N/A	N/A
Fire-Resistance Rating(s) Required	N/A	N/A
Design Numbers	N/A	N/A
<b>Penetrations of Fire-Rated Assemblies</b>		
Shown		X
Listed Penetration Sealant(s) Shown		X
Fire-Resistance Rating(s) Required	1	
Design Numbers		Not shown
<b>Doors/Dampers in Fire-Rated Assemblies</b>		
Proper Fire-Rated Assembly Provided		Not shown
Doors Self-Closing and Self-Latching		Not shown
Draft Stops Provided at all Combustible Concealed Spaces		Not shown
Fire Stops Shown		Not shown

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>8. FIRE RESISTANCE OF VERTICAL OPENINGS</b>		
	<b>Yes</b>	<b>No</b>
<b>Shafts Connecting Four or More Stories (2-hour)</b>		
Shown	N/A	N/A
Required	N/A	N/A
Fire-Resistance Rating(s) Required	N/A	N/A
Design Numbers	N/A	N/A
Opening Protection (1-1/2-hour)	N/A	N/A
Self-Closing and Latching	N/A	N/A
Special Temperature Rating on Exit Enclosure Doors	N/A	N/A
<b>Shafts Connecting Three or Fewer Stories (1-hour)</b>		
Shown	N/A	N/A
Required	N/A	N/A
Fire-Resistance Rating(s) Required	N/A	N/A
Design Numbers	N/A	N/A
Opening Protection (1-hour)	N/A	N/A
Self-Closing and Latching	N/A	N/A
Shaft Penetrations Limited to Those in Stairway Enclosures	N/A	N/A
Notes/Special Considerations		
Sleeping rooms to be separated with ½ hour or 1 hour fire partitions per IBC 420.		
Duct penetrations through ceiling require ceiling radiation dampers. Corridors required to be protected.		
Laundry and Mechanical Rooms shown as separated with 1-hour assembly WP3514		
<b>9. INTERIOR FINISHES</b>		
	<b>Class Shown</b>	<b>Class Required</b>
Exits		
Exit Access		
Other Spaces		
<b>10. FLOOR FINISHES</b>		
	<b>Class Shown</b>	<b>Class Required</b>
Exits	Not shown	II
Exit Access	Not shown	II
Other Spaces	Not shown	Pill Test
Notes/Special Considerations		
Ceiling in corridor has dropped ACT. Need details to show ½ or 1 hour lid on corridor. Floor finish not shown; carpet to be minimum Class II.		

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>11. PORTABLE FIRE EXTINGUISHERS</b>		
	<b>Number Shown</b>	<b>Number Required</b>
<b>Portable Fire Extinguishers</b>		
<b>Class Shown</b>	<b>0</b>	
<b>Class Required</b>	<b>2-A:10-B:C, K</b>	<b>5, 1</b>
<b>Special Hazards (Kitchens/Flammable Liquids, etc.)</b>	<b>0</b>	<b>1</b>
<b>12. SPECIAL ATRIUM REQUIREMENTS</b>		
	<b>Rating Shown</b>	<b>Rating Required</b>
<b>Separation from Adjoining Spaces</b>		<b>N/A</b>
	<b>Yes</b>	<b>No</b>
<b>Automatic Fire Sprinkler Protection Provided</b>	<b>X</b>	
<b>Engineered Smoke Control/Management System Provided</b>		<b>X</b>
<b>Notes/Special Considerations</b>		
<b>Architect to show fire sprinkler protection in drawing on code analysis. Door hardware details missing. Provide listed through penetration assemblies for openings in fire-rated assemblies (1-hour ceiling).</b>		
<b>Kitchen cooking appliances to be provided with Type I hood and duct ventilation system and fire protection consisting of fire suppression system and Class K extinguisher.</b>		
<b>Fire extinguishers not shown. Suggested locations: 1 at each exit and at the intersections of corridor; Class K in kitchen.</b>		
<b>13. SPECIAL HIGH-RISE REQUIREMENTS</b>		
	<b>Yes</b>	<b>No</b>
<b>Floor Surface Used For Human Occupancy Located More Than 75 ft. Above Lowest Level of Fire Department Vehicle Access</b>	<b>N/A</b>	<b>N/A</b>
<b>Smokeproof Enclosures Provided</b>	<b>N/A</b>	<b>N/A</b>
<b>Automatic Fire Detection System</b>		
<b>Smoke Detectors Located in Mechanical, Electrical, Transformer, Telephone Equipment, Elevator Machine, and Similar Rooms</b>	<b>N/A</b>	<b>N/A</b>
<b>Smoke Detector Located in Every Elevator Lobby</b>	<b>N/A</b>	<b>N/A</b>
<b>Smoke Detector Located in all Recirculating Air Systems Serving More than One Story</b>	<b>N/A</b>	<b>N/A</b>
<b>Smoke Detector Located in Every Connection to a Return Air Vertical Duct Serving a Recirculating System of More than One Story</b>	<b>N/A</b>	<b>N/A</b>
<b>Voice Command Fire Alarm System Provided</b>	<b>N/A</b>	<b>N/A</b>
<b>Two-Way Fire Department Communication System Provided</b>	<b>N/A</b>	<b>N/A</b>
<b>Fire Command Center</b>		
<b>Command Center Provided</b>	<b>N/A</b>	<b>N/A</b>
<b>Required Fire Separation Provided</b>	<b>N/A</b>	<b>N/A</b>
<b>Location Approved By Fire Department</b>	<b>N/A</b>	<b>N/A</b>
<b>Required Controls in Fire Command Center</b>		
<b>Smoke Control</b>		
<b>Natural Ventilation Provided</b>	<b>N/A</b>	<b>N/A</b>
<b>Mechanical Ventilation Provided</b>	<b>N/A</b>	<b>N/A</b>
<b>Elevators and Elevator Lobbies</b>		
<b>Elevator Recall Provided</b>	<b>N/A</b>	<b>N/A</b>

