

Fire Inspection Principles 1

FIP 1-Student Manual

1st Edition, 5th Printing-May 2023



FEMA

FEMA/USFA/NFA
FIP 1-SM
May 2023
1st Edition, 5th Printing

Fire Inspection Principles 1



FEMA

Fire Inspection Principles 1

FIP 1-Student Manual

1st Edition, 5th Printing-May 2023



FEMA

This Student Manual may contain material that is copyright protected. USFA has been granted a license to use that material only for NFA-sponsored course deliveries as part of the course materials, and it shall not be duplicated without consent of the copyright holder. States wishing to use these materials as part of state-sponsorship and/or third parties wishing to use these materials must obtain permission to use the copyright material(s) from the copyright holder prior to teaching the course.

This page intentionally left blank.

TABLE OF CONTENTS

	PAGE
Table of Contents	iii
Acknowledgments	v
Course Goal.....	vii
Audience, Scope and Course Purpose	vii
Schedule	ix
Copyright Clearance.....	xiii
Firefighter Code of Ethics	xv
A Student Guide to End-of-course Evaluations.....	xvii
UNIT 1: GENERAL FIRE SAFETY	SM 1-1
UNIT 2: LIFE SAFETY	SM 2-1
UNIT 3: FIRE AND CODES: THEIR RELATIONSHIP.....	SM 3-1
Appendix: NFPA Article by John L. Bryan	
UNIT 4: SPECIAL HAZARDS	SM 4-1

Acronyms

This page intentionally left blank.

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 people participated in the creation of this course:

Woody Stratton, Training Specialist
Course Manager
Fire Prevention: Technical Curriculum
U.S. Fire Administration, National Fire Academy
Emmitsburg, Maryland

Dana Moat
Instructional Systems Specialist
U.S. Fire Administration, National Fire Academy
Emmitsburg, Maryland

James “Cotton” Thompson
Subject Matter Expert

This page intentionally left blank.

COURSE GOAL

The course goal is to provide the students with the fundamental knowledge, skills and attitudes to conduct basic fire safety inspections effectively and confidently.

More specific outcomes include:

Knowledge

A better understanding of the code process provides the foundation for hazard recognition and dealing with people.

Skills

The ability to apply inspection procedures to daily activities.

The ability to identify problems and develop solutions to these problems by recognizing hazards and dealing effectively with people. This will include such skills as:

- Hazard recognition.
- Code interpretation.
- Selling fire safety (audience identification, knowledge of product, and the ability to motivate people to do something about hazards).
- Effective communication.
- Education (educate the public about what to do to mitigate hazards and why).

Attitudes

Enhanced professionalism through course participation. This professionalism will be derived from stressing the importance of fire prevention activities, gaining skills, instructor enthusiasm, and a solid foundation in knowledge of the topics covered in the course.

The fire prevention specialist with a more professional attitude will improve the image of the fire prevention bureau within the fire department. Because of this, an additional course outcome will hopefully be to change department attitudes about prevention and increase respect for those people in fire prevention.

AUDIENCE, SCOPE AND COURSE PURPOSE

The fire prevention or code enforcement officer with limited fire inspection experience. Suppression Company Officers (COs) who have responsibility for fire prevention inspections. Related professionals whose responsibility requires a basic knowledge of the fire prevention and code enforcement process.

“Fire Inspection Principles 1” (FIP 1) has been designed to provide the student with the fundamental knowledge, skills and attitudes to conduct basic fire safety inspections effectively and confidently. This course is appropriate for the fire prevention or code enforcement official, and other allied professionals with limited fire inspection and code enforcement experience, who have the responsibility for conducting fire safety inspections. Students will be introduced to various codes and standards in order to develop a working knowledge of their application in the inspection process.

Due to the variety of regional and local codes and ordinances which each of you must deal with on a daily basis, the academy must, for the purpose of this course, assume that each of you is familiar with the codes and standards in effect in your jurisdiction. All of the activities have been designed to allow you to accomplish them from the perspective of the codes enforced in your local jurisdiction.

This page intentionally left blank.

SCHEDULE

TIME	DAY 1	DAY 2
8:00 - 9:00	Introduction	Unit 1: General Fire Safety (cont'd) Unit 2: Life Safety
9:00 - 9:10	<i>Break</i>	<i>Break</i>
9:10 - 10:00	Introduction (cont'd)	Unit 2: Life Safety (cont'd) Activity 2.1: Applications of Occupancy Separations
10:00 - 10:15	<i>Break</i>	<i>Break</i>
10:15 - 12:00	Assign Jeb's Project Letter (due Friday morning) Unit 1: General Fire Safety	Unit 2: Life Safety (cont'd) Activity 2.2: Determining Occupancy Classifications
12:00 - 1:00	<i>Lunch</i>	<i>Lunch</i>
1:00 - 2:15	Unit 1: General Fire Safety (cont'd) Activity 1.1: Site Problem Identification	Unit 2: Life Safety (cont'd) Activity 2.2: Determining Occupancy Classifications (cont'd)
2:15 - 2:30	<i>Break</i>	<i>Break</i>
2:30 - 5:00	Unit 1: General Fire Safety (cont'd)	Unit 2: Life Safety (cont'd) NETC Library

FIRE INSPECTION PRINCIPLES 1

TIME	DAY 3	DAY 4
8:00 - 9:00	Unit 2: Life Safety (cont'd)	Unit 3: Fire and Codes: Their Relationship (cont'd)
9:00 - 9:10	<i>Break</i>	<i>Break</i>
9:10 - 10:00	Unit 2: Life Safety (cont'd) Activity 2.3: Calculation of Occupant Loads	Unit 3: Fire and Codes: Their Relationship (cont'd)
10:00 - 10:15	<i>Break</i>	<i>Break</i>
10:15 - 12:00	Unit 2: Life Safety (cont'd) Activity 2.4: Calculation of Means of Egress	Unit 3: Fire and Codes: Their Relationship (cont'd)
12:00 - 1:00	<i>Lunch</i>	<i>Lunch</i>
1:00 - 2:15	Unit 2: Life Safety (cont'd)	Unit 3: Fire and Codes: Their Relationship (cont'd) Unit 4: Special Hazards
2:15 - 2:30	<i>Break</i>	<i>Break</i>
2:30 - 5:00	Unit 2: Life Safety (cont'd) Unit 3: Fire and Codes: Their Relationship Review	Unit 4: Special Hazards (cont'd) NETC Library

TIME	DAY 5	DAY 6
8:00 - 9:00	Unit 4: Special Hazards (cont'd)	Jeb's Letter Due
9:00 - 9:10	<i>Break</i>	<i>Break</i>
9:10 - 10:00	Unit 4: Special Hazards (cont'd) Activity 4.1: Hazardous Material Code Search	Final Exam
10:00 - 10:15	<i>Break</i>	<i>Break</i>
10:15 - 12:00	Unit 4: Special Hazards (cont'd) Activity 4.1: Hazardous Material Code Search (cont'd)	Life Safety Code Project — Benson Building
12:00 - 1:00	<i>Lunch</i>	<i>Lunch</i>
1:00 - 2:15	Unit 4: Special Hazards (cont'd) Activity 4.2: Electrical Code Search	Life Safety Code Project — Benson Building (cont'd) Review of Final Exam and Life Safety Code Project
2:15 - 2:30	<i>Break</i>	<i>Break</i>
2:30 - 5:00	Unit 4: Special Hazards (cont'd)	Graduation

This page intentionally left blank.

COPYRIGHT CLEARANCE

Copyrights that are obtained for use of the materials in this manual are expressly obtained for this course. If users wish to duplicate these copyrighted materials, copyright must be obtained from the publishers.

From: National Fire Protection Association, Inc., Quincy, MA 02269

For *National Electrical Code NFPA #70* (NEC 70-1990), Article 500-3 on page 663; and Article 500-3 FPN Number 14 on page 666.

National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Inc., Quincy, MA 02269.

For Standard for Installation of Warm Air Heating and Air Conditioning Systems, NFPA 90B-1989. Article 4-1.8.2 page 90-13.

For the Code of Ethics for Fire Marshals, adopted May 17, 1966, Sections 5 thru 12 (Relations with the Public) as published on page 22 of "Fire Marshal's Association of North America 1990-91 Directory."

This page intentionally left blank.

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

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."	- The (ABC) fire video is out-of-date because of the dangerous tactics it demonstrates. The available (XYZ) video shows current practices. - The student manual references building codes that are 12 years old.
2 "We want an advanced class in (fill in the blank)."	- We would like a class that enables us to calculate energy transfer rates resulting from exposure fires. - We would like a class that provides one-on-one workplace harassment counseling practice exercises.
3 "More activities."	- An activity where students can physically measure the area of sprinkler coverage would improve understanding of the concept. - Not all students were able to fill all ICS positions in the exercises. Add more exercises so all students can participate.
4 "A longer course."	- The class should be increased by one hour per day to enable all students to participate in exercises. - The class should be increased by two days so that all group presentations can be peer evaluated and have written abstracts.
5 "Readable plans."	- The plans should be enlarged to 11 by 17 and provided with an accurate scale. - My plan set was blurry, which caused the dotted lines to be interpreted as solid lines.
6 "Better student guide organization," "manual did not coincide with slides."	- The slide sequence in Unit 4 did not align with the content in the student manual from slides 4-16 through 4-21. - The instructor added slides in Unit 4 that were not in my student manual.
7 "Dry in spots."	- The instructor/activity should have used student group activities rather than lecture to explain Maslow's Hierarchy. - Create a pre-course reading on symbiotic personal relationships rather than trying to lecture on them in class.
8 "More visual aids."	- The text description of V-patterns did not provide three-dimensional views. More photographs or drawings would help me imagine the pattern. - There was a video clip on NBC News (date) that summarized the topic very well.
9 "Re-evaluate pre-course assignments."	- The pre-course assignments were not discussed or referenced in class. Either connect them to the course content or delete them. - The pre-course assignments on ICS could be reduced to a one-page job aid rather than a 25-page reading.
10 "A better understanding of NIMS."	- The instructor did not explain the connection between NIMS and ICS. - The student manual needs an illustrated guide to NIMS.

This page intentionally left blank.

UNIT 1: GENERAL FIRE SAFETY

TERMINAL OBJECTIVE

The students will be able to:

- 1.1 *Evaluate the general fire safety of a structure by researching the concepts within their code.*

ENABLING OBJECTIVES

The students will be able to:

- 1.1 *Analyze the general fire safety of a site.*
 - 1.2 *Analyze the general fire safety of a structure.*
 - 1.3 *Analyze the general fire safety pertaining to a structure's use.*
-

This page intentionally left blank.



UNIT 1: GENERAL FIRE SAFETY

Slide 1-1

TERMINAL OBJECTIVE

Evaluate the general fire safety of a structure by researching the concepts within their code.

Slide 1-2

ENABLING OBJECTIVES

- Analyze the general fire safety of a site.
- Analyze the general fire safety of a structure.
- Analyze the general fire safety pertaining to a structure's use.

Slide 1-3

TOPICS TO BE COVERED

- General fire safety of a site.
- General fire safety of a structure.
- General fire safety pertaining to a structure's use.

Slide 1-4

I. GENERAL FIRE SAFETY OF A SITE

GENERAL FIRE SAFETY OF A SITE

Slide 1-5

CONSIDERATIONS FOR ACCESS



Slide 1-6

CONSIDERATIONS FOR ACCESS (cont'd)



Slide 1-7

A. Considerations for access.

1. Building with no apparent access to it.

NARROW ALLEYWAY



Slide 1-8

2. Narrow alley access to rear of buildings.

Apparatus may not be required to get to back of buildings; however, where access is necessary, it must normally be 20 feet wide to accommodate two pieces of apparatus passing each other.

VERTICAL CLEARANCE



Slide 1-9

3. Vertical clearance.
 - a. Access to rear of building only 8 feet 2 inches.
 - b. Codes usually require 13 feet 6 inches of vertical clearance so that apparatus has free access.

VERTICAL CLEARANCE (cont'd)



Slide 1-10

VERTICAL AND HORIZONTAL CLEARANCES



Slide 1-11

SIDEWALK INTENDED FOR ACCESS



Slide 1-12

4. Sidewalk designated for fire department access to interior of college campus.

Narrow width and trees planted close to concrete; branches much too low, restricting apparatus access.

DIRT ACCESS ROAD



Slide 1-13

5. Surface of access roads.
 - a. Gravel country road which may, under some conditions, hamper apparatus.
 - b. Requirements of some codes call for “all weather” driving surface.
 - c. Dirt access to the site. It would not take a great deal of rain to make this muddy enough to cause access problems.

TURNING RADIUS

- Established by local needs.
 - Inside and outside.
 - Front and rear.
- Computer programs.
 - Department of Transportation (DOT) models.



Slide 1-14

6. Turning radius.
 - a. Inspectors must find out the turning radius of their apparatus.
 - Apparatus turning radius being measured.

BOLLARDS



Slide 1-15

- Bollards placed so that the apparatus is unable to make the turn.

- The turning radius may be impeded by bollards installed after the access road was constructed.

BOLLARDS (cont'd)



Slide 1-16

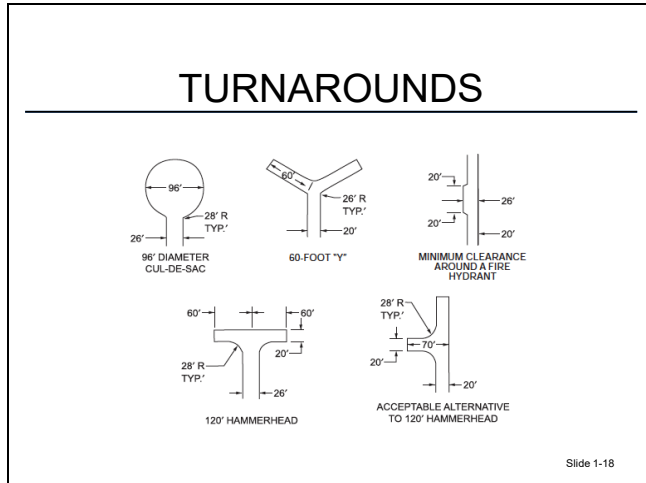
CUL-DE-SAC



Slide 1-17

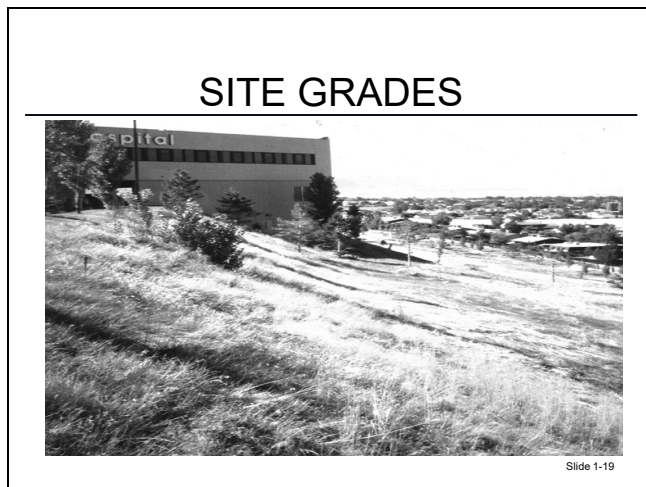
- b. Inspectors must be constantly on guard for changes made on the site which cause problems for access.

- May be faced with a cul-de-sac or circular turnaround.



7. Turnarounds.

On-site turnarounds may be required when the dead-end access road is greater than 150 feet in length (International Fire Code (IFC) 503.2.5 and National Fire Protection Association (NFPA) 1 — 18.2.3.4.4).



8. Site grades.

- a. Example building has two sides of a triangular wing on a steep hill.
- b. Inspector must watch to be sure when questionable access occurs that no changes take place that would affect existing access.

MARKINGS AND SIGNAGE



Slide 1-20

9. Signs.

- a. To identify and prohibit obstruction.
- b. Signs when required by code official and/or code requirements.
- c. Stripes and lettering — local requirements.

MARKINGS AND SIGNAGE (cont'd)



Slide 1-21

MARKINGS AND SIGNAGE (cont'd)



- d. Painting curbs and striping road surface is not sufficient. For the courts to prosecute, signs must be provided.

OBSTRUCTIONS TO ACCESS



- B. Obstructions to access.

Example: Cars parked in such a way as to obstruct access.

TURF BLOCKS

- Ensure that edges are clearly marked in some permanent fashion.
- Verify fire chief approval before using turf blocks.



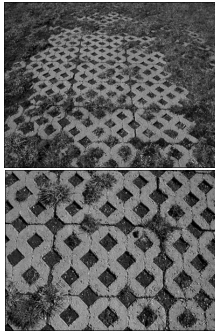
Slide 1-24

1. Turf blocks.

a. Example shows marking the edges of turf block access.

TURF BLOCKS (cont'd)

- Turf blocks create a solid base for fire apparatus to navigate effectively.



Slide 1-25

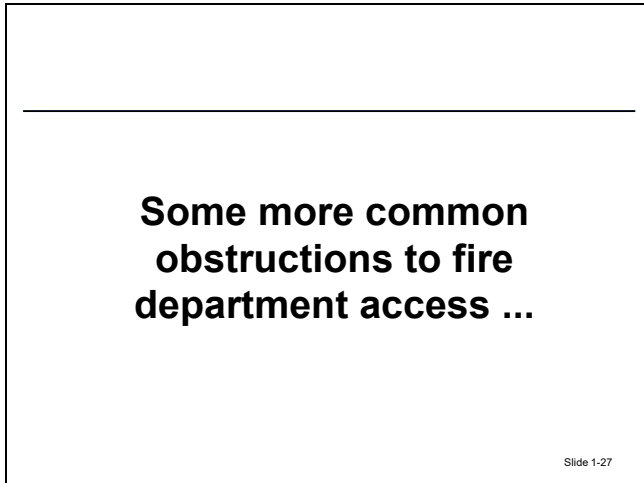
MARKINGS AND SIGNAGE (cont'd)

- In the example, the handicapped parking sign is for a parking space at the curb, but the access road behind is not clearly defined as fire department access.

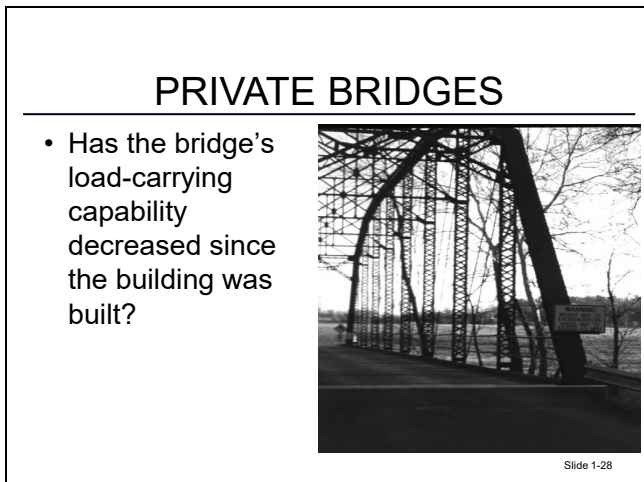


Slide 1-26

- b. Inspector must ensure that, if turf block-type access is used, edges are marked in some permanent way.



2. Common fire department obstructions.



- a. Bridges could be:
- Too narrow.
 - Too low (can't go under).
 - Not structurally sound.

PRIVATE BRIDGES (cont'd)

- Surfaces not intended for fire department access must be clearly marked.



Slide 1-29

TREES

Have trees encroached on the required:

- 13-foot 6-inch vertical clearance.
- 20 feet minimum width.



Slide 1-30

b. Trees.

- Example shows an access road with entrance effectively blocked by low tree branches.
- Unless they are properly planned for and trimmed, trees can be an obstruction.
- Few landscape architects design for mature trees consider fire department access.

GUTTERS



Slide 1-31

c. Gutters.

- Deep gutters with abrupt climbs or drops can cause apparatus to drag going through them.

BARRICADES



Slide 1-32

d. Barricades.

- Anything which may impede access is a barrier. Even temporary barricades must be set up with access in mind, and the fire department must be informed.
- Chains across site access openings can cause delays and, if not seen, can also cause serious damage to the apparatus.

GATES



Slide 1-33

e. Gates.

- Gates across a building access to restrict vehicular traffic to backs of buildings and a construction site.

SECURITY GATES



Slide 1-34

- Inspector should note that when gates are locked they create added delays. Also the width must be considered to permit apparatus access.

GATED ACCESS



Slide 1-35

NARROW ROADS



Slide 1-36

- f. Narrow roads.
 - Example: road with parking on both sides.
 - Narrow access roads are always a problem because other problems, such as additional cars, equipment, crates, deliveries, etc., make response to a fire impossible.

Integrity of the Water Supply

Slide 1-37

C. Integrity of the water supply.

OBSTRUCTED HYDRANT



Slide 1-38

1. Obstructions to fire hydrants.

Inspectors must be certain that all hydrants are properly accessible and not obstructed in any way.

OBSTRUCTIONS TO A FIRE DEPARTMENT CONNECTION



Slide 1-39

2. Obstructions to Fire Department Connection (FDC).

OBSTRUCTIONS TO A FIRE DEPARTMENT CONNECTION (cont'd)



Slide 1-40

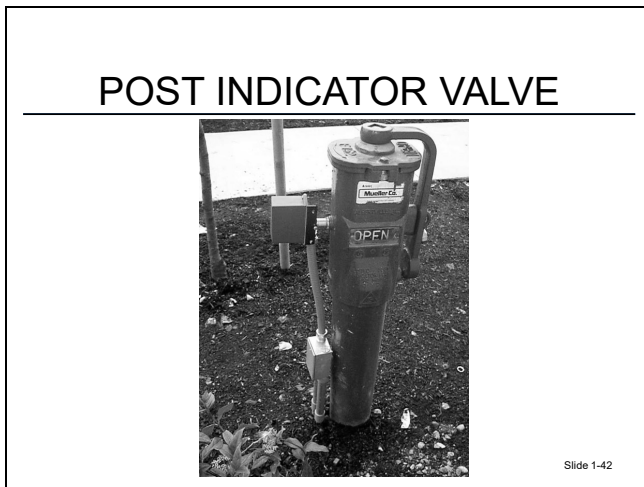
MAINTENANCE OF HYDRANTS



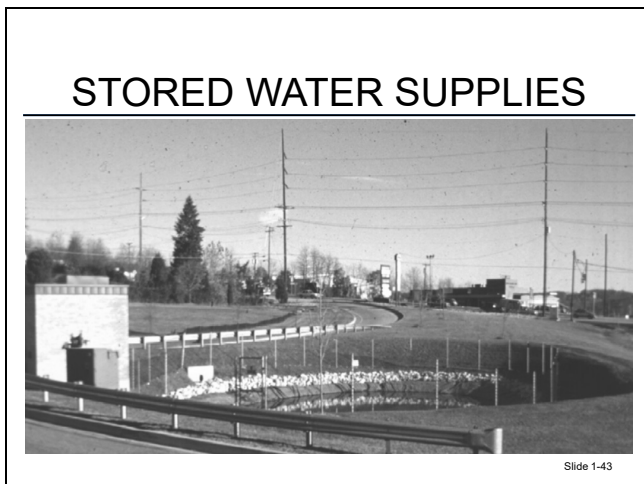
Slide 1-41

3. Maintenance of hydrants.

- a. A hydrant in the center of a parking lot with bollards which appear to have been run into a number of times.
- b. More important may be the holes through the asphalt indicating the washing away of soils which would indicate that there may be a broken line or hydrant. Since there is no water showing, a control valve has been turned off, cutting off much of the fire protection.



- 4. Post indicator valve.
 - a. New post indicator valve at a new building.
 - b. Inspectors must not assume that because something is supposed to be new, it is correct. Everything should be checked.



5. Water.
 - a. Water supplies change for many reasons. Don't assume because the water supply was acceptable at one time that it still is.
 - b. The inspector should monitor the adequacy of the water supply on each inspection visit.
 - c. Example of pump house with retention pond (source of water).

ACTIVITY 1.1

Site Problem Identification

Purpose

Identify appropriate codes and apply them to evaluating the general fire safety of a site.

Directions

1. As you see each slide, make notes as to any possible violations.

2. After all ten slides have been shown, the groups must research the codes and cite proper code references.

3. Slides will be shown again, and each group will tell what their code says about each.

II. GENERAL FIRE SAFETY OF A STRUCTURE

GENERAL FIRE SAFETY OF A STRUCTURE

Slide 1-55

Integrity of Protection of Structural Elements

Slide 1-56

A. Integrity of protection of structural elements.

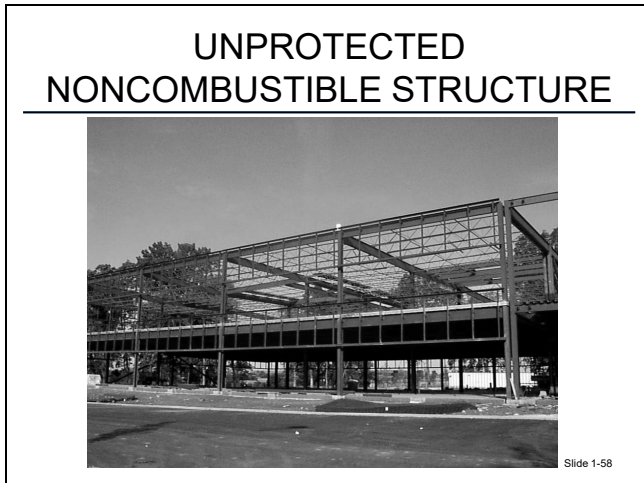
UNPROTECTED WOOD TRUSS



Slide 1-57

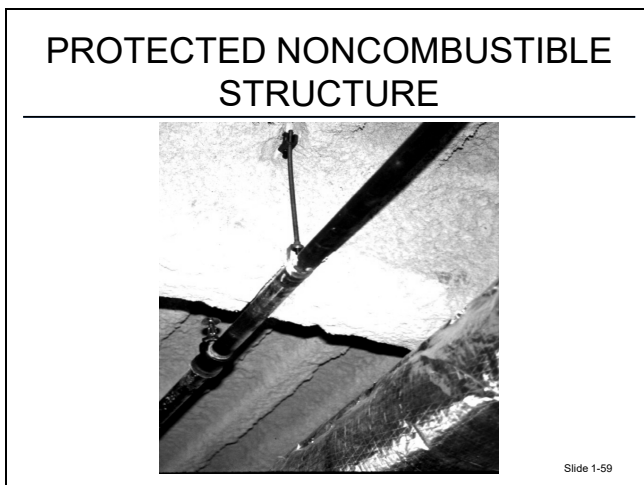
1. Unprotected combustible truss.

Inspector should know that this type of structure probably constitutes the majority of the construction in the U.S. Under “normal” conditions this is considered good construction, but fire is not normal. This construction offers very rapid fire spread.



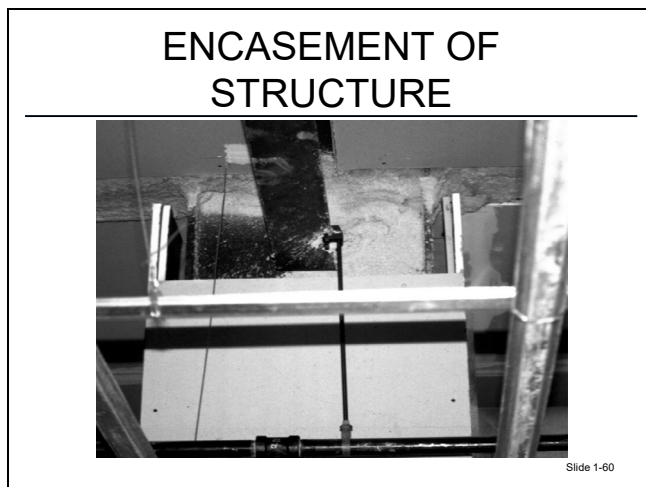
2. Unprotected noncombustible structure.

- a. Masonry going up in front left corner indicates questionable protection for steel. Sometimes this type of construction gives us a false sense of security, thinking that steel is strong and normally it will not burn.
- b. Structural steel starts to lose its ability to carry a designed load around 800 °F (427 °C), and fails around 1,200 °F (649 °C).



3. Protected noncombustible structure.

- a. Example shows a beam and steel deck with sprayed on protection.
- b. The insulation has been cut into to apply sprinkler hanger, which is not protected.
- c. Note color of primed web of beam showing through spray which might indicate no uniform application.

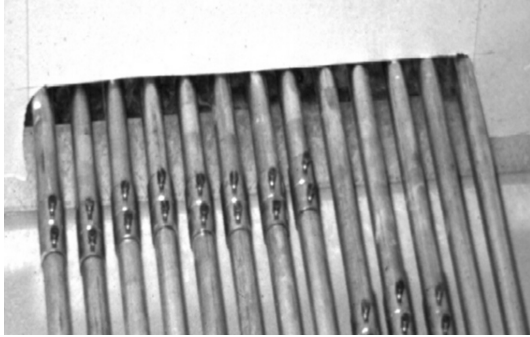


- 4. Encasement of structure.
 - a. Example shows a column and beam being encased in gypsum board.
 - b. Will beam be protected?
 - c. Will gypsum board construction be continued up to complete the encasement of the column to beam joint, which becomes the critical point?



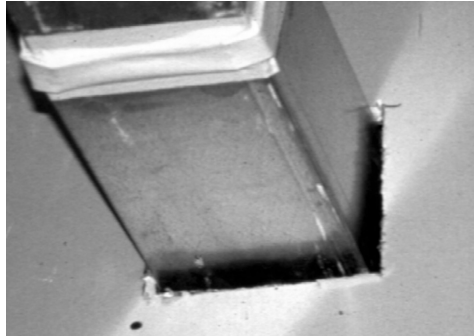
B. Integrity of compartmentation.

PENETRATIONS AROUND
ELECTRICAL CONDUIT



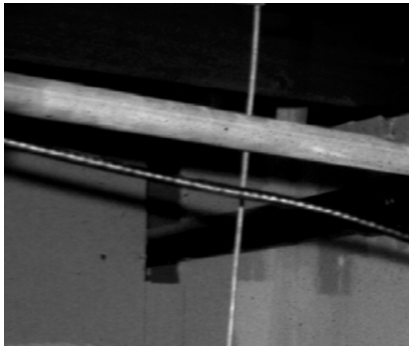
1. Penetrations left around conduits.
 - a. Example shows penetrations of a rated assembly around a conduit.
 - b. Inspectors should be aware of the fact that the pressure developed in an incident can push fire through the smallest of holes.

PENETRATIONS AROUND
DUCTWORK



2. Penetrations left around ducts.
 - a. Example shows a hole larger than necessary for ductwork with excess space left unprotected. (Note the masking tape.)
 - b. Contractors have no concept of the power and force of fire, and therefore they do not realize the danger created by leaving penetrations.

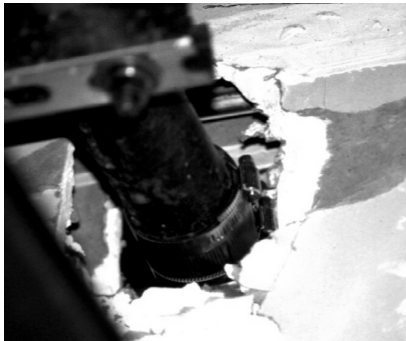
PENETRATIONS AROUND SPRINKLER PIPING



Slide 1-64

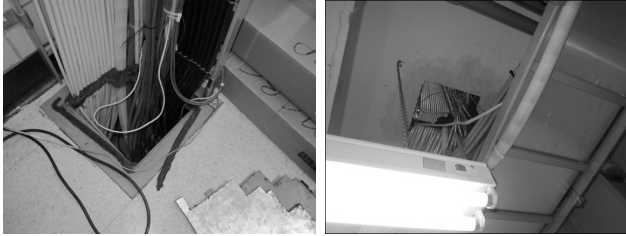
3. Penetrations left around sprinkler pipes.
 - a. Example shows large hole left unsealed by the sprinkler contractor.
 - b. Sprinkler contractors have the mistaken idea that they do not have to worry about penetrations they leave after the sprinklers are installed.

PENETRATIONS BY PLUMBING LINES



Slide 1-65

PENETRATIONS FOR DATA CABLES



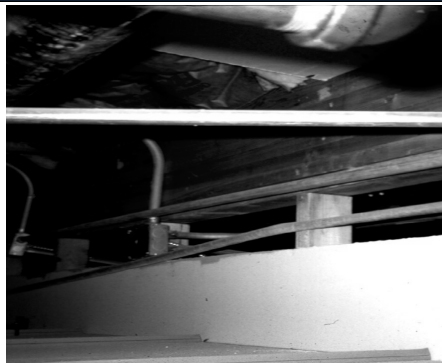
Slide 1-66

SLEEVE NOT SEALED



Slide 1-67

INTEGRITY OF FIRE-RATED WALLS



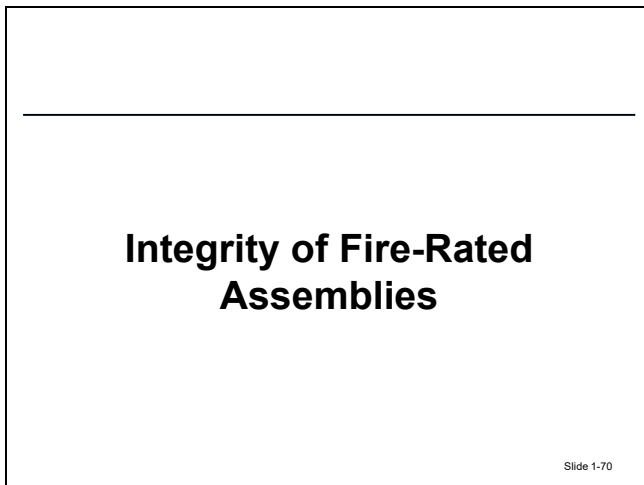
Slide 1-68

4. Fire-rated walls.
 - a. The example shows a fire-rated wall which stops just above the ceiling.

- b. Generally fire-rated walls must go all the way to the structure above and be sealed to it.
- c. Inspectors must know that they have to look above the ceiling to be sure the walls are complete.
- d. Gypsum board on only one side of a stud wall does not make a one-hour rating.



- 5. Proper materials.
 - a. A storage room with a wall which is supposed to have a one-hour rating, but has plywood on one side and nothing on the other.
 - b. Inspector must know that walls required to be rated must be constructed properly and of the correct materials.



- C. Integrity of fire-rated assemblies.

Concept of Fire/Area Separation Walls

Intent is to divide building into separate fire areas.

Slide 1-71

1. Concept of fire/area separation wall based on Standard Time Temperature Curve (STTC).
 - a. Firewalls — one-hour/two-hour/four-hour assemblies.
 - b. In some cases, parapets are required.

Concept of Occupancy Separation Walls

Intent is to separate one occupancy from another.

Slide 1-72

2. Concept of occupancy separation walls.
 - a. To separate different hazard occupancies.
 - b. Mixed occupancy situations.

CONCEPT OF FIRE-RATED ASSEMBLIES

- Specific components.
- Constructed or assembled in a specific manner.

Slide 1-73

3. Concept of a fire-rated assembly.
 - a. Related parts completely assembled create a whole.
 - b. Tested and rated as a whole so everything must be complete, as tested, to be a rated assembly.

FIRE DOOR ASSEMBLY

- Rated and labeled door leaf/leaves.
- Rated and listed hardware.
- Hinges.
- Closing/Latching devices.
- Rated and labeled frame.



Slide 1-74

4. Door assembly.

Consists of:

- a. Labeled door.
- b. Rated and labeled hardware, including ball-bearing hinges.
- c. Rated and labeled frame.

EXIT ENCLOSURES

- Labeled means of egress.
- Maximum transmitted temperature:
 - 450 °F at 30 minutes.



Slide 1-75

d. Doors in exit enclosures:

- Labeled means of egress.
- Maximum transmitted temperature: 450 °F at 30 minutes.

HARDWARE

- | | |
|---|--|
| <ul style="list-style-type: none">• Fire door.<ul style="list-style-type: none">– Closers.– Cables.– Tracks.– Usually shipped with door. | <ul style="list-style-type: none">• Builders.<ul style="list-style-type: none">– Handles.– Hinges.– Closers.– Usually shipped separately. |
|---|--|

Slide 1-76

e. Hardware.

- Fire door hardware is normally shipped with the door.
 - Closers.
 - Cables.
 - Tracks.
- Builders hardware is normally shipped separate from the door assembly.

- Handles.
- Hinges.
- Closers.

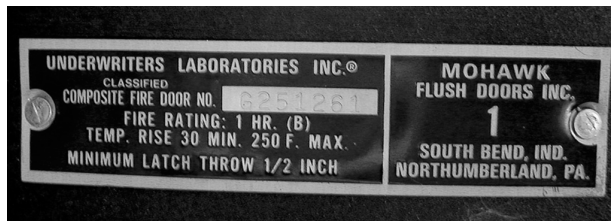
LABELS AND CERTIFICATIONS

- Label.
 - Door meets performance test.
- Certified.
 - Conforms to requirement of design, materials and construction (normally used for doors too large to test).

Slide 1-77

f. Labels and certifications.

- Label indicates the door meets the performance test standards.
- Certified indicates the door conforms to requirement of design, materials and construction (normally used for doors too large to test).



Slide 1-78

g. Shows a typical door label.

OVERSIZE DOORS

Maximum listing size = 120 square feet.



Slide 1-79

- h. Example of oversized doors that cannot be tested. Based on the test furnaces used for the Underwriters Laboratories (UL) tests, the maximum door size that can be tested is 120 square feet.
- These doors are certified, but not labeled.

FIRE DOORS

- Listed components installed in correct fashion.
 - Door label will indicate hourly rating.
 - Frame label may only indicate that it is a rated fire door frame.
- Class versus hourly rating.

Slide 1-80

- i. Listed components installed in correct fashion.
- Door label will indicate hourly rating.
 - Frame label may only indicate that it is a rated fire door frame.

SUCCESSFUL PERFORMANCE

- Assembly remains in wall.
- No openings in door (failures).
- No flame on unexposed side within first 30 minutes of test.
- Transmitted temperature limits not part of the National Fire Protection Association (NFPA) 252, *Standard Methods of Fire Tests of Door Assemblies*, requirements.

Slide 1-81

j. Successful performance.

- Assembly remains in wall.
 - No openings in door (failures).
- No flame on unexposed side within first 30 minutes of test.
- Transmitted temperature limits to the unexposed side of the door are not part of the NFPA 252, *Standard Methods of Fire Test of Door Assemblies*, requirements; however, the International Building Code (IBC) restricts temperature transmission for some wall opening protectives. Listing/Labeling/Approval agencies indicate the maximum transmitted temperature.

