PDHonline Course G258W (2 PDH)

An Introduction to Fire Protection Engineering for Buildings (Live Webinar)

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AN INTRODUCTION TO FIRE PROTECTION ENGINEERING IN BUILDINGS

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This seminar will introduce you to fire protection engineering fundamentals related to building materials and design, water supply for fire protection, fire extinguishing systems, fire alarm systems, special occupancies and hazards, and storage of flammable and hazardous materials. You will be introduced to the basics of using occupancy hazard classification for determining sprinkler densities and hose streams, and procedures for determining fire flow demand for unsprinklered facilities.

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The presenter….

J. Paul Guyer, P.E., R.A.

Paul Guyer is a registered fire protection engineer, mechanical engineer, civil engineer, and architect with over 35 years experience in the design of buildings and related infrastructure. For an additional 9 years he was a senior-level advisor to the California Legislature on infrastructure and capital outlay issues, including those involving fire and life safety. He is a graduate of Stanford University and has held numerous national, state and local positions with the American Society of Civil Engineers, Architectural Engineering Institute and National Society of Professional Engineers.

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Topics to be covered….

I. The five fundamental elements of fire protection engineering….

A. Building materials and design
B. Water supply for fire protection
C. Fire extinguishing systems
D. Fire alarm systems
E. Special occupancies and hazards

2. We will also look at….

F. Occupancy hazard classification system
G. Codes and other professional resources
H. An Afterword: The NFPA/ICC Issue

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Topics to be covered….

A. Building Materials and Design

1. Basic criteria
2. Fire areas
3. Height limitations
4. Interior fire spread
5. Egress
6. Interior finishes
7. Insulation
8. Roof coverings
9. Roof and fire department access
10. Air handling
11. Plastic pipe and conduit
12. Fire retardant wood products

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Topics to be covered….

B. Water Supply

1. Demand for sprinklered facilities
2. Demand for unsprinklered facilities
3. Pressure requirements
4. Required quantities and on-site storage
5. Fire pumps
6. Distribution systems

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Topics to be covered….

C. Fire Extinguishing Systems

1. Automatic sprinkler systems
2. Foam (AFFF) systems
3. Standpipes
4. Dry chemical systems
5. Carbon dioxide systems
6. Halon 1301 and "clean agent" systems
7. Portable extinguishers

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Topics to be covered….

D. Fire Alarm Systems

1. Detection systems
2. Reporting systems
3. Evacuation systems

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Topics to be covered….

E. Special Occupancies and Hazards

1. In general
2. Food preparation
3. Medical facilities
4. Detention facilities
5. Electronics and telecommunications facilities
6. High Rise Buildings

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Topics to be covered….

F. Occupancy hazard classification system

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Topics to be covered….

G. Codes and other professional resources

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Topics to be covered….

H. An Afterword: The NFPA/ICC Issue

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Some points to keep in mind….

• Fire protection engineering is almost completely code-and-regulation driven. With the exception of the hydraulic principles of fluid flow in sprinkler system pipes, there is little in the field that is theoretical in nature. This means that in order to find out what you need to do in a given situation you will almost always need to refer to a code or regulation.

• Fire safety is a highly regulated enterprise. This means that your building designs will be meticulously reviewed by the regulatory authorities. In the case of a typical commercial building design project, this means the local building department *and the fire department.*

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Some points to keep in mind….

• Managing fire department reviews requires a special level of diplomacy and care. Absent the fire department approval, your project will never get built. As fire departments have developed over the years, the individuals who review drawings for new construction are almost always individuals who began their careers as fire fighters. Rarely is a professional engineer the reviewer at the fire department. Occasionally a fire department reviewer may feel a bit defensive when dealing with a professional engineer during the review process. The only way to manage this type of situation is to take special care to clearly explain your design in terms as non-technical as possible, deferentially accept the fact that the fire department reviewer controls the fate of your project, and just plain be diplomatic.

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Some points to keep in mind….

•Keep in mind that this course is only an introductory overview of fire protection engineering. As noted above, in practice you must ***always*** be guided by the codes and regulations applicable to your project in your local jurisdiction. References to specific codes and regulations in this course ***are for illustration*** only.

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The first step in fire protection design….

The Design Analysis

A fire protection *Design Analysis* is required for all designs and must address the fire protection requirements of the project as required by applicable codes and regulations. Where applicable, discuss the minimum fire protection provisions (include required vs. provided) indicated in Figure 1:

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Figure 1 Typical Design Analysis Contents
Building code analysis (i.e., type of construction, height and area limitations, and building separation or exposure protection)
Classification of occupancy
Compliance with applicable codes and regulations
Requirements for fire-rated walls, fire-rated doors, fire dampers with their fire-resistive ratings, smoke compartmentation, smoke barriers
NFPA 101, Life Safety Code application
Analysis of automatic sprinkler systems and suppression systems and protected areas, including hydraulic analysis of required water demand
Water supplies, water distribution, location of fire hydrants
Smoke control methods and smoke control systems
Fire alarm system, type and location of equipment
Fire detection system and location of detectors
Standpipe systems and fire extinguishers
Interior finish ratings
Alarm reporting system
Identification of occupancy and hazard areas
Fire department access

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Now we will look at….