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

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<b>13. SPECIAL HIGH-RISE REQUIREMENTS</b>		
	<b>Yes</b>	<b>No</b>
<b>Elevator Lobbies Provided on All Floors Except Main Floor</b>	N/A	N/A
<b>Rating Shown</b>	N/A	N/A
<b>Rating Required</b>	N/A	N/A
<b>Design Numbers</b>	N/A	N/A
<b>Standby/Emergency Power and Light</b>		
<b>Generator provided</b>	N/A	N/A
<b>Two-hour fuel supply provided</b>	N/A	N/A
<b>Standby Loads (elevator, smoke control, fire pumps) transfer within 60 seconds</b>	N/A	N/A
<b>Emergency Loads (voice/fire alarm, fire department communication, elevator car lighting, emergency lighting) transfer within 10 seconds</b>	N/A	N/A
<b>Notes/Special Considerations</b>		

<b>SECTION C — MECHANICAL PLANS</b>		
Mechanical Plan Date:	Sheets:	
Stamped and Signed by:		
1. VENTS, CHIMNEYS AND FLUES		
	<b>Shown</b>	<b>Required</b>
Classification		
Termination Above Roof		
Combustion Air		
Fire Dampers		
Smoke Dampers		
2. AIR DUCTS		
	<b>Yes</b>	<b>No</b>
Approved materials		
Space Above Ceiling Meets Requirements for Plenum		
3. HEATING SYSTEM		
Steam/Hot Water	Electric	Gas
Solid Fuel	Solar	Heat Pump
Btu/Hour Output		
	<b>Yes</b>	<b>No</b>
Fire Separation Required for Boiler		
Equipment Listings Included		
Adequate Clearances from Combustibles		
4. STAIR ENCLOSURE PRESSURIZATION		
	<b>Yes</b>	<b>No</b>
Positive Pressure Required		
Engineered Design Solution Provided		
5. COMMERCIAL COOKING OPERATIONS		
	<b>Yes</b>	<b>No</b>
Hood Over Heat Sources	Type:	
Proper Clearances Provided		
Proper Grease Removal Provided		
Exhaust Ducts Provided	Metal Gage:	
Cleanouts Provided		
Proper Clearances Provided		
Liquid-tight Joints Provided		
	<b>Shown</b>	<b>Required</b>
Air Velocity		
Makeup Air		
Location of Exhaust Termination		
Clearance Above Roof Surface of Exhaust Discharge		
Clearance From Adjoining Property of Exhaust Discharge		

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

	<b>Yes</b>	<b>No</b>
<b>Automatic Makeup Air Shutdown Provided</b>		
<b>6. APPLIANCES</b>		
	<b>Yes</b>	<b>No</b>
<b>Electric</b>		
<b>Gas</b>		
<b>Solid Fuel</b>		
<b>Shutdowns Provided</b>		
<b>Fixed Fire Protection System Provided</b>		
<b>Fire System Manual Release Shown</b>		
<b>Portable Fire Protection Equipment Provided</b>		
<b>Portable Fire Protection Equipment Suitable for Hazard</b>		
<b>7. SPECIAL VENTILATION SYSTEMS</b>		
<b>Notes/Special Considerations</b>		