LISTING/LABELING AGENCIES

- Underwriters Laboratories (UL), Inc.
- Underwriters Laboratories of Canada (ULC).
- Factory Mutual Global Research.
- Intertek/Warnock Hersey.

Slide 1-82

- k. Listing/Labeling agencies.
- UL, Inc.
 - Underwriters Laboratories of Canada (ULC).
 - Factory Mutual Global Research.
 - Intertek/Warnock Hersey.

FIRE DOORS CLASSES

Class describes where fire-door assembly should be installed.

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



Slide 1-83

- l. Class versus hourly rating.

Class describes where fire-door assembly should be installed.

- A — firewalls and in walls that divide a single building into fire areas.
- 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 1-84

- 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.



5. Counter door assembly.
 - a. Counter door that is jammed part way closed due to faulty installation.
 - b. Inspector must require the installer to demonstrate the proper operation of each rated counter roll-up door.
 - c. Must be carefully installed and adjusted.
 - d. Usually difficult to reset.
 - e. If not properly adjusted, become guillotines.

PROBLEMS WITH ROLLING FIRE DOORS

- Wired open.
- Blocked open.
- Disconnected from activator.
- Not interconnected with smoke detectors for activation.
- Can be blocked by anything on the floor/counter.

Slide 1-86

6. Common problems with counter doors.
 - a. Wired open.
 - b. Blocked open.
 - c. Disconnected from activator.
 - d. Not interconnected to smoke detectors for activation.
 - e. Anything on top makes it ineffective.

SUSPENDED RATED CEILING ASSEMBLY



Slide 1-87

7. Floor-ceiling assembly.
 - a. The suspension wires must be tightly twisted, or they have a tendency to straighten out in a fire.

- b. The underside of the floor deck in this example and the suspended ceiling grid-work must be completed exactly as the tested assembly called for in order to be acceptable.

FIRE DAMPERS

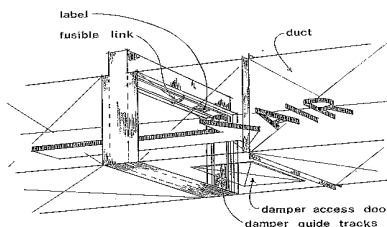
- May be installed inside ductwork which penetrates rated walls or ceiling.
- May be installed in return air plenums.
- Must be tested and listed.
- Must be checked for proper installation and maintenance.
- Proper access must be provided.
- May not stop spread of smoke.

Slide 1-88

8. Fire dampers.

- a. The example on slide 89 shows proper installation of a fire damper in a rated wall of a return air plenum.
- b. As seen on slide 90, dampers must bear the label of a testing lab, such as UL, to be acceptable.
- c. Be sure dampers are not painted, as the paint may impair operation and may prevent the fusible link from working.

FIRE DAMPER (out of air stream)



- damper set in wall
- damper mounted in a sleeve
- seal around sleeve and damper
- can have either gravity or spring activation
- must be installed right side up

Slide 1-89

FIRE DAMPER IN RATED WALL



Slide 1-90

IMPAIRMENTS TO FIRE DAMPERS

- Wires running through them.
- Damage to guides.
- Wired open.
- Blocked open.
- Heavily painted.

Slide 1-91

- d. Fire dampers may also be impaired by:
- Wires running through them.
 - Damage to guides.
 - Wired open.
 - Blocked open.
 - Heavily painted.
- e. Proper access must be provided to reset damper — 12-inch square access 24 inches from damper is not sufficient.

Smoke Partitions/Walls

Smoke dampers

Slide 1-92

9. Smoke walls.
 - a. Requirements for division into smoke compartments vary from code to code.
 - b. The penetrations of smoke walls become more critical due to the fact that these walls are required where it is necessary to defend the occupants “in place” rather than evacuate them.

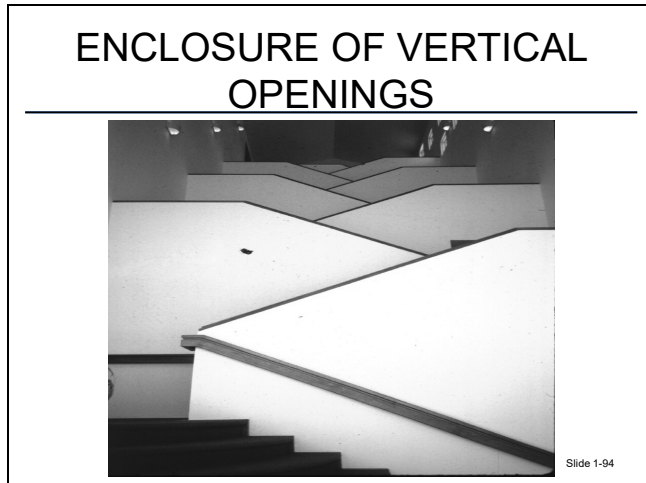
MOTORIZED SMOKE DAMPER IN WALL OF AIR HANDLING ROOM



Slide 1-93

10. Motorized smoke or air leakage damper.
 - a. The example shows a motorized air leakage damper in a large air handling room.
 - b. These are used in smoke barriers and heating, ventilating and air conditioning (HVAC) systems where smoke movement must be managed.

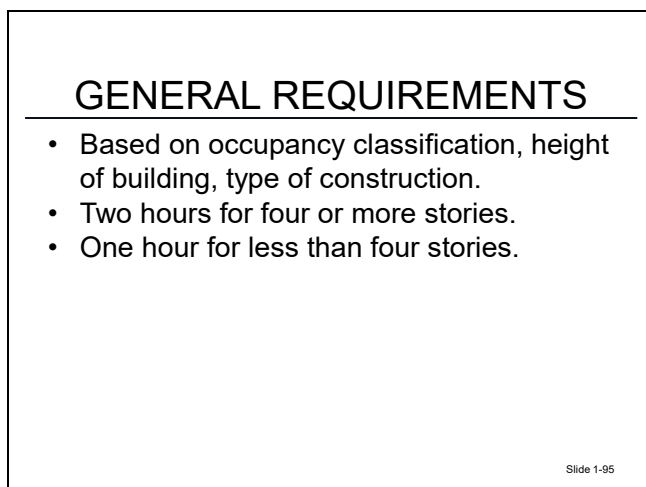
- c. Fire dampers do not have to pass the stringent air movement criteria.



11. Vertical openings.

a. Stairs.

- Example shows an open stairway five stories high.
- This could certainly give rise to question as to conformance with model codes.



b. General requirements.

- Protection of stairways is building.
- Two hours protection for four stories or more.
- One hour protection for less than four stories.



c. Elevators.

- Typical bank of elevators which are open, in this case, to an atrium space in a four-story building.
- The doors of elevators generally make a fire rating, but do not make a smoke or air leakage rating.



d. Equivalencies.

- Controversy over compartmentation versus sprinklers or both.
- Sprinklers may possibly be used to reduce the fire-resistive rating of components of buildings.
- Remember that the burden of equivalency proof of something clearly rests with the person requesting it.

INSPECTORS MUST BE CONSTANTLY ON THE ALERT FOR CHANGES

- From approved plans.
- Remodeling.
- Change of occupancy.

Slide 1-98

e. Changes.

- From approved plans.
- Remodels of spaces in buildings.
- Inspectors must be constantly on the alert for changes whether they deal with new construction or not.
- Very few buildings are not constantly undergoing change and many times the owner does not bother to tell you.

APPROVAL DIRECTORIES ONLINE

- UL Online Certifications Directory.
- Gypsum Association Directory.

Slide 1-99

12. Approval directories online.

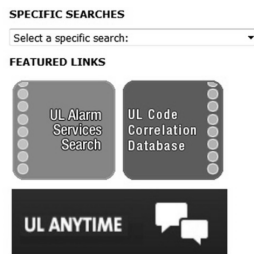
HOW TO USE THE ONLINE UL DIRECTORY

- UL design number U905.
- Go to www.ul.com and click on “Online Certifications Directory.”

Slide 1-100

HOW TO USE THE ONLINE UL DIRECTORY (cont'd)

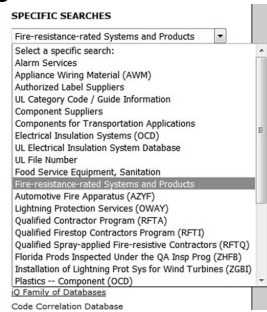
- On the right-hand side of the screen, look for the “Specific Searches” drop-down box.



Slide 1-101

HOW TO USE THE ONLINE UL DIRECTORY (cont'd)

- Select “Fire-resistance-rated Systems and Products.”



Slide 1-102

HOW TO USE THE ONLINE UL DIRECTORY (cont'd)

- On the left side, type in "U905" in the "Search for a design" box and click SEARCH.
- The search results will be displayed. Click on "**BXUV.U905**" to see the design information.

SEARCH FOR A DESIGN

Enter Number to Search:

u905

SEARCH CLEAR

Search results

You may choose to Refine Your Search.

Company Name	Category Name	Link to File
Design No. U905	Fire-resistance Ratings - ANSI/UL 263	BXUV.U905

Slide 1-103

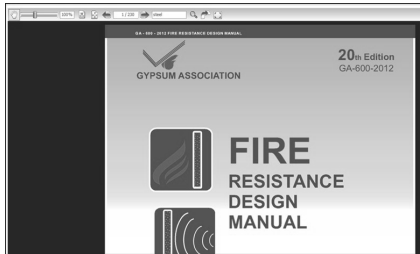
HOW TO USE THE ONLINE GA DIRECTORY

- GA design number WP 1204, a one-hour wall with metal studs.
- Go to the Gypsum Association Directory: <http://www.gypsum.org/wp/wp-content/uploads/2011/11/GA-600-12-web-version-1.html>

Slide 1-104

HOW TO USE THE ONLINE GA DIRECTORY (cont'd)

- The directory will load as a single, unsearchable PDF file.



Slide 1-105

HOW TO USE THE ONLINE GA DIRECTORY (cont'd)

- There is a search box, but it is nonfunctional.



Slide 1-106

HOW TO USE THE ONLINE GA DIRECTORY (cont'd)

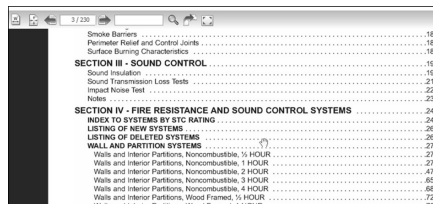
- Use the "Next Page" and "Previous Page" buttons to scroll through the document to the table of contents.



Slide 1-107

HOW TO USE THE ONLINE GA DIRECTORY (cont'd)

- One-hour noncombustible walls start on page 27.
- Go to page 27 by typing 27 in the page number box.



Slide 1-108

HOW TO USE THE ONLINE GA DIRECTORY (cont'd)

- The first design shown is WP 1015. Scroll through the designs to reach WP 1204.

WALLS AND INTERIOR PARTITIONS, NONCOMBUSTIBLE			
GA FILE NO. WP 1204	GENERIC	1 HOUR FIRE	40 to 44 STC SOUND
GYPSUM WALLBOARD, STEEL STUDS Base layer 1/2" type X gypsum wallboard or gypsum veneer base applied parallel to each side of 3 1/2" 20 ga steel studs 24" o.c. with 1/4" Type S-12 drywall screws 12" o.c. Face layer 1/2" type X gypsum wallboard or gypsum veneer base applied parallel to each side with 1/4" Type S-12 drywall screws 12" o.c. Studs attached to each side of floor and ceiling runners by welding or with 1/2" Type S-12 pan head screws. Joints staggered 24" each layer and side. Bracing: Lateral bracing spaced not over 40" o.c. shall be 1" by 16 ga steel straps attached to each side or channel bracing attached to each stud with a clip angle. For studs with holes or punch outs in the web the "C" factor shall be determined by means of stub column tests. Tested at 100 percent of design load. (Passed 90 minute fire test.) (LOAD-BEARING)			
			
		Thickness: 5/8" Approx. Weight: 9 pcf Fire Test: UL NC 505-1, 7-29-82. UL Design U425 Sound Test: See WP 1615 (NGC 2250, 1-3-68)	

Slide 1-109

FIRE TEST STANDARDS

- American Society for Testing and Materials (ASTM) E119 (fire-rated assemblies).
- ASTM E152 (fire-rated door).
- ASTM E163 (glazing).
- ASTM E814 (fire stopping).
- UL 555 (fire dampers).
- UL 555S (smoke dampers).

Slide 1-110

Test standards:

- American Society for Testing and Materials (ASTM) E119 (fire-rated assemblies).
- ASTM E152 (doors).
- ASTM E163 (glazing).
- ASTM E814 (penetrations of rated walls needing fire stopping).
- UL 555 (fire dampers).
- UL 555S (smoke dampers).

III. GENERAL FIRE SAFETY PERTAINING TO A STRUCTURE'S USE

**GENERAL FIRE SAFETY
PERTAINING TO A
STRUCTURE'S USE**

Slide 1-111

**General Storage
Requirements**

Slide 1-112

A. General storage requirements.

DUMPSTERS

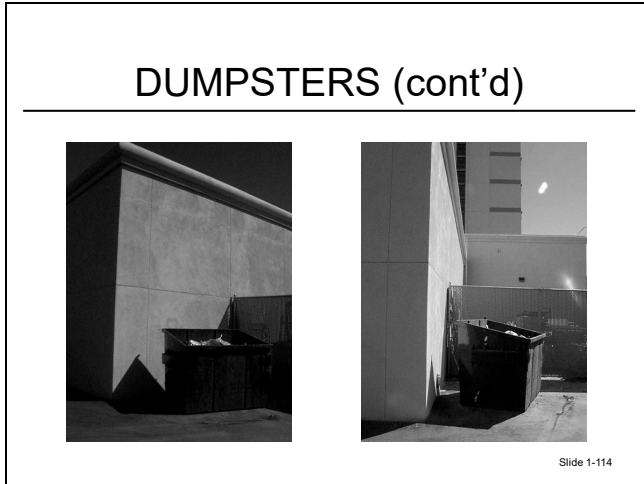
- How far from the building must a dumpster be located?
- What about plastic lids?
- Any other problems visible?



Slide 1-113

1. Dumpster.

- a. Open dumpster lids under an overhang and flush to the building wall.



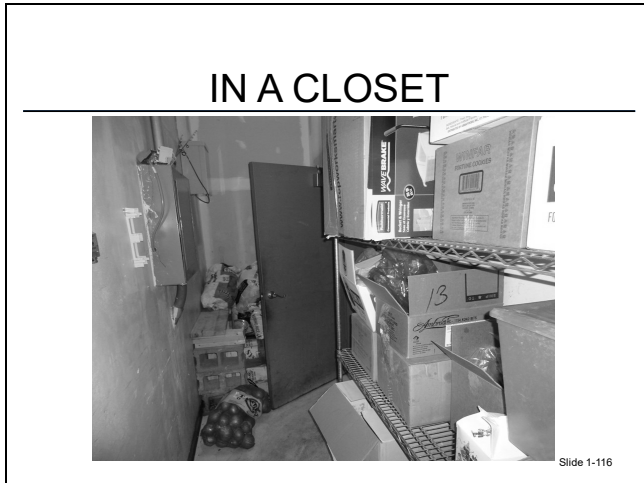
- b. Dumpsters must be placed a reasonable distance from openings and combustible walls. For example: IFC 304.3.3 and 304.3.4 says 5 feet; NFPA 1 19.2.1.4 says 10 feet.
- c. Plastic lids can double the temperature of a dumpster fire.



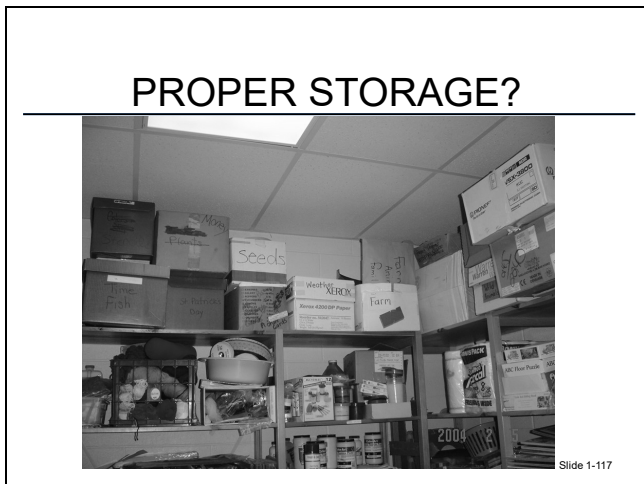
2. Rubbish or combustibles.

- a. Combustibles thrown into an unorganized pile, thereby becoming rubbish.
- b. Inspector must convey to property owners that rubbish or combustibles are not permitted because they become a fire hazard.

- c. Materials not properly stored, or that are declared rubbish or waste material, must be removed daily.



- 3. Improper storage.
 - a. Combustibles thrown into a closet — a classic example of improper storage.
 - b. Combustibles not properly stored become litter.



- 4. Proper storage.
 - a. This shows an example of proper storage, except for the material on the top of the shelves.
 - b. The codes require storage to be kept 2 feet (24 inches) from the ceiling (example: IFC 315.3.1).

WAREHOUSE STORAGE



Slide 1-118

5. Warehouse storage.

Storage must be orderly and kept away from exterior walls by an aisle to provide fire department access and to keep water-saturated material from swelling and pushing out the wall.

CLEAR WIDTH OF CORRIDOR IMPAIRED



Slide 1-119

6. Plant storage in corridor.

- a. In this example, there are a multitude of plants in the corridor of the school. The corridor is 8 feet wide, but the plants take up at least 50 percent of it.
- b. Inspectors must, in cases such as this, calculate the width required for the corridor and not permit anything within that space.

OBSTRUCTIONS IN CORRIDOR



Slide 1-120

7. Obstructions in corridor.
 - a. Chair and table storage in corridor of education occupancies.
 - b. Owners not understanding the codes (or reasons for codes) many times feel they can block off a little-used corridor for storage.
 - c. No building has enough storage space.

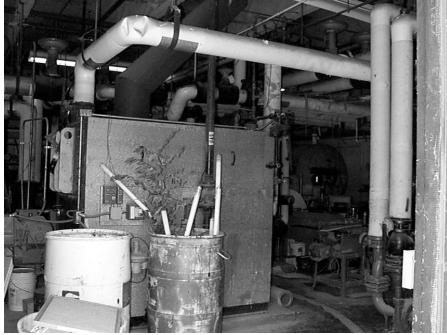
STORAGE OBSTRUCTING EXIT



Slide 1-121

8. Storage obstructing exit.
 - a. Storage and litter obstructing the exit doors.
 - b. Inspector must know that he or she must never leave a building without having this type of violation corrected.
 - c. Inspector must also take this opportunity to educate the owner of the code and the liability associated therewith.

BOILER ROOMS



Slide 1-122

B. Storage areas.

1. Boiler rooms.

BOILER ROOMS (cont'd)



Slide 1-123

- a. Boiler room with combustible waste, drums and containers.
- b. No storage is permitted in boiler rooms.
- c. Flammables in a boiler room are incidents waiting to happen.

ATTIC SPACES



Slide 1-124

2. Attic spaces.
 - a. Storage in a combustibles attic space around a single vent pipe from heating unit.
 - b. Inspector must know that no storage is permitted in attic spaces, particularly when it is not constructed with a one-hour rating on storage side (example: IFC 315.3.4).

ATRIUMS



Slide 1-125

3. Atriums.
 - a. A three-story atrium within a shopping mall.
 - b. Combustibles must be limited as per codes — usually 9,000 British thermal unit (Btu) per pound or, in other words, normal combustibles, not flammables. This is an area difficult to judge.
 - c. No open-flame equipment is permitted in atriums.

VACANT BUILDINGS



Slide 1-126

4. Vacant buildings.

- a. An incomplete, vacant building.
- b. Vacant buildings are commonly frequented by vandals and transients who build fires to stay warm, sometimes burning the buildings.
- c. Vacant buildings must have all waste or rubbish removed from them and be properly secured per code.

SPECIAL STORAGE PROBLEMS

- Flammable and combustible liquids.
- Gasoline-fueled equipment.
- Compressed gas cylinders.
- Records storage.

Slide 1-127

C. Special storage problems.

FLAMMABLE/COMBUSTIBLE LIQUIDS



Slide 1-128

1. Flammable and combustible liquids.
 - a. This example shows over 100 gallons of Class 1 flammable and combustible liquids openly stored in a school.
 - b. These flammable-liquid storage cabinets are located in the corridor at the base of an open stairway.
 - c. Flammables must not be permitted to be stored indiscriminately, especially in quantities exceeding the limits permitted by code.

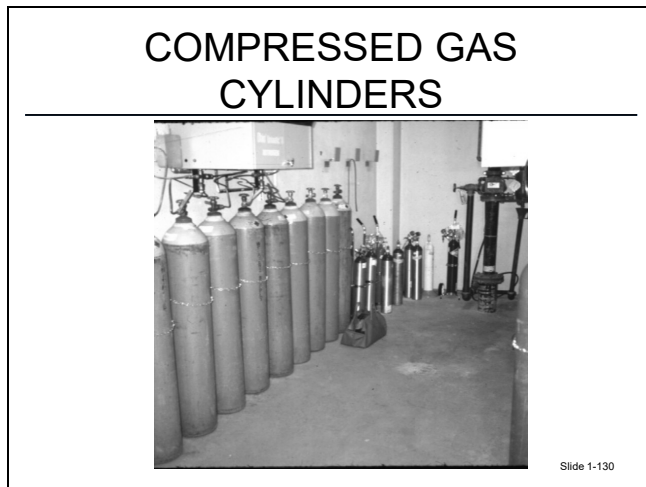
GASOLINE-FUELED EQUIPMENT



Slide 1-129

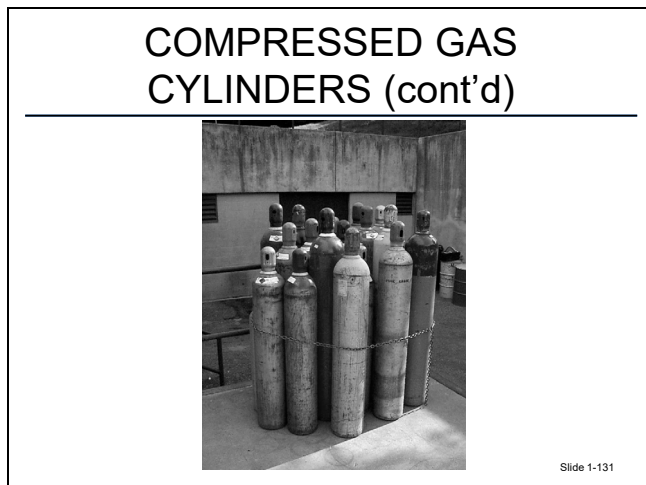
2. Gas-fueled equipment.
 - a. This example shows multiple pieces of gas-powered equipment inside a building.

- b. Hazardous, gas-operated equipment is not to be stored inside buildings, except within a location specifically designated, designed and constructed for that purpose.



3. Gas cylinders.

- a. Cylinders manifold together to be used in hospital.



- b. Compressed gas cylinders must be properly stored.
- c. They must be chained or otherwise securely restrained in the upright position to keep them from falling and damaging or knocking off the valve.

RECORDS STORAGE



Slide 1-132

4. Records storage.
 - a. The example shows a typical rolling file storage unit.
 - b. Storage of records such as these pack a maximum amount of combustibles in a comparatively small area and may compromise sprinklers due both to proximity of heads to cabinets and high fuel load.
 - c. Positive aspect may be that they may be slow burning due to tightly packed condition.

Control of Ignition Sources

Slide 1-133

- D. Ignition sources.

SMOKING MATERIALS



Slide 1-134

1. Cigarettes.

Smoking is so common that little thought is given to its hazards, and people are careless.

ELECTRICAL WIRING

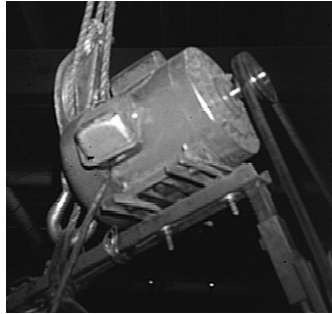


Slide 1-135

2. Wiring.

- a. Shows an old, frayed and repaired extension cord.
- b. All wiring to equipment of any kind must be kept in good condition at all times.

MOTORS

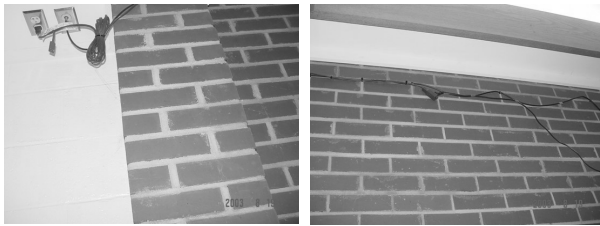


Slide 1-136

3. Motors.

- a. The example shows a relatively clean motor suspended by block and tackle.
- b. Motors overheat when they become dirty and are permitted to accumulate lint, waste or other debris which interfere with motor ventilation.

EXTENSION CORDS



Slide 1-137

4. Extension cords.

- a. The slide shows a classic example of misuse of extension cords.
- b. Extension cords should be used only with portable appliances or fixtures. They should never be used as a substitute for permanent wiring.

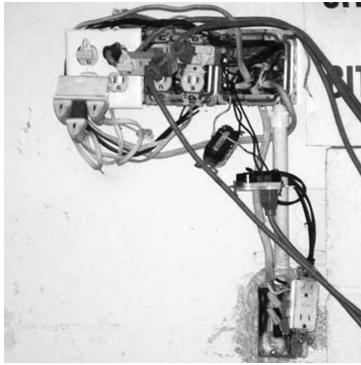
MULTIPLUG ADAPTERS



Slide 1-138

5. Multiple plug adapters.
 - a. The slide shows the ever-more-popular multiple plug adapters.
 - b. Octopus connections permit overloading of circuits, and zip cords overheat and burst into flame.
 - c. Multiple plug adapters are prohibited.

RECEPTACLES



Slide 1-139

6. Duplex outlets.
 - a. Duplex outlets without a cover plate, not in an approved junction box, and incorrect use of extension cords.

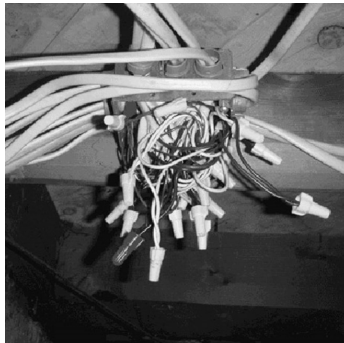
RECEPTACLES (cont'd)



Slide 1-140

- b. Duplex outlets must have covers and proper clearance from combustibles. Those showing burned plates should be checked immediately.

JUNCTION BOX



Slide 1-141

- c. Junction boxes must be properly secured and have an appropriate cover plate per the National Electrical Code (NEC) 70.

TEMPORARY WIRING



Slide 1-142

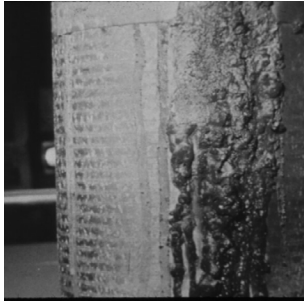
TEMPORARY WIRING (cont'd)



Slide 1-143

7. Temporary wiring.
 - a. Extension cord wiring being used for the lighting in a community theater.
 - b. Extension cords should never be used as a substitute for permanent wiring.
 - c. Temporary wiring is permitted only during construction (remodeling, etc.).

CHIMNEYS/FLUES



Slide 1-144

8. Chimneys.

- a. This example shows the problem of creosote. It has oozed out and run down the outside of the chimney.
- b. Chimneys must be installed properly using proper materials, and be cleaned and inspected regularly.
- c. This is an example of creosote inside a single-wall connector pipe.

SOLID FUEL STOVES

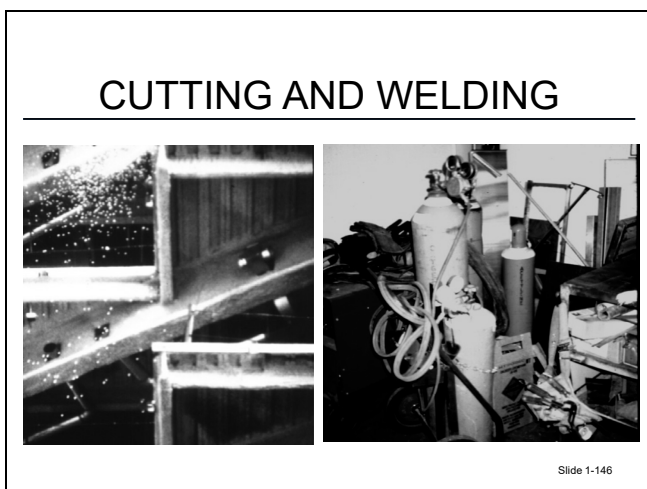


Slide 1-145

9. Solid fuel stoves.

- a. This example appears to be a homemade solid fuel stove made from a barrel.
 - Note the elbows on the connector piping near the roof.
 - These should always rise to the outlet.

- b. Solid fuel stoves must be installed with proper clearances following the manufacturer's instructions. Where none exist or when in doubt, use 36 inches as the distance to combustibles.
- c. Be certain adequate combustion air is provided.
- d. Caution must be taken regarding burns to small children and placing things that are too dry too close to the stove.



E. Control of environment.

1. Welding.

- a. This example shows cylinders for welding on a cart near an electric arc welding unit.
 - Note that the oxygen and acetylene cylinders in the background are not anchored upright.
- b. Welding or cutting must be watched closely.
- c. None should be conducted in flammable atmospheres or around combustible materials.
- d. Must provide a 30-minute fire watch after operations finished for the day.

PAINT BOOTHS



Slide 1-147

2. Paint booth.

- a. This shows a paint finishing room with a number of problems.
- b. Paint booths must be kept clean and in good working order, with filters changed as needed.

WOODWORKING SHOPS



Slide 1-148

3. Wood shops.

- a. This is an example of a rather clean wood shop, but notice the footprints in the dust-covered floor on the left, indicating some problems with the exhaust system.
- b. Wood shops must be kept clean with sawdust collection systems fully in place and properly maintained.

FLAMMABLE RESINS



Slide 1-149

4. Flammable resins.

a. This example shows a part of a cultured marble resin plant.

- Note the 55-gallon flammable resin drum on its side, where the product is being drawn by gravity.

b. Shops using flammable resins, including plants with hazardous production materials (HPM) are extremely dangerous environments and must be supplied with proper ventilation and extinguishing systems.

CUSTODIAL CLOSETS



Slide 1-150

5. Custodial closets.

a. This example shows a relatively clean custodial closet.

- Note the panel door.

- No closer.
- Louvers on door.
- b. Spontaneous combustion (such as from oiled dust mops) must be controlled by hanging them to properly air out.
- c. Custodial closets always have many hazards associated with them.

CHEMICAL STORAGE



Slide 1-151

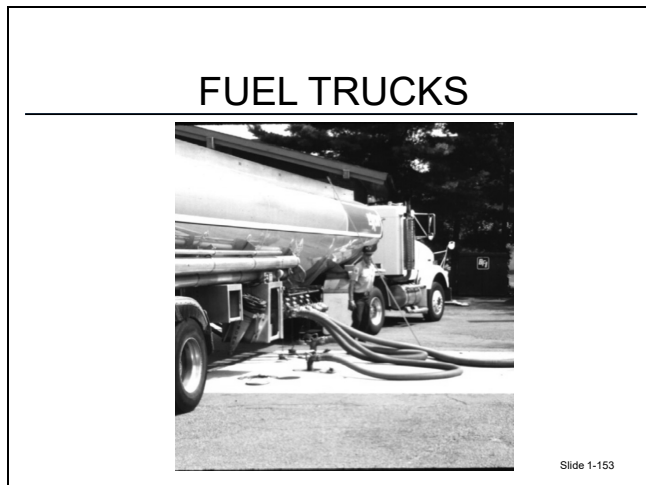
6. Chemical storage.
- a. The example shows chemicals stored in a chemistry lab storage room.
 - b. Caution must be taken when chemicals which are reactive may be stored together.
 - c. A spill or broken bottle could create a fire condition.

FLAMMABLES

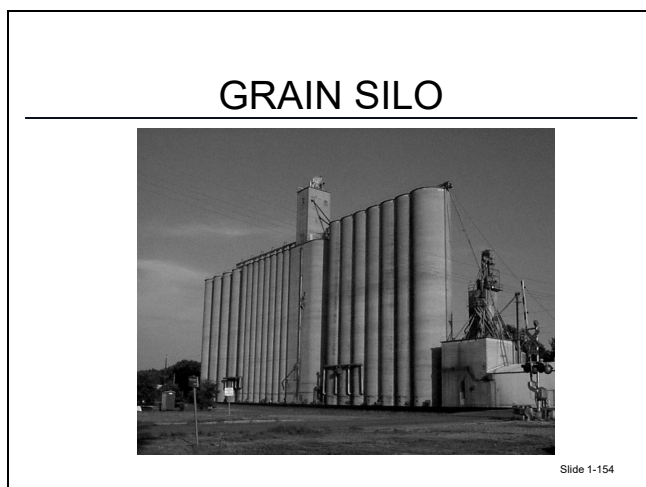


Slide 1-152

7. Flammables.
 - a. Barrels of flammable cleaning solvent in a printing plant; the quantity of flammables far exceeds the allowable quantity.
 - b. Quantities and use of flammables, as well as waste materials and solvents, must be tightly controlled.

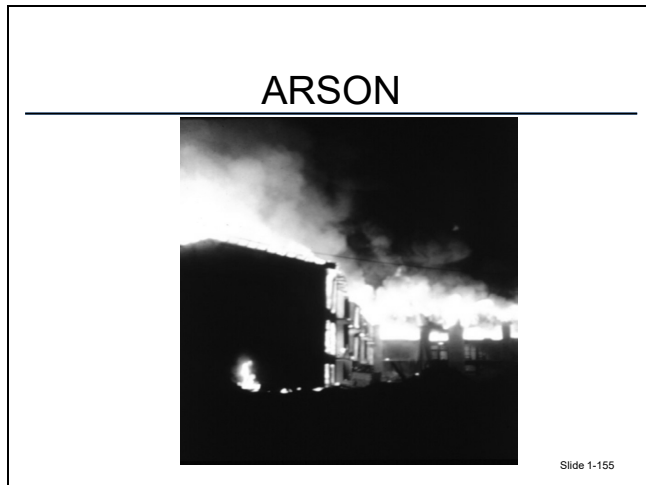


8. Fuel trucks.
 - a. Example of semitrailer truck at service station delivering fuel into underground tanks.
 - b. Transfer of fuels creates severe hazards, and requires grounding and bonding to mitigate static electric buildup.



9. Grain elevators.

- a. Grain elevators are a familiar sight.
- b. Grain elevators create static electric hazards with elevators and chutes, as well as explosive atmospheres due to accumulations of grain dusts.



10. Arson.

Unfortunately, we in prevention cannot control arson. We only hope that, through complete plan reviews and good inspections, the effects of arson may be minimized.

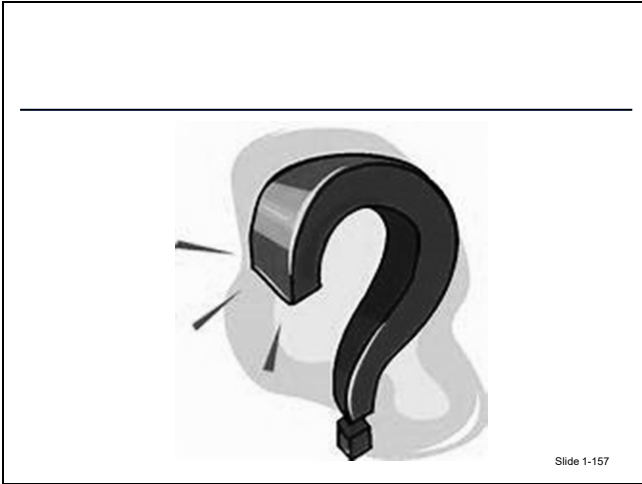
IV. SUMMARY



SUMMARY

- Analyze the general fire safety of a site.
- Analyze the general fire safety of a structure.
- Analyze the general fire safety pertaining to a structure's use.

Slide 1-156



REFERENCES

ICC. (2015). *International fire code*. International Code Council.

NFPA. (2015). *National fire protection association 1, Fire code*.

This page intentionally left blank.

UNIT 2: LIFE SAFETY

TERMINAL OBJECTIVE

The students will be able to:

- 2.1 *Evaluate if an acceptable level of life safety is provided for the occupants of a structure by using their codes.*

ENABLING OBJECTIVES

The students will be able to:

- 2.1 *Identify the fundamental principles of life safety.*
- 2.2 *Determine the occupancy classification for a given structure.*
- 2.3 *Calculate the occupant load for a given structure by using their codes.*
- 2.4 *List the basic components of an exit system.*
- 2.5 *Determine the number of required exits for a given structure.*
- 2.6 *Evaluate the adequacy of the egress system for a given structure.*
- 2.7 *Determine the code requirements for interior finishes.*
- 2.8 *Explain the impact of the fire suppression and detection systems on life safety.*
-

This page intentionally left blank.



UNIT 2: LIFE SAFETY

Slide 2-1

TERMINAL OBJECTIVE

Evaluate if an acceptable level of life safety is provided for the occupants of a structure by using their codes.

Slide 2-2

ENABLING OBJECTIVES

- Identify the fundamental principles of life safety.
- Determine the occupancy classification for a given structure.
- Calculate the occupant load for a given structure by using their codes.
- List the basic components of an exit system.

Slide 2-3

ENABLING OBJECTIVES (cont'd)

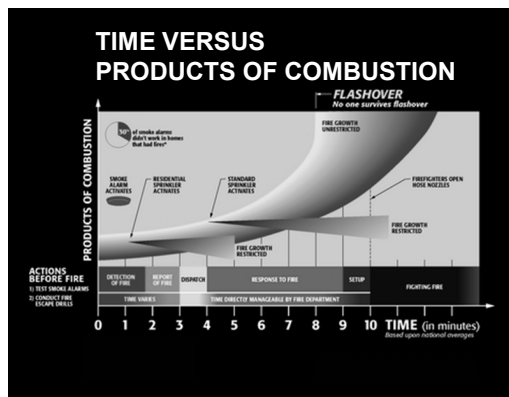
- Determine the number of required exits for a given structure.
- Evaluate the adequacy of the egress system for a given structure.
- Determine the code requirements for interior finishes.
- Explain the impact of the fire suppression and detection systems on life safety.