SECTION D — ELECTRICAL PLANS				
Electrical Plan Date: : 4/26/99			Sheets: 5	
Stamped and Signed by: None				
1. SERVICE				
Size		Voltage		Phase
			Shown	Required
Main Service Disconnect				
Location				
Sign Provided When Additional Service Mains Exist				
2. FIRE PUMPS				
			Yes	No
Separate Service Provided for Fire Pump				
Separate Disconnect Provided for Fire Pump and Building				
3. EMERGENCY GENERATOR				
Size		Location		
Type	Diesel		Gas/LPG	
			Yes	No
Minimum 8-hour Fuel Supply Provided				
4. EGRESS ILLUMINATION				
			Yes	No
Normal Illumination: All Portions of Means of Egress				
Emergency Lighting: All Portions of Means of Egress				
Provided for Other Required Areas				
Type Provided				
5. EXIT SIGNS				
			Yes	No
Signs Provided at all Exits				
Directional Signage Provided				
All Exit Signs Provided with "Normal" Illumination				
All Exit Signs Provided with "Emergency" Illumination				
6. EMERGENCY/STANDBY POWER				
			Yes	No
Fire Alarm System				
Fire Pump				
Smoke Control				
Elevators				
Toxic Gas Scrubbers/Treatment Systems				
Health Care Equipment				

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>7. FIRE ALARM AND DETECTION SYSTEM</b>			
		<b>Required</b>	<b>Provided</b>
<b>Manual Fire Alarm and Detection System</b>			
<b>Automatic Fire Alarm and Detection System</b>			
<b>Combination Manual and Automatic Fire Alarm and Detection System</b>			
<b>Manufacturer</b>		<b>Fire Alarm Control Panel Location</b>	
<b>Voltage</b>	<b>Location of Fire Alarm Control Panel (FACP) Dedicated AC Circuit</b>		
		<b>Yes</b>	<b>No</b>
<b>Secondary Power Provided</b>			
<b>Secondary Power Calculations Provided</b>			
<b>Voltage Drop Calculations Provided</b>			
<b>Location of FACP Acceptable</b>			
<b>Location of Remote Annunciator Acceptable</b>			
<b>Electrical</b>			
<b>Initiating Device Circuit Wiring Style</b>			
<b>Notification Appliance Device Circuit Wiring Style</b>			
<b>Signaling Line Circuit Wiring Style</b>			
		<b>Yes</b>	<b>No</b>
<b>Addressable System Provided</b>			
<b>Alarm Verification Provided</b>			
<b>Voice Alarm Message Acceptable (if provided)</b>			
<b>Type of Conductors Acceptable</b>			
<b>End-of-Line-Device Location Identified/Provided</b>			
<b>Power to FACP on Dedicated Circuit</b>			
<b>FACP Circuit Properly Identified in Panelboard</b>			
<b>Location of Panelboard Circuit Identified at FACP</b>			
<b>Access to FACP Circuit Limited to Authorized Persons</b>			
<b>Initiating Devices</b>			
		<b>Yes</b>	<b>No</b>
<b>Pull Station Locations Acceptable</b>			
<b>Smoke Detector Type and Locations Acceptable</b>			
<b>Heat Detector Type and Locations Acceptable</b>			
<b>Water Flow Switches Acceptable</b>			
<b>Alarm Connections to Fire Suppression Systems Provided</b>			
<b>Supervisory Connections to Fire Suppression Systems Provided</b>			
<b>Other Type of Devices Provided</b>			
<b>Indicating Appliances</b>			
		<b>Yes</b>	<b>No</b>
<b>Visual Appliances Type and Locations are Acceptable</b>			
<b>Audible Appliances Type and Locations are Acceptable</b>			

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>Elevator</b>			
		<b>Yes</b>	<b>No</b>
Elevator Recall (Phase I)			
Firefighter Service (Phase II)			
<b>Smoke Control</b>			
		<b>Yes</b>	<b>No</b>
HVAC Shutdown and Controls			
Automatic Door Closures			
Stairway Door Controls			
Exit Door Controls			
<b>Fire Pump Controls</b>			
		<b>Yes</b>	<b>No</b>
Pump Running			
Loss of Phase			
Phase Reversal			
Pump Overheating			
<b>Generator Controls</b>			
		<b>Yes</b>	<b>No</b>
Emergency Fuel Controls			
Generator Running			
Low Battery			
<b>Monitoring Service</b>			
Local Alarm Only	Auxiliary	Proprietary	
Remote Station	Central Station	Other	
		<b>Yes</b>	<b>No</b>
Central Station Information Identification Provided at FACP			
System will be Certificated (if monitored by Central Station)			
DACT Provided with Two Telephone Lines			
DACT Connected Ahead of PBX Equipment			
<b>Notes/Special Considerations</b>			