Slide 2-4

I. LIFE SAFETY FACTORS

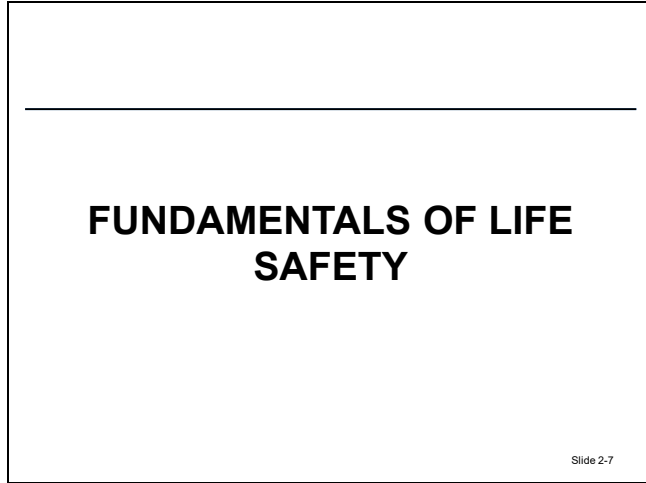
LIFE SAFETY FACTORS

Slide 2-5

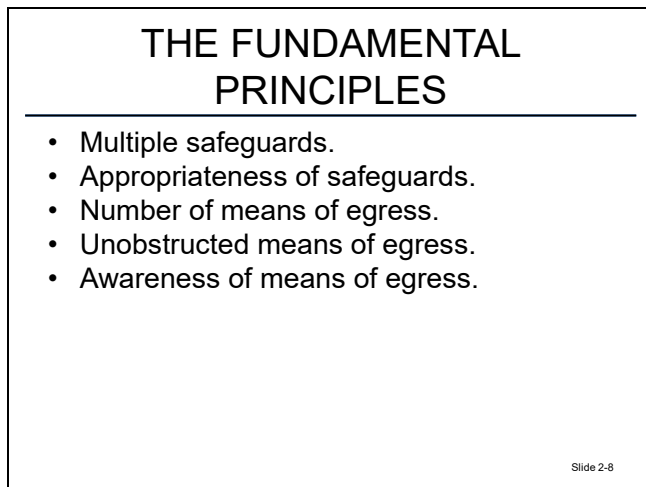


Slide 2-6

II. FUNDAMENTALS OF LIFE SAFETY



Chapter 4 of the National Fire Protection Association (NFPA) 101, *Life Safety Code*®, 2015 edition provides fundamental requirements for life safety. These fundamental requirements provide some basic life safety principles which are the basis of many life safety code requirements.



- Multiple safeguards.
- Appropriateness of safeguards.
- Number of means of egress.
- Unobstructed means of egress.
- Awareness of means of egress.

- A. The design of every building or structure intended for human occupancy shall be such that reliance for safety to life does not depend solely on any single safeguard.
- B. Every building or structure shall be provided with means of egress and other fire and life safety safeguards appropriate to the individual building or structure.
- C. Two means of egress, as a minimum, shall be provided in every building, structure, section or area where size, occupancy and arrangement endanger occupants attempting to use a single means of egress that is blocked by fire or smoke.
- D. In every occupied building or structure, means of egress from all parts of the building shall be maintained free and unobstructed.

- E. Every exit shall be clearly visible, or the route to reach every exit shall be conspicuously indicated and shall be arranged or marked so that the way to a place of safety is indicated.

THE FUNDAMENTAL PRINCIPLES (cont'd)

- Provide adequate lighting.
- Occupant notification.
- Vertical openings.
- System design/installation.
- Maintenance.

Slide 2-9

- F. Where artificial illumination is needed in a building or structure, egress facilities shall be included in the lighting design.
- G. In every building or structure of such size, arrangement or occupancy that a fire itself might not provide adequate warning to occupants, fire alarm systems shall be provided where necessary to warn of the existence of fire.
- H. Every vertical opening between the floors of a building shall be suitably enclosed or protected as necessary, to afford reasonable safety to occupants while using the means of egress.
- I. Fire protection systems, building service equipment, features of protection or safeguard shall be designed, installed and approved in accordance with applicable NFPA standards.
- J. Whenever or wherever any device, equipment, system, condition, arrangement, level of protection, or any other feature is required for compliance, shall thereafter be maintained.

III. OCCUPANCY CLASSIFICATION

OCCUPANCY CLASSIFICATION

Slide 2-10

MIXED OCCUPANCIES

Two methods used to address buildings which contain mixed uses:

- Separated.
- Intermingled.

Slide 2-11

A. Two methods used to address buildings which contain mixed uses:

1. Separated.
2. Intermingled.

SEPARATED

- When possible, individual occupancies are evaluated based on use and are physically separated.
- Tables for requirements.
- International Building Code (IBC) Table 508.4.
- Vertical, horizontal or both as necessary to provide complete separation.

Slide 2-12

- B. When possible, individual occupancies are evaluated based on use and are physically separated.

INTERNATIONAL BUILDING CODE TABLE 508.4

REQUIRED SEPARATION OF OCCUPANCIES (HOURS)																				
OCCUPANCY	A, E		I-1, I-3, I-4		I-2		R ^a		F-2, S-2 ^b , U		B ^a , F-1, M, S-1		H-1		H-2		H-3, H-4		H-5	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	1	2	2	NP	1	2	N	1	1	2	NP	NP	3	4	2	3	2	NP
I-1, I-3, I-4	—	—	N	N	2	NP	1	NP	1	2	1	2	NP	NP	3	NP	2	NP	2	NP
I-2	—	—	—	—	N	N	2	NP	2	NP	2	NP	NP	NP	3	NP	2	NP	2	NP
R ^a	—	—	—	—	—	—	N	1 ^c	2 ^c	1	2	NP	NP	3	NP	2	NP	2	NP	NP
F-2, S-2 ^b , U	—	—	—	—	—	—	—	N	N	1	2	NP	NP	5	4	2	3	2	NP	NP
B ^a , F-1, M, S-1	—	—	—	—	—	—	—	—	N	N	NP	NP	2	3	1	2	1	NP	NP	NP
H-1	—	—	—	—	—	—	—	—	—	N	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP
H-2	—	—	—	—	—	—	—	—	—	—	N	NP	1	NP	1	NP	1	NP	1	NP
H-3, H-4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1 ^d	NP	1	NP	NP
H-5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	NP	NP

S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.
 NS = Buildings not equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.
 N = No separation requirement.
 NP = Not permitted.
 a. See Section 420.
 b. The required separation from areas used only for private or pleasure vehicles shall be reduced by 1 hour but not to less than 1 hour.
 c. See Section 406.3.4.
 d. Separation is not required between occupancies of the same classification.
 e. See Section 422.2 for ambulatory care facilities.

Slide 2-13

REQUIRED SEPARATION OF OCCUPANCIES (HOURS)

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

S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.
 NS = Buildings not equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.
 N = No separation requirement.
 NP = Not permitted.

- a. See Section 420.
 b. The required separation from areas used only for private or pleasure vehicles shall be reduced by 1 hour but not to less than 1 hour.
 c. See Section 406.3.4.
 d. Separation is not required between occupancies of the same classification.
 e. See Section 422.2 for ambulatory care facilities.

INTERMINGLED

Separation is not possible; considered as a single occupancy and built to the higher level of life safety.

Slide 2-14

- C. Separation is not possible; considered as a single occupancy and built to the higher level of life safety.

HAZARD AREAS AND INCIDENTAL SPACES

- Incidental Uses — IBC Table 509 — 2015.
- In some instances, the codes limit the size of the incidental use to 10 percent of the overall floor area.

Slide 2-15

This page intentionally left blank.

ACTIVITY 2.1

Applications of Occupancy Separations

Purpose

Determine the required separation (hours) of individual occupancies, evaluated based on use and physical separation.

Directions

Working individually and using your local codes, determine the fire-rated occupancy separation for the following sprinklered and nonsprinklered occupancies. You can use “no system” (NS) and “automatic system” (AS).

1. Souvenir shop and restaurant with occupant load of 60 people.

2. Vehicle repair shop and parking garage.

3. Museum with a single office.

4. Museum and a lodge (transient) with 30 rooms.

5. Single office and a storage warehouse (general).

ACTIVITY 2.2

Determining Occupancy Classifications

Purpose

Determine occupancy classifications by using local codes, the IBC, and NFPA 101.

Directions

Working individually and using your local codes, determine the occupancy classification for the following:

1. Lawyer's office.

2. Souvenir shop.

3. Restaurant with occupant load of 60 people.

4. Maintenance garage.

5. Parking garage.

6. Hotel (transient) with 30 rooms.

7. Museum.

8. Office building.

Occupancy classification for Benson Building.

1. Retail sales area “B” on first floor.

2. Restaurant seating area (over 300 people) on first floor.

3. Kitchen on first floor.

4. Day care center on second floor (+12 children all over 2 1/2 years of age for less than 24 hours a day).

5. Multipurpose room (over 300 people) on second floor.

6. Third through fifth floors used as offices.

This page intentionally left blank.

IV. OCCUPANT LOAD

OCCUPANT LOAD

The total number of people that are permitted to occupy a building or portion thereof at any one time.

Slide 2-23

The total number of people that are permitted to occupy a building or portion thereof at any one time.

IMPORTANT POINTS

- During activities, please use the dimensions that are given to you by the instructor.
- Make notes of activities involving Benson plans, as they may be very helpful during the Life Safety Application activity on Friday.

Slide 2-24

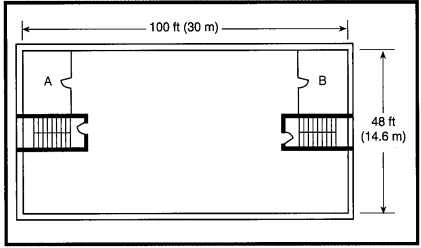
GROSS FLOOR AREA

- The floor area within the inside perimeter of the **exterior walls** of the building.
- No deductions for corridors, stairways, ramps, closets, thickness of interior walls, columns or other features.

Slide 2-25

A. Gross floor area.

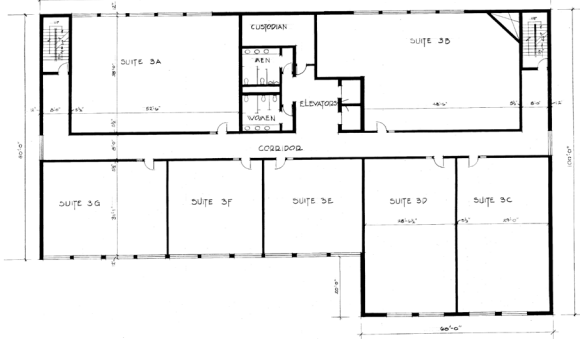
GROSS FLOOR AREA (cont'd)



- $100 \times 48 = 4,800$ gross square feet.

Slide 2-26

1. Example of gross floor area.

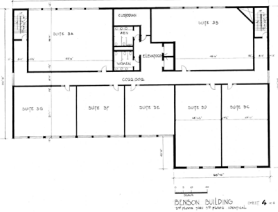


Calculate gross floor area for third through fifth floors.

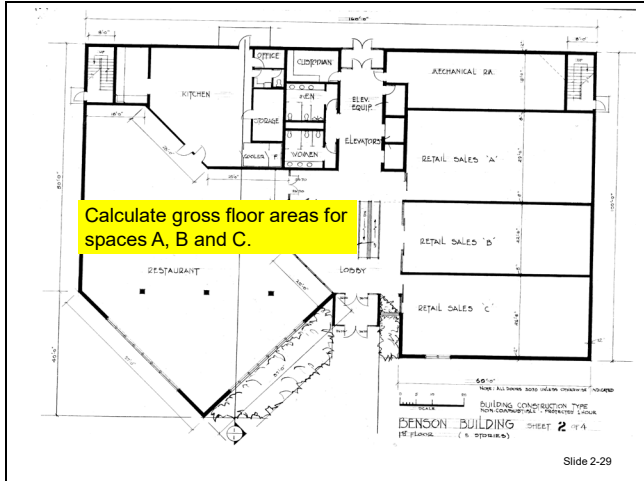
BENSON BUILDING
3RD FLOOR 3000 3RD FLOOR IDENTICAL
SHEET 4 of 4
Slide 2-27

CALCULATION

- $158 \times 78 = 12,324$ feet.
- $58 \times 20 = 1,160$ feet.
- Total gross floor area per floor is 13,484 square feet.
- Third through fifth floors are the same.



Slide 2-28



a. Gross floor area for spaces A, B and C.

CALCULATIONS — GROSS SQUARE FEET

- “A” $58 \times 29.0 = 1,682$ square feet.
- “B” $58 \times 22.5 = 1,305$ square feet.
- “C” $58 \times 26.5 = 1,537$ square feet.

BENSON BUILDING SHEET 2 OF 4
(1st floor) (1:100)

Slide 2-30

b. Calculations — Gross square feet.

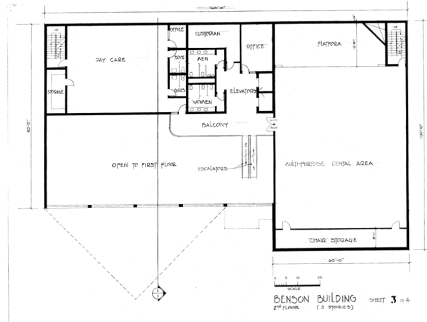
USING THE MULTIPURPOSE ROOM ON THE SECOND FLOOR OF THE BENSON BUILDING

- Gross floor area.
- Net (usable) floor area.

Slide 2-31

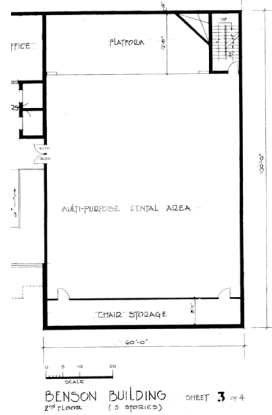
2. Multipurpose room.

NOW LETS CALCULATE THE "GROSS FLOOR AREA" OF THE SECOND FLOOR ASSEMBLY ROOM



Slide 2-32

98 x 58 = 5,684 gross floor area.



Slide 2-33

98 x 58 = 5,684 gross floor area.

NET FLOOR AREA

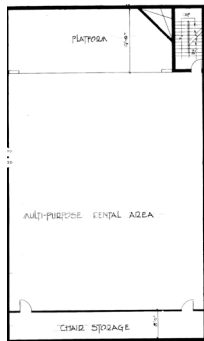
Net floor area is the actual occupied area not including accessory unoccupied areas, such as corridors, stairways, ramps, closets, thickness of walls, columns, toilet rooms, mechanical rooms or similar areas.

Slide 2-34

B. Net floor area.

Now lets calculate the net floor area of the second floor assembly room.

Slide 2-35



Chair storage
8 x 58 = 464

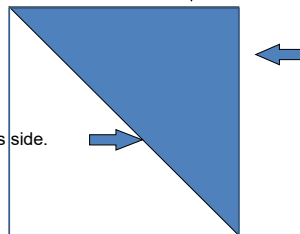
Slide 2-36

1. Chair storage.

Square the area off, and treat it like a square or rectangle.

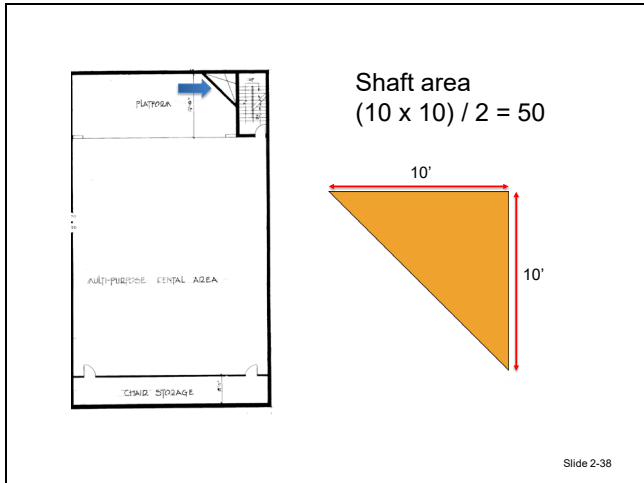
Measure these sides.

Don't measure this side.

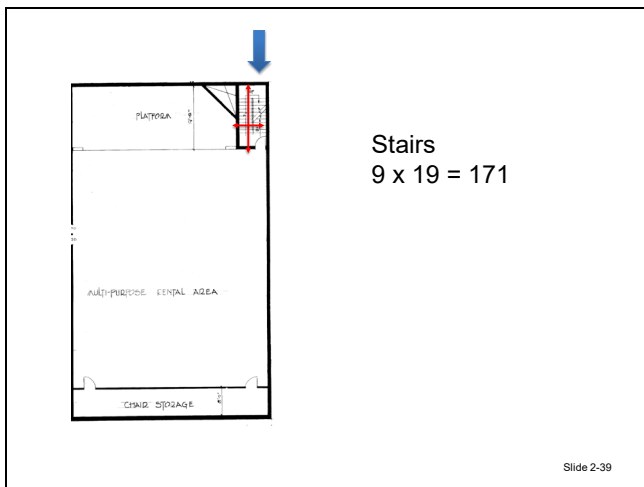


Formula: $\text{Height} \times \text{Base} \div 2 (1/2) =$

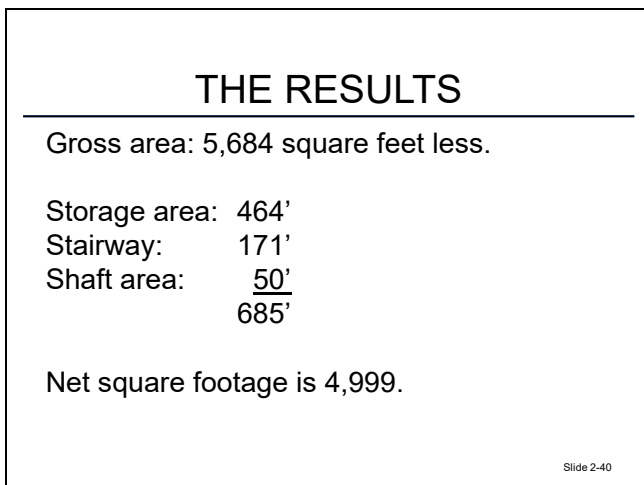
Slide 2-37



2. Shaft area.



3. Stairs.



4. Results.

OCCUPANT LOAD FACTORS

- Reflects the number of people per square foot that can occupy a room, space or building.
- Some are based on gross square footage, others on net square footage.

Slide 2-41

C. Occupant load factors.

1. Reflects the number of people per square foot that can occupy a room, space or building.
2. Some are based on gross square footage, others on net square footage.

EXAMPLES OF LOAD FACTORS

Occupancy	Factor (ft ² per person)*
Assembly — Unconcentrated (tables and chairs)	15 net
Assembly — Concentrated (chairs only — not fixed)	7 net
Offices — Business	100 gross
Classrooms	20 net
Kitchens, commercial	200 gross
Hotels/Dormitories	200 gross
Mercantile — Street floor	60 gross
Mercantile — Above street floor	60 gross

Examples from IBC Table 1004.1.2, 2015 Edition.

Slide 2-42

INCREASE OF OCCUPANT LOAD

- The occupant load permitted in any building, or portion thereof, is permitted to be increased from that number established by the factors.
- Provided that all other requirements of the code are also met based on such modified number.

Slide 2-43

D. Increase of occupant load.

1. The occupant load permitted in any building, or portion thereof, is permitted to be increased from that number established by the factors.
2. Provided that all other requirements of the code are also met based on such modified number.

INCREASE OF OCCUPANT LOAD (cont'd)

- Occupant load may not exceed one occupant per 7 square feet.
- Where required by code official, an approved aisle, seating or fixed equipment diagram shall be submitted and posted.

Slide 2-44

3. Occupant load may not exceed one occupant per 7 square feet.
4. Where required by code official, an approved aisle, seating or fixed equipment diagram shall be submitted and posted.

THE OCCUPANT LOAD MAY BE LIMITED
TO THE AVAILABLE EXIT CAPACITY

- Subject to the approval of the authority having jurisdiction (AHJ).
- Applicable to existing occupancies only!

Slide 2-45

5. The occupant load may be limited to the available exit capacity.
 - a. Subject to the approval of the authority having jurisdiction (AHJ).
 - b. Applicable to existing occupancies only!

This page intentionally left blank.

ACTIVITY 2.3

Calculation of Occupant Loads

Purpose

Calculate the occupant load for each occupancy by using the occupant load factors listed in the building code.

Directions

Working individually, determine the occupant load based on the square feet using the IBC, 2015 edition.

1. One story office building with 5,000 gross square feet.

2. Museum with 100,000 net square feet.

3. Restaurant with 64,000 net square feet.

4. Three story mercantile with 3,000 gross square feet per floor.

5. Warehouse with 12,653 gross square feet.

6. Multistory office building with 15,000 gross square feet per floor.

IV. OCCUPANT LOAD (cont'd)

OCCUPANT LOAD FOR THE SECOND FLOOR ASSEMBLY AREA

- This is a multipurpose room, which means it can be used for both concentrated and less concentrated uses.
- Occupant load must be calculated on the worst case basis or highest possible occupant loading.
- What is the load factor for concentrated use?
- Occupant load of room is 714.

Slide 2-48

E. Occupant load for the second floor assembly area.

1. This is a multipurpose room, which means it can be used for both concentrated and less concentrated uses.
2. Occupant load must be calculated on the worst case basis or highest possible occupant loading.
3. What is the load factor for concentrated use?
4. Occupant load of room is 714.

WHAT ABOUT STANDING SPACE?

- Codes provide for standing space at one person per 3 to 5 square feet.
- **This is to be used for dedicated waiting areas only.**
- This space cannot encroach upon the required clear exit width.
- Occupants at this density are at a jam point!



Slide 2-49

F. Standing space.

1. Codes provide for standing space at one person per 3 to 5 square feet.

2. **This is to be used for dedicated waiting areas only.**
3. This space cannot encroach upon the required clear exit width.
4. Occupants at this density are at a jam point!

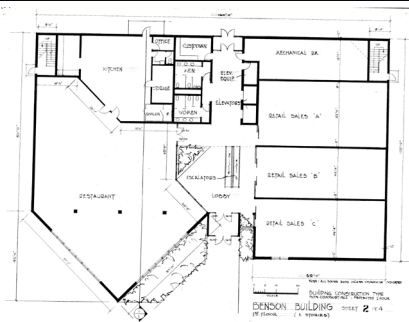
EVER WONDER JUST HOW MUCH SPACE IS 3 TO 5 SQUARE FEET?

Equals about an unfolded newspaper!



Slide 2-50

FLOOR USED FOR MIXED OCCUPANCIES

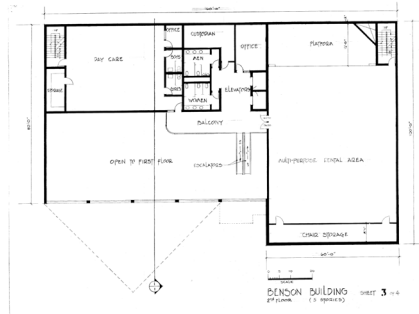


Slide 2-51

G. Floor used for mixed occupancies.

1. Retail sales A, B and C.
2. Restaurant.
3. Kitchen.
4. Mechanical room.

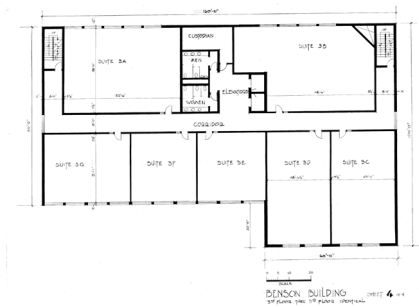
FLOOR USED FOR MIXED OCCUPANCIES (cont'd)



Slide 2-52

5. Multipurpose area.
6. Day care.

FLOOR USED FOR SINGLE OCCUPANCY



Slide 2-53

- H. Floor used for single occupancy.
- Business.

ADDITIONAL CALCULATIONS

- What other areas on the first floor would be calculated?
- Occupant load for retail area A, B and C.
- For the purposes of the Benson building, the “lobby” is part of the means of egress and will not be used for any other purpose.
- Occupant load for third through fifth floors.

Slide 2-54

I. Additional calculations.

Additional areas on first floor, which will be calculated later in this unit are:

1. Restaurant.
2. Kitchen.
3. Mechanical room.

J. Occupant loads for retail (mercantile occupancy) area:

International Building Code (IBC) 2015 edition.

1. Area A: $1,682 \text{ gross square feet} / 60 = 28$.
2. Area B: $1,350 \text{ gross square feet} / 60 = 22$.
3. Area C: $1,537 \text{ gross square feet} / 60 = 26$.
4. Business $13,484 \text{ gross square feet} / 100 = 134.84$ or 134.

V. MEANS OF EGRESS

WHAT IS A MEANS OF EGRESS?

A means of egress is a continuous and unobstructed path of vertical and horizontal egress travel from any occupied portion of a building or structure to a public way.

Slide 2-55

MEANS OF EGRESS

A means of egress consists of three separate and distinct parts:

- Exit access.
- Exit.
- Exit discharge.

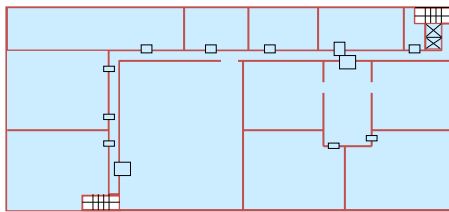


Slide 2-56

- A. A means of egress is a continuous and unobstructed path of vertical and horizontal egress travel from any occupied portion of a building or structure to a public way.

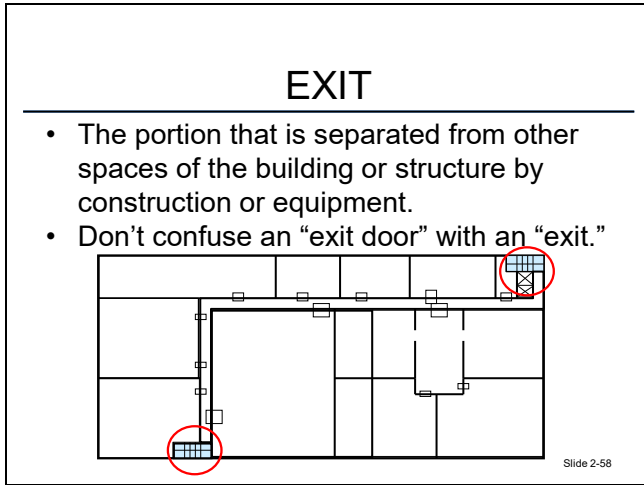
EXIT ACCESS

The portion of the exit path (travel distance) from any point in a building to an exit.

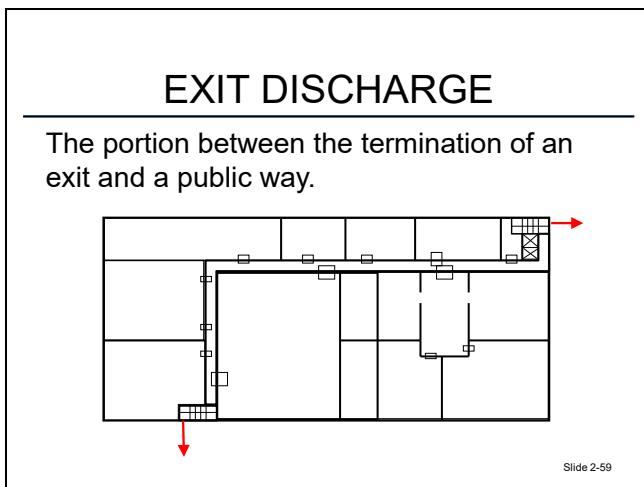


Slide 2-57

1. Exit access.
 - a. This component is essentially unprotected.
 - b. Travel distance is only calculated in exit access.



2. Exit.
 - a. That portion of the means of egress that is separated from other spaces of the building or structure by construction or equipment.
 - b. Essentially, this component is protected. It provides additional protection and safety to exit the building.



3. Exit discharge.
 - a. That portion of the means of egress between the termination of an exit and a public area, known as the public way.

- b. The opening by which an occupant leaves the building or structure for a public area.

PUBLIC WAY

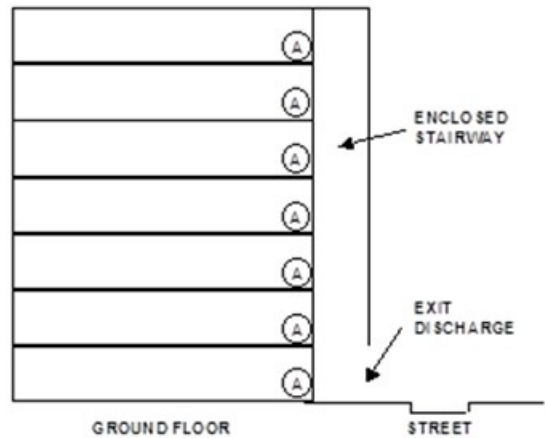
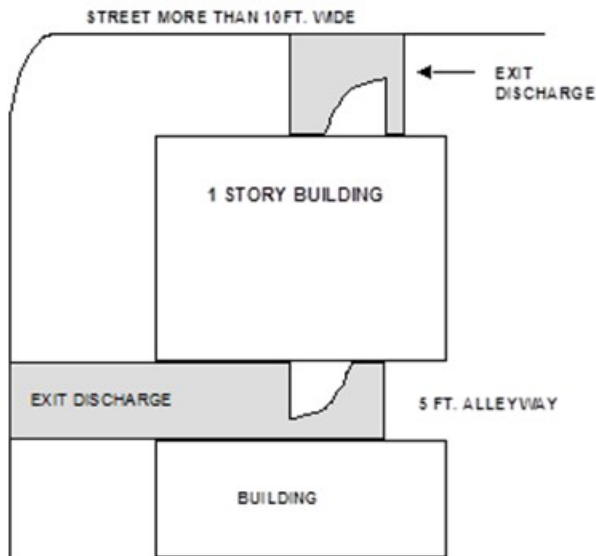
Any street, alley or other similar parcel of land essentially open to the outside air, deeded, dedicated, or otherwise permanently appropriate to the public for public use, and having a clear width and height of not less than 10 feet.



Slide 2-60

4. Public way.

Any street, alley or other similar parcel of land essentially open to the outside air, deeded, dedicated, or otherwise permanently appropriate to the public for public use, and having a clear width and height of not less than 10 feet.

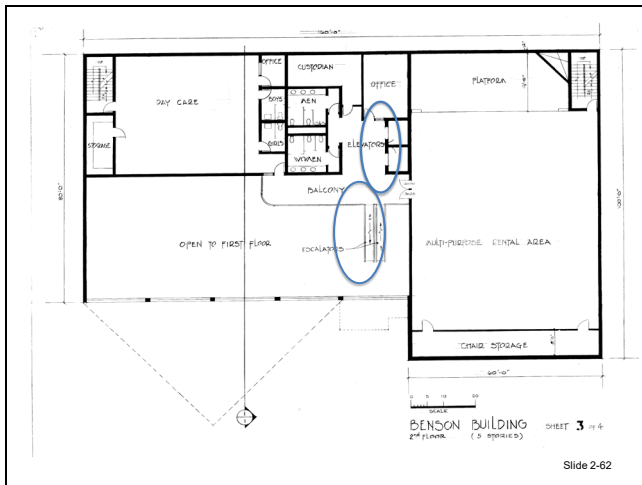


PROHIBITED ELEMENTS

- Escalators.
- Elevators.
 - Exceptions for occupant evacuation — elevators now provided for in the codes.

Slide 2-61

5. Prohibited elements.



Slide 2-62

ELEVATORS

- Phase 1 (recall).
 - Smoke detectors in elevators lobbies.
 - Recall may be connected to general fire alarm by AHJ; if not, they will continue to operate after activation of a general alarm.
 - Recall to primary floor.
 - Recall to alternative floor.



Slide 2-63

ELEVATORS (cont'd)

- Phase 2 (fire service).
 - Key operated service.
- Signage.
 - Elevators not to be used in event of fire.
 - Located at elevator call button.
- ANSI A17.1.



Slide 2-64

CHECKLIST FOR DETERMINING THE MEANS OF EGRESS

- Occupancy classification.
- Occupant load.
- Minimum number of exits.
- Capacity of exits.
- Arrangement of exits (remoteness, intervening rooms, dead-end corridors, common path of travel).



CHECKLIST FOR DETERMINING THE MEANS OF EGRESS (cont'd)

- Travel distance.
- Special considerations (main-exit rule — 50 percent remaining-capacity rule).



NUMBER OF EXITS REQUIRED

- Determined by occupant load.
- Minimum of two, with exceptions.
- If occupant load is 501 to 1,000, minimum of three exits.
- If occupant load is over 1,000, minimum of four exits.

Slide 2-67

B. Number of exits required

1. Minimum of two, but there are special exceptions.
2. Based on occupant load.
 - a. If the occupant load is between 501 and 1,000, at least three exits are required.
 - b. When the occupant load is over 1,000, at least four exits must be provided.

ARRANGEMENT OF EXITS

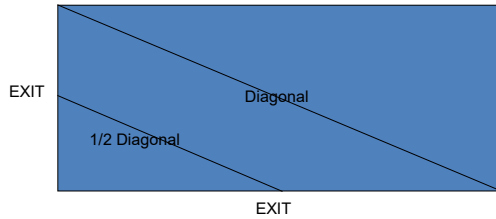
- Intent is to provide exits remote from each other so that if one is blocked by fire or smoke, the other may be used.
- The term "remote as possible or practical" was subjective.
- Codes now require that exits be located at least one-half diagonal of area served apart.

Slide 2-68

C. Arrangement of exits.

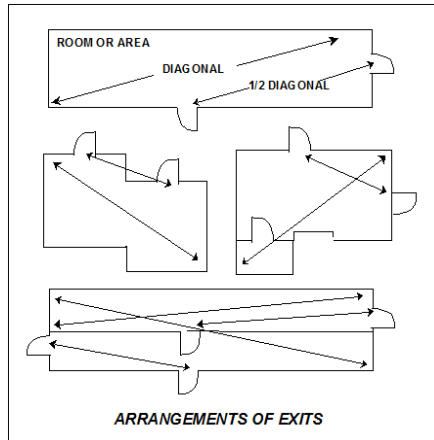
1. Where two exits, exit access doorways, exit access stairways or ramps, or any combination thereof, are required from any portion of the exit access, they shall be placed a distance apart equal to no-less-than one-half of the length of the maximum overall diagonal dimension when building is not equipped with an automatic sprinkler system (IBC 1007.1.1).

ONE-HALF DIAGONAL RULE



Slide 2-69

2. Example of the one-half diagonal rule.

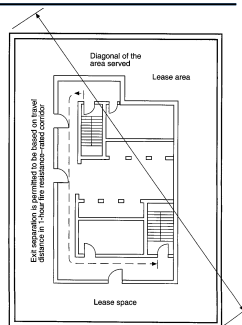


Slide 2-70

3. Examples of arrangements of exits.

EXCEPTIONS

- IBC — measured in one-hour corridor or one-third diagonal with automatic system.
- National Fire Protection Association (NFPA) 101, *Life Safety Code*® — Measured in one-hour corridor or one-third diagonal with automatic system.



Slide 2-71

4. Exceptions.

- a. There are also exceptions for existing buildings that permit existing exit arrangements to continue to be used with approval of the fire code official.

EXCEPTIONS (cont'd)

- Sprinkler and one-hour corridor exceptions **cannot** be combined.
- One-half diagonal rule **does** not apply to existing high-rise in NFPA 101.

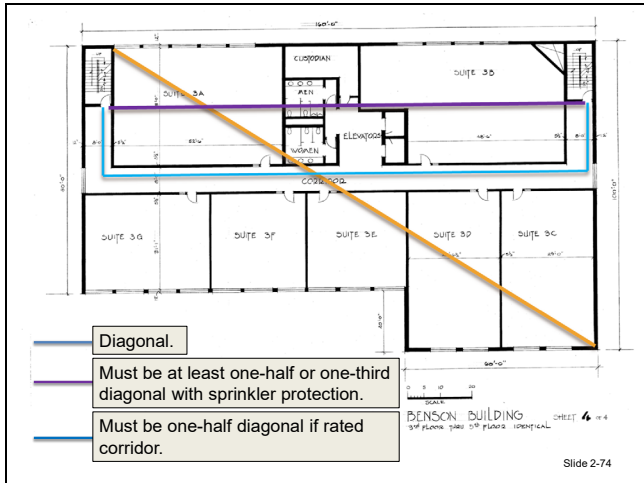
Slide 2-72

BENSON BUILDING
3rd Floor 3000 1st Floor 1000th Floor

Slide 2-73

Are the exits for the floor remote on the third through fifth floors?

- b. (Business occupancy for third to fifth floors.)



c. (Example of diagonal rule for third to fifth floors.)

SPECIAL CONSIDERATIONS

- Assembly occupancies require main exit capable of handling at least 50 percent of the total occupant load (IBC 2012 forward, only if occupant load is over 300).
- Remaining exits must handle the other 50 percent of the occupant load.
- Special exceptions for stadiums and similar facilities.

Slide 2-75

D. Special considerations.

1. Fifty percent for main exit (IBC 1028.2, 2012 edition) (1029.2, 2015 edition).
2. Fifty percent of remaining exits (IBC 1029.3).

EXIT CAPACITY

- Capacity is based upon the occupant load.
- Exit capacity is calculated using the clear width (opening).
- If door opens 180 degrees, then the full width of the door leaf can be considered (only permitted in existing building).
- New door openings must be measured between face of door and door stop with door open 90 degrees.

Slide 2-76

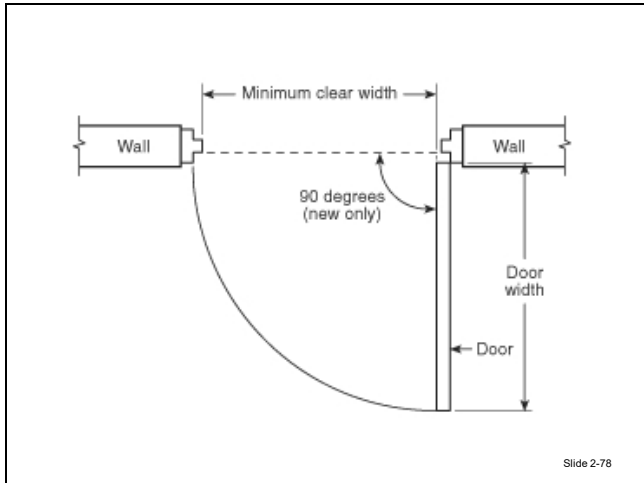
E. Exit capacity.

1. The number of people the egress system can accommodate safely during an emergency.
2. Egress capacity is calculated based upon the available width of egress components (doors, stairs, corridors, walkways, etc.)