<b>SECTION E — SPRINKLER AND STANDPIPE PLANS</b>			
Fire Protection Plan Date:		Sheets:	
Stamped and Signed by:			
<b>1. STANDPIPE SYSTEM</b>			
		<b>Required</b>	<b>Provided</b>
<b>Manual Standpipe System</b>			
<b>Class:</b>	I	II	III
<b>Water Supply</b>			
		<b>Yes</b>	<b>No</b>
<b>Water Supply Combined With Sprinkler System Demand</b>			
		<b>GPM</b>	<b>PSI</b>
<b>Demand</b>			
		<b>Yes</b>	<b>No</b>
<b>Backflow Prevention Device Required</b>			
<b>Backflow Prevention Device Provided</b>		<b>Class:</b>	
<b>Supervision Provided of Control Valves</b>			
<b>Fire Department Connection Location Approved</b>			
<b>Class I Outlets</b>			
		<b>Yes</b>	<b>No</b>
<b>Located in Each Required Stairway</b>			
<b>Maximum Travel Distance to Outlet Does Not Exceed 150 ft. (unsprinklered) or 200 ft. (sprinklered)</b>			
<b>Located on Each Side of Horizontal Exits</b>			
<b>Located In Each Exit Passageway</b>			
<b>In Covered Mall Buildings, Located at Entrance to Each Exit Passageway or Exit Corridor and at Exterior Public Entrances</b>			
<b>Class II Outlets</b>			
		<b>Yes</b>	<b>No</b>
<b>Maximum Travel Distance to Outlet Does Not Exceed 130 feet</b>			
<b>100 ft. of Hose and Nozzle Provided/Connected for Each Outlet</b>			
<b>Class III Outlets</b>			
		<b>Yes</b>	<b>No</b>
<b>Meet Requirements of Both Class I and Class II</b>			
<b>Roof Outlet/Manifold</b>			
		<b>Yes</b>	<b>No</b>
<b>Roof Outlet Manifold Required</b>			
<b>Roof Outlet Manifold Provided</b>			
<b>Number of Outlets</b>			
<b>Location of Roof Outlet Manifold Control Valve</b>			
<b>Pressure Regulating Devices</b>			
		<b>Yes</b>	<b>No</b>
<b>Pressure-Reducing Valves</b>			
<b>Pressure Control Valve</b>			
<b>Pressure Restricting Orifice</b>			

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>2. AUTOMATIC SPRINKLER SYSTEM</b>		
	<b>Yes</b>	<b>No</b>
<b>Automatic Fire Sprinkler System Required</b>		
<b>Automatic Fire Sprinkler System Provided</b>		
<b>Limited Area System</b>		
<b>Wet</b>	<b>Dry</b>	<b>Pre-Action</b>
<b>Deluge</b>	<b>Antifreeze</b>	<b>Other</b>
	<b>Hazard</b>	<b>Group</b>
<b>Hazard Classification</b>		
	<b>Yes</b>	<b>No</b>
<b>Special Considerations</b>		
<b>High-Piled Storage, Rolled Paper, Flammable Liquids, Tire Storage</b>		
<b>Other Special Hazards</b>		
<b>Storage Occupancies</b>		
<b>Miscellaneous/Incidental Storage Areas</b>		
<b>Commodity Classifications Shown</b>		
<b>Group A, B, or C Plastics Identified</b>		
<b>Class Adjusted for Plastic Content</b>		
<b>Commodity Classification(s)</b>		
<b>Maximum Storage Height Shown</b>		
<b>Storage Method (Solid Pile/Rack/Pallet) Shown</b>		
<b>Rack Configuration (Single/Double/Multiple/Flow-through) Shown</b>		
<b>Pallets Described (Solid/Slatted/Wood/Plastic/Metal/Slave)</b>		
<b>Aisle Widths Shown</b>		
<b>Mechanized or Carousel Storage</b>		
<b>Standard Selected</b>		
	<b>Yes</b>	<b>No</b>
<b>NFPA 13: Standard for Installation of Automatic Sprinkler Systems</b>		
<b>NFPA 13R: Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies</b>		
<b>NFPA 13D: Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes</b>		
<b>Other Standard (specify)</b>		
<b>Special Ruling (specify)</b>		
<b>Hydraulic Calculations Required</b>		
<b>Hydraulic Calculations Provided</b>		
<b>Hydraulic "Safety Margin" Provided</b>		
<b>Pipe Schedule System</b>		
<b>Water Supply</b>		
	<b>Yes</b>	<b>No</b>
<b>Water Supply Combined With Standpipe System Demand</b>		
	<b>GPM</b>	<b>PSI</b>
<b>Demand</b>		
	<b>Yes</b>	<b>No</b>
<b>Exterior Considerations</b>		
<b>Backflow Prevention Device Required</b>		
<b>Backflow Prevention Device Provided Class:</b>		
<b>Exterior Control Valve Location Approved</b>		
<b>Supervision Provided for Control Valves</b>		
<b>Fire Department Connection Location Approved</b>		