EXIT CAPACITY (cont'd)

- When working with plans, take the width of the door leaf and subtract 4 inches to get the clear opening.
- When there are multiple doors in a single opening (i.e., pair of doors), each door must be calculated individually (even if there is a mullion).

Slide 2-77



(Example of minimum clear width.)

CLEAR WIDTH OF OTHER ELEMENTS

- Stairs — width of tread.
- Corridor/Hallway/Aisle.
- Measured in the clear at the narrowest point.
- Handrails are not considered to reduce clear width (maximum projection of 4 1/2 inches on side).

Slide 2-79

F. Clear width of other elements.

CAPACITY FACTORS

Each code sets forth factors to be used for capacity.

- Level travel for most occupancies is 0.2 inches per person.
- For the purposes of capacity, ramps are considered to be level travel.
- Stairway travel for most occupancies is 0.3 inches per person.
- Some occupancies have special factors.

Slide 2-80

G. Capacity factors.

1. 0.2 factor.

IBC 1005.3.2, Other egress components, 2015 edition.

2. 0.3 factor.

IBC 1005.3.1, Stairways, 2015 edition.

MODIFICATIONS

IBC allows for modifications, depending upon the edition, with the following requirements:

- Buildings equipped throughout with an automatic sprinkler system.
- Buildings equipped with an emergency voice/alarm communication system.

Slide 2-81

H. Modifications.

INTERNATIONAL BUILDING CODE MODIFICATIONS

- 2000 to 2006 for NFPA 13, *Standard for the Installation of Sprinkler Systems* or NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies* protection.
 - 0.2 reduced to 0.15 and 0.3 reduced to 0.2.
- 2009 all modifications deleted.

Slide 2-82

I. IBC modifications.

1. Stairways: IBC 1005.3.1 (1), 2015 edition.
2. Other egress components: IBC 1005.3.2 (1), 2015 edition.

INTERNATIONAL BUILDING CODE MODIFICATIONS (cont'd)

- 2012 for NFPA 13, NFPA 13R and emergency voice alarm in other than Group H and I-2 Occupancies.
 - 0.2 reduced to 0.15 and 0.3 reduced to 0.2.

Slide 2-83

EXAMPLES

- Door with clear opening of 36 inches.
 - $36/0.2 = 180$ people.
- Stairway with clear width of 44 inches.
 - $44/0.3 = 147$ people.
 - Capacity of "exit" is 147.
- Stairway with clear width of 48 inches served by door with clear width openings of 32 inches.
 - $32/0.2 = 160$ people, $48/0.3 = 160$ people.
 - Capacity of "exit" is 160 people.

Slide 2-84

3. Examples.

- a. Door with clear opening of 36 inches.
- b. Capacity is 147 people for that one opening due to stair width.
- c. Door with clear width opening of 32 inches swings 90 degrees.
 - Capacity is 160 people.

EXAMPLES (cont'd)

- Occupant load of a building is 350 people.
- Based on occupant load of 350, requires a minimum of two exits.
 - $350 \times 0.2 = 70$ clear inches of level exit width.
 - $350 \times 0.3 = 105$ clear inches of stairway width.

Slide 2-85

4. Total clear width inches required for all egress components based on occupant load.

Multiply occupant load by egress factor 0.2 for level exit width.

ACTIVITY 2.4

Calculation of Means of Egress

Purpose

Evaluate the adequacy of the exit capacity components of an egress system for a given structure.

Directions

Working individually and using your local codes, determine the exit capacity for the following:

1. Door leaf 40 inches wide.

2. One set of double doors, each with a 42 inch wide leaf.

3. Corridor with width of 50 inches.

4. Stairway with clear width of 60 inches.

5. Ramp with clear width of 48 inches.

6. Stairway with clear width of 50 inches, with door leaves of 40 inches.

7. Aisle with clear width of 36 inches.

8. One set of double doors with 48 inch wide leaves separated by a mullion.

V. MEANS OF EGRESS (cont'd)

REMAINING CAPACITY RULE

- Multiple means of egress must be sized so that the loss of any one exit will not reduce the remaining capacity to less than 50 percent of the required capacity.
- Would apply only to new construction and change of occupancy.
- This began in the 2009 edition of the IBC.
- Not retroactive.

Slide 2-89

J. Remaining capacity rule.

1. Multiple means of egress must be sized so that the loss of any one exit will not reduce the remaining capacity to less than 50 percent of the required capacity.
2. Would apply only to new construction and change of occupancy.
3. This began in the 2009 edition of the IBC.
4. Not retroactive.

EVALUATING EXIT CAPACITY

Using the Benson building plans, you will calculate the occupant load of and determine exiting requirements for the restaurant seating area on the first floor.

Slide 2-90

K. Evaluating exit capacity.

Using the Benson Building Plans, you will calculate the occupant load of and determine exiting requirements for the restaurant seating area on the first floor.

[illegible][illegible][illegible]

NET FLOOR AREA

- Gross floor area: 4,771 square feet.
- Less: (2.25 for each column x 3) 6.75.
- Net floor area: 4,764 square feet.

Slide 2-94

CALCULATION OF OCCUPANT LOAD FOR SEATING AREA

- Seating area will be used for tables and chairs.
- Occupant load factor for this type of usage is 15 square feet per person.
- The occupant load for seating area is 317 people.
- If there were booths, that area would be subtracted from the overall gross area.

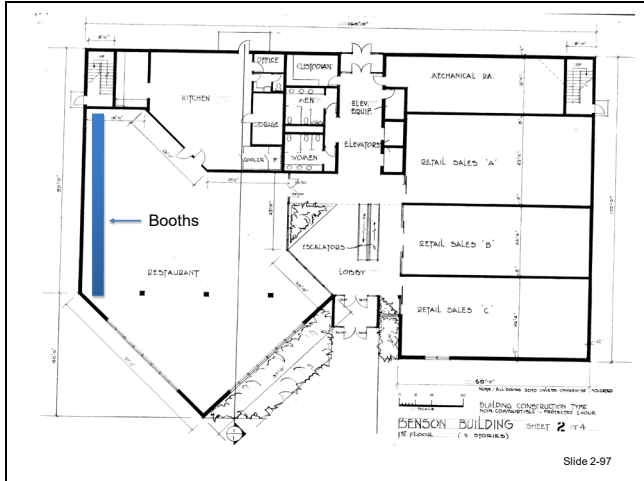
Slide 2-95

1. $4,764 \text{ square feet} / 15 = 317 \text{ people.}$

WHAT IF?



Slide 2-96



2. Placement of booths.

OCCUPANT LOAD CALCULATION WITH BOOTHS

- Nine booths ($4 \times 6 = 24$); ($24 \times 9 = 216$ square feet).
 - Gross floor area: 4,771 square feet.
 - Less: 222.75.
 - Columns: 6.75 square feet.
 - Booths: 216 square feet.
222.75 square feet.
- Net floor area: 4,548 square feet.
 - $4,548/15 = 303$ people (tables and chairs).

Slide 2-98

3. Net floor area.

CAPACITY OF EXITS

Determine the capacity of exits for:

- The restaurant seating area.
- The third through fifth floors.
- The multipurpose room on second floor.

Slide 2-99

L. Evaluating exit systems.

Determine the capacity of exits for:

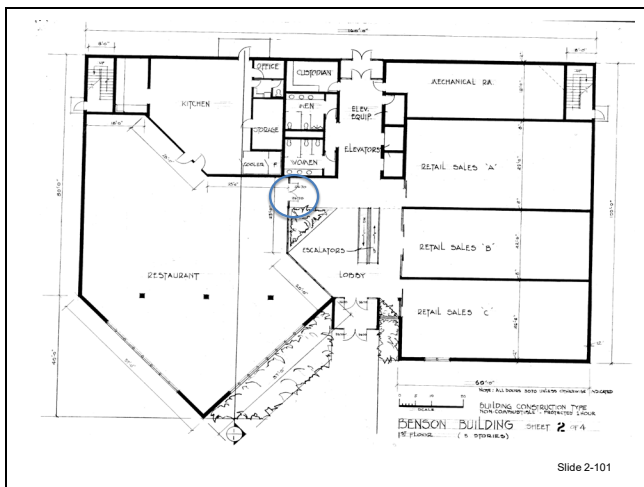
1. The restaurant seating area.
2. The third through fifth floors.
3. The multipurpose room on second floor.

NECESSARY DATA

- Front doors in restaurant are a pair 2 feet 6 inches.
- All other doors at 36 inches.
- Stair width is 44 inches.

Slide 2-100

4. Necessary data.
 - a. Front doors in restaurant are a pair 2 feet 6 inches.
 - b. All other doors at 36 inches.
 - c. Stair width is 44 inches.



Slide 2-101

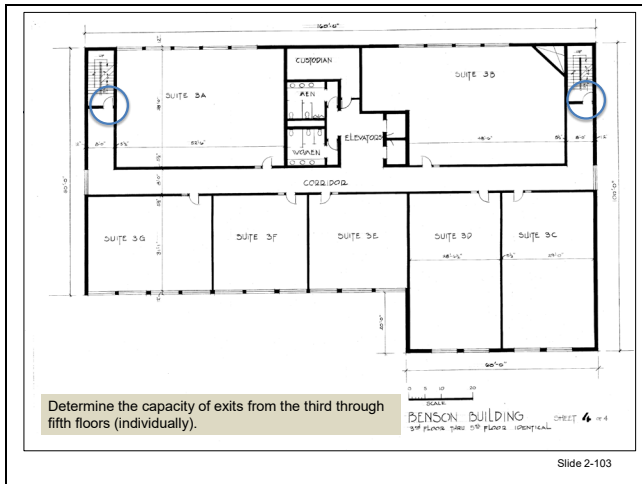
RESTAURANT CAPACITY

- 2 feet 6 inches = 30 inches clear opening for one door x 2 = 60 inches clear opening.
- Door swings 90 degrees (30 - 4 = 26 inches per leaf x 2 = 56 inches of clear width).
- $56/0.2 = 280$ people.

Slide 2-102

5. Restaurant capacity.

- 2 feet 6 inches = 30 inches clear opening for one door x 2 = 60 inches clear opening.
- Door swings 90 degrees (30 - 4 = 26 inches per leaf x 2 = 56 inches of clear width).
- $56/0.2 = 280$ people.

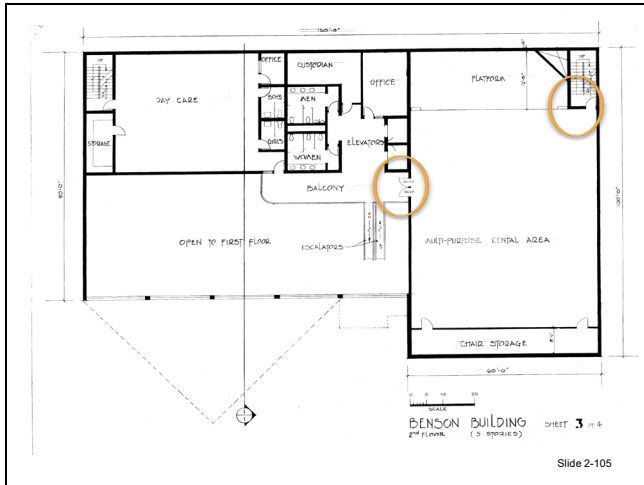


CAPACITY OF THIRD THROUGH FIFTH FLOORS

- Two exit doors of 36 inches clear opening each leaf x 2 = 72 inches total clear opening.
- Each door swings 90 degrees; deduct 4 inches per leaf for total deduction of 8 inches for a total of 64 inches clear width
– $64/0.2 = 320$ people, 160 per door.
- Stairs of $44 \times 2 = 88$ inches; $88/0.3 = 294$ total people for stairs.
- Total capacity of each floor is 294 people.

Slide 2-104

6. Capacity of third to fifth floors.



7. Capacity of multipurpose room.

- Stairway door is 3070.
 - Clear opening of 32 inches.
 - $32/0.2 = 160$.
- Stairway is 44 clear.
 - $44/0.3 = 147$.
- Front doors are each 3 feet.
 - $32 \times 2 = 64$ inches.

- $64/0.2 = 320$.

d. Capacity is 467 ($320 + 147 = 467$).

EGRESS-RELATED HUMAN FACTORS

Physical characteristics of human body.

- Individuals tend to establish “territories.”
- Most adult males measure 21 inches at shoulder.
- Side sway of approximately 1.5 inches.

Slide 2-106

8. Egress-related human factors.

Physical characteristics of human body.

- a. Individuals tend to establish “territories.”
- b. Most adult males measure 21 inches at shoulder.
- c. Side sway of approximately 1.5 inches.

TRAVEL SPEED

Based on actual observation in various studies.

- 250 to 275 feet/minute level.
- 187 feet/minute on stairs.
- 196 feet/minute level for disabled.
- 75 feet/minute stairs for disabled.

Slide 2-107

M. Travel speed.

Based on actual observation in various studies.

1. 250 to 275 feet/minute level.
2. 187 feet/minute on stairs.
3. 196 feet/minute level for disabled.
4. 75 feet/minute stairs for disabled.

REQUIRED SAFE EGRESS TIME

Required Safe Egress Time (RSET) is defined as the time period required for an occupant to travel from his or her initial location to a location of safety.

— NFPA Fire Protection Handbook, 20th Edition,
“Calculation Methods for Egress Prediction,” by Rita F.
Fahy.

Slide 2-108

- N. Definition of Required Safe Egress Time (RSET).

RSET is defined as the time period required for an occupant to travel from his or her initial location to a location of safety (Fahy, 2008).

AVAILABLE SAFE EGRESS TIME

Available Safe Egress Time (ASET) is defined as the time interval between the ignition and the time at which conditions become untenable and occupants are unable to move to a location of safety.

— NFPA Fire Protection Handbook, 12th Edition,
“Calculation Methods for Egress Prediction,” by Rita F.
Fahy.

Slide 2-109

- O. Definition of Available Safe Egress Time (ASET).

ASET is defined as the time interval between the ignition and the time at which conditions become untenable and occupants are unable to move to a location of safety (Fahy, 2008).

REQUIRED SAFE EGRESS TIME FORMULA

$RSET = t_d + t_a + t_o + t_i + t_e$.

- t_d = time from ignition to detection.
- t_a = time from detection to notification of occupants of a fire emergency.
- t_o = time from notification until occupants decide to take action.
- t_i = time from decision to take action until evacuation commences.
- t_e = time from the start of evacuation until it is completed.

Slide 2-110

P. RSET formula.

$RSET = t_d + t_a + t_o + t_i + t_e$.

1. t_d = time from ignition to detection.
2. t_a = time from detection to notification of occupants of a fire emergency.
3. t_o = time from notification until occupants decide to take action.
4. t_i = time from decision to take action until evacuation commences.
5. t_e = time from the start of evacuation until it is completed.

TRAVEL DISTANCE

- The measurement of exit access distance from the most remote point of an occupancy to an exit.
- Measured on the walking surface in the natural path of travel.
- Curves around corners or obstructions with a 1-foot clearance.

Slide 2-111

Q. Travel distance.

1. Travel distance is measured from the most remote point in a building to the entrance of an approved exit, which is essentially the exit access path.

2. Travel in the exit is not counted as a part of the overall travel distance measurement.

TRAVEL DISTANCE (cont'd)

- Ends at the center of the doorway or other point at which the exit begins.
- Codes allow increase in distance with complete sprinkler protection (generally a 50-foot increase).

Slide 2-112

3. Common paths of travel and dead-end distances could both be a part of the overall travel distance. The model codes regulate travel distances based upon the occupancy classification and presence of automatic sprinkler protection.
4. Typically, the presence of automatic sprinklers would permit longer travel distances since the operation of the sprinkler system would control the fire and associated products permitting additional time to exit the area.

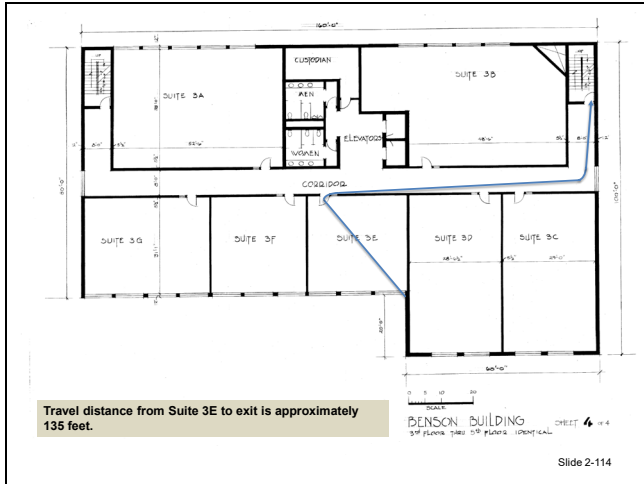
COMMENTARY

- Natural exit path is influenced by the contents and occupancy of the building.
- Furniture, fixtures, machinery or storage can serve to increase the length of travel.
- Good practice to recognize this influence.

Slide 2-113

5. Commentary.
- a. Natural exit path is influenced by the contents and occupancy of the building.

- b. Furniture, fixtures, machinery or storage can serve to increase the length of travel.
- c. Good practice to recognize this influence.



6. Travel distance from Suite 3E.

Approximately 135 feet.

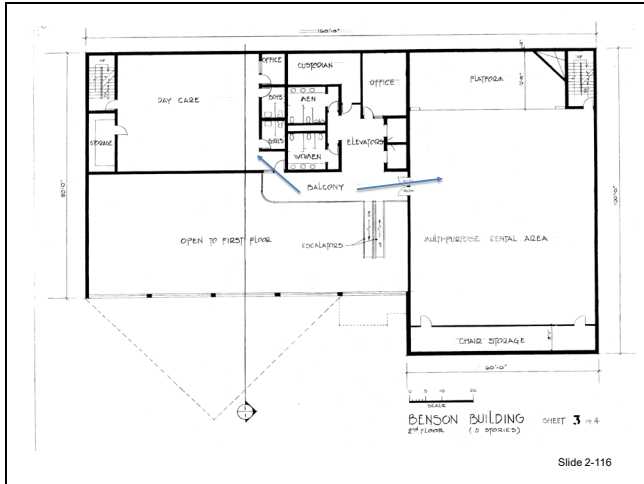
ADJOINING ROOMS/ INTERVENING ROOMS

- Exit travel can be through adjoining rooms.
- Rooms must not be subject to locking.
- Clear path of travel must be maintained.
- Travel through adjoining hazardous areas is not permitted.
- Exit access for rear (secondary) exits in mercantile through store room.

7. Travel through adjoining rooms.

- a. A room may exit through an adjoining room, provided certain conditions are met. The codes differ a little on this point, and the students must be familiar with what their code says.
- b. NFPA 101 states that adjoining rooms must be accessory to the area served and must provide a direct means of egress to an exit.

- c. IBC states, "Egress from a room or space shall not pass through adjoining or intervening rooms or areas, except where such adjoining rooms or areas and the area served are accessory to one or the other, and provide a discernible path of egress travel to an exit."



- d. Example of adjoining rooms.

DOOR SWING

- In direction of exit travel.
- IBC — occupant load 50 or more, or high hazard area.

Slide 2-117

8. Door swing.

- a. There are always a few exceptions, but generally, doors must swing in the direction of exit when the occupant load exceeds 50.

FLOOR LEVEL AT DOORS

- Not vary by more than one-half inch from one side to the other.
- Elevation maintained on both sides for a distance not less than the width of the widest leaf.

Slide 2-118

b. Floor level at doors.

- Not vary by more than one-half inch from one side to the other.
- Elevation maintained on both sides for a distance not less than the width of the widest leaf.

SPECIAL DOORS

All doors in a means of egress must be side hinged, swinging type with limited exceptions:

- Sliding doors in detention and correctional facilities.
- Sliding doors in some horizontal exits.
- Sliding doors and security doors in limited circumstances.

Slide 2-119

9. Special doors.

These are not generally permitted as required exit doors, due to special knowledge or effort required to operate them. Some may be permitted under special exception, such as the special requirements that apply to horizontal sliding doors.

MINIMUM DOOR SIZE

- Really means clear opening.
- Applies to doors in the means of egress.
- Minimum opening for most occupancies is 32 inches.
- Exceptions provided for residential occupancies.
- Exceptions provided for existing occupancies.
- Special requirements for certain occupancies, such as health care.

Slide 2-120

10. Minimum door size.

Door openings in means of egress shall be not less than 32 inches (810 millimeters (mm)) in clear width, except under any of the following conditions:

- In existing buildings, the existing door leaf width shall not be less than 28 inches.
- Residential egress doors shall not be less than 28 inches (710 mm) wide, and bathroom doors and doors serving a room not exceeding 70 square feet (6.5 square meters) shall not be less than 24 inches.

FIRE DOOR ASSEMBLIES

- All fire doors must be equipped with proper hardware and must be labeled with proper rating.
- All doors required to be rated must be self-closing and self-latching.
- Some codes permitted rated doors to be connected to hold open devices connected to the fire alarm system.

Slide 2-121

R. Fire door assemblies.

- Only approved fire-exit hardware shall be used on fire protection-rated door assemblies.

2. Devices that hold the latch in the retracted position shall be prohibited on fire-exit hardware, unless such devices are listed and approved for such a purpose.

QUESTION

- Can listed panic hardware be installed on a fire-rated door assembly?
- Answer: No.
 - Fire doors must be equipped with listed fire-exit hardware (if “panic type” hardware is required or desired).
 - Fire-exit hardware is provided with a panic bar.

Slide 2-122

UNDERWRITERS LABORATORY LABELED FIRE-EXIT HARDWARE



Slide 2-123

3. Fire-exit hardware.

PANIC HARDWARE

- Required in only a limited number of occupancies, such as places of assembly, education or hazardous.
- May be installed as an option on any door (except a fire door which would require “fire-exit hardware”).

Slide 2-124

4. Panic hardware.
 - a. Door assemblies that have a fire-resistive rating shall be equipped only with listed fire-exit (panic) hardware when required to be equipped with the same.
 - b. Doors that do not have a fire-resistive rating can be equipped with listed exit (panic) hardware when required to be equipped with the same.

SPECIAL LOCKING DEVICES

- Delay locking hardware.
- Opening delayed for 15 to 30 seconds after panic bar depressed.
- Permitted only in certain occupancies.
- Require complete sprinkler and/or detection systems.
- Audible alarm at door.
- Open upon activation of fire alarm.
- Open upon loss of building power.
- Requires instructional signage at door.

Slide 2-125

5. Special locking devices.
 - a. The delay electronics of the delayed egress locking system shall:
 - Deactivate upon actuation of the automatic sprinkler system or automatic fire detection system, allowing immediate, free egress.
 - Deactivate upon loss of power controlling the lock or lock mechanism, allowing immediate, free egress.
 - Deactivate at the fire command center and other approved locations.
 - b. Irreversible release action with panic hardware which releases in 15 seconds when pressed. This must also sound a local alarm.
 - c. Once the delay electronics have been deactivated, rearming the delay electronics shall be by manual means only.
 - d. Proper signage is required, but time release may vary between codes.

LOCKING DEVICES ON EXIT DOORS

- All doors in means of egress must be arranged to be readily opened from the egress side whenever the building is occupied.
- Locks, if provided, shall not require the use of a key, tool, special knowledge or effort for operation from the inside of the building.

Slide 2-126

6. Locking devices on exit doors.

- a. All doors in means of egress must be arranged to be readily opened from the egress side whenever the building is occupied.
- b. Locks, if provided, shall not require the use of a key, tool, special knowledge or effort for operation from the inside of the building.

EXCEPTIONS

- Detention and correctional occupancies.
- Limited areas in health care occupancies.
- Main entrance/exit door in business and mercantile occupancies.
 - Signage must be provided noting the door must remain open when building is occupied.

Slide 2-127

7. Exceptions.

- a. Detention and correctional occupancies.
- b. Limited areas in health care occupancies.
- c. Main entrance/exit door in business and mercantile occupancies.
 - Signage must be provided noting the door must remain open when building is occupied.

**BUILDING IS CONSIDERED OPEN WHEN ANY
OF THE FOLLOWING CONDITIONS EXIST**

- It is open for general occupancy.
- It is open to the public.
- It is occupied by more than 10 people.

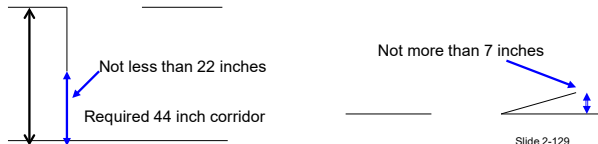
Slide 2-128

d. Building considered open if:

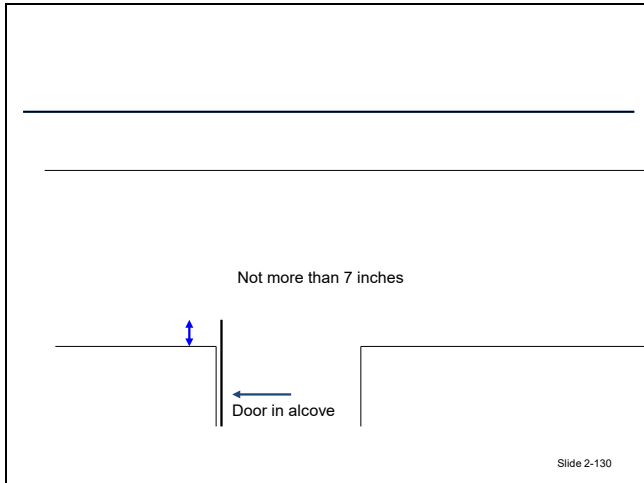
- It is open for general occupancy.
- It is open to the public.
- It is occupied by more than 10 people.

PROJECTIONS

- Doors swinging into corridors, hallways, stairways may not obstruct more than half the required width of the exit path.
- Doors which swing fully open must not project more than 7 inches from the wall.



Slide 2-129



8. Projections.

- a. Because corridors are the “way out” and are expected to be safe, they also are expected to be free of obstructions, including projections.
- b. Doors may not swing into corridors more than one-half the required width, nor more than seven inches when fully opened against the wall.

DEAD-END CORRIDORS

- Exit travel should be arranged to avoid “dead-end corridors.”
- Dead-end corridors are those spaces which could be mistaken for exit travel.
- A person traveling into this space could believe that it leads to an exit.

Slide 2-131

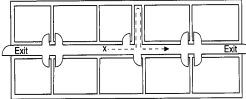
9. Dead-end corridors.

- a. Exit travel should be arranged to avoid “dead-end corridors.”
- b. Dead end corridors are those spaces which could be mistaken for exit travel.

- c. A person traveling into this space could believe that it leads to an exit.

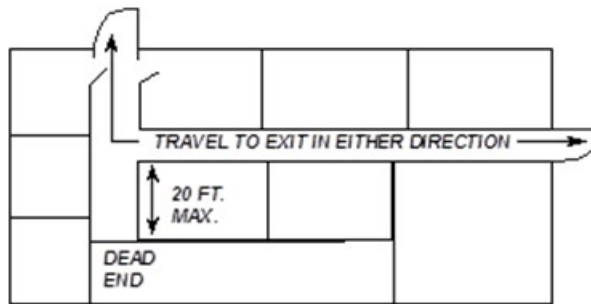
DEAD-END CORRIDORS (cont'd)

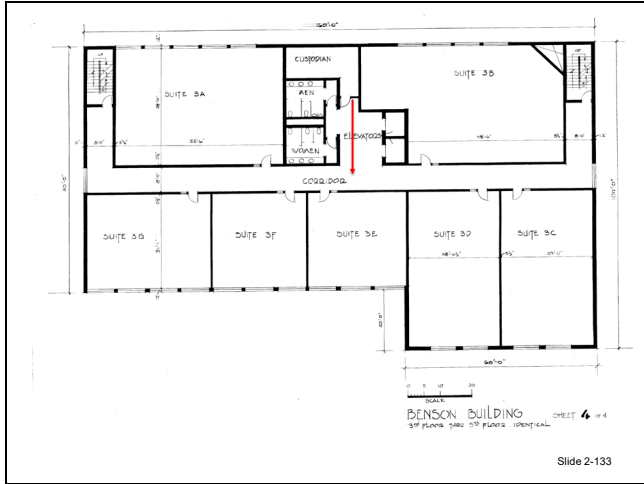
- Codes generally limit the distance of dead-end corridors to a maximum of 20 feet.
- Greater distances may be permitted by some codes and in existing buildings.
- Exceptions in IBC and NFPA 101 by occupancy.



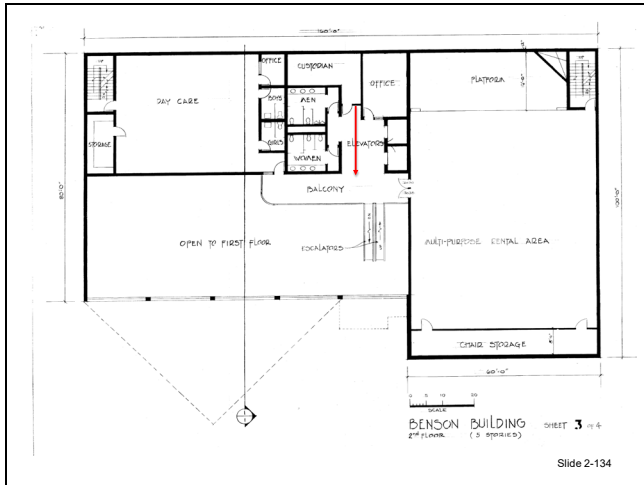
Slide 2-132

- d. Codes generally limit the distance of dead-end corridors to a maximum of 20 feet.
- e. Greater distances may be permitted by some codes and in existing buildings.
- f. Exceptions in both IBC and NFPA 101 by occupancy.





g. Example of dead end on third floor.



h. Example of dead end on second floor.

COMMON PATH OF TRAVEL

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

Slide 2-135

10. Common path of travel.

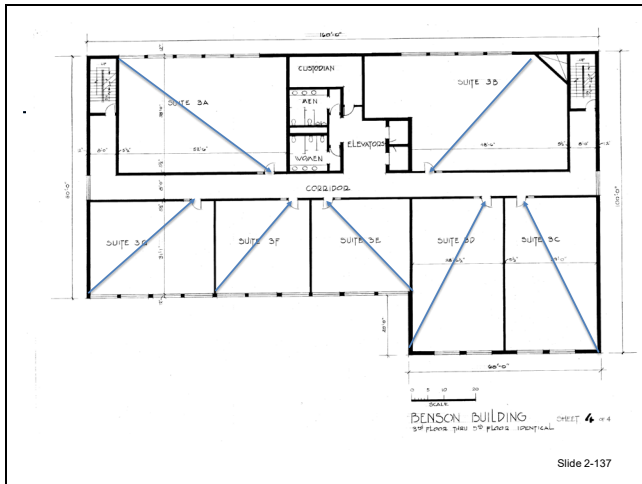
- a. Common path of travel represents the distance from the most remote starting point in any location to a point where there is a choice of two separate exits

COMMON PATH OF TRAVEL (cont'd)

- In most instances, the common path of travel is part of the total permitted travel distance.
- In some occupancies, separate common path distance may be specified (health care suites as an example).
- In some residential occupancies, the common path of travel may be permitted to start at the door to the living unit.

Slide 2-136

- b. Codes regulate common path of travel in the same manner as the requirements for travel distance, and vary upon the nature of the occupancy and presence of automatic sprinkler protection.



Slide 2-137

- c. Example of common path of travel from suites on third floor.

VI. EVALUATING THE MEANS OF EGRESS

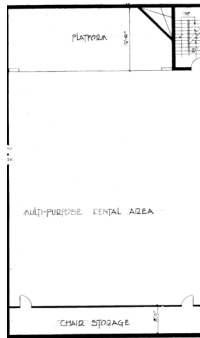
EVALUATING THE MEANS OF EGRESS

- Evaluate the means of egress from both: the restaurant seating area and the second floor multipurpose room.
- Use the “check list.”

Slide 2-138

OCCUPANCY CLASSIFICATION

Place of assembly.



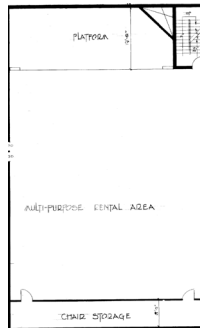
Slide 2-139

A. Multipurpose room.

1. Place of assembly.

OCCUPANT LOAD

- Multipurpose.
- Both concentrated and less concentrated use.
- Load factor of seven.
- Occupant load of 714.



Slide 2-140

2. Occupant load.
 - a. Both concentrated and less concentrated use.
 - b. Load factor of seven.
 - c. Occupant load of 714.

MINIMUM NUMBER OF EXITS

- Minimum number of three.
- Occupant load 501 to 1,000 requires no less than three.

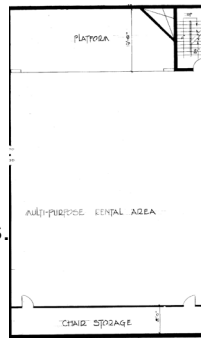


Slide 2-141

3. Minimum number of exits.
 - a. Minimum number of three.
 - b. Occupant load is 714.
 - c. Occupant load 501 to 1,000 requires no less than three.

CAPACITY

- Stairway door is 3070 with clear opening of 32 inches: $32/0.2 = 160$.
- Stairway is 44 clear: $44/0.3 = 147$.
- Front door each leaf is 3,070: $32 \times 2 = 64$ inches.
 $64/0.2 = 320$.
- Capacity: $320 + 147 = 467$.



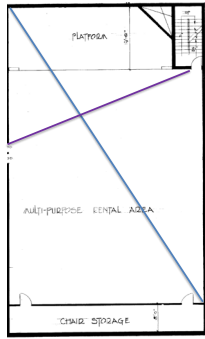
Slide 2-142

4. Capacity.

- a. Stairway door is 3070 with a clear opening of 32 inches: $32/0.2 = 160$.
- b. Stairway is 44 clear: $44/0.3 = 147$.
- c. Front door each leaf is 3070:
 - $32 \times 2 = 64$ inches.
 - $64/0.2 = 320$.
- d. Capacity: $320 + 147 = 467$.

ARRANGEMENT

- The one-half diagonal rule.
- Diagonal is 108 feet.
- One half is 54 feet.
- One third is 36 feet (with an automatic sprinkler system).

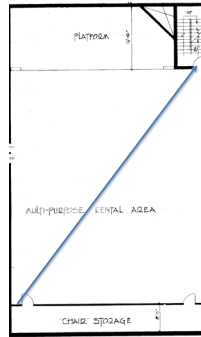


Slide 2-143

5. Arrangement.
 - a. Codes use the term “separation distance.”
 - b. The one-half diagonal rule without an automatic sprinkler system.
 - c. Diagonal is 108 feet.
 - d. One- half is 54 feet.
 - e. One-third is 36 feet (with an automatic sprinkler system).

TRAVEL DISTANCE

- What is maximum allowed?
- Measured in natural path of travel.
- From most remote point to "exit."

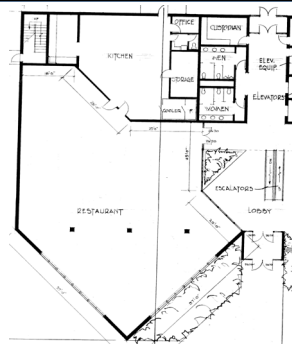


Slide 2-144

6. Travel distance.
 - a. What is maximum allowed?
 - b. Measured in natural path of travel.
 - c. From most remote point to "exit."
 - d. Approximately 81 feet.

OCCUPANCY CLASSIFICATION

Place of assembly.

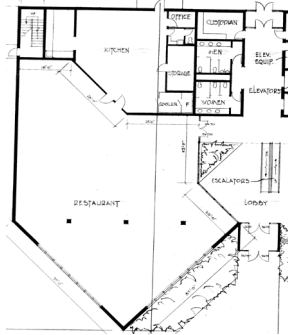


Slide 2-145

- B. Place of public assembly.

OCCUPANT LOAD

- Seating area with tables and chairs.
- Less concentrated use.
- Load factor of 15.
- Occupant load of 317.

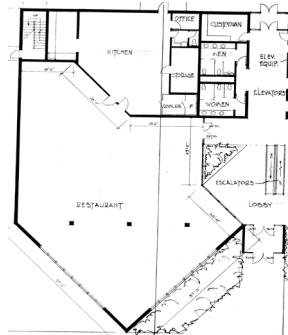


Slide 2-146

1. Occupant load.
 - a. Seating area with tables and chairs.
 - b. Less concentrated use.
 - c. Occupant load factor of 15 net.
 - d. Occupant load of 317.

MINIMUM NUMBER OF EXITS

- Minimum required is two based on occupant load.
- Occupant load 500 or less, not less than two.

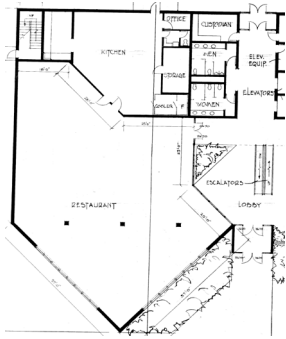


Slide 2-147

2. Minimum number of exits.
 - a. Minimum required is two based on occupant load of 315.
 - b. Occupant load 500 or less, not less than two.

CAPACITY

- Front doors are 2 feet 6 inches (30 inches).
- Clear opening for each door leaf is 26 inches; $26 \times 2 = 52$ inches.
- Capacity of front doors $52/0.2 = 260$.



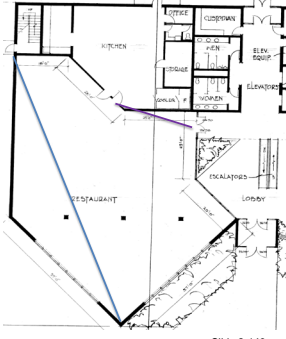
Slide 2-148

3. Capacity.

- Front doors are 2 feet 6 inches (30 inches).
- Clear opening for each door leaf is 26 inches: $26 \times 2 = 52$ inches.
- Capacity of front doors $52/0.2 = 260$.

ARRANGEMENT

- The one-half diagonal rule.
- Diagonal is 105 feet.
- One-half is 52.5 feet.
- One-third is 35 feet.



Slide 2-149

4. Arrangement.

- The one-half diagonal rule.
- Diagonal is 105 feet.
- One-half is 52.5 feet.
- One-third is 35 feet (with an automatic sprinkler system).

ARRANGEMENT (cont'd)

- Kitchen?
 - Egress shall not pass through kitchens.
 - Kitchen must have its own exit and is not calculated in the total capacity of a floor.
 - Minimum clear opening: $32/0.2 = 160$.

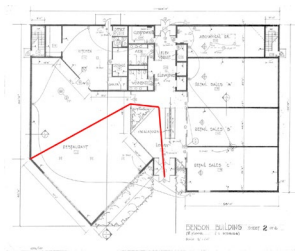
Slide 2-150

e. Kitchen?

- Egress shall not pass through kitchens.
- Kitchen must have its own exit and is not calculated in the total capacity of a floor.
- Minimum clear width: $32/0.2 = 160$ (for kitchen only).

TRAVEL DISTANCE

- What is maximum allowed?
- Measured in natural path of travel.
- From most remote point to "exit."



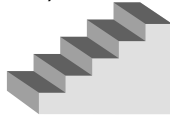
Slide 2-151

5. Travel distance.

- a. What is maximum allowed?
- b. Measured in natural path of travel.
- c. From most remote point to "exit."
- d. Approximately 128 feet.

STAIRWAYS

- Minimum clear width is 44 inches (exception for occupant load less than 50 to 36 inches).
- If occupant load is equal to or greater than 2,000, minimum width is 56 inches (NFPA 101 — new stairs).



Slide 2-152

C. Stairways.

1. Minimum clear width is 44 inches (exception for occupant load less than 50 to 36 inches).
2. If occupant load is equal to or greater than 2,000, minimum width is 56 inches (NFPA 101 — new stairs).

STAIRWAYS (cont'd)

- Maximum height of riser is 7 inches.
- Minimum height of riser is 4 inches.
- Minimum tread depth is 11 inches.

Slide 2-153

3. Maximum height of riser is 7 inches.
4. Minimum height of riser is 4 inches.
5. Minimum tread depth is 11 inches.

HANDRAILS

- Must be provided with handrails on both sides.
- Handrails with 30 inches on all portions of stairway.
- Handrails must be between 34 and 38 inches above the tread surface.
- Handrails that are part of a guardrail, not more than 42 inches above the tread surface.

Slide 2-154

D. Handrails.

1. Must be provided with handrails on both sides.
2. Handrails with 30 inches on all portions of stairway.
3. Handrails must be between 34 and 38 inches above the tread surface.
4. Handrails that are part of a guardrail (NFPA 101), not more than 42 inches above the tread surface.

HANDRAILS (cont'd)

- Handrails must have circular cross section of at least 1 1/4 inches and not more than 2 inches.
- Handrails must be continuously graspable along the entire length.
- Distance from handrails to adjoining surface (wall) will vary depending upon the code and edition. Minimum distance may vary from 1 1/2 inches to 2 1/4 inches from wall.

Slide 2-155

5. Handrails must have circular cross section of at least 1 1/4 inches and not more than 2 inches.
6. Handrails must be continuously graspable along the entire length.

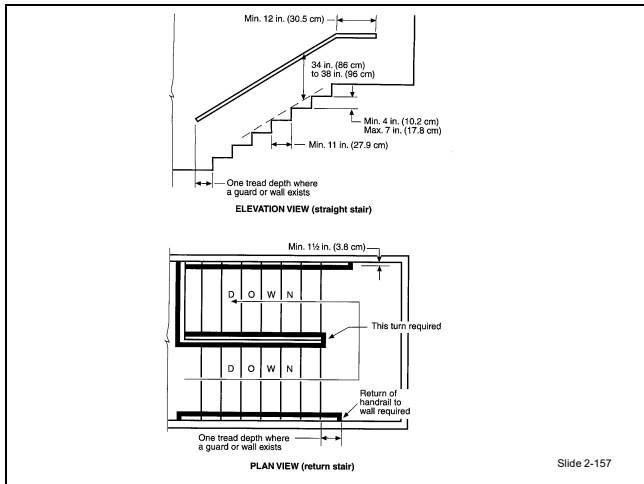
7. Distance from handrails to adjoining surface (wall) will vary depending upon the code and edition. Minimum distance may vary from 1 1/2 inches to 2 1/4 inches from wall.

HANDRAILS (cont'd)

- Americans with Disabilities Act (ADA) requires:
 - Handrail gripping surface shall be 1 1/4- to 1 1/2-inches in diameter (32 to 38 mm).
 - Clear space between handrails and wall shall be 1 1/2 inches (38 mm).

Slide 2-156

8. Americans with Disabilities Act (ADA) requires:
- Handrail gripping surface shall be 1 1/4- to 1 1/2-inches in diameter.
 - Clear space between handrails and wall shall be 1 1/2 inches.



Slide 2-157

INTERMEDIATE HANDRAILS

- Space between handrail and top of floor or walking surface must be protected.
- Intermediate rails or an ornamental pattern with openings should be designed so that a 4-inch sphere cannot pass through.

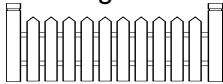
Slide 2-158

E. Intermediate handrails.

1. Space between handrail and top of floor or walking surface must be protected.
2. Intermediate rails or an ornamental pattern with openings should be designed so that a 4-inch sphere cannot pass through.

GUARDRAILS

- The sides of unenclosed floor and roof openings, open and glazed sides of landings and ramps, balconies and porches 30 inches or more above the floor must be protected.
- Top of guardrail must be at least 42 inches high.
- Intermediate railings are also required.



Slide

F. Guardrails.

1. The sides of unenclosed floor and roof openings, open and glazed sides of landings and ramps, balconies and porches 30 inches or more above the floor must be protected.
2. Top of guardrail must be at least 42 inches high.
3. Intermediate railings are also required.

RAMPS

- Walking surfaces must be stable, firm and slip-resistant.
- Maximum slope of ramp is 1 foot rise per 12 feet.
- Same handrail and guard requirements as stairs.
- Ramps with steeper slopes were permitted in past but are being replaced in order to comply with the ADA.



Slide 2-160

G. Ramps.

1. Walking surfaces must be stable, firm and slip-resistant.
2. Maximum slope of ramp is 1 foot rise per 12 feet.
3. Same handrail and guard requirements as stairs.
4. Ramps with steeper slopes were permitted in past but are being replaced in order to comply with the ADA.

RAMPS (cont'd)

- ADA requires:
 - The minimum clear width of a ramp shall be 36 inches.
 - The landing shall be at least as wide as the ramp run leading to it.
 - The landing length shall be a minimum of 60 inches in clear.
 - A minimum 4-inch curb required at open sides.

Slide 2-161

5. ADA requires:
 - a. The minimum clear width of a ramp shall be 36 inches.
 - b. The landing shall be at least as wide as the ramp run leading to it.
 - c. The landing length shall be a minimum of 60 inches in clear.

ENCLOSURE OF VERTICAL SHAFTS

- Applies to **all** vertical shafts — stairs, elevator, mechanical.
- If serve or connect four or more stories, enclosure must be two hours.
- If serve or connect three or less stories, enclosure must be one hour.
- IBC requires enclosure to not be less than the floor rating.

Slide 2-162

H. Enclosure of vertical shafts.

1. Applies to **all** vertical shafts — stairs, elevator, mechanical.
2. If serve or connect four or more stories, enclosure must be two hours.
3. If serve or connect three or less stories, enclosure must be one hour.
4. IBC requires enclosure to not be less than the floor rating.

ENCLOSURE OF VERTICAL SHAFTS (cont'd)

- All door openings in stairways must be protected with self-closing, self-latching, fire-rated door assemblies.

Slide 2-163

5. All door openings in stairways must be protected with self-closing, self-latching, fire-rated door assemblies.

SIGNAGE IN STAIRWAYS IF SERVE THREE OR MORE STORIES

- Signage inside stairway at each landing, visible when door is both open and closed.
- Indicate floor level.
- Terminus of top and bottom of stair.
- Floor level of and direction to exit discharge.
- Level of exit discharge.
- Identify the stair.
- Access to roof (access required if four or more stories).

Slide 2-164

I. Signage in stairways.

1. Signage inside stairway at each landing, visible when door is both open and closed.
2. Indicate floor level.
3. Terminus of top and bottom of stair.
4. Floor level of and direction to exit discharge.
5. Level of exit discharge.
6. Identify the stair.
7. Access to roof (access required if four or more stories).

DISCHARGE OF STAIRWAYS

- Directly to the outside.
- Exit passageway.
- Extension of stairway enclosure with same rating and restrictions.
- Lobbies of certain sizes.
- Fifty percent may discharge across level of exit discharge with automatic sprinkler protection.

Slide 2-165

J. Discharge of stairways.

1. Directly to the outside.
2. Exit passageway.
3. Extension of stairway enclosure with same rating and restrictions.
4. Lobbies of certain sizes.
5. Fifty percent may discharge across level of exit discharge with automatic sprinkler protection.

OPENINGS INTO STAIRWAYS

- Limited to normally occupied spaces.
- No pipes, conduit or ductwork unless serving the stairway enclosure.
- Storage areas may be enclosed under stairway space, but must be properly separated and cannot be accessed from the inside of the stairway enclosure.
- Same requirements would apply to an “exit passageway.”

Slide 2-166

K. Openings into stairways.

1. Limited to normally occupied spaces.
2. No pipes, conduit or ductwork unless serving the stairway enclosure.
3. Storage areas may be enclosed under stairway space, but must be properly separated and cannot be accessed from the inside of the stairway enclosure.
4. Same requirements would apply to an “exit passageway.”

SMOKE PROOF ENCLOSURES

- Required interior exit stairway serving floors more than 75 feet above the lowest level of fire department vehicle access shall be a smoke proof enclosure.
- Stair enclosure designed so that the movement into the smoke proof enclosure is limited of products of combustion produced by a fire occurring in any part of the building.

Slide 2-167

L. Smoke proof enclosures.

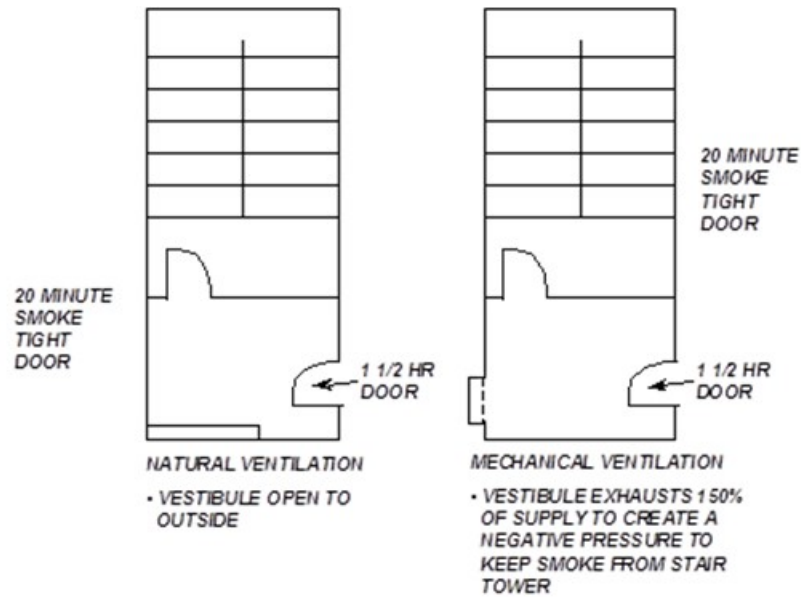
1. Required interior exit stairway serving floors more than 75 feet above the lowest level of fire department vehicle access shall be a smoke proof enclosure.
2. Stair enclosure designed so that the movement into the smoke proof enclosure is limited of products of combustion produced by a fire occurring in any part of the building.

SMOKE PROOF ENCLOSURES (cont'd)

- May be internal or external.
- May be pressurized or ventilated — natural or mechanical.

Slide 2-168

3. May be internal or external.
4. May be pressurized or ventilated — natural or mechanical.



ATRIUMS

- Opening connecting two or more floors.
- Separation of one hour.
- Exception — Up to three floors may be open to the atrium.
- Smoke control for atrium and any areas open to atrium (IBC has exception for atriums connecting only two stories).
- Sprinkler protection for entire building.

Slide 2-169

M. Atriums.

1. Opening connecting two or more floors.
2. Separation of one hour.
3. Exception — Up to three floors may be open to the atrium.
4. Smoke control for atrium and any areas open to atrium (IBC has exception for atriums connecting only two stories).
5. Sprinkler protection for entire building.

- [illegible]

[illegible]

- [illegible]

N. Exit marking.

1. Exits must be marked by an approved sign, readily visible from any direction of exit access.
2. Access to exits shall be marked, readily visible in all cases where the exit or the way to the reach it is not readily apparent to the occupant.

EXIT MARKING (cont'd)

- Sign placement shall be such that no point in the exit access is more than 100 feet from the nearest visible sign.
- Be aware of listing of signs relative to spacing.
- Sign color shall be distinctive and contrast with adjoining surfaces.

Slide 2-173

3. Sign placement shall be such that no point in the exit access is more than 100 feet from the nearest visible sign.
4. Be aware of listing of signs relative to spacing.
5. Sign color shall be distinctive and contrast with adjoining surfaces.

LOW LEVEL SIGNS

- All codes set forth requirements on how to install exit signs near the floor level.
- Required in “special amusement” buildings and now in R-1.



Slide 2-174

O. Low level signs.

1. All codes set forth requirements on how to install exit signs near the floor level.
2. Required in “special amusement” buildings and now in R-1.

MEANS OF EGRESS ILLUMINATION

- Signs and means of egress illuminated when building is occupied.
- Includes the exit discharge.
- Emergency illumination required in certain occupancies.
- Illumination of exit signs may be internal or external, unless specifically required to be internal.



Slide 2-175

P. Means of egress illumination.

1. Signs and means of egress illuminated when building is occupied.
2. Includes the exit discharge.
3. Emergency illumination required in certain occupancies.
4. Illumination of exit signs may be internal or external, unless specifically required to be internal.

IMPEDIMENTS TO EGRESS

- No device or alarm installed to restrict improper use of means of egress shall be designed and installed so that it cannot, even in the case of failure, impede or otherwise prevent emergency use of such means of egress.
- Exceptions maybe provided in individual occupancy chapters.

Slide 2-176

Q. Impediments to egress.

1. No device or alarm installed to restrict improper use of means of egress shall be designed and installed so that it cannot, even in the case of failure, impede or otherwise prevent emergency use of such means of egress.
2. Exceptions maybe provided in individual occupancy chapters.



RELIABILITY

- Maintained continuously free of **all** obstructions or impediments to full instant use.
- No furnishings, decorations or other objects shall obstruct exits, access to them, egress from them, or visibility.

A photograph of a bathroom stall with a glass door. An 'EXIT' sign is mounted above the door. The stall is clean and unobstructed. The slide is labeled 'Slide 2-178' in the bottom right corner.

R. Reliability.

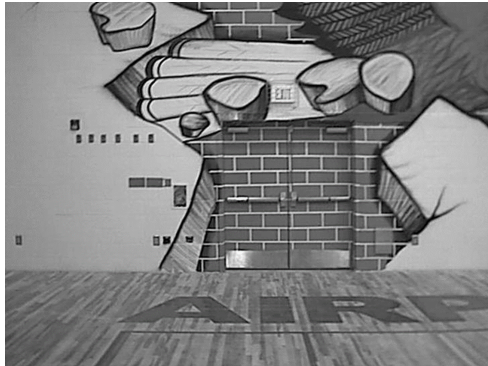
1. Maintained continuously free of **all** obstructions or impediments to full instant use.
2. No furnishings, decorations or other objects shall obstruct exits, access to them, egress from them, or visibility.

RELIABILITY (cont'd)

- Mirrors shall not be placed on exit doors.
- Mirrors shall not be installed in or adjacent to any exit in such a manner as to confuse the direction of egress.

Slide 2-179

3. Mirrors shall not be placed on exit doors.
4. Mirrors shall not be installed in or adjacent to any exit in such as manner as to confuse the direction of egress.



Slide 2-180

VII. INTERIOR FINISHES

INTERIOR FINISHES

- Interior wall and ceiling finish means the exposed interior surfaces of buildings, including, but not limited to, fixed or movable walls and partitions, columns and ceilings.
- Tested in accordance to American Society for Testing and Materials (ASTM) E84 (Steiner Tunnel).

Slide 2-181

A. Interior finish.

1. Interior wall and ceiling finish means the exposed interior surfaces of buildings, including, but not limited to, fixed or movable walls and partitions, columns, and ceilings
2. Tested in accordance to American Society for Testing and Materials (ASTM) E84 (Steiner Tunnel).

STEINER TUNNEL TEST

Materials are exposed to gas jets in a 25-foot horizontal furnace.



Slide 2-182

3. View of Steiner Tunnel test.

CLASSES OF INTERIOR FINISHES

- Class A: = Flame spread index 0 to 25; smoke developed index 0 to 450.
- Class B: = Flame spread index 26 to 75; smoke developed index 0 to 450.
- Class C: = Flame spread index 76 to 200; smoke developed index 0 to 450.
- All classes, the maximum smoke developed is 450.

Slide 2-183

B. Classes of interior finishes.

CLASSES OF INTERIOR FINISHES (cont'd)

- Interior finish requirements:
 - Use group.
 - Location in building.
 - Sprinkler protection.

Slide 2-184

Interior finish requirements.

1. Use group.
2. Location in building.
3. Sprinkler protection.

SPECIAL CONDITIONS

- Class of interior and floor finishes can be reduced one class with automatic sprinkler protection.
- Use of plastics is limited to incidental trim.
- Tufted or looped materials (carpet) must meet 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*, or Class A with automatic sprinkler protection.

Slide 2-185

C. Special conditions.

1. Class of interior and floor finishes can be reduced one class with automatic sprinkler protection.
2. Use of plastics is limited to incidental trim.
3. Tufted or looped materials (carpet) must meet 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*, or Class A with automatic sprinkler protection.
4. IBC 803.1.4, Acceptance criteria for textile and expanded vinyl wall or ceiling coverings tested to ASTM E84 or UL723.

INTERIOR FLOOR FINISH

- Means the exposed floor surfaces of buildings including coverings that might be applied over a normal finished floor or stair, including risers.
- Tested accordance to NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source* (critical radiant flux test).
- Floor finish was not included in International Fire Code (IFC) until 2012.

Slide 2-186

D. Interior floor finish.

1. Means the exposed floor surfaces of buildings including coverings that might be applied over a normal finished floor or stair, including risers.
2. Tested accordance to NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source* (critical radiant flux test).
3. Floor finish was not included in International Fire Code (IFC) until 2012.

CLASSES OF FLOOR FINISH

- Class I: Minimum critical radiant flux of 0.45 width/square centimeter (cm).
- Class II: Minimum critical radiant flux of 0.22 width/square cm.
- No smoke developed rating.
- No correlation between ASTM E84 and NFPA 235, critical radiant flux test.

Slide 2-187

E. Classes of floor finish.

1. Class I: Minimum critical radiant flux of 0.45 width/square centimeter (cm).
2. Class II: Minimum critical radiant flux of 0.22 width/square cm.
3. No smoke developed rating.
4. No correlation between ASTM E84 and NFPA 253, critical radiant flux test.

ALL CARPETING IS SUBJECTED TO THE "PILL TEST"

Test simulates the ability of the carpet to resist cigarette ignition.

Slide 2-188

F. "Pill Test."

Test simulates the ability of the carpet to resist cigarette ignition.

PILL TEST

- Nine-by-9 inch sample.
- Eight inches in diameter; hole in metal plate is centered over sample.
- Pill (methanamine) is placed in center of hole and ignited.
- Fails if the fire burns to the edge of the metal plate.

Slide 2-189

1. Nine-by-9 inch sample.
2. Eight inches in diameter; hole in metal plate is centered over sample.
3. Pill (methanamine) is placed in center of hole and ignited.
4. Fails if the fire burns to the edge of the metal plate.

VIII. EMERGENCY PROCEDURES

EMERGENCY PROCEDURES

- Need for written plans.
- Need for training.
- Exercises or drills.
- Documentation.



Slide 2-190

- A. Emergency procedures.
1. Need for written plans.

- a. Fire evacuation plans.
- b. Fire safety plans.
2. Need for training.
 - a. Where fire safety and evacuation plans are required, employees shall be trained in fire emergency procedures based on plans prepared.
 - b. Records of training shall be maintained.
3. Exercises or drills.

Drills shall be held at unexpected times and under varying conditions to simulate the unusual conditions that occur in the case of fire.

4. Documentation.

Records shall be maintained of required emergency evacuation drills.

EMERGENCY EVACUATION DRILLS

- Conducted as specified.
- Where appropriate action of the AHJ.
- Drills shall be designed in cooperation with local authorities.
- Frequency as required.
- Suitable procedures to ensure that all people subject to the drill participate.

Slide 2-191

B. Emergency evacuation drills.

1. Conducted as specified.
 - a. IFC Table 405.2, Fire and Evacuation Drill Frequency and Participation.
 - b. NFPA 1, 10.5.2 Drill Frequency.
 - c. LSC 101 required by Chapters 11 through 43 or the AHJ.
2. Where appropriate action of the AHJ.
3. Drills shall be designed in cooperation with local authorities.

4. Frequency as required.
5. Suitable procedures to ensure that all persons subject to the drill participate.

DRILL CRITERIA

- Emphasis shall be placed on orderly evacuation rather than on speed.
- Drills be held at expected and unexpected times.
- Varying conditions to simulate the unusual conditions that can occur in an actual emergency.
- Written records must be kept.

Slide 2-192

C. Drill criteria.

1. Emphasis shall be placed on orderly evacuation rather than on speed.
2. Drills be held at expected and unexpected times.
3. Varying conditions to simulate the unusual conditions that can occur in an actual emergency.
4. Written records must be kept.

EMERGENCY PLAN

- Where required by fire codes.
- Required by AHJ.
- Submitted to AHJ for review.
- Reviewed and updated as required by the AHJ.

Slide 2-193

D. Emergency plan.

1. Where required by provisions of fire codes.

2. Where required by action of the AHJ.
3. Submitted to AHJ for review.
4. Reviewed and updated as required by the AHJ.

PLANS SHALL INCLUDE:

- Procedures for reporting of emergencies.
- Occupant and staff response.
- Evacuation procedures.
- Appropriate use of elevators.
- Design and conduct of fire drills.
- Type and coverage of fire protection systems.
- Other items required by AHJ.

Slide 2-194

E. Plans shall include:

1. Procedures for reporting of emergencies.
2. Occupant and staff response.
3. Evacuation procedures.
4. Appropriate use of elevators.
5. Design and conduct of fire drills.
6. Type and coverage of fire protection systems.
7. Other items required by AHJ.

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

Slide 2-195

- F. Occupational Safety and Health Administration (OSHA) evacuation plans and procedures.

CROWD MANAGER

- Requirement in assembly occupancies.
- <https://crowdmanagers.com/training/>.
- This two-hour online course was written by fire safety code experts in accordance with NFPA 1, *Fire Code*, as well as the IFC.

Slide 2-196

- G. Crowd manager.

LIFE SAFETY ASSESSMENT PROJECT

- On Friday, you will be working on an **individual** activity.
- You may use your codes, ordinances, notes and Student Manual (SM).

Slide 2-200



Slide 2-201

REFERENCES

- Fahy, R. (2008). Calculation methods for egress prediction. *Fire protection handbook*. NFPA.
- ICC. (2012). *International building code*. International Code Council, Inc.
- ICC. (2015). *International building code*. International Code Council, Inc.
- ICC. (2015). *International fire code*. International Code Council, Inc.
- NFPA. (2015). *National Fire Protection Association 101, Life safety code*[®].

This page intentionally left blank.

UNIT 3: FIRE AND CODES: THEIR RELATIONSHIP

TERMINAL OBJECTIVE

The students will be able to:

- 3.1 *Explain the significance of methods of fire travel, building construction types and systems, and occupancy classes.*

ENABLING OBJECTIVES

The students will be able to:

- 3.1 *Explain methods of fire travel.*
 - 3.2 *Explain the methods of heat energy transfer.*
 - 3.3 *Explain the characteristics of the different building systems.*
 - 3.4 *Recognize the effects of fire on building construction materials.*
 - 3.5 *Differentiate among the types of construction and identify the protection associated with each.*
 - 3.6 *Explain the factors used to establish the occupancy classes.*
 - 3.7 *Differentiate among "code," "standard," "recommended practices," and "guides."*
 - 3.8 *Explain the characteristics that impact occupant behavior during a fire (age, mobility, knowledge of the building, etc.).*
-

This page intentionally left blank.



UNIT 3: FIRE AND CODES: THEIR RELATIONSHIP

Slide 3-1

TERMINAL OBJECTIVE

Explain the significance of methods of fire travel, building construction types and systems, and occupancy classes.

Slide 3-2

ENABLING OBJECTIVES

- Explain methods of fire travel.
- Explain the methods of heat energy transfer.
- Explain the characteristics of the different building systems.
- Recognize the effects of fire on building construction materials.
- Differentiate among the types of construction and identify the protection associated with each.

Slide 3-3

ENABLING OBJECTIVES (cont'd)

- Explain the factors used to establish the occupancy classes.
- Differentiate among “code,” “standard,” “recommended practices,” and “guides.”
- Explain the characteristics that impact occupant behavior during a fire (age, mobility, knowledge of the building, etc.).

Slide 3-4

I. FIRE GROWTH AND DEVELOPMENT

What is fire?



Slide 3-5

A. Definition of fire.

1. Fire is the chemical decomposition of matter.
2. Combustion is an exothermic, self-sustaining reaction involving a solid-, liquid- and/or gas-phase fuel.
 - a. Combustion does not have to involve fire.
 - b. Primary focus of this unit is fire, not combustion.

DVD PRESENTATION

“FIRE: CONCEPTS AND BEHAVIOR”



Slide 3-6

FUEL — COMBUSTIBLE MATERIAL

- Material may have to be heated before it will ignite or support flame.
- Burning will continue until:
 - Fuel is removed or consumed.
 - Heat is removed.
 - Oxygen is consumed.
 - Chemical chain reaction is interrupted.

Slide 3-7

3. Fuel — combustible material.

- a. The combustible material may have to be heated before it will ignite or support fire.
- b. Burning will continue until:
 - Fuel is removed.
 - Heat is removed.
 - Oxygen is consumed.
 - Chemical reaction is interrupted.

4. Heat.
 - a. Both fuel and oxygen molecules must be activated before they can interact chemically to produce heat.
 - b. This can be by other molecules from a nearby flame or spark, or by the general temperature of the fuel.

WHAT IS IGNITION TEMPERATURE?

Minimum temperature to which a substance must be heated for it to ignite under specific test conditions.

Slide 3-8

- B. Minimum temperature to which a substance must be heated for it to ignite under specific test conditions.

PILOTED IGNITION

Combustion by heat with the assistance of a spark, an external flame, or glowing ember.

Slide 3-9

1. Piloted ignition is combustion by heat with the assistance of a spark, an external flame, or glowing ember.

AUTOIGNITION

Combustion by heat without the assistance of a spark or a flame.

Slide 3-10

2. Autoignition is combustion by heat without the assistance of a spark or a flame.

C. Object of involvement.

1. For most combustibles, the flame reaction occurs in the gas or vapor phase.
2. Influenced by:
 - a. Rate of air flow (oxidant).
 - b. Rate of heating.
 - c. Size and shape of the solid or liquid.

AREA OF ORIGIN

Fire growth hazard is based upon the combustion characteristics within the room.

Slide 3-11

D. Area of origin.

1. Fire growth hazard is based on the combustion characteristics within the room.

**FACTORS WHICH INFLUENCE THE
LIKELIHOOD OF FULL INVOLVEMENT**

- Fuel load (type of materials and their distribution).
- Interior finish.
- Air supply; includes ventilation.
- Size, shape and construction.

Slide 3-12

2. Factors which influence the likelihood of full involvement.
 - a. Fuel load (type of materials and their distribution).
 - b. Interior finish.
 - c. Air supply.
 - d. Size, shape and construction.

FIRE DEVELOPMENT

- Not a consistent progression from ignition to full involvement.
- Risk of full involvement is dependent on the ability of the flame to reach the ceiling.

Slide 3-13

3. Fire development is:
 - a. Not a consistent progression from ignition to full involvement.

- b. Risk of a full involvement is dependent on the ability of the flame to reach the ceiling.
 - If the flames are unable to reach the ceiling, fire growth potential is usually low.
 - Fire growth potential is comparatively high where fire grows to ceiling height, because of room content and density or interior finish.

E. Fire growth.

- 1. Fire growth depends on different factors as it progresses.
- 2. Growth and development is a complex issue.

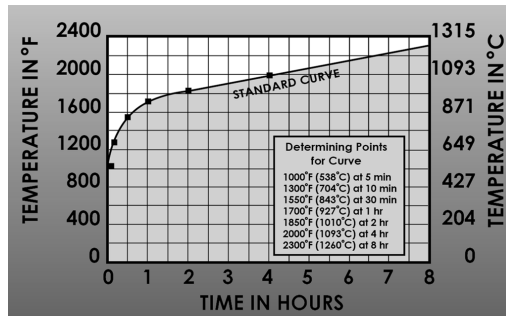
**STANDARD TIME
TEMPERATURE CURVE**

- Basis for laboratory fire testing.
- Controlled laboratory conditions.
- Maximum temperature of 2,000 °F at end of four-hour test period.
- May not accurately reflect “actual” fire conditions.
- Should not be used as a indicator of fire severity.

Slide 3-14

- 3. The Standard Time Temperature Curve (STTC) uses 8,000 British thermal units (Btu) per pound to determine the heat of the fire at particular times, which is not realistic.
- 4. Is conservative in certain occupancies, such as residential, institutional and some commercial.
- 5. Should not be used as an indicator of fire severity in combustibles having a light heat release or when fire conductors produce temperatures higher than the STTC.

STANDARD TIME TEMPERATURE CURVE (cont'd)



Slide 3-15

What is flashover?

Slide 3-16

F. Flashover.

1. Definition: Combustible materials in fire are heated to ignition temperature.

FLASHOVER IS LIKELY TO OCCUR IF ...

- Temperature of upper layer reaches 1,100 °F (600 °C).
- Influenced by HRR (heat release rate).
- Influenced by ventilation.
- Influenced by dimensions of enclosure.
- Influenced by interior finish.

Slide 3-17

2. Flashover of enclosure is likely to occur if the temperature of the upper gas layer reaches approximately 1,100 °F (600 °C). This depends on:
- a. Heat released by the burning fire.
 - b. Ventilation of the enclosure.
 - c. Dimensions of the enclosure.
 - d. Type of material lining the enclosure.





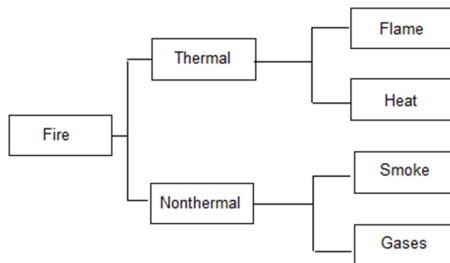
FIRE HAZARDS CAN BE ...

- Thermal (heat and flame).
- Nonthermal (soot and gases).

Slide 3-20

G. Factors that affect fire spread.

1. Fire hazards can be thermal, heat and flame, or nonthermal (smoke and gases).



Reprinted with permission from Fire Protection Handbook, 16th edition, Copyright© 1986, National Fire Protection Association (NFPA), Quincy, MA 02269.

Slide 3-21

HEAT AND FLAME TRANSFERRED THROUGH:

- Radiation.
- Conduction.

Slide 3-22

2. Heat and flame transferred through:
 - a. Radiation.
 - b. Conduction.

GASES AND SOOT ARE SPREAD BY:

- Convection.
- Heating, ventilating, and air conditioning (HVAC).

Slide 3-23

3. Gases and smoke spread by:
 - a. Convection.
 - b. Heating, ventilating, and air conditioning (HVAC) systems.
4. Recognizing the hazards posed by each component, and the dangers posed by products, is a challenge for the fire inspector.

RADIATION

- Energy traveling through space or materials as an electromagnetic wave.
- Travel is at speed of light.
- Travel is in a straight line.

Slide 3-24

5. Radiation.
 - a. Definition: Energy traveling through space or materials as an electromagnetic wave (light, radio waves, or X-rays).

- b. Travel = speed of light.
- Travel in a straight line.
 - Heat and flame can move quickly through the building.
 - Your eyes see only a fraction of the energy being emitted by radiation.
 - Intensity of heat transfer cannot be determined easily.
 - The receiving surface will absorb most of the radiant heat. It is black or dark in color. Most nonmetallic materials are effectively “black” to radiant heat even if they appear light.
 - Radiant heat energy transmitted from a point source to a receiving surface will vary inversely with separation distance (doubling the distance will decrease the radiant heat by a factor of four).

CONDUCTION

- Transfer of heat through a material.
- All materials in direct contact will transmit heat.

Slide 3-25

6. Conduction.
- a. The transfer of heat through a material.
 - b. All materials in direct contact will transmit heat.
 - c. For heat conduction the most important physical properties of a material are:
 - Thermal conductivity: The degree to which an object will transfer heat.

- For example, wood is a poor conductor; steel is a good conductor.
- Density: mass per unit volume.
- Specific heat: defines the amount of heat a substance absorbs as its temperature increases.

CONVECTION

- Transfer of heat by its absorption by a fluid at one point, followed by motion of the fluid and rejection of the heat at another point.
- Method most responsible for heat spread in a structural fire.

Slide 3-26

7. Convection.

- a. Transfer of heat by its absorption by a fluid at one point, followed by motion of the fluid and rejection of the heat at another point.
 - Heat transfer method most responsible for the spread of fire.
- b. Heat generated in a room is initially transmitted by convection (air), then by conduction.
- c. Heated air expands and rises upward resulting in extension of a fire.

HEATING, VENTILATING, AND AIR CONDITIONING

- Primary function is to maintain a controlled environment.
- May actively or passively contribute to overall building fire protection design.
- May simply shut down and protect openings.
- System may actively protect by pressurization of exits or exhausting smoke from the fire area.

Slide 3-27

8. HVAC systems.
 - a. Primary function is to maintain a controlled environment for the building occupants or equipment.
 - b. These systems may also contribute actively or passively to the overall building fire protection design.
 - System may simply shut down and protect openings.
 - System may actively protect by pressurization of exits or exhausting smoke from the fire area.

II. BUILDING MATERIALS AND FIRE SPREAD

BUILDING MATERIALS AND FIRE SPREAD

- Amount of heat produced is determined almost entirely by the chemical composition of the material.
- Speed with which heat is produced (RHR) is determined by the physical form of the material.
- On a weight basis, pound for pound, hydrocarbon produces twice the heat.

Slide 3-28

A. Introduction.

1. The amount of heat produced on burning is determined almost entirely by the chemical composition of the material.
2. The speed with which heat is produced is determined by the physical form of the material.
3. Hydrocarbon-based materials consume 50 percent more oxygen than equivalent amounts of other materials, and thus produce about 50 percent more heat.
4. On a weight basis, pound-for-pound, hydrocarbons produce twice the heat.

Example: 16,000 Btu per pound for plastics versus 8,000 Btu per pound for wood.

Building materials play an important role in building fire safety.

Slide 3-29

- B. The selection of building materials and the design of the details of construction play an important role in building fire safety.
1. Two considerations are:
 - a. Structural frame to avoid collapse.
 - b. Ability of barriers to prevent ignition and flame spread to adjacent spaces.

STRUCTURAL COLLAPSES POTENTIAL

- American Society for Testing and Materials (ASTM) in 1907 by using the Standard Time Temperature Curve (STTC).
- NFPA fire tests in 1918.

Slide 3-30

2. Structural collapse potential and fire endurance of beams, girders and columns that comprise the structure's frame have been determined:
 - a. By the American Society for Testing and Materials (ASTM) in 1907 using the STTC.
 - b. By fire-resistance tests established in 1918 by the National Fire Protection Association (NFPA).

c. By fire-resistance ratings which are commonly referred to as:

- 15 minutes.
- 30 minutes.
- 45 minutes.
- 1 hour.
- 1 1/2 hours.
- 2 hours.
- 3 hours.
- 4-hour assembly rating.

3. A one-hour rating indicates that the assembly withstood the standard test for one hour or longer; two-hour rating indicates the assembly withstood a two hour or longer test without failure of a critical element.

ACCEPTANCE CRITERIA

- Failure to support load.
- Temperature increase on the unexposed surface 250 °F above ambient.
- Passage of heat or flame sufficient to ignite cotton waste.
- Excess temperature on steel members.
- Failure under hose stream (walls and partitions).

Slide 3-31

4. Acceptance criteria are specific and may include:

- a. Failure to support load.
- b. Temperature increase on the unexposed surface 250 °F above ambient.
- c. Passage of heat or flame sufficient to ignite cotton waste.
- d. Excess temperature on steel members.
- e. Failure under hose stream (walls and partitions).

FIRE TEST STANDARDS

- ASTM E84, Test for Surface Burning Characteristics of Building Materials.
- ASTM E119, Test Methods for Fire Tests of Building Construction and Materials.
- ASTM E163, Standard Methods of Fire Tests of Window Assemblies.
- ASTM E648, Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.

Slide 3-32

FIRE TEST STANDARDS (cont'd)

- ASTM E 814, Standard Test Method for Fire Tests of Penetration Firestop Systems.
- ASTM E2074, Methods of Fire Tests of Door Assemblies.

Slide 3-33

STEEL

- Popular due to high strength and ease of fabrication.
- Exposed steel vulnerable to fire damage and collapse.
- Fire protection by encasing in concrete, plaster, gypsum board, sprayed fibers, ceiling membrane.

Slide 3-34

C. Steel.

1. The popularity of steel-frame building construction is due to its high strength, ease of fabrication, and assured uniformity of quality.

2. Exposed structural steel is vulnerable to fire damage and structural collapse.
3. Fire protection generally is provided for steel by:
 - a. Encasing the members in concrete, lath and plaster, and/or sprayed fibers.
 - b. Installing a ceiling membrane barrier, such as tiles in a grid system.

**FACTORS INFLUENCING LOAD
CARRYING CAPACITY OF STEEL**

- The higher the load stress, the more quickly a member will fail at elevated temperature.
- Critical temperature is 1,100 °F.
- At critical temperature, 60 percent of capacity is lost.

Slide 3-35

4. The intensity of stress in a steel member influences the load carrying capacity.
 - a. The higher the load stress, the more quickly a member will fail at elevated temperatures.
 - b. A temperature of 1,100 °F is normally considered to be the critical temperature.
 - c. At 1,100 °F, steel has lost 60 percent of its carrying capacity at room temperatures (60 percent capacity is normally used as the design-working stress).

EXPANSION CHARACTERISTICS

- If member is restrained, expansion due to heat under load can cause rapid collapse.
- Fifty feet of steel heated uniformly over its length from 721 °F to 972 °F will expand 3.9 inches.
- Fire testing uses 1,000 °F as point of test failure.

Slide 3-36

5. If the ends of a structural member are restrained, expansion due to heat under load can cause rapid collapse.
6. Fifty feet of steel heated uniformly over its length from 721 °F to 972 °F expands 3.9 inches.
7. Fire testing of steel uses 1,000 °F as the point of test failure.