**PLANS REVIEW FOR FIRE AND LIFE SAFETY**

<b>Pipe or Tube</b>		
Pipe or Tube: Ferrous	Copper	CPVC/PEX
Layout: Tree	Loop	Grid
	<b>Yes</b>	<b>No</b>
Maximum Service Area per Riser Identified		
Hangers Shown		
Earthquake Bracing Shown (four-way/ Lateral/Longitudinal)		
Pipe Slope for Drainage Shown		
Auxiliary Drains Required		
Auxiliary Drains Provided		
<b>Valves</b>		
	<b>Yes</b>	<b>No</b>
Indicating Valves for Water Supplies Shown		
Alarm/Dry Pipe/Pre-Action/Deluge Valve Shown		
Sectional Control/Floor Isolation Valves Provided		
Supervision Provided for Control Valves		
Inspector's Test Valve Location Shown		
<b>Alarms</b>		
	<b>Yes</b>	<b>No</b>
Water Flow Alarm Shown		
Flow Switch(es) Shown		
Retard Chamber Apparatus Shown		
High/Low Air Pressure Alarm Shown		
<b>Sprinklers</b>		
	<b>Yes</b>	<b>No</b>
Correct Sprinklers Selected for Hazard		
Coverage Provided in All Areas (Except Limited Area Systems)		
Area per Sprinkler Identified		
Sprinklers Installed in Concealed Combustible Spaces		
Vertical Obstructions to Discharge Identified		
Horizontal Obstructions to Discharge Identified		
Spare Sprinklers and Cabinet Identified		
<b>Calculations</b>		
	<b>Yes</b>	<b>No</b>
Design Density Specified		
Area of Application (Remote Area) Identified		
Adjustments for Dry-Pipe or Quick Response Sprinklers Identified		
Hydraulic Nameplates Identified		
<b>Miscellaneous</b>		
	<b>Yes</b>	<b>No</b>
Air Compressor Provided		
Notes/Special Considerations		

# ACRONYMS

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**ACRONYMS**

<b>ADA</b>	Americans with Disabilities Act
<b>AGA</b>	American Gas Association
<b>AHJ</b>	authority having jurisdiction
<b>ASCE</b>	American Society of Civil Engineers
<b>Btu</b>	British thermal unit
<b>CCTV</b>	closed-circuit television
<b>cfm</b>	cubic feet per minute
<b>CPSC</b>	Consumer Product Safety Commission
<b>CSI</b>	Construction Specifications Institute
<b>FACP</b>	Fire Alarm Control Panel
<b>FLA</b>	full load amperage
<b>gpm</b>	gallons per minute
<b>HC</b>	Handicap
<b>HVAC</b>	heating, ventilating, and air conditioning
<b>HWR</b>	Hot Water Return
<b>HWS</b>	Hot Water Supply
<b>IBC</b>	International Building Code
<b>IEBC</b>	International Existing Building Code
<b>IFC</b>	International Fire Code
<b>IFSTA</b>	International Fire Service Training Association
<b>IG</b>	Instructor Guide
<b>IMC</b>	International Mechanical Code

<b>IRC</b>	International Residential Code
<b>LP</b>	liquefied petroleum
<b>NCST</b>	National Construction Safety Team
<b>NCSTAR</b>	National Construction Safety Team Act Reports
<b>NEC</b>	National Electrical Code®
<b>NFA</b>	National Fire Academy
<b>NFPA</b>	National Fire Protection Association
<b>NIST</b>	National Institute of Standards and Technology
<b>NTS</b>	not to scale
<b>PRFLS</b>	“Plans Review for Fire and Life Safety”
<b>psi</b>	pounds per square inch
<b>RCP</b>	Reflected ceiling plan
<b>SAT</b>	suspended acoustical tile
<b>SAW</b>	Student Activity Worksheet
<b>SM</b>	Student Manual
<b>UFC</b>	Uniform Fire Code
<b>UL</b>	Underwriters Laboratories
<b>UPS</b>	uninterruptible power supply
<b>WTC</b>	World Trade Center