CONCRETE

- Collapse is rare, but loss in strength does occur.
- Type of aggregate, moisture content, type of loading, and stress level influence strength reduction.
- Failure of prestressed involves elevated temperatures of steel.
- Elasticity is reduced by 20 percent at 600 °F.
- Wires permanently weakened at 800 °F.

Slide 3-37

D. Concrete.

1. Although collapse of reinforced concrete structures is rare, loss in strength and damaging effects do occur.
2. Factors that influence strength reduction are:
 - a. Type of aggregate.
 - b. Moisture content.

- c. Type of loading.
- d. Level of stress.
3. The greatest problem of prestressed and post-stressed concrete involves the elevated temperature of the stressed steel.
 - a. Elasticity is reduced by 20 percent when the temperature of the steel reaches 600 °F.
 - b. Prestressed wires are permanently weakened when they reach 800 °F.

WOOD

- Form or size affects ability to provide reasonable structural integrity during fire.
- Fire retardant delays ignition and retards combustion.
- Lightweight construction will fail early in fire.

Slide 3-38

E. Wood.

1. Depending on its form, wood may or may not provide reasonable structural integrity in a fire.
2. Factors are:
 - a. Physical size.
 - b. Moisture content.
3. Fire retardant treatment delays ignition and retards combustion; however, all wood will burn.
4. Burning wood produces charcoal.
5. The charcoal initially provides a protective coating that insulates the unburned wood.

- a. Thicker members provide much more structural integrity over the period of fire exposure than do thin ones.
- b. Heavy timber has proven to be an excellent form of construction.
- c. Wood frame uses structural members smaller than mill construction; when exposed to fire, it offers relatively little structural integrity.

III. BUILDING SYSTEMS

BUILDING SYSTEMS

- Electrical.
- Heating.
- Ventilation.
- Air conditioning.
- Plumbing.
- Transportation.

Slide 3-39

- A. Building systems provide for the practical use of a structure. These include:
1. Electrical.
 2. Heating.
 3. Ventilation.
 4. Air conditioning.
 5. Plumbing.
 6. Transportation.

A basic knowledge of these systems and their relationship to the structure is needed to understand how they may affect fire safety.

Slide 3-40

- B. A basic knowledge of these systems and their relationship to the structure is needed to understand how they may affect fire safety.
- C. These systems may be considered separately; however, it must be understood that each system is only one part of the total building system.

ELECTRICAL

- Properly designed, installed and maintained systems are both convenient and safe.
- Improper systems can be a source for both fire and injury.
- Fire protection involves preventing arcing and overheating.

Slide 3-41

- D. Electrical system.
1. If properly designed, installed and maintained, electrical systems are both convenient and safe; otherwise they may be a source for both fire and injury.
 2. When an electric circuit carrying current is interrupted intentionally or unintentionally, arcing or heating is produced.
 3. Fire protection standards are requirements intended to prevent:
 - a. Arcing and overheating.

- b. Accidental contact, which may cause electric shock.
- 4. Electrical fires can be divided into three categories.
 - a. Worn-out or “tired” electrical equipment.
 - Responsible for the largest percent of electrical fires.
 - Examples:
 - The electric motor.
 - Worn-out insulation.
 - Electronic appliances.
 - Appliance cords.
 - Fixtures.
 - Heating appliances.
 - b. Improper use of approved equipment. Two common problems with the misuse of electrical equipment are:
 - Electric motors.
 - Extension cords.
 - c. Accidental occurrence. Operator error includes such items as:
 - Clothes left in contact with lamps.
 - Items dropped into electric equipment.
 - Heating equipment left on.
 - Defective installations.

HEATING

- Normally operate above the ignition temperatures of many common materials.
- Installation, use and maintenance must be considered as an ignition potential.

Slide 3-42

E. Heating.

1. Heat-producing appliances and associated equipment are the most prevalent accidental cause of fire. Heat-producing appliances normally operate at temperatures above the ignition temperature of many common materials.
2. Installation, use and maintenance of heating systems must be considered as an ignition potential.

Examples:

- a. Fuels and fuel controls.
- b. Available air and air-fuel mixtures.
- c. Fuel storage, boilers and boiler controls.
- d. Solid fuel heating (woodstoves, fireplaces, etc.).
- e. Cooking equipment.
- f. Steam systems venting.

VENTILATION AND AIR CONDITIONING

- Used to treat air to control its temperature, humidity, cleanliness and distribution.
- Duct work can spread heat and smoke.
- Fire dampers, smoke dampers and smoke detectors use control systems under fire conditions.

Slide 3-43

F. Ventilation and air conditioning.

1. Definition: The process of treating air to control its temperature, humidity, cleanliness and distribution simultaneously.
2. The system of ducts usually associated with ventilation present the possibility of spreading fire, fire gases and smoke throughout the area served.
3. Filters, ducts and fire-separation penetrations are rated for a specified use which depends on a building's needs or use.
4. Generally, smoke detectors must be installed in all systems over 2,000 cubic feet per minute (cfm) and are not to be used as replacements for the smoke detectors required for the occupancy.

TRANSPORTATION

- Elevators and escalators.
- Installations present paths for heat and smoke travel.
- Use of elevators by building occupants during fire is prohibited.
- Escalators not permitted as means of egress.

Slide 3-44

G. Transportation.

1. Building transportation systems, such as elevators and escalators make modern buildings possible.

2. Special precautions must be taken to prevent elevator use during fires and to prevent spread of fire due to escalator floor openings.
3. Signs prohibiting the use of elevators in the case of fire are widely used.
4. Modern elevator systems usually are designed to operate in a special emergency mode during a fire.
5. Openings for escalators must be protected to prevent the spread of smoke and fire.

PLUMBING

Penetrations of fire-rated assemblies.

Slide 3-45

H. Plumbing.

1. Plastic pipes must be protected to prevent the spread of fire, and it is usually acceptable by providing a chase or enclosure.
2. Other aspects of plumbing are usually not considered fire-spread hazards.

FLOOR PENETRATIONS



Slide 3-46

FIRE SPREAD

- Conflagrations were common at the turn of the century.
- Increased knowledge of fire behavior and building design helped to confine fire to the building of origin.
- Technology continues to develop to limit fire to small areas within a room.

Slide 3-47

I. Fire spread.

1. At the turn of the century, conflagrations were a common occurrence.
2. Increased knowledge of fire behavior and building design helped to confine the fire to the building of origin.
3. Recent development has led to fire designs which contain the fire to the floor of origin and even the room.
4. At present, technology has enabled the control of hostile fire in even smaller areas within a room.

OBJECTIVES OF FIRE-SAFE BUILDING DESIGN

- Life safety.
- Property protection.
- Continuation of building operations.

Slide 3-48

- J. The objectives of fire-safe designs in building construction are life safety, property protection, and the continuation of building operations.

LIFE SAFETY

- Characteristics of occupants.
- Evacuation or defend in place.

Slide 3-49

1. Life safety.
 - a. First step of life safety is to identify the occupant characteristics of the building.
 - Occupant capabilities (i.e., physical and mental).
 - Range of activities.
 - Location.
 - b. Design for life safety may involve:
 - Evacuating occupants.
 - Defending the occupants in place.
 - Providing an effective area of refuge.
 - c. Evacuation involves:
 - Availability of a path of escape.
 - Alerting the occupants.
 - d. Defend in places where evacuation has an unacceptably low likelihood of success (hospitals, nursing homes, prisons, other institutions).

Uses performance criteria of:

 - Time.

- Tenability.
- e. Area of refuge.
 - Involves occupant movement through the building to a refuge space.

PROPERTY PROTECTION

- Items of monetary value.
- Special considerations, e.g., computers.

Slide 3-50

2. Property protection.

- a. Items of high monetary or other value (e.g., vital records, computers, etc.) must be identified for protection.
- b. Special protection should be considered in relation to the property to be protected.

CONTINUITY OF OPERATIONS

- Downtime may have serious impact on business.
- Sensitive areas must be protected.

Slide 3-51

3. Continuity of operations.

- a. Downtime of the building may have a serious impact that must be evaluated.

- b. Sensitive areas must be protected.

IV. TYPES OF BUILDING CONSTRUCTION

Classification of Building Construction aka Type of Construction

Slide 3-52

COMPARISON OF EACH TYPE OF CONSTRUCTION

CROSS REFERENCE GUIDE TO CONSTRUCTION TYPES									
NFPA	I(443)	I(332)	II(222)	II(111)	II(000)	III(211)	III(200)	IV(201)	V(111)
UBC	N/A	IFR	IFR	II 1 hr	II N	III 1 hr	III N	IV 1 hr	V N
BOCA	1A	1B	2A	2B	2C	3A	3B	4	5A
SBC	I	II	N/A	IV 1 hr	IV unsp	V 1 hr	V unsp	III	VI 1 hr
IBC	N/A	1A	1B	IIA	IIB	IIIA	IIIB	IV	VA

Slide 3-53

CRITERIA

- International Building Code (IBC) Chapter 6 — Tables 601 and 602.
- NFPA 220, *Standard on Types of Building Construction*.
 - First number — exterior bearing walls.
 - Second number — columns, beams, girders, trusses supporting bearing walls, columns or loads from more than one floor.
 - Third number — floor construction.

Slide 3-54

“MINIMUM DEGREE OF FIRE RESISTANCE”

- Related to construction types in the IBC.
- Means a fire-resistance rating of one hour.

Slide 3-55

TABLE 601
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	
	3 ^a	2 ^a	1	0	1	0	HT	1	0	
Primary structural frame ¹ (see Section 202)										
Bearing walls	3	2	1	0	2	2	2	1	0	
Exterior ^{6, f}	3 ^a	2 ^a	1	0	1	0	1/HT	1	0	
Interior										
Nonbearing walls and partitions	See Table 602									
Exterior										
Nonbearing walls and partitions	0	0	0	0	0	0	See Section 602.4.6	0	0	
Interior ^d										
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 ^e	1 ^{b, c}	1 ^{b, c}	0 ^c	1 ^{b, c}	0	HT	1 ^{b, c}	0	

From Chapter 6, IBC 2015 Edition

Slide 3-56

FIRE RESISTIVE



Slide 3-57

FIRE RESISTIVE (cont'd)

- All structural members are noncombustible and have high degrees of fire resistance.
- No combustible materials are permitted.
- No exposed steel is permitted.
- Exterior walls may be curtain walls.

Slide 3-58

A. Fire resistive.

1. Structural members are noncombustible and are fire protected as specified.
2. Usually divided into two subtypes, with the basic difference between the subtypes being the level of fire protection specified for the structural frame.
3. Only noncombustible materials are permitted.
4. A building in which no structural steel is exposed and all vertical openings are protected with approved doors.
5. Bearing walls may be made of steel with a fire-resistive covering applied.

STEEL PROTECTION



Concrete encasement



Spray-on membrane



One or more gypsum wallboard layers

Slide 3-59

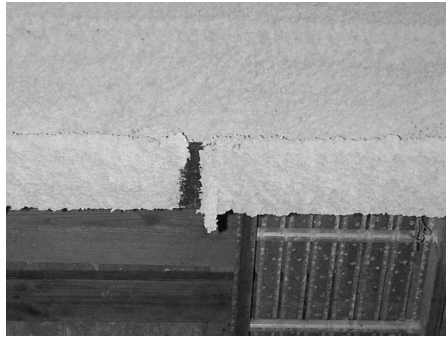
6. Often, structural steel is protected by encasing, sprayed-on protection, or membrane ceilings.

SPRAY PROTECTION APPLIED TO STEEL



Slide 3-60

LOOSE SPRAY PROTECTION FROM I-BEAM DUE TO OIL RESIDUE ON BEAM



Slide 3-61

LIMITS ON MEMBRANE PROTECTION

- IBC 2009.
- Limits use of membrane protection to “secondary structural members.”
- Definitions of “primary” and “secondary” structural members are contained in the IBC.

Slide 3-62

CURTAIN WALL



Slide 3-63

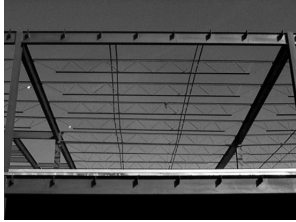
7. Exterior walls generally will be curtain walls and not structurally supporting.
8. Exterior or interior nonbearing walls will have a varying degree of fire resistance.
9. Stairwells are enclosed in fire-resistive materials.
10. Roof construction may be similar to that used for floors.

CODE CLASSIFICATIONS

- IBC Types IA and IB.
- NFPA 220 Types I (443), I (332), II (222).

Slide 3-64

NONCOMBUSTIBLE CONSTRUCTION



Slide 3-65

B. Noncombustible.

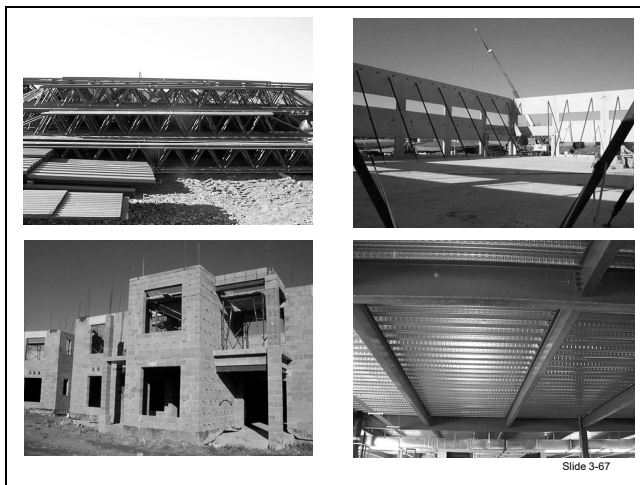
NONCOMBUSTIBLE

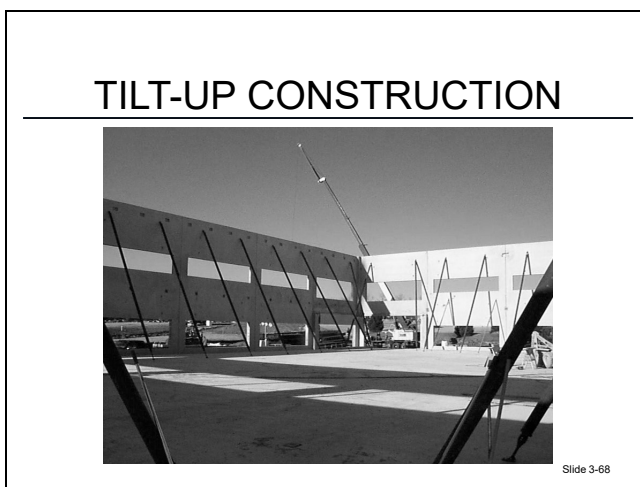
- All structural members are of noncombustible or limited combustible materials.
- Unprotected steel is very common.
- Concrete can also be considered noncombustible.
- Exterior walls may be curtain walls.
- May have limited fire-resistive ratings (one hour).

Slide 3-66

1. Structural elements are made entirely of noncombustible or limited combustible materials, as permitted.
2. Usually subdivided based upon fire-resistive requirements.
3. Steel.
 - a. A totally noncombustible building in which the structural elements are exposed to the effects of fire.
 - Totally noncombustible refers only to structural materials, not to interior finish and contents.
 - b. Structural framework is made of steel beams bolted, riveted or welded together.

- c. Susceptible to expansion, distortion or relaxation of steel members resulting in early collapse.
- d. Wall enclosures may be masonry, steel, aluminum, glass or other materials.
 - Once wall coverings are in place, it may be difficult to determine if structural elements are exposed or protected.
- 4. Concrete construction also can be considered noncombustible.
- 5. The floor and roof support system will often be lightweight bar joists, trusses or other lightweight steel.
- 6. Examples here are ordinary, heavy timber, and frame structural elements.





CODE CLASSIFICATIONS (cont'd)

- IBC Type IIA and IIB.
- NFPA 220 Types II (111) and II (000).

Slide 3-69

ORDINARY CONSTRUCTION



Slide 3-70

ORDINARY

- Exterior walls are of noncombustible materials.
- Floors and roof may be entirely or partially of combustible materials.
- Interior walls may be entirely or partially of combustible materials.
- May have limited fire-resistive ratings.

Slide 3-71

C. Ordinary exterior protected.

1. Construction type in which all or part of the interior structural element may be combustible.

2. Exterior walls are required to be noncombustible or of noncombustible materials. Can have a fire-resistance rating depending upon the horizontal separation and the fire load.
3. Usually divided into protected and unprotected subtypes.

MASONRY ENCLOSURE OF WINDOW OPENINGS



Slide 3-72

4. The building will have masonry exterior walls (usually brick), and wooden structural members and interior construction.
5. The building generally will not exceed six stories, and will most often be two or three stories in height; often called “Main Street USA.”

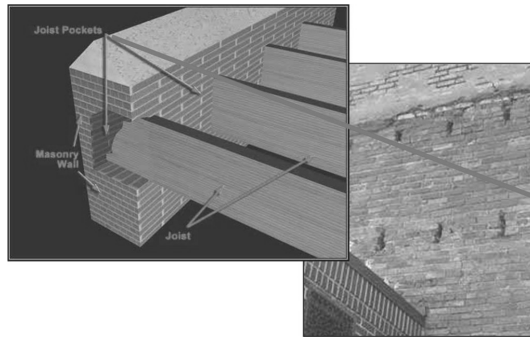
SPREADER BARS



Slide 3-73

6. Floor and roof supports are usually wood, but other materials, such as steel bar joists, may be found.
7. Floor and roof decking will most frequently be wooden boards, tongue-and-groove boards, plywood or composition board.

FIRE JOIST CUTS



Slide 3-74

WALL SOCKETS



Slide 3-75

8. Common walls between buildings may share wall sockets for floor joists and roof rafters.

CODE CLASSIFICATIONS (cont'd)

- IBC IIIA and IIIB.
- NFPA 220 Types III (211) and III (200).

Slide 3-76

HEAVY-TIMBER CONSTRUCTION



Slide 3-77

HEAVY TIMBER

- Structural members are unprotected wood with large cross sectional areas.
- Minimum dimension of wood supports is 8 inches.
- Minimum thickness of floors is generally 3 inches.
- Roof decking thickness is a minimum of 1 1/8 inches.

Slide 3-78

D. Heavy timber.

1. Heavy-timber structural members — columns, beams, arches, floors and roofs — are unprotected wood with large cross-sectional areas.
2. Concealed spaces are usually not permitted.

BEAM SUPPORTED BY MASONRY WALL



Slide 3-79

3. These buildings consist of masonry (noncombustible) exterior walls and structural members of substantial timber construction.
4. Minimum dimension of structural wood supports, 8 inches for columns, beams, girders and arches.
5. All exposed wood has a minimum dimension of 2 inches.
6. Commonly found in older factories and mills.

TONGUE AND GROOVE FLOORING



Slide 3-80

7. Wood floors will generally be a minimum thickness of 3 inches.

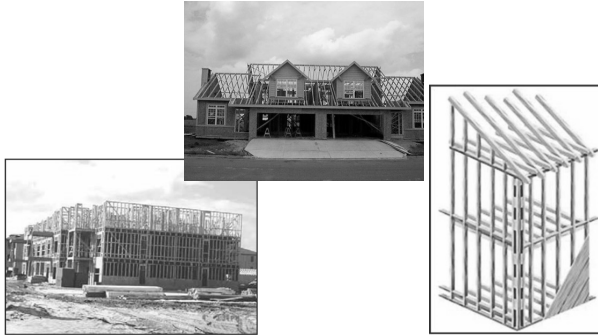
May be oil-soaked from years of supporting heavy machinery with lubricating oils.
8. Roof supports will be wood with minimum dimensions of 4-by-6 inches, and a minimum roof decking thickness of 1 1/8 inches.

CODE CLASSIFICATIONS (cont'd)

- IBC IV.
- NFPA 220 Type IV (2HH).
- No listed or specific fire-resistance ratings.

Slide 3-81

WOOD-FRAME CONSTRUCTION



Slide 3-82

E. Wood frame.

WOOD FRAME

- All structural members are wood.
- Post and beam.
- Balloon frame.
- Platform.
- May have some limited degree of fire resistance.

Slide 3-83

1. Construction in which the structural members are entirely of wood.

2. Usually subdivided into two types.
 - a. Protected — structural elements protected as required.
 - b. Unprotected — no fire protection requirement.
3. Walls, floors and roof structure are of wood framing.

BEAM CONSTRUCTION



Plank and beam



Post and beam

Slide 3-84

4. Post and beam construction has a frame of substantial dimension wood and is sided with a lightweight covering, such as wood boards.
 - a. Commonly used for barns, sheds and storage buildings.
 - b. Also may be used in dwellings and other occupancies.

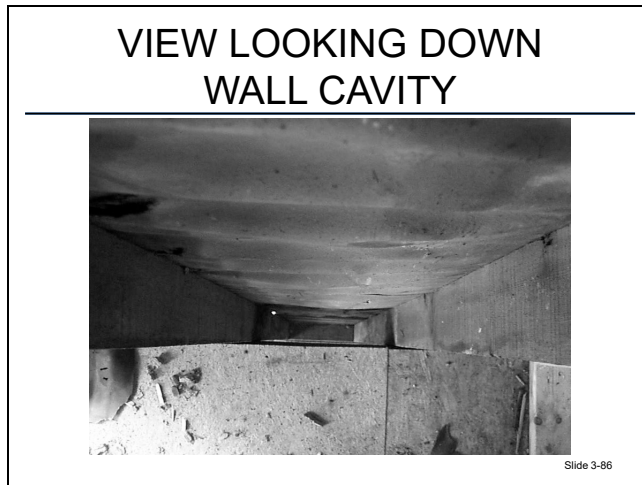
BALLOON-FRAME CONSTRUCTION



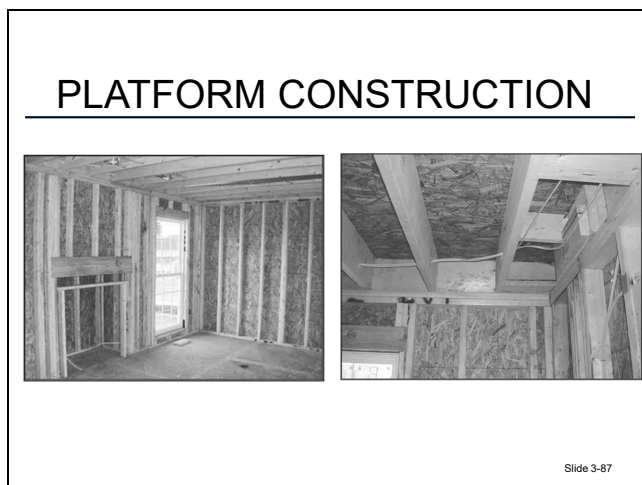
Slide 3-85

5. In balloon-frame construction, studs run from the foundation to the attic.

- a. Used extensively in many parts of the country until the late 1930s for residential and light commercial.
- b. Floor joists are tied into the wall, allowing for fire extension in any direction.



- c. Fire stopping was not a common practice, and only rarely will it be found.



- 6. In platform-frame construction, the walls of each successive story are built on a platform formed by the preceding floor.
 - a. Modern wood-frame construction.
 - b. The joists for the deck may be full-dimension lumber or of lightweight construction.
 - c. Once the floor/deck is in place, walls are placed on it with a sill at the bottom of the wall and a plate at the top.

THREE-STORY PLATFORM



Slide 3-88

- d. Platform-frame construction provides a natural fire barrier for vertical extension within walls.

OTHER WOOD-FRAME ISSUES



Slide 3-89

JOIST HANGERS



Slide 3-90

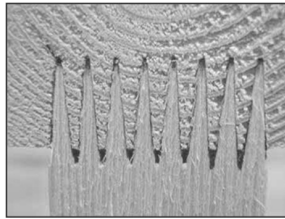
TRUSSES

- Used in both roof and floors.
- Surface-to-mass ratio issue.
- Truss components dependent upon each other.
- Trusses dependent upon each other.
- Metal plates.
- New glued finger joints.

Slide 3-91

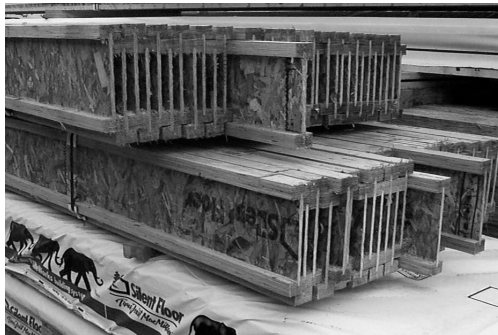
FINGER JOINT CONNECTIONS

No plates or nails — thermoset glue.



Slide 3-92

ENGINEERED WOOD “I” BEAM



Slide 3-93

CODE CLASSIFICATIONS (cont'd)

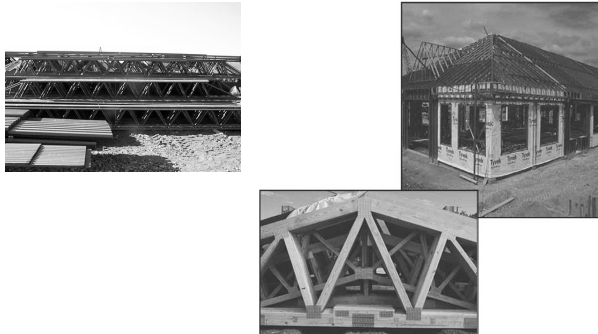
- IBC Type VA and VB.
- NFPA 220 Types V (111) and V (000).

Slide 3-94

Some other construction issues

Slide 3-95

LIGHTWEIGHT CONSTRUCTION



Slide 3-96

METAL CONSTRUCTION



Slide 3-97

V. OCCUPANCY CLASSES

OCCUPANCY CLASSIFICATIONS

Occupancy classes are based on an assessment of life safety considering the characteristics of occupants and purpose served by the occupancy.

Slide 3-98

- A. Occupancy classes are based on an assessment of life safety from fire in buildings which is determined through an analysis of:
 - 1. Characteristics of occupants.
 - 2. Purpose served by the occupancy. (What is going on?)
- B. The use of an occupancy is determined by the processes occurring within a building. These are categorized into occupancy classes.

In order to:

- 1. Identify and deal with special needs.

2. As an example:

Whether a building is fire resistive or not is unimportant until there are occupants in that building. When the building is used as an office, it becomes important that the building is fire resistive.

**OCCUPANCY CLASSES ARE THE
FOUNDATION OF THE CODE PROCESS**

- IBC Chapter 3.
- International Fire Code (IFC) Chapter 2.

Slide 3-99

- C. Occupancy classes are the foundation of the code process.

1. Fire prevention does not involve regulation of building construction. Codes regulate what occurs in the building.
2. Relationship among building materials and construction and occupancy classes involves a complex inter-relationship.

ASSEMBLY

Gathering of 50 or more people for civic, social or religious functions, recreation, food or drink consumption, or awaiting transportation.

Slide 3-100

- D. Assembly occupancy.

BUSINESS

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

Slide 3-101

E. Business occupancy.

EDUCATIONAL

Six or more people for educational purposes through 12th grade — four or more hours a day or more than 12 hours a week. Also includes some day care centers.

Slide 3-102

F. Educational occupancy.

1. The major code groups have developed occupancy groups which do not correspond in every case.
2. Building types, rather than rooms within buildings, have been grouped with regard to their relative hazards.

LIFE SAFETY CODE

- Day care centers are separate classification.

Slide 3-103

INSTITUTIONAL

Care or supervision is provided to people who are not capable of self-preservation without physical assistance or are being detained for penal or correctional purposes. Includes some day care centers. I-1 through 1-4.

Slide 3-104

LIFE SAFETY CODE (cont'd)

- Health care.
- Ambulatory health care.
- Detention and correctional.

Slide 3-105

RESIDENTIAL

Sleeping accommodations for normal residential purposes — one- and two-family dwellings, apartments, hotels, motels and dormitories.

Slide 3-106

G. Residential occupancy.

Sleeping accommodations for normal residential purposes — one- and two-family dwellings, apartments, hotels, motels and dormitories.

MERCANTILE

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

Slide 3-107

H. Mercantile occupancy.

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

FACTORY (INDUSTRIAL)

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

Slide 3-108

I. Factory (industrial) occupancy.

1. Factories, processing, assembling, mixing, packaging, finishing, decoration or repairing.
2. These types of classifications are the basis for building code.

HAZARDOUS

Quantities greater than those permitted in a control area. H-1 through H-5. Special industrial under NFPA 101, *Life Safety Code*®.

Slide 3-109

J. Hazardous occupancy.

Quantities greater than those permitted in a control area. H-1 through H-5. Special industrial under NFPA 101, *Life Safety Code*®.

STORAGE

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

Slide 3-110

K. Storage occupancy.

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

UTILITY AND MISCELLANEOUS

Buildings and structures of an accessory character and miscellaneous not classified in any specific occupancy.

Slide 3-111

L. Utility and miscellaneous occupancy.

Buildings and structures of an accessory character and miscellaneous not classified in any specific occupancy.

CONSTRUCTION TYPE + OCCUPANCY

- Determines basis for allowable area and height.
- All building codes contain a table or chart which establishes the basic allowable area and height.
- Modifications (increases) are permitted in certain conditions.
- NFPA 101 does not specifically address area and height, but does set limits on location of certain occupancies.

Slide 3-112

M. Construction type + occupancy.

1. Determines basis for allowable area and height.
2. All building codes contain a table or chart which establishes the basic allowable area and height.
3. Modifications (increases) are permitted in certain conditions.
4. NFPA 101 does not specifically address area and height, but does set limits on location of certain occupancies.

VI. CHANGE OF USE

CHANGE OF USE

Slide 3-113

CHANGE OF OCCUPANCY

- All codes deal with this matter in the same way.
- Change of occupancy is treated as new construction.
- **International Existing Building Code (IEBC)**, 2015 edition.
- It is the change of how the building is used, not occupant or ownership.

Slide 3-114

- A. All major code groups deal with change of use in a similar way.
- B. When a different use is proposed as the principal use of a building or structure, the requirements for a new structure of similar use is required.
- C. Often major revisions to the structure are required.
 - 1. Firewalls to limit building size.
 - 2. Fire protection enhancements (i.e., sprinklers, alarms).
 - 3. HVAC controls are required for the new use.
- D. Sometimes the use is denied because the code does not permit that use in the type of construction (i.e., high-hazard storage in a large, open, wood structure).
- E. Construction materials must meet new construction requirements; the requirements for interior finish and fire separation must meet what would be required under the code now in effect, not what was required by the code in effect at the time of construction.

VII. CODES AND STANDARDS

CODES

- Defined as a document containing only mandatory provisions using the word “shall” to indicate requirements and in a form generally suitable for adoption into law.
- Minimum requirements.

Slide 3-115

A. Codes.

1. Definition: A document containing only mandatory provisions using the word “shall” to indicate requirements and in a form generally suitable for adoption into law.
2. Sets forth minimum requirements to protect the health and safety of society, and generally represents a compromise between optimum safety and economic feasibility.
3. Codes are written in legally adapted language and are intended to be adopted by the authority having jurisdiction (AHJ) into the local or state statutes.

TWO TYPE OF CODES

- Prescriptive code (formally known as Specification).
- Performance code.
- National Fire Academy (NFA) six-day course “Evaluating Performance Based Designs” (EPBD) (R0108).

Slide 3-116

4. Two types of codes.

- a. Prescriptive (formally known as Specification) — Spell out in detail what materials can be used, the size of components, and how they are to be assembled.
- b. Performance — Detail the objective to be met and establish criteria for determining if the objective has been met.
 - Methods and materials can be selected as long as it can be shown that the performance criteria can be met.
 - Performance-oriented codes still embody a fair amount of specification-type requirements, but the provision exists for substitution of alternate methods and materials if they can be proven adequate “trade-offs.”

STANDARDS

- Defined as a document containing only mandatory provisions using the word “shall” to indicate requirements.
- Set forth how to do something.

Slide 3-117

B. Standards.

- 1. Definition: A document containing only mandatory provisions using the word “shall” to indicate requirements.
- 2. Requirements found in codes are excerpts from, or based on, the standards published by nationally recognized organizations.
- 3. The most extensive use of standards is their adoption into the code by reference, thus keeping the code to a workable size and eliminating duplication of effort.
- 4. Examples of such standards are those that deal with:
 - a. Extinguishing systems.
 - b. Flammable liquids.

- c. Hazardous processes.
- d. Combustible dusts.
- e. Building materials.
- f. Water systems.
- g. Mechanical systems, etc.

RECOMMENDED PRACTICES

- Defined as a document containing only advisory provisions using the word “should.”
- Can become mandatory if adopted or referenced in an adopted code.

Slide 3-118

C. Recommended practices.

Definition: A document containing only advisory provisions (using the word “should” to indicate recommendations) in the body of the text.

1. Shall: Indicates a mandatory requirement.
2. Should: Indicates a recommendation or that which is advised but not required.
 - a. Published by nationally recognized organization. Intended to deal with maintenance and operational standards for the various systems required by the code.
 - b. Recommended practices can be adopted into the code by reference, and are usually used by the AHJ as the guide to determine compliance with the intent of the code writers.

AMERICANS WITH DISABILITIES ACT

- Sets forth requirements in the Americans with Disabilities Act (ADA) Accessibility Guidelines.
- Requirements for fire alarms, areas of rescue assistance, automatic sprinkler protection, exiting.

Slide 3-119

D. Americans with Disabilities Act (ADA).

VIII. HUMAN BEHAVIOR AND FIRE

HUMAN BEHAVIOR AND FIRE

- NFPA 921, *Guide for Fire & Explosion Investigations*, 2017 Edition.
- Chapter 11: Fire Related Human Behavior.
- Chapter 25: Fire and Explosion Death and Injuries.
- Society of Fire Protection Engineers (SFPE) Handbook.

Slide 3-120

HOW ONE REACTS DURING A FIRE EMERGENCY IS RELATED TO:

- Role assumed.
- Studies show that in groups, people use the reaction of others to determine the level or degree of threat.

Slide 3-121

- A. How one reacts during a fire emergency is related to:
- B. Role assumed.
 - 1. Studies show that in groups, people use the reactions of others to determine the level/degree of threat, i.e., a group of occupants stay longer in a room full of smoke than an individual. The group will stay until a member of the group starts action or a movement role.
 - 2. Role relationship has been shown to affect the outcome of critical incidents as people look to those in charge during a fire incident.
 - a. Beverly Hills Supper Club — The staff of the facility took charge and were responsible for saving multiple lives — even the busboys and waiters led people to safety.
 - b. Students in school look to the teachers, and aircraft passengers easily take direction from the flight attendants during a fire threat.
 - c. Fire safety training is essential for assembly occupancies.

PREVIOUS EXPERIENCE

Affects ability to size up and compare the present experience with any previous fire experience.

Slide 3-122

- C. Previous experience.
 - 1. Affects ability to size up and compare the present experience with any previous fire experience.
 - 2. Dynamic process which alters choices.

EDUCATION

- Fire suppression equipment.
- Fire alarms.
- Fire drills/evacuation planning.

Slide 3-123

D. Education.

1. Fire extinguisher.

- An individual's emotional reaction to a fire will be largely influenced by:
 - Familiarity with the extinguisher.
 - Experience in using it or observing its use.
 - Training and self-confidence.
 - Role perceived.
- Training is, therefore, very important. Many facilities practice with extinguishers when the extinguisher is scheduled for recharging.

2. Fire drill.

- Well-marked exits do not ensure life safety during a fire.
- Exit drills are necessary so that occupant will know how to make an efficient and orderly escape.
- Exit drills are usually required in schools and health care facilities, and are common in high-hazard industries.
- Drills should be conducted whenever it is possible, or wherever confusion during occupant escape might lead to greater confusion.

- e. Generally, drills conducted a few minutes before a meal break have been found to minimize loss of time and production.
 - f. A recommended practice is to establish fire wardens to train and monitor evacuation procedures.
 - g. In a health care facility, a drill might just be for the staff training, and it is recommended that a drill be conducted once a month for the staff to learn and reinforce proper evacuation procedures (i.e., closing doors, moving patients).
3. Reactions to special hazards.
- a. Plant/Industrial fire safety — Often protection is provided by specially trained plant personnel, such as:
 - Fire brigade.
 - Hazmat responders.
 - b. Flammable material, unstable material, and manufacturing or transportation of flammable, hazardous material require special procedures and staff reaction during a fire/spill incident.

PERSONALITY

- Occupants who engage in firefighting behavior are usually male.
- Women predominantly notify the fire department first.

Slide 3-124

E. Personality.

- 1. Occupants who engage in firefighting behavior are usually male, and it has been determined that this is culturally determined/expected as a male role.
- 2. Women predominantly notify the fire department first.
- 3. Occupants will move through smoke in an evacuation process.

PERCEIVED THREAT

Panic is a rare event that occurs under specific conditions.

Slide 3-125

F. Perceived threat.

1. Panic is a rare event that occurs under specific conditions.
 - a. Most important individual decisions and behavior occur prior to the arrival of the fire department.
 - b. The way in which an individual is alerted determines the degree of threat perceived.
2. Perception of threat is based on the smoke thickness and the degree to which an individual has available clearly-demonstrated visual paths or systems to use.

MEANS OF EGRESS

Clear, unobstructed means of egress reduces the perception of threat.

Slide 3-126

G. Means of egress.

1. Clear, unobstructed means of egress reduces the perception of threat.

2. Special consideration must be provided for occupants who, because of age, are unable to evacuate.
3. The very young and elderly are not as likely to be able to manage the threat of fire.
4. The very young — usually under six.
5. Restrained individuals (jails, detention/psychiatric institutions).

ACTIONS OF OTHERS

Follow the leader ...

Slide 3-127

H. Actions of others.

A Review of Human Behavior in The Station Nightclub

Slide 3-128

REFERENCES

Bryan, J. (2002). Human behavior in fire. *Fire Protection Engineering*, No. 16. Retrieved from www.frocc.org/pdf/building_eva/historical_review.pdf

IBC. (2015). *International existing building code (IEBC)*.

This page intentionally left blank.

APPENDIX

NFPA ARTICLE BY JOHN L. BRYAN

This page intentionally left blank.

The following is excerpted from an NFPA article by Dr. John L. Bryan.

The recognition of ambiguous threat cues as signaling an emergency condition may be inhibited by the presence of other people. Experimental studies of the inhibition of adaptive reaction to emergencies (Latane and Darley 1968) created an experimental situation involving college students. While the students were completing a written questionnaire, the experimenter would introduce smoke into the room through a small vent in the wall. If the student left the room and reported the smoke, the experiment was terminated. If the student had not reported the presence of smoke within a six-minute interval from the time smoke was first noticed, the experiment was considered completed. Students alone in the room reported the smoke in 75 percent of the cases. When two passive noncommittal people joined each student, only 10 percent of the groups reported the smoke. When the total experimental group consisted of three naive subjects, in only 38 percent of the groups did one individual report the smoke.

Of the 24 people involved in the eight naive subject groups, only one person reported the smoke within the first four minutes of the experiment. In the single subject situations, 55 percent of the subjects had reported the smoke within two minutes and 75 percent in four minutes.

It was reported in the study that noticing the smoke was apparently delayed by the presence of other people, with the median being five seconds for single subjects but 20 seconds in both of the group conditions. These results undoubtedly reflect the constraints that people accept regarding their behavior in public places. The performance of naive subjects in the passive confederate situation was reported as follows:

“The other nine stayed in the waiting room as it filled up with smoke, doggedly working on their questionnaires, and waving the fumes away from their faces. They coughed, rubbed their eyes, and opened the window, but did not report the smoke.”

It has been suggested that while trying to interpret the emergency potential of ambiguous threat cues, the individual is influenced by the behavioral reaction of others. Should these others remain passive and seem to interpret the situation as a nonemergency, the individual will tend to have this interpretation modified by this inhibiting social influence (Latané and Darley 1968). This behavioral experiment may help explain the reported tendency of people to (1) disregard threat cues, or (2) interpret them as being nonthreatening when the threat situation occurs where there are many other people, such as in a restaurant, motion picture theater, or department store. These experimental results may be of assistance in explaining the incidence of calls received by fire departments minutes or even hours after the incident was first detected. In the report of the Arundel Park Hall Fire (Bryan 1957), several of the sample population indicated that when they entered the hall after observing the fire from outside the building, they warned their friends and suggested they should leave, but were laughed at and their warning apparently disregarded.

This page intentionally left blank.

UNIT 4: SPECIAL HAZARDS

TERMINAL OBJECTIVE

The students will be able to:

- 4.1 *Evaluate the management of special hazards, including electrical and heating equipment hazards and hazardous materials for code compliance.*

ENABLING OBJECTIVES

The students will be able to:

- 4.1 *Categorize hazardous materials and processes.*
 - 4.2 *Evaluate code compliance for storage, handling and use of hazardous materials.*
 - 4.3 *Differentiate among electrical equipment, components and the associated terminology.*
 - 4.4 *Identify common electrical hazards.*
 - 4.5 *Recognize hazards associated with electric and heating systems.*
 - 4.6 *Explain electric and heating system hazard mitigation strategies.*
-

This page intentionally left blank.


FEMA


U.S. Fire
Administration

UNIT 4: SPECIAL HAZARDS

Slide 4-1

TERMINAL OBJECTIVE

Evaluate the management of special hazards, including electrical and heating equipment hazards and hazardous materials for code compliance.

Slide 4-2

ENABLING OBJECTIVES

- Categorize hazardous materials and processes.
- Evaluate code compliance for storage, handling and use of hazardous materials.
- Differentiate among electrical equipment, components and the associated terminology.
- Identify common electrical hazards.

Slide 4-3

ENABLING OBJECTIVES (cont'd)

- Recognize hazards associated with electric and heating systems.
- Explain electric and heating system hazard mitigation strategies.

Slide 4-4

I. HAZARDOUS MATERIALS IN YOUR JURISDICTION

PERCEIVING THE PRESENCE OF HAZARDOUS MATERIALS

One of the problems facing the inspector can be found in the “normal” environment during a “routine” inspection.



Slide 4-5

- A. Perceiving the presence of hazardous materials is one of the problems for the basic-level fire prevention inspector.
1. One **expects** to find hazardous materials at a chemical manufacturer.
 2. Must also be **aware** of their possible presence in some of your inspection environments.

LIFE CYCLE OF HAZARDOUS MATERIALS

- Processing.
- Storage.
- Shipping.
- Transferring.
- Total consumption.
- Waste generated.



Slide 4-6

B. Life cycle of hazardous materials.

Steps in the cycle.

1. Processing.
2. Storage.
3. Often hazardous materials are shipped or transferred to a facility closer to their point of end-use.
4. Here they can again be stored and/or transferred to a smaller container for distribution and sale.
5. Finally, hazardous materials may either be totally consumed, or waste may be generated for disposal.

RESPONSIBILITIES OF THE INSPECTOR

- You must perceive the presence of the hazard and the nature of the material.
- You need to know what questions to ask.
- You must be familiar with the applicable codes and standards.
- Know when to ask for assistance.

Slide 4-7

C. Responsibilities of the inspector.

1. You must be able to perceive:
 - a. The hazard from these materials in various settings within the community.
 - b. The nature of the material and the occupancy classification of the structure.
2. You need to know questions to ask in relation to dealing with a hazardous material.
3. You must be able to recognize that a hazard exists and be able to work methodically toward the solution of the problem by using the proper code requirement.
4. You must become totally familiar with a jurisdiction's codes and what types of materials the codes address.

II. CODES

APPLICABLE CODES

- Department of Transportation (DOT) Code of Federal Regulations (CFR) 49 Parts 100 through 177.
- Fire prevention codes.
- National Fire Protection Association (NFPA) documents.



Slide 4-8

A. Department of Transportation (DOT).

Code of Federal Regulations (CFR) — Title 49 Transportation Parts 100 through 177.

B. Fire prevention codes.

1. Types of codes.

- a. International Code Council (ICC); International Fire Code (IFC).

- b. National Fire Protection Association (NFPA) 1, *Fire Code*.
 2. The model codes devote several chapters to each of the major groups of hazardous materials (IFC 17 chapters and NFPA 1 15 chapters).
 3. Many requirements are similar in both codes.
- C. The National Fire Codes have several different NFPA standards that deal with each of the hazardous materials.

Model fire codes reference those NFPA standards for requirements that deal with hazardous materials.

III. HAZARDOUS MATERIALS IDENTIFICATION

HAZARDOUS MATERIALS
IDENTIFICATION

- Most difficult and sometimes tedious task.
 - Accuracy is paramount.
- Often very little information is initially available.
- Owner or employee may not be of much help.
- Owner or employee may not perceive “hazard.”
 - Consider third-party evaluations.

Slide 4-9

- A. Task encountered by an inspector.
1. Most difficult.
 2. Often very little information is available.
 3. The owner or employee of an occupancy containing hazardous materials may not be of much help.

INFORMATION SOURCES

- NFPA documents (www.nfpa.org).
 - Product- or process-specific codes, standards, guides and practices.
 - Electrical Classification in Hazardous Vapor and Gas Environments.
 - Electrical Classification in Hazardous Dust Environments.
 - Organic Coating Manufacture.
- National Institute of Occupational Safety and Health (NIOSH) (www.niosh.gov).

Slide 4-10

B. Information sources.

1. NFPA documents.
2. National Institute of Occupational Safety and Health (NIOSH).

INFORMATION SOURCES (cont'd)

- DOT (www.dot.gov).
 - Transportation only.
 - Hazardous Materials Emergency Response Guide.
- Computer-Aided Management of Emergency Operations (CAMEO).
- United States Coast Guard, Chemical Hazards Response Information System (CHRIS).

Slide 4-11

3. United States DOT.
4. Computer-Aided Management of Emergency Operations (CAMEO).
5. U.S. Coast Guard, Chemical Hazards Response Information System (CHRIS).

INFORMATION SOURCES (cont'd)

- Chemical Transportation Emergency Center (CHEMTREC) (www.chemtrec.org).
- State environmental or health agency.
- Chemical Abstract Service (www.cas.org).
- Industrial chemists.
- Colleges and universities.
- CFR 172.101.

Slide 4-12

6. Chemical Transportation Emergency Center (CHEMTREC).
7. State environmental or health agency.
8. Chemical Abstract Service.
9. Industrial chemists.
10. Colleges and universities.

INFORMATION SOURCES (cont'd)

- National Institutes of Health (www.nih.gov).
- Wireless Information System for Emergency Responders (WISER).



Slide 4-13

11. National Institutes of Health.
12. Wireless Information System for Emergency Responders (WISER).

INFORMATION SHOULD INCLUDE:

- Name of substance.
 - May be difficult.
 - Be careful of correct spelling.
- Classification of substance.
 - Boiling point.
 - Vapor density.
 - Flammable limits.
 - Flashpoint.



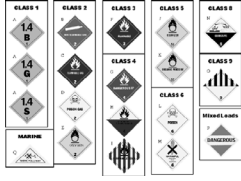
Slide 4-14

C. The initial information that should be obtained includes:

1. The name of the substance.
 - a. May be more difficult than one may think.
 - b. The name may be a trade name only, which doesn't tell you anything about the hazard.
 - c. The name may be the chemical name only.
 - d. It is very important to record the correct spelling of the chemical name. Some of the spellings will be very similar, but there can be a big difference in the hazard or way that the material reacts.
2. It is not enough to know that a substance is a flammable or combustible liquid; its class must also be determined.
 - a. Boiling point.
 - b. Vapor density.
 - c. Flammable limits.
 - d. Flashpoint.

DEPARTMENT OF TRANSPORTATION SYSTEMS

- DOT labeling for containers involved in shipping.
 - Only general characteristics.
- Four-digit code for specific chemical identification.
 - DOT Emergency Response Guidebook.
- Transportation only.




1005

Slide 4-15

D. Marking systems for special hazard materials.

DOT labeling system is used for materials involved in interstate shipping.

1. Labels.

- a. The system only identifies the general hazardous characteristics of the material labeled.
- b. In some categories, such as explosives and poisonous materials, there are different classifications within the general category.
- c. If the material has more than one hazard classification, the shipper should attach the appropriate label for each significant hazard.

CAUTION

- Just because a product doesn't have a label doesn't mean it is not hazardous.
- A good example is anhydrous ammonia.

Slide 4-16

- Caution: Just because a product doesn't have a label doesn't mean it is not hazardous.

2. Placards.
 - a. The DOT system requires that placards be displayed on the transporting vehicle itself and labels need displayed on the containers or packages that are being carried inside the transporting vehicle.
 - b. The system requires displaying a four-digit identification number on the placard or orange panel display.
 - On the shipping papers.
 - The inspector can locate the identification number in the DOT Emergency Response Guide.
 - After locating the number in the book, you will find a guide number listed.

**NATIONAL FIRE PROTECTION
ASSOCIATION 704**

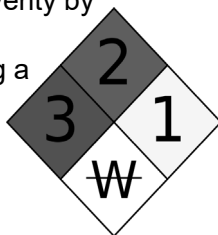
- NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*.
- Addresses health, flammability, instability and related hazards that are presented by short-term, acute exposure under conditions of fire, spill or similar emergencies.
- Provides a readily recognized and easily understood system of markings that provide a general idea of the hazards.

Slide 4-17

3. The NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response* (degree of fire hazards of materials).
 - a. This system establishes a marking system used where materials are stored, handled or used.
 - b. It applies only to stationary facilities, not transportation.
 - The system can be used for buildings, tanks and piping that handle the material.
 - This is the best marking system of hazardous materials available, both from a prevention point of view and a firefighting point of view.

NATIONAL FIRE PROTECTION ASSOCIATION 704 (cont'd)

- Identifies hazards of materials in terms of health, flammability and instability.
- Indicates the degree of severity by a numerical rating system, ranging from four indicating a severe hazard, to zero indicating minimal hazard.
- Refer to NFPA 704 for detailed explanations.



Slide 4-18

- c. It is a complete system that identifies the characteristics that are most important for safety. These include:
- Fire hazard (flammability).
 - Health hazard (toxic, irritant).
 - Chemical reaction hazard.
 - A portion of the sign can be used to identify such other special hazards as radiation and water reactivity.
- d. Use of a combination of colors and numbers allows someone who is familiar with the system to easily identify the relative hazard of the materials involved in all important safety categories.
- e. The numbers used indicate the relative hazard within each main category, beginning with zero which indicates no special hazard, and ending with four which indicates a severe hazard.

HAZARD MARKINGS

Warning signs required for rooms housing high-hazard materials.

- NFPA 704 diamond.
- Sign(s) to restrict smoking and open flames.



Courtesy of National Fire Academy (NFA)

Slide 4-19

NFPA 704 MARKING ON CUSTODIAL CLOSET



Courtesy of C. Thompson

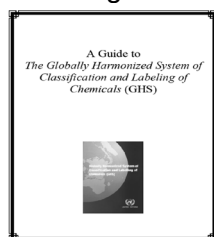


Courtesy of C. Thompson

Slide 4-20

GLOBALLY HARMONIZED SYSTEM

Occupational Safety and Health
Administration (OSHA)-Accepted
Pictograms



Slide 4-21

4. Globally Harmonized System (GHS).
 - a. Dec. 1, 2013: Employers were required to train employees on new label requirements and Safety Data Sheet (SDS) format.
 - b. Dec. 1, 2015: Distributors shall not ship products labeled by chemical manufacturers or importers unless the labels comply with GHS.
 - c. June 1, 2016: Employers were required to update workplace labeling and HazCom programs and train employees on newly identified physical or health hazards.

WHY DOES OSHA NEED IT?

- OSHA's Hazard Communication Standard (HCS) has performance-oriented requirements for labels and Safety Data Sheets (SDSs).
- Hazard communication is often inconsistent as a result.
- Users of labels and SDSs would prefer a standardized approach.
- Adoption of the Globally Harmonized System (GHS) would address this domestic concern.

Slide 4-22

- d. A main purpose of the new GHS is to standardize the types of chemical hazards that exist and the way entities in the chemical industry classify chemicals that have those hazards. To that end, the GHS names three main hazard groups: physical, health and environmental.

BENEFITS OF ADOPTING THE GLOBALLY HARMONIZED SYSTEM

- Increase the quality and consistency of information.
- Reduce confusion and increase comprehension of hazards.
- Help address literacy problems.

Slide 4-23

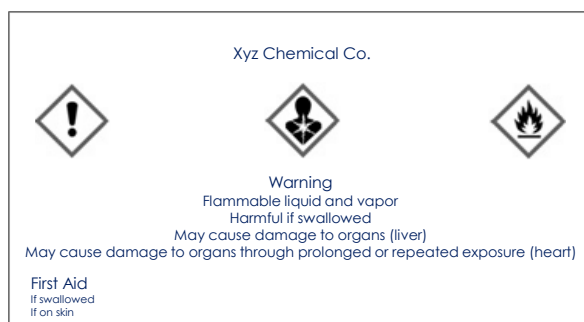
- e. The basic goal of hazard communication is to ensure that employers, employees and the public are provided with adequate, practical, reliable and comprehensible information on the hazards of chemicals so that they can take effective preventive and protective measure for their health and safety. Thus, implementation of effective hazard communication provides benefits for governments, companies, workers and members of the public.

NOTABLE CHANGES

- Labels are more defined and will now require:
 - Product identifier.
 - Pictogram.
 - Signal word.
 - Hazard statement(s).
 - Precautionary statement(s).
 - Name, address and phone number.
- SDS (not Material Safety Data Sheet (MSDS)).
 - Uses a 16 section format.

Slide 4-24

LABEL EXAMPLE



Slide 4-25

IV. FLAMMABLE AND COMBUSTIBLE LIQUIDS

FLAMMABLE AND COMBUSTIBLE LIQUIDS

Of all hazardous materials, flammable and combustible liquids are probably the greatest concern.

- Not necessarily the most dangerous.
- Most common material found in a wider variety of occupancies.
- Comprise more emergency calls.
- Addressed in more detail by the codes.

Slide 4-26

- A. Of all the hazardous materials, flammable and combustible liquids are probably the greatest concern.
1. They are not more dangerous than explosives or toxic gases, but they are found more frequently in a wider variety of occupancies and comprise more of the emergency calls received by the fire department.
 2. Fire codes address the requirements for the safe storage, handling and use of these liquids in more detail.

FLAMMABLE LIQUID

- Liquid having a flashpoint below 100 °F and having a vapor pressure not exceeding 40 pounds per square inch (psi).
- Subclassifications:
 - Class IA — Flashpoint below 73 °F and having a boiling point below 100 °F.
 - Class IB — Flashpoint below 73 °F and boiling point at or above 100 °F.
 - Class IC — Flashpoint at or above 73 °F and below 100 °F.

Slide 4-27

- B. Flammable liquids.
1. A term used to designate any liquid having a flashpoint below 100 °F and having a vapor pressure not exceeding 40 pounds per square inch (psi) (2068.6 millimeters (mm)) at 100 °F (37.8 °C).
 2. Flammable liquids are further classified as:
 - a. Class I — Liquids having flashpoints below 100 °F and subdivided as follows:
 - Class IA — Flashpoint below 73 °F (22.8 °C) and having a boiling point below 100 °F.
 - Class IB — Flashpoint below 73 °F and having a boiling point at or above 100 °F.
 - Class IC — Flashpoint at or above 73 °F and below 100 °F.
 - b. Examples of the three classes are:
 - Class IA — ethyl chloride.

- Class IB — gasoline.
- Class IC — butyl alcohol.

COMBUSTIBLE LIQUID

- Liquid having a flashpoint at or above 100 °F.
- Subclassifications:
 - Class II — Flashpoint at or above 100 °F and below 140 °F.
 - Class IIIA — Flashpoint at or above 140 °F and below 200 °F.
 - Class IIIB — Flashpoint at or above 200 °F.

Slide 4-28

3. Combustible liquids.

- a. A term used to designate any liquid having a flashpoint at or above 100 °F (37.8 °C).
- b. This classification is subdivided as follows:
 - Class II — Liquids having a flashpoint at or above 100 °F (37.8 °C) and below 140 °F (60 °C).
 - Class IIIA — Liquids having a flashpoint at or above 140 °F (60 °C) and below 200 °F (93.4°C).
 - Class IIIB — Liquids having a flashpoint at or above 200 °F (93.4 °C).
- c. Examples of the three classes are:
 - Class II — kerosene or fuel oil 1.
 - Class IIIA — fuel oil 6.
 - Class IIIB — fish oil.

SOLIDS WITH FLASHPOINTS

- Chemicals which are solids at 100 °F or above.
- When heated, the solids become liquids, giving off flammable vapors, allowing flashpoints to be determined.
- Examples are sterno, paste waxes and polishes.

Slide 4-29

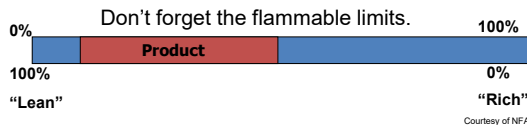
4. Solids with flashpoints.

- There are many chemicals that are solids at 100 °F or above and therefore are classified as solids.
- When heated, the solids become liquids, giving off flammable vapors, allowing flashpoints to be determined.
- When in a liquid state, these solids should be treated as liquids with similar flashpoints.
- These solids include paste waxes and polishes.
- The flashpoint and amount of liquid in the material will determine the degree of hazard.

DETERMINING CODE REQUIREMENTS

When determining code requirements, remember:

- Vapor will burn or explode.
- Liquid will not.



Slide 4-30

- C. In determining fire prevention code requirements, it is important to remember that it is the vapor of a flammable or combustible liquid, rather than the liquid itself, which will burn or explode.

PERMITS

International Fire Code (IFC) and NFPA 1, *Fire Code* require that permits be obtained from the authority having jurisdiction (AHJ)/fire code official for the storage, handling or use of flammable and combustible liquids that exceed a given amount.

Slide 4-31

- D. Permits.

Usually the codes require a permit for the storage, handling or use of flammable and combustible liquids that exceed a given amount. The permit is used to control who handles liquids, as well as where and when they are stored and used.

SOURCES OF IGNITION

- Open flames.
- Lightning.
- Smoking.
- Cutting and welding.
- Hot surfaces.
- Frictional heat.
- Sparks from static electrical discharge.



Slide 4-32

- E. Sources of ignition.

1. Some ignition sources may be obvious, such as unregulated smoking, open flames, heating appliances, or electrical faults (sparks, arcs and static).
2. Other ignition sources may be just as dangerous but less obvious: friction, compression, materials handling equipment (conveyors, powered industrial trucks), or even sunlight.

CONTAINER AND PORTABLE TANK STORAGE

- Portable tank has capacity over 60 gallons and is not intended for fixed installation.
- Container has capacity of 60 gallons or less.
- Safety-can capacity not over 5 gallons with spring-closing lid, spout cover, and pressure relief.

Slide 4-33

F. Container and portable tank storage.

1. Portable tank has capacity over 60 gallons and is not intended for fixed installation.
2. Container capacity of 60 gallons or less used for transporting or storing hazardous materials.
3. Safety-can is an approved container not more than 5-gallon capacity, having a spring-closing lid and spout cover so that it will relieve internal pressure when subjected to fire exposure.

FLAMMABLE LIQUID SAFETY CONTAINERS



Slide 4-34

INSIDE STORAGE

- Not more than 120 gallons in cabinet, of which not more 60 gallons can be Class I or Class II.
- IFC allows 120 gallons of Class I or Class II.
- Single containers — no larger than 5 gallons.



Slide 4-35

G. Inside storage.

1. Combined total liquid in cabinet cannot exceed 120 gallons.
2. Maximum 60 gallons of Class I and 60 gallons of Class II.

INSIDE STORAGE (cont'd)

- No more than three cabinets in any one fire area (100 feet between each cabinet).



Courtesy of NFPA

Slide 4-36

OUTDOOR STORAGE

- Minimum clearances provided between piles, property lines and public ways.
- Quantities limited based upon classification of liquids.
- Height limited based upon classification of liquids.



Courtesy of NFPA

Slide 4-37

H. Outdoor storage.

1. Minimum clearance is based upon the classification of the liquid class.

Example: Class IA, IB and IC.

- a. Five feet between piles.
 - b. Fifty feet to property line.
 - c. Ten feet to street or alley.
2. The storage area shall be kept free of weeds, debris and other combustible materials not necessary to the storage for a distance of at least 10 feet.

V. GASES, CHEMICALS AND EXPLOSIVES

GASES

Term applied only to substances which exist in the gaseous state at so called normal temperature and pressure (NTP) of 70 °F and 14.7 pounds per square inch absolute (PSIA).

Slide 4-38

A. Gases.

Gas is a term applied only to substances which exist in the gaseous state at so-called normal temperature and pressure (NTP) conditions (approximately 70 °F and 14.7 pounds per square inch absolute (PSIA)). Gases are further grouped into the following classes:

COMPRESSED GAS

- Varies by individual code.
- At normal temperature inside its container, exists solely in the gaseous state under pressure.
- In general, pressure exceeds 40 psi at 70 °F.



Slide 4-39

1. Compressed gas — At normal temperature inside its container, exists solely in the gaseous state under pressure (example: hydrogen).

LIQUEFIED GAS

- Exists at normal temperature inside its container, partly in the liquid state and partly in the gaseous state; under pressure as long as any liquid remains in the container.
- Example: liquefied petroleum gas (LPG).

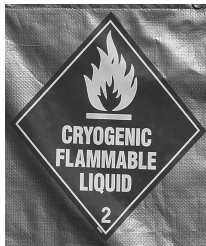


Slide 4-40

2. Liquefied gas — Exists at normal temperature inside its container, partly in the liquid state and partly in the gaseous state; under pressure as long as any liquid remains in the container (example: liquefied petroleum gas (LPG)).

CRYOGENIC GAS

- Liquefied gas which exists in its container at temperatures far below normal atmospheric temperatures, usually slightly above its boiling point.
- Example: liquid oxygen.



Slide 4-41

3. Cryogenic gas — A liquefied gas which exists in its container at temperatures far below normal atmospheric temperatures, usually slightly above its boiling point at NTP (example: liquid oxygen).

FLAMMABLE GAS

- Any gas which will burn with normal concentrations of oxygen in air.
- Example: acetylene.



Slide 4-42

4. Flammable gas — Any gas that will burn with normal concentrations of oxygen in the air (example: acetylene).

NONFLAMMABLE GAS

- Gas which will not burn in any concentration of air or oxygen.
- Example: nitrogen.

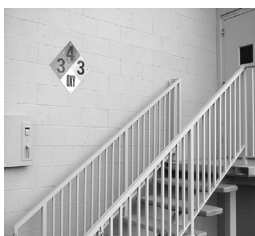


Slide 4-43

5. Nonflammable gas — Any gas that will not burn in any concentration of air or oxygen (example: nitrogen). Some nonflammable gases will support combustion and are referred to as “oxidizers” (example: oxygen).

REACTIVE GAS

- Gas that will react with other material or by itself with the production of potentially hazardous quantities of heat or reaction products.
- Examples: fluorine and silane (pyrophoric).



Slide 4-44

6. Reactive gas — Any gas that will react with other material or by itself (with the production of potentially hazardous quantities of heat or reaction products) (example: fluorine).

TOXIC GAS

- Gas that presents a serious life hazard when released into the atmosphere.
- Included are gases which are poisonous or irritating when inhaled or contacted.
- Examples: chlorine and sulfuryl fluoride.



Slide 4-45

7. Toxic gas — Any gas that presents a serious life hazard if released into the atmosphere. Included are gases that are poisonous or irritating when inhaled or contacted (example: chlorine).

FUEL GASES

Flammable gases used for heating.

- NFPA 54, *National Fuel Gas Code*.
- NFPA 58, *Liquefied Petroleum Gas Code*.
- NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*.

Slide 4-46

8. Fuel gases — Flammable gases used for heating.
- a. NFPA 54, *National Fuel Gas Code*.
 - b. NFPA 58, *Liquefied Petroleum Gas Code*.
 - c. NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*.

INDUSTRIAL GASES

Used for welding and cutting, chemical processes, refrigeration, etc.



Slide 4-47

9. Industrial gases — Used for welding and cutting, chemical processing, refrigeration, etc.

MEDICAL GASES

- Used for medical purposes, such as anesthesia and respiratory therapy.
 - Examples: oxygen, nitrous oxide.
- NFPA 99, *Health Care Facilities Code*.

Slide 4-48

10. Medical gases — Used for medical purposes, such as anesthesia and respiratory therapy.

FIRE CODES

- Address gases in general categories.
- Compressed gases.
- LPGs.
- Cryogenic.



Slide 4-49

11. Fire codes.

The fire prevention codes have sections on gases, LPGs and cryogenic gases, and they reference NFPA standards for code requirement.

COLOR CODING SYSTEMS FOR COMPRESSED GASES

- Published by the Compressed Gas Association (CGA).
- Voluntary “standard.”
- Not adopted or referenced by any other building or fire codes.
- System is not reliable since it is not widely used.

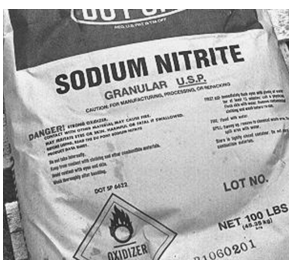


Courtesy of NFPA
Slide 4-50

12. Color coding systems for compressed gases.

CHEMICALS

- Typical inspector is not expected to be an “expert” in all hazardous chemicals.
- Must know where information can be obtained.



Courtesy of NFPA

Slide 4-51

B. Chemicals.

Role of the fire inspector.

1. The typical fire inspector cannot be expected to be an expert in all hazardous chemicals.
2. He or she should know where information may be obtained.
3. Research is essential in determining what fire prevention techniques to employ.

4. One cannot trust to memory the tremendous number and variety of hazardous materials.
5. The fire inspector is not expected to make on-the-spot decisions about hazardous materials (other than in an emergency situation).
6. Consult fire codes, NFPA standards, reference books and other experts.

EXPLOSIVES

- Very specialized area.
- Require a basic knowledge of explosives and terminology.



Courtesy of NFPA
Slide 4-52

C. Explosives.

1. The area of explosives and blasting agents is very specialized.
2. The inspector should have a basic knowledge of the requirements for explosives and an understanding of the nature and terminology of explosives in order to evaluate the hazard.
3. Inspectors should understand the basic precautions and have access to applicable regulations for the explosives and operations involved.
4. Regulation of the manufacture, distribution and storage by the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF).

EXPLOSIVE MATERIAL

- Explosive.
- Blasting agents.
- Water gels.
- Detonators.



Slide 4-53

5. Examples of explosive material.

FIREWORKS

- Most common explosive.
- Many states regulate sales and use by the general public.



Slide 4-54

D. Fireworks.

1. The most common explosive material is fireworks, which are a Class C explosive and sometimes Class B explosive.
2. Many states regulate sales and use by the general public.
3. The biggest problems are grass, roof and trash fires caused by fireworks.
4. Class B and C fireworks are used in public shows.
5. The DOT regulates transportation and shipping of these items.

“PUBLIC” DISPLAY

- NFPA 1123, *Code for Fireworks Display.*
- NFPA 1124, *Code for the Manufacture, Transportation, and Storage of Fireworks and Pyrotechnic Articles.*
- NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience.*



Slide 4-55

6. “Public” display.

Fire codes have a chapter that deals with explosives and fireworks and references several NFPA standards.

“PUBLIC” DISPLAY (cont’d)

- NFPA 160, *Standard for the Use of Flame Effects Before an Audience.*

Slide 4-56

ACTIVITY 4.1

Hazardous Material Code Search

Purpose

Identify the appropriate sections of the various fire codes dealing with the incidental storage, handling and use of flammable and combustible liquids, gases and hazardous materials.

Directions

Working individually, use your fire codes to answer the following questions regarding the incidental storage, handling and use of flammable and combustible liquids, gases and hazardous materials.

1. You are inspecting a warehouse, and in the basement, you find 50 lbs. of a (solid) Class II oxidizer. It is stored on a pallet and in two 25 lb. bags. Can it be stored in this capacity?

2. Can a Class I liquid be used for spot cleaning in a dry-cleaning facility?

3. In a high school chemistry lab, what is the maximum quantity of flammable IA liquids that can be allowed in a control area?

4. Is there any limit to the size of container and quantity of alcoholic beverages that can be kept in a retail sales area?

5. During the inspection of a restaurant with a seating area for 300 people, you find 15 gallons of lamp oil (Class IIIA liquid) in the original 1-gallon safety containers being stored in a one-hour fire-rated cabinet, in a closet. The building is protected by an automatic sprinkler system. Is this acceptable?

6. What is the maximum quantity of a Class IA flammable liquid that can be kept in any one listed storage cabinet?

7. What is the maximum quantity of a Level 2 aerosol that can be displayed in an open array in a ground-level general merchandise sales area? Building is protected by automatic sprinklers.

SPECIAL HAZARDS

8. You have just conducted an inspection of an automobile repair shop. During the inspection, you determine that employees have been using gasoline to spot clean the floor. Is the use of gasoline for this purpose acceptable?

9. During the inspection of a large painting contractor's warehouse, you find a 55-gallon drum of paint thinner (flashpoint of 98 °F, boiling point 150 °F). This drum is laying on its side in a metal cradle and is being dispensed into smaller containers by gravity with a manually controlled valve. Is this type of dispensing acceptable?

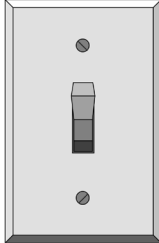
10. How much of a Class III liquid oxidizer material can be kept before a permit is required?

This page intentionally left blank.

VI. ELECTRICAL

ELECTRICAL

- Electrical systems are one of top five fire causes.
- You do not need to be electrical inspector or electrical engineer to recognize hazards.



Slide 4-58

A. Introduction.

1. Electrical systems are one of the five most common causes of fire; most of us are not electrical inspectors, engineers or experts. It is so important to recognize electrical hazards.
2. Most electrical problems result from some type of movement (switch, relay, receptacle, motor).
3. When excessive extension cords (zip cords) are used on a circuit, more resistance is encountered, and heat will start to build up.
4. If properly designed, installed and maintained, electrical systems are safe.
 - a. If not installed and maintained in accordance with well-established standards, they may introduce both fire and personal injury hazards.
 - b. Electricity may become a fire hazard through arcing or overheating of electrical equipment.
5. Work with local electrical inspectors in correcting the deficiency.

ELECTRICAL THEORY

- Hydraulic versus electrical.

Hydraulic	Electrical
Water/Fluid	Electrons
Pump	Generator
Pressure	Voltage
Psi	Volts
Flow	Current
Gallons per minute (gpm)	Amperes
Friction loss in hoseline	Resistance

Slide 4-59

B. Electrical theory.

1. Hydraulics versus electrical.

ELECTRICAL THEORY (cont'd)

- Ohm's Law is stated as:
 - “The amount of current flowing in a circuit made up of pure resistance is directly proportional to the electromotive forces impressed on the circuit and inversely proportional to the total resistance of the circuit.”

Slide 4-60

2. Ohm's Law.

- Ohm's Law was named after Georg Simon Ohm (1787 to 1854).
- “The amount of current flowing in a circuit made up of pure resistance is directly proportional to the electromotive forces impressed on the circuit and inversely proportional to the total resistance of the circuit.”

OHM'S LAW — POWER VARIATION

$$P = IV$$

- P — Power (watts).
- I — Current (amperes).
- V — Voltage (volts).

Slide 4-61

c. Ohm's Law — Power variation.

OHM'S LAW — RESISTANCE VARIATION

$$V = IR$$

- V — Voltage (volts).
- I — Current (amperes).
- R — Resistance (ohms).

Slide 4-62

d. Ohm's Law — Resistance variation.

OVERLOAD

- An extension cord is supplying power to two space heaters.
 - Heater A **1,500 watts**
 - Heater B **1,500 watts**
3,000 watts
- Supplied voltage — **120 volts.**
- **$I = P \div V$ or E (Example: $3,000w \div 120v = 25 \text{ amps.}$)**
- Cord rated at 10 amps.
- **25 amps through a 10 amp cord = FIRE.**

Slide 4-63

e. Overload.

BASIC TERMS

- Electricity.
 - The flow of electrons due to a difference in energy potential between two points on a conductor.
- Ampere (amp).
 - Amount (density/strength) of current flow.
- Voltage (volts).
 - Electrical pressure (force) that moves the electrons through the conductor.

Slide 4-64

C. Basic terms.

1. Electricity.

The flow of electrons due to a difference in energy potential between two points on a conductor.

2. Ampere (amp).

Amount (density/strength) of current flow.

3. Voltage (volts).

Electrical pressure (force) that moves the electrons through the conductor.

BASIC TERMS (cont'd)

- Resistance (R).
 - Opposition to flow of electrical force.
 - Measured in ohms.
- Watt (power or kW).
 - Rate at which electrical energy is consumed in an electrical circuit.
 - Watt = volts x amps.
 - Kilowatt = 1,000 watts.

Slide 4-65

4. Resistance (R).

Opposition to flow of electrical force. Measured in ohms.

5. Watt (power or kW).

Rate at which electrical energy is consumed in an electrical circuit.

a. Watt = volts x amps.

b. Kilowatt = 1,000 watts.

BASIC TERMS (cont'd)

- Conductors (wire).
 - Materials that allow current to flow freely with minimal resistance.
 - Bare — no insulation.
 - Covered/Insulated — encased within a material or composition.

Slide 4-66

6. Conductors (wire).

Materials that allow current to flow freely with minimal resistance.

a. Bare — no insulation.

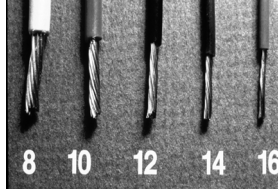
b. Covered/Insulated — encased within a material or composition.

c. Copper and aluminum — two of the most recognized; both are used in electrical systems.

d. Gold and silver also used, usually at point of contact.

WIRE

- Size varies with load current circuit intended to carry.
- Performance is affected by conductor material, size and insulation type.
- Smaller numerical designation equates to larger physical size and higher capacity.



Slide 4-67

- e. Size varies with load current circuit intended to carry.
- f. Performance is affected by conductor material, size and insulation type.
- g. Smaller numerical designation equates to larger physical size and higher capacity.

WIRE (cont'd)

- New construction specifies sizes based upon installation method and insulation material.

Slide 4-68

- h. New construction specifies sizes based upon installation method and insulation material.

INSULATORS

Work the opposite of conductors; oppose or stop the flow of current. Some insulators are glass, porcelain, air and pure water.



Slide 4-69

7. Insulators.

Substances which strongly oppose flow of electricity. Some insulators are glass, porcelain, air and pure water.

KNOB AND TUBE WIRING

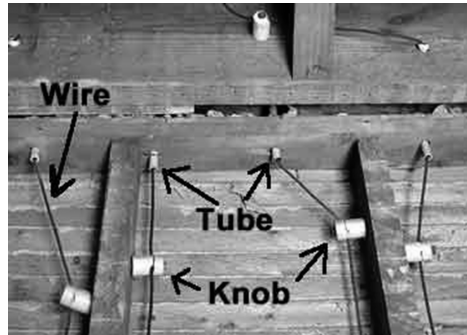
- Wires bare or insulation deteriorated.
- Wiring not properly separated from each other and metal objects.
- Wiring not properly supported.
- Called “open wiring” in the new construction.
- Restrictions on new installations per Article 398 to only industrial or agricultural.

Slide 4-70

8. Knob and tube wiring.

- a. Wires bare or insulation deteriorated.
- b. Wiring not properly separated from each other and metal objects.
- c. Wiring not properly supported.
- d. Called “open wiring” in the new construction.
- e. Restrictions on new installations per Article 398 (NFPA 70, *National Electrical Code*®, 2017 edition) to only industrial or agricultural.

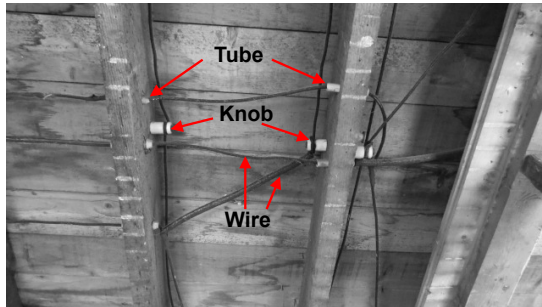
KNOB AND TUBE INSULATORS



Courtesy of C. Thompson

Slide 4-71

KNOB AND TUBE INSULATORS (cont'd)



Slide 4-72

OVERLOAD (cont'd)

- Operation of equipment in excess of normal, full load rating, or of a conductor in excess of the rated capacity that, when it persists for a sufficient period of time, would cause damage or dangerous overheating.
- A fault, such as a ground fault, is not an overload.

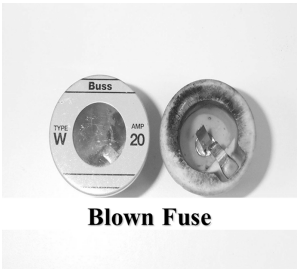
Slide 4-73

9. Overload.

- a. Operation of equipment in excess of normal, full load rating, or of a conductor in excess of the rated capacity that, when it persists for a sufficient period of time, would cause damage or dangerous overheating.
- b. A fault, such as a ground fault, is not an overload.

SHORT CIRCUIT

Leaves the normal circuit; takes "short-cut" around the load and back to the source.



Blown Fuse

Courtesy of NFA

Slide 4-74

10. Short circuit.

Leaves the normal circuit; takes a "short-cut" around the load and back to the source.

GROUND

- Electrical systems must be properly grounded to prevent shock and fire hazards.
- A "ground" is defined as a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth or some conducting body serving in place of the earth.

Slide 4-75

11. Ground.

- a. Electrical systems must be properly grounded to prevent shock and fire hazards.

- b. A “ground” is defined as a conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth or some conducting body serving in place of the earth.

APPROVAL

- All conductors and equipment are required to be approved.
- Approved means acceptable to the AHJ/ Fire Code Official.
- Usually relies upon third-party testing and listing.

Slide 4-76

12. Approval.

- a. All conductors and equipment are required to be approved.
- b. Approved means acceptable to the authority having jurisdiction (AHJ)/fire code official.
- c. Usually relies upon third-party testing and listing.

UNDERWRITERS LABORATORIES

- Only a sample device is tested by Underwriters Laboratories (UL). All devices are not tested.
- Listing assumes proper assembly and maintenance.
- Devices and equipment directories.



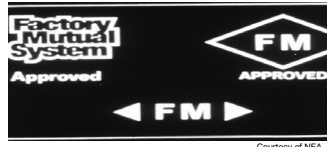
Courtesy of NFA
Slide 4-77

13. Underwriters Laboratories (UL) listed — tested by UL, Inc.

This means that a sample of the device was tested by the UL, not that each device was tested. Therefore, the listing assumes proper assembly and maintenance.

FACTORY MUTUAL

- Maintains an electrical testing laboratory.
- Uses same formats as UL for testing equipment and devices.



Slide 4-78

14. Factory Mutual.

- a. Maintains an electrical testing laboratory and is a highly reputable testing lab.
- b. Uses the same formats as UL for testing its equipment or devices (selected sample devices).

ELECTRICAL TESTING LABORATORIES

- Only performs electrical testing.
- Uses same formats as UL for testing equipment and devices.

Slide 4-79

15. Electrical Testing Laboratories (ETL).

- a. Only performs electrical testing.
- b. Uses same formats as UL for testing equipment and devices.

OVERCURRENT PROTECTION

- Protecting against any current in excess of the rated current of equipment or the ampacity of a conductor.
- It may result from overload, short circuit, or ground fault.
- Most common devices are fuses and circuit breakers.



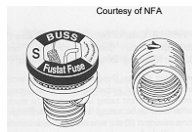
Slide 4-80

16. Overcurrent protection.

- a. Protecting against any current in excess of the rated current of equipment or the ampacity of a conductor.
- b. It may result from overload, short circuit, or ground fault.
- c. Most common devices are fuses and circuit breakers.

SCREW-IN TYPES

- Edison — may be used only as replacement where there is no evidence of tampering or over fusing.
- Type S — tamper resistant.



Slide 4-81

17. Screw-in type.

- a. Hexagon window is 15 amps.
- b. Round window is 20 and 25 amps.

CARTRIDGE TYPE

- One time only.
- Renewable.

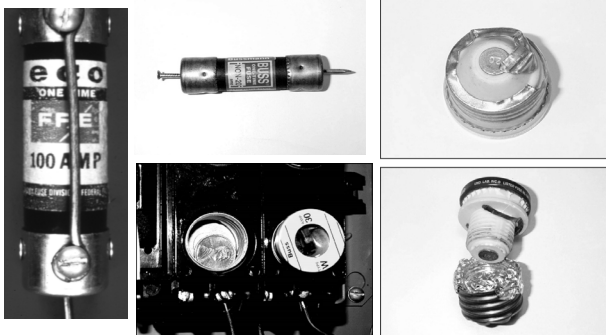


Slide 4-82

18. Cartridge type.

Contains a fusible link that opens when an electrical fault occurs. Size and rating is marked on the fuse itself. Usually over 30 amps.

TAMPERING

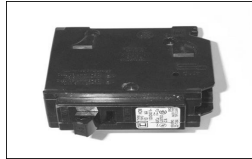


Slide 4-83

19. Tampering.

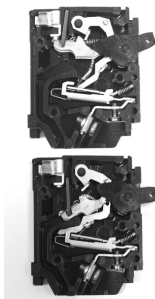
CIRCUIT BREAKERS

- Device designed to open and close a circuit by a nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating.
- Adjustable and nonadjustable.



Slide 4-84

CIRCUIT BREAKERS (cont'd)



On

Tripped

Courtesy of NFA

Slide 4-85

20. Circuit breakers.

- a. Device designed to open and close a circuit by a nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating.
- b. Adjustable and nonadjustable.

ADJUSTABLE

- Circuit breaker can be set to trip at various values of current, time or both, within a predetermined range.
- Generally used only in larger installations.
- Can be found as the “main” or on other large loads.



Slide 4-86

21. Adjustable.

- a. Circuit breaker can be set to trip at various values of current, time or both, within a predetermined range.
- b. Generally used only in larger installations.
- c. Can be found as the “main” or on other large loads.

FIXED

- Circuit breaker does not have any field adjustment to alter the value of current at which it will trip or the time required for its operation.
- Most common type.
- Tampering with factory set screw should be further investigated.

Slide 4-87

22. Fixed.

- a. Circuit breaker does not have any field adjustment to alter the value of current at which it will trip or the time required for its operation.
- b. Most common type.
- c. Tampering with factory set screw should be further investigated.

GROUND-FAULT CIRCUIT INTERRUPTERS

- May be incorporated into a circuit breaker or receptacle.
- Provide personnel protection against shock.
- Trip at 4 to 6 milliampere (mA).



Courtesy of C. Thompson
Slide 4-88

23. Ground-fault circuit interrupters (GFCIs).
- May be incorporated into a circuit breaker or receptacle.
 - Provide personnel protection against shock.
 - Trip at 4 to 6 milliampere (mA).

GROUND-FAULT CIRCUIT INTERRUPTER USES

Potential uses:

- Bathrooms.
- Kitchens.
- Garages and outdoors.
- Laundry rooms.
- Pools, bathhouses and fountains.
- Construction sites.



Courtesy of C. Thompson

Slide 4-89

ARC-FAULT CIRCUIT INTERRUPTERS

- Intended to provide protection from the effects of arcs.
- Recognizes characteristics unique to arcing.



Courtesy of C. Thompson

Slide 4-90

24. Arc-fault circuit interrupters (AFCIs)

- a. Intended to provide protection from the effects of arcs.
- b. Recognizes characteristics unique to arcing.

WHERE REQUIRED BY NEW CONSTRUCTION

- New construction — dwelling units.
- All 120-volt 15- and 20-amp branch circuits.
- Outlets in family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar areas.

Slide 4-91

25. Where required by new construction.

- a. New construction — dwelling units.
- b. All 120-volt 15- and 20-amp branch circuits.
- c. Outlets in family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, or similar areas.

PANELBOARDS

- Must be provided with covers.
- Circuits must be identified.
- Must be used in accordance with its listing.
- Knockouts sealed.
- Cables secured.

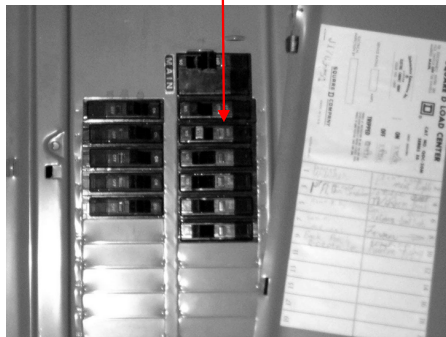


Slide 4-92

26. Panelboards.

- a. Must be provided with covers.
- b. Circuits must be identified.
- c. Must be used in accordance with its listing.
- d. Knockouts sealed.
- e. Cables secured.

TRIPPED BREAKER



Slide 4-93

DISTRIBUTION PANELS

- May be service entrance equipment.
- Carry heavier loads.
- May serve smaller panelboards through building.



Slide 4-94

27. Distribution panels.

- a. May be service entrance equipment.
- b. Carry heavier loads.
- c. May serve smaller panelboards through building.

OUTLETS

- Must have covers.
- Must be securely fastened.
- If floor mounted, must be listed for such use.
- If outdoors, must have weatherproof cover.



Courtesy of NFPA

Slide 4-95

28. Outlets.

- a. Must have covers.
- b. Must be securely fastened.
- c. If floor mounted, must be listed for such use.
- d. If outdoors, must have weatherproof cover.

- e. Floor receptacles — unprotected from trash and dust, must have an approved cover.

JUNCTION BOXES

- Must have covers.
- Must be securely fastened.
- Cables secured.
- Knockouts sealed.



Photos courtesy of NFA

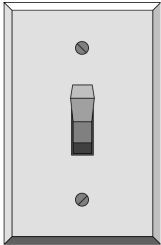
Slide 4-96

29. Junction boxes.

- a. Must have covers.
- b. Must be securely fastened.
- c. Cables secured.
- d. Knockouts sealed.

SWITCHES

- General use — for use in branch circuits.
- Disconnects — for use at equipment (must be identified).
- Not enclosed in proper box or cabinet.
- Poor maintenance.
- Not properly marked.



Slide 4-97

30. Switches.

- a. General use — for use in branch circuits.
- b. Disconnects — for use at equipment (must be identified).

- c. Not enclosed in proper box or cabinet.
- d. Poor maintenance.
- e. Not properly marked.

PORTABLE LAMPS/LIGHTING

- Operate at temperatures sufficient to ignite ordinary combustibles.
- Broken lamps can ignite flammable vapors.
- Should not be used in areas such as paint spray rooms, etc.
- Must be listed.



Slide 4-98

31. Portable lamps/lighting.

- a. Lamps often operate at temperatures sufficient to ignite combustible material, or are not mounted to provide safe clearances.
- b. Portable lamps, if unguarded, may ignite paper, wood, cloth, etc., if in contact with them.
- c. A broken lamp, such as a mechanic's trouble lamp, can ignite flammable vapors.
- d. Portable lamps should not be used in areas such as paint spray rooms, etc.
- e. Portable lamps should be of suitable approved types having sturdy guards and cords.

LIGHTING FIXTURES

- Deteriorated, dirty, poorly maintained or subject to moisture.
- Not properly secured.
- Exposed conductors.
- Lamp guards missing where required.

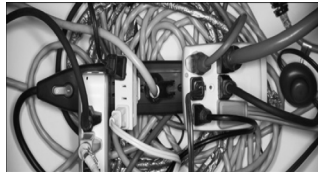
Slide 4-99

32. Lighting fixtures.

- a. Deteriorated, dirty, poorly maintained or subject to moisture.
- b. Not properly secured.
- c. Exposed conductors.
- d. Lamp guards missing where required.

FLEXIBLE CORDS

- Used in place of permanent wiring.
- Not listed.
- Spliced.
- Tied to or draped over pipes or other supports.
- Under carpets or subject to foot traffic.
- Overloaded.



Slide 4-100

33. Flexible cords.

- a. Used in place of permanent wiring.
- b. Not listed.
- c. Spliced.

- d. Tied to or draped over pipes or other supports.
- e. Under carpets or subject to foot traffic.
- f. Overloaded.

IFC AND NFPA 1

- Not as substitute for permanent wiring.
- Use only with portable appliances.
- Connected directly into an approved receptacle.
- Serve only one appliance, except approved multiplug strips.
- Capacity not less than the rated capacity of appliance.

Slide 4-101

34. IFC and NFPA 1 requirements.

- a. Not as substitute for permanent wiring.
- b. Use only with portable appliances.
- c. Connected directly into an approved receptacle.
- d. Serve only one appliance, except approved multiplug strips.
- e. Capacity not less than the rated capacity of appliance.

IFC AND NFPA 1 (cont'd)

- Maintained in good condition without splices, deterioration or damage.
- Be of grounded type when servicing grounded appliances.
- Not affixed to structures.
- Not extended through walls, ceilings, floors, under doors or floor coverings.
- Not subject to environmental damage or physical impact.

Slide 4-102

- f. Maintained in good condition without splices, deterioration or damage.
- g. Be of grounded type when servicing grounded appliances.
- h. Not affixed to structures.
- i. Not extended through walls, ceilings, floors, under doors or floor coverings.
- j. Not subject to environmental damage or physical impact.

RECEPTACLES

- Insufficient number provided.
- Inadequate location.
- Use of multiplug adapters.



Slide 4-103

35. Receptacles.
- a. Insufficient number provided.
 - b. Inadequate location.
 - c. Use of multiplug adapters.

MULTIOUTLET ASSEMBLIES

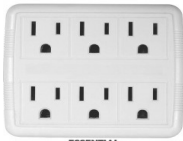
- Addressed by IFC and NFPA 1.
- Multiplug adapters, such as cube adapters, unfused plug strips or any other device not complying with NFPA 70, *National Electrical Code®*, are prohibited.
- Address the use of “power taps.”

Slide 4-104

36. Multioutlet assemblies.
- Addressed by IFC and NFPA 1.
 - Multiplug adapters, such as cube adapters, unfused plug strips or any other device not complying with NFPA 70, *National Electrical Code*[®], are prohibited.
 - Address the use of “power taps.”

POWER TAPS

- Device for indoor use.
- Attachment plug on one end of a flexible cord and two or more receptacles on the other end.
- Provided with overcurrent protection.



ESSENTIAL HARDWARE

Slide 4-105

37. Power taps.
- Device for indoor use.
 - Attachment plug on one end of a flexible cord and two or more receptacles on the other end.
 - Provided with overcurrent protection.

POWER TAPS (cont'd)

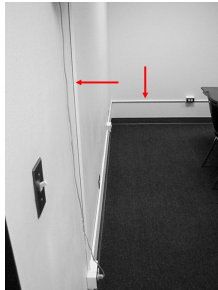
- Must be polarized or grounded type and listed.
- Connected directly to a permanently installed receptacle.
- No extend through walls, ceilings, floors, under doors or floor coverings.
- Not subject to environmental or physical damage.

Slide 4-106

- d. Must be polarized or grounded type and listed.
- e. Connected directly to a permanently installed receptacle.
- f. No extend through walls, ceilings, floors, under doors or floor coverings.
- g. Not subject to environmental or physical damage.

CONDUITS AND RACEWAYS

- Badly deteriorated.
- Not securely fastened in position.
- Not securely fastened to outlet boxes, cabinets or equipment.



Slide 4-107

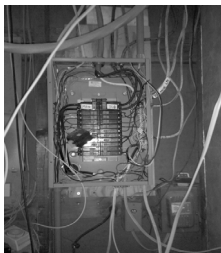
38. Conduits and raceways.

Raceway. An enclosed channel for wires or cables, usually metal or insulating material.

- a. Badly deteriorated.
- b. Not securely fastened in position.
- c. Not securely fastened to outlet boxes, cabinets or equipment.

BOXES AND CABINETS

- Door of cabinet missing or does not close.
- No cover on junction box.
- Unused openings not closed.
- Inadequate clearance in front and around cabinets (3-foot working clearance).



Slide 4-108

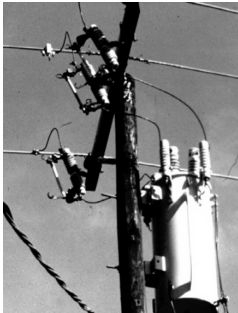
39. Boxes and cabinets.
- a. Door of cabinet missing or does not close.
 - b. No cover on junction box.
 - c. Unused openings not closed.



- d. Inadequate clearance in front and around cabinets (3-foot working clearance).

TRANSFORMERS

- Used to raise or lower voltage of alternating currents.
- Dry or oil filled.



Courtesy of NFA
Slide 4-110

40. Transformers.
- a. Used to raise or lower voltage of alternating currents.
 - b. Dry or oil filled.

TRANSFORMERS (cont'd)

- Fire characteristics of oil can vary substantially.
- May be located inside and outside.
- Polychlorinated biphenol (PCB) may be present in older equipment.



Courtesy of NFA

Courtesy of NFA
Slide 4-111

- c. Fire characteristics of oil can vary substantially.
- d. May be located inside and outside.
- e. Polychlorinated biphenyl (PCB) may be present in older equipment.

MOTORS

- Sparking, arcing or overheating may occur within the motor itself or in its starting equipment.
- Must be installed in accordance with its listing.
- Good housekeeping and maintenance is a must.



Slide 4-112

41. Motors.

- a. Sparking, arcing or overheating may occur in the motor itself, or in its starting equipment.
- b. Good housekeeping should be maintained at switches, controllers and other devices.
- c. Cleaning and overhauling should be done according to the needs of the equipment.
- d. Be suspicious of noisy electrical motors.

- e. The noises could indicate burned-out bearings or other serious mechanical problems. This is common with heating and air conditioning units and with commercial refrigeration units.

HAZARDOUS LOCATIONS

- Known in new construction as “classified locations.”
- Covered in new construction Article 500.
- Classification based on properties of flammable vapors, liquids or gases; **or** combustible dusts or fibers that may be present and the likelihood that a flammable or combustible concentration or quantity is present.
- Classes — Divisions — Groups.

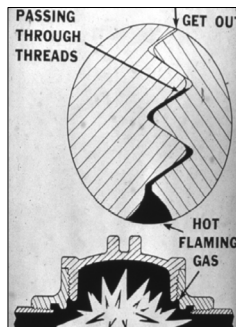
Slide 4-113

D. Hazardous locations.

1. Known in new construction as “classified locations.”
2. Covered in new construction Article 500 of NFPA 70, 2017 edition.
3. Classification based on properties of flammable vapors, liquids or gases; **or** combustible dusts or fibers that may be present and the likelihood that a flammable or combustible concentration or quantity is present.
4. Classes — Divisions — Groups.

EXPLOSION PROOF

- Concept is that if vapor gets into the electrical system and ignites, the flame will not propagate outside the fixture or wiring.
- Also designed to minimize the entrance of hazardous materials.

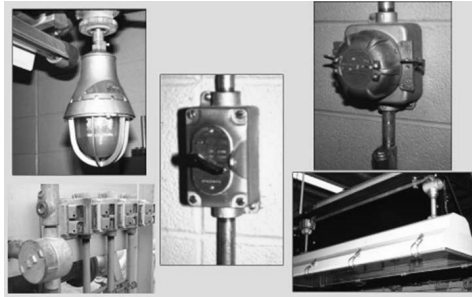


Slide 4-114

5. Explosion proof.

- a. Concept is that if vapor gets into the electrical system and ignites, the flame will not propagate outside the fixture or wiring.
- b. Also designed to minimize the entrance of hazardous materials.

SAMPLE EQUIPMENT



Slide 4-115

CLASSES

- Class I.
 - Flammable vapors or gases are present to produce ignitable mixture.
- Class II.
 - Combustible or conductive dusts are present.
- Class III.
 - Ignitable fibers are present.
 - Not sufficient quantity to produce ignition.

Slide 4-116

6. Classes.
 - a. Class I.
 - Flammable vapors or gases are present to produce ignitable mixture.
 - b. Class II.
 - Combustible or conductive dusts are present.

c. Class III.

- Ignitable fibers are present.
- Not sufficient quantity to produce ignition.

DIVISIONS

- Division 1.
 - Substance is present during normal conditions and operations.
- Division 2.
 - Substance present only during abnormal conditions.
 - Container failure.
 - Operational breakdown.

Slide 4-117

7. Divisions.

a. Division 1.

- Substance is present during normal conditions and operations.

b. Division 2.

- Substance present only during abnormal conditions.
 - Container failure.
 - Operational breakdown.

GROUPS

Group	Sample Products
A	Acetylene
B	Hydrogen and fuel gases
C	Ethyl and ethylene
D	Gasoline, acetone, ammonia, benzene
E	Combustible metal dusts: aluminum
F	Carbon dusts: charcoal, coal
G	Flour, wood, grain and plastic dusts

Slide 4-118

8. Groups.

SPRAY BOOTH



Courtesy of NFA

Slide 4-119

9. Spray booth.

UNACCEPTABLE MODIFICATION TO "LISTED" SPRAY BOOTH



Courtesy of NFA

Slide 4-120

STATIC ELECTRICITY

The electrification of materials through physical contact and separation.



Courtesy of NFA
Slide 4-121

E. Static electricity.

The electrification of materials through physical contact and separation.

GENERAL

- Precautions are needed in locations where flammable vapors, gases or dust are present, or where there are easily ignited materials.
- Flowing gases, liquids or granular solids generate static electricity.
- If discharge occurs, spark is caused and ignition of surrounding materials can occur.

Slide 4-122

1. General.

- a. Precautions are needed in locations where flammable vapors, gases or dust are present, or where there are easily ignited materials.
- b. Flowing gases, liquids or granular solids generate static electricity.
- c. If discharge occurs, spark is caused and ignition of surrounding materials can occur.

FOUR NECESSARY CONDITIONS

- Means of generation.
- Means of accumulating the charge and maintaining a difference of potential.
- A spark discharge of adequate energy.
- Spark occurs in an ignitable mixture.

Slide 4-123

2. Four necessary conditions.

- a. Means of generation.
- b. Means of accumulating the charge and maintaining a difference of potential.
- c. A spark discharge of adequate energy.
- d. Spark occurs in an ignitable mixture.

PREVENTION METHODS

- Methods for bringing the situation under control include:
 - Humidification.
 - Bonding, grounding.
 - Ionization.
- Or combination of the three.

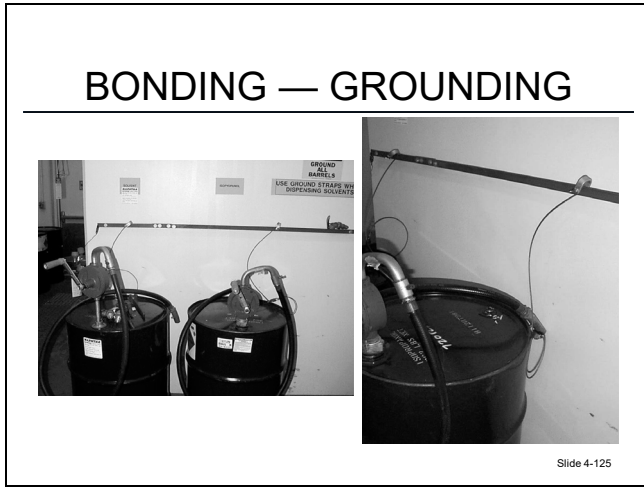
Slide 4-124

3. Prevention methods.

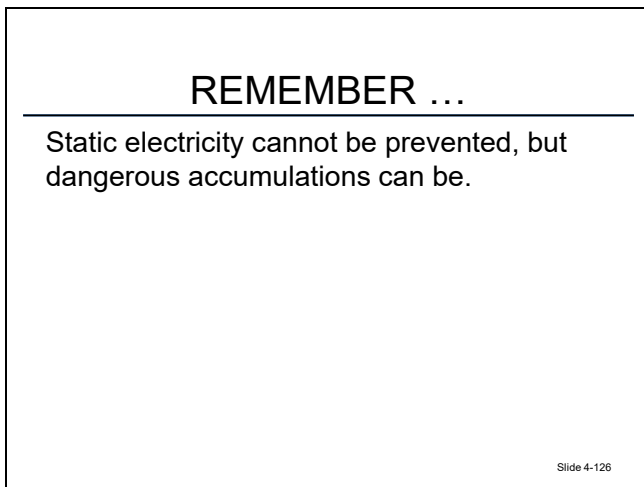
- a. Methods for bringing the situation under control include:
 - Humidification.
 - Bonding, grounding.

- Ionization.

b. Or combination of the three.



4. Bonding and grounding.



This page intentionally left blank.

ACTIVITY 4.2

Electrical Code Search

Purpose

Research and become familiar with your fire codes and how to deal with electrical problems encountered during an inspection.

Directions

Working individually, use your fire codes and answer the following questions. Site code references for you answers.

1. When using an extension cord for a portable appliance, can the current capacity of the extension cord be less than the rated capacity of the appliance?

2. What is the minimum clearance for access to an electrical control panel?

3. Must a container of ethylene be bonded or grounded?

4. May temporary wiring be attached to a structure?

SPECIAL HAZARDS

5. Must relocatable power taps be polarized type or grounded type? Must they be listed?

6. May a 50-foot cut and frayed extension cord be used as wiring?

7. Temporary wiring for electrical power and lighting installations is allowed for a period not to exceed how many days?

8. Must static-producing equipment located in flammable gas areas be grounded?

9. When dispensing a Class I liquid inside of a building, must you provide for adequate bonding and grounding?

10. Must explosive-proof wiring and equipment be used in flammable vapor areas in flammable finishing operations?

This page intentionally left blank.

VII. HEATING SYSTEMS AND EQUIPMENT

**HEATING SYSTEMS —
EQUIPMENT**

- Found in most occupancies.
- One of the most prevalent fire causes since they operate at or above the normal ignition temperature of many combustible materials.

Slide 4-128

- A. Heating, ventilating and air conditioning (HVAC) systems are found in most occupancies and present unique problems for the inspector.
- B. There are various types of systems the inspector will come in contact with during his or her inspection duties.
- C. Heating appliances and equipment are one of the most prevalent causes of fires because their function is to operate at or above the normal ignition temperature of many combustible materials.
- D. Defective or overheated heating units are among the leading causes of fires.

COMMON HAZARDS

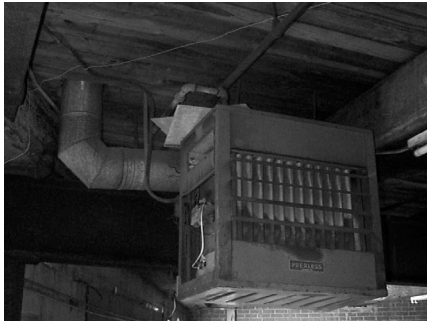
- Improper installation.
- Improper maintenance.
- Improper operation.
- Inadequate clearance of appliances and combustible materials.
- Inadequate clearance of flue and vents.
- Inadequate clearance of steam pipes.

Slide 4-129

- E. Common hazards.
1. Improper installation.

2. Improper maintenance.
3. Improper operation.
4. Inadequate clearance of appliances and combustible materials.
5. Inadequate clearance of flue and vents.
6. Inadequate clearance of steam pipes.

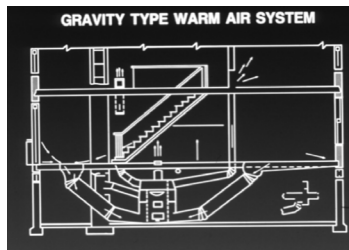
SUSPENDED GAS HEATER



Slide 4-130

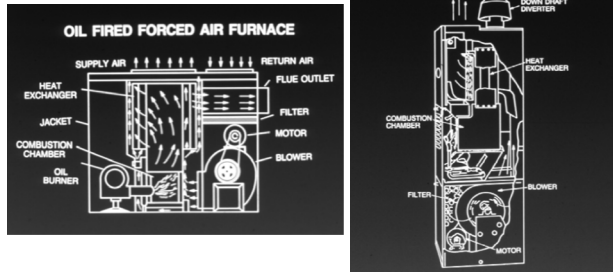
WARM AIR FURNACE

- Gravity type.
- Gravity type with integrated fan.
- Gravity boost fan.



Slide 4-131

WARM AIR FURNACE (cont'd)



Slide 4-132

F. Warm air furnace.

1. Gravity type.

- Movement of air is by gravity.
- Gravity furnaces are floor mounted and heat the space around them.

2. Gravity type with integrated fan.

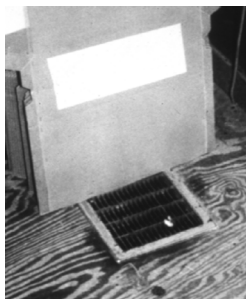
For overcoming internal resistance to air flow, fan is part of the construction of the furnace.

3. Gravity boost fan.

- Fan does not restrict flow of air.
- Flow of air is by gravity when fan is not operating.

PROBLEMS

Floor vent



Return air vent

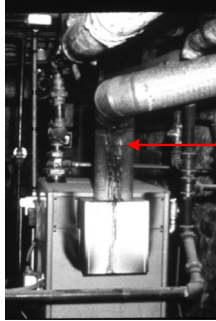


Slide 4-133

G. Problems.

1. Floor vent restricted.
2. Return air vent dirty and restricted.

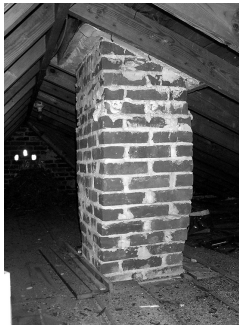
A FEW MORE PROBLEMS



Slide 4-134

FIREPLACES — CHIMNEYS

- Masonry.
- Factory built.
- Metal.
- Building codes.
- Mechanical codes.
- NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*.
- NFPA 54.



Slide 4-135

H. Fireplaces — chimneys.

1. Masonry.
2. Factory built (must meet UL 103, *Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances*, 2015 edition).
3. Metal.
4. Building codes.
5. Mechanical codes.

6. NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*.
7. NFPA 54, 2015 edition.

FIRE CAUSES

- Ignition by radiation of combustibles.
- Ignition of sparks.
- Burning improper materials or fuels.

Slide 4-136

- I. Fire causes.
 1. Ignition by radiation of combustibles.
 2. Ignition of sparks.
 3. Burning improper materials or fuels.

MAINTENANCE

- NFPA 211.
- All chimneys, fireplaces, vents, connectors, spark arrestors, cleanouts and tee fittings must be inspected at least once a year for soundness, freedom from deposits and correct clearances.
- Cleaning, maintenance and repairs shall be done if necessary.

Slide 4-137

- J. Maintenance.
 1. NFPA 211.

2. All chimneys, fireplaces, vents, connectors, spark arrestors, cleanouts and tee fittings must be inspected at least once a year for soundness, freedom from deposits and correct clearances.
3. Cleaning, maintenance and repairs shall be done if necessary.

PORTABLE/SPACE HEATERS

- Electric.
- Kerosene.
- Gas.

Slide 4-138

K. Portable/Space heaters.

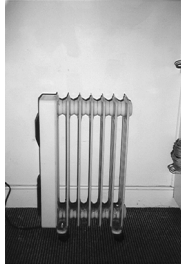
1. Electric.
2. Kerosene.
3. Gas.

ELECTRIC HEATERS

- Too close to combustibles.
- Use of extension cords.



Electric Oil Heater



Slide 4-139

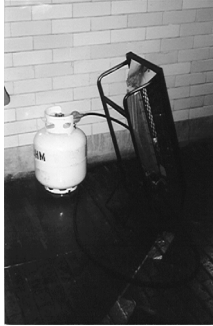
L. Electric heaters.

1. Too close to combustibles.

2. Use of extension cords.

LIQUEFIED PETROLEUM GAS SPACE HEATER

- Not properly vented.
- Too close to combustibles.
- Not following the manufacturer's instructions for clearances.
- Check the manufacturer's instructions for proper use, ventilation/enough fresh air.



Slide 4-140

M. LPG space heater.

1. Not properly vented.
2. Too close to combustibles.
3. Not following the manufacturer's instructions for use and clearances.
4. Check the manufacturer's instructions for proper use, ventilation/enough fresh air.

KEROSENE

- Too close to combustibles.
- Improper fuel.
- Inadequate ventilation.
- Improper storage of fuel.



Slide 4-141

N. Kerosene.

1. Too close to combustibles.
2. Improper fuel.

3. Inadequate ventilation.
4. Improper storage of fuel.

COMMON PROBLEMS WITH GAS SPACE HEATERS

- Too close to combustibles.
- Inadequate ventilation.
- Improper conversion.



Slide 4-142

O. Common problems with gas space heaters.

1. Too close to combustibles.
2. Inadequate ventilation.
3. Improper conversion.

PROHIBITED LOCATIONS

- May not be installed in bathroom, bedrooms or occupied rooms normally kept closed, unless of the direct vent type.
- In residential garages, burner must be at least 18 inches above floor.
- May not be installed in any area where flammable vapors are likely to be present, unless the burner is 18 inches above floor.

Slide 4-143

P. Prohibited locations.

1. May not be installed in bathroom, bedrooms or occupied rooms normally kept closed, unless of the direct vent type.
2. In residential garages, burner must be at least 18 inches above floor.

3. May not be installed in any area where flammable vapors are likely to be present, unless the burner is 18 inches above floor.

GAS FIRED WATER HEATERS

- May not be installed in bathroom, bedrooms or occupied rooms normally kept closed, unless of the direct vent type.
- In residential garages, burner must be at least 18 inches above floor.
- May not be installed in any area where flammable vapors are likely to be present, unless the burner is 18 inches above floor.

Slide 4-144

Q. Gas fired water heaters.

1. May not be installed in bathroom, bedrooms or occupied rooms normally kept closed, unless of the direct vent type.
2. In residential garages, burner must be at least 18 inches above floor.
3. May not be installed in any area where flammable vapors are likely to be present, unless the burner is 18 inches above floor.

SOLID FUEL STOVES

- Improper clearances.
- Use of flammable/combustible liquids.
- Improper chimney/flue.
- Improper fuel.
- Inadequate maintenance of chimney/flue.



Slide 4-145

- R. Solid fuel stoves.
1. Improper clearances.
 2. Use of flammable/combustible liquids.
 3. Improper chimney/flue.
 4. Improper fuel.
 5. Inadequate maintenance of chimney/flue.

SOLID FUEL STOVES (cont'd)



Slide 4-146

VENT PIPES

- Single wall.
 - May not originate in any unoccupied space.
 - May not pass through any attic, inside wall or concealed space.
 - Minimum of 6 inch clearance from combustible materials.



Slide 4-147

- S. Vent pipes.
1. Single wall.
 - a. May not originate in any unoccupied space.

- b. May not pass through any attic, inside wall or concealed space.
- c. Minimum of 6 inch clearance from combustible materials.

VENT PIPES (cont'd)

- Type B.
 - Metal.
 - Double wall.
 - Can be run directly through roof or wall to exterior of building.
 - Used for gas appliance with draft hood.



Slide 4-148

2. Type B.

- a. Metal.
- b. Double wall.
- c. Can be run directly through roof or wall to exterior of building.

VENT PIPES (cont'd)

- Type BW.
 - Metal.
 - Double wall.
 - Used for recessed gas furnaces.



Slide 4-149

3. Type BW.

- a. Metal.
- b. Double wall.

- c. Used for recessed gas furnaces.

VENT PIPES (cont'd)

- Type L.
 - Metal.
 - Double wall.
 - Interior pipe is stainless steel.
 - Used for high temperature appliances, such as oil burning equipment and some solid fuel appliances (example: corn, pellets).

Slide 4-150

4. Type L.

- a. Metal.
- b. Double wall.
- c. Interior pipe is stainless steel.
- d. Used for high temperature appliances, such as oil burning equipment and some solid fuel appliances.

VENT PIPES (cont'd)

- Plastic.
 - High-temperature plastic vent (HTPV).
 - Polyvinyl chloride (PVC).
 - Chlorinated polyvinyl chloride (CPVC).
 - Used in high efficiency gas fired heating units.
 - Some brands of HTPV have been recalled.

Slide 4-151

5. Plastic.

- a. High-temperature plastic vent (HTPV).
- b. Polyvinyl chloride (PVC).

- c. Chlorinated polyvinyl chloride (CPVC).
- d. Used in high efficiency gas fired heating units.
- e. Some brands of HTPV have been recalled.

RECALL INFORMATION

- Pipes are gray or black in color.
- Different manufacturers involved: 27.
- Names “Plexvent,” “Plexvent II” or “Ultravent” marked on pipe.
- Additional information can be obtained from the Consumer Product Safety Commission (CPSC) online at <https://www.cpsc.gov/>.

Slide 4-152

T. Recall information.

1. Pipes are gray or black in color.
2. Different manufacturers involved: 27.
3. Names “Plexvent,” “Plexvent II” or “Ultravent” marked on pipe.
4. Additional information can be obtained from the Consumer Product Safety Commission (CPSC) online at <https://www.cpsc.gov/>.

METAL CHIMNEYS

- Metal.
- Must be installed in accordance with manufacturer’s instructions.

Double Wall



Triple Wall



Slide 4-153

U. Metal chimneys.

1. Metal.
2. Must be installed in accordance with manufacturer's instructions.

VIII. SUMMARY

FEMA

U.S. Fire
Administration

SUMMARY

- Categorize hazardous materials and processes.
- Verify code compliance for storage, handling and use of hazardous materials.
- Differentiate among electrical equipment, components and the associated terminology.
- Identify common electrical hazards.

Slide 4-154

FEMA

U.S. Fire
Administration

SUMMARY (cont'd)

- Recognize hazards associated with electric and heating systems.
- Explain electric and heating system hazard mitigation strategies.

Slide 4-155



This page intentionally left blank.

REFERENCES

- ICC. (2015). *International fire code*. International Code Council, Inc.
- NFPA. (2015). *National fire protection association 1: Fire code*.
- UL. (2015). *Underwriters Laboratory 103: Standard for factory-built chimneys for residential type and building heating appliances*.

This page intentionally left blank.

ACRONYMS

This page intentionally left blank.

ACRONYMS

ADA	Americans with Disabilities Act
AFCIs	Arc-fault circuit interrupters
AHJ	authority having jurisdiction
ASET	Available Safe Egress Time
ASTM	American Society for Testing and Materials
ATF	Bureau of Alcohol, Tobacco, Firearms and Explosives
Btu	British thermal unit
CAMEO	Computer-Aided Management of Emergency Operations
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CHEMTREC	Chemical Transportation Emergency Center
CHRIS	Chemical Hazards Response Information System
COs	Company Officers
CPSC	Consumer Product Safety Commission
CPVC	chlorinated polyvinyl chloride
DOT	Department of Transportation
EPBD	“Evaluating Performance Based Designs”
ETL	Electrical Testing Laboratories
FIP 1	“Fire Inspection Principles 1”
GFCIs	ground-fault circuit interrupters
GHS	Globally Harmonized System
gpm	gallons per minute

HCS	Hazard Communication Standard
HRR	heat release rate
HTPV	high-temperature plastic vent
HVAC	heating, ventilating, and air conditioning
IBC	International Building Code
ICC	International Code Council
IEBC	International Existing Building Code
IFC	International Fire Code
IG	Instructor Guide
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MSDS	Material Safety Data Sheet
NEC	National Electrical Code
NFA	National Fire Academy
NFPA	National Fire Protection Association
NIOSH	National Institute of Occupational Safety and Health
NTP	normal temperature and pressure
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
psi	pounds per square inch
PSIA	pounds per square inch absolute
PVC	polyvinyl chloride
RSET	Required Safe Egress Time

SDSs	Safety Data Sheets
SFPE	Society of Fire Protection Engineers
SM	Student Manual
STTC	Standard Time Temperature Curve
UL	Underwriters Laboratory
ULC	Underwriters Laboratories of Canada
WISER	Wireless Information System for Emergency Responders

This page intentionally left blank.