A.Building Materials and Design

1. Basic criteria
2. Fire areas
3. Height limitations
4. Interior fire spread
5. Egress
6. Interior finishes
7. Insulation
8. Roof coverings
9. Roof and fire department access
10. Air handling
11. Plastic pipe and conduit

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Building Materials and Design….

Basic Criteria

Conform building construction to fire resistance requirements, allowable floor areas, building height limitations, and building separation distance requirements of the *International Building Code (IBC)*. These include:

- **Egress and Safety to Life.** Comply with *National Fire Protection Association (NFPA) 101* for building construction related to egress and safety to life. For conflicts between the IBC and NFPA 101 related to fire resistance rating, consider favoring NFPA 101.
- **Partitions.** IBC fire resistance requirements for permanent partitions do not apply to non-bearing partitions. For fire resistance ratings of non-bearing partitions comply with NFPA 101. Occupancy separation must comply with the "Required Separation of Occupancies" table in the IBC.

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Building Materials and Design….

Basic Criteria

- **Type of Construction.** Follow the requirements of the IBC to determine the permitted types of construction, except where approved by local authority Type V (wood) roofs may be constructed on buildings of Type I or II construction provided that they are separated from all other areas of the building by horizontal 2-hour concrete or masonry fire resistive construction. Such roofs will not require sprinkler protection but will require draft stops to divide the spaces into areas not exceeding 3000 SF, with self-closing and latching access doors of similar construction in the draft stop where there is no other means of access to the area.
- **Separation Between Buildings.** Use the IBC to determine required separation distances between buildings.

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Building Materials and Design….

Fire Areas

Conform to the IBC.

Height Limitations

Conform to the IBC.

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Building Materials and Design….

Limiting Interior Fire Spread

- **Partition Construction.** Conform to IBC and applicable local codes and regulations.
- **Door Openings:** Door openings, in fire resistive construction, must be protected in accordance with NFPA 80, *Fire Doors and Fire Windows*. Fire door assemblies are required on each side of the door opening in 4-hour fire walls when openings are fitted with 3-hour rolling or sliding fire doors. Use fire doors listed by Underwriters Laboratories Inc. (UL), FM, or a nationally recognized testing laboratory (NRTL). Do not modify approved fire doors in the field. Local fabrication of fire doors is not permitted.
- **Penetrations:** The protection of ducts at point of passage through firewalls must be in accordance with NFPA 90A, *Installation of Air-Conditioning and Ventilating Systems*, and/or NFPA 90B, *Installation of Warm Air Heating and Air-Conditioning Systems*. All other penetrations, such as piping, conduit, and wiring, through firewalls must be protected with a material or system of the same hourly rating that is listed by UL, FM, or a nationally recognized testing laboratory (NRTL).

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Building Materials and Design….

Means of Egress

- **Requirements:** Comply with the requirements of NFPA 101.
- **Means of Egress Marking:** Mark means of egress in accordance with NFPA 101. Signs must have lettering on an opaque background. Internally illuminated signs must be light emitting diode (LED) type, electroluminescence (LEC), or cold cathode type. Incandescent fixtures are not permitted except existing fixtures, which may remain in use. Radioluminous exit signs are not permitted. Photoluminescent exit signs and egress path marking is permitted only where provided with a reliable external illumination (charging) source providing a minimum illumination of 54 lux (5 foot-candles) of unfiltered fluorescent light.

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Building Materials and Design….

Interior Finish

- **Interior Wall and Ceiling Finish:** Wall and ceiling finishes and movable partitions must conform to the requirements of NFPA 101 for interior finishes. Drop-out ceilings are not permitted.
- **Insulation Requirements:** Use thermal and acoustical insulation with a flame spread (FS) rating not higher than 75, and a smoke developed (SD) rating not higher than 150 when tested in accordance with ASTM E84 (NFPA 255), *Standard Method of Test of Surface Burning Characteristics of Building Materials*. Test cellular plastic insulation in the same densities and thicknesses as the material that will be used in construction applications. For certain types of insulation exceptions apply.

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Building Materials and Design….

Roof Coverings and Roof Deck Assemblies

- **Roof Coverings:** Use roof coverings approved and listed by a nationally recognized testing laboratory (NRTL). The UL Roofing Materials and Systems Directory lists three Classes (A, B, and C) of acceptable roof coverings based on compliance with UL 790, *Tests for Fire Resistance of Roof Covering Materials* and NFPA 256, *Fire Tests of Roof Coverings*. Restrict Class C roof coverings to housing and buildings under 8,000 SF and that are not mission essential.

- **Roof Deck Assemblies:** Roof deck assemblies must be FM Class 1 approved or UL listed as Fire Classified or equal listing or classification by an NRTL, with the exceptions of: (a) fully sprinklered buildings and (b) buildings less than 8,000 SF.

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Building Materials and Design….

Roof and Fire Department Access

- **Roof Access.** All enclosed exit stairs that extend to the top floor in any building three or more stories in height must have, at the highest point of the stair tower, an approved hatch opening to the roof with an appropriate ladder that conforms to 29 CFR 1910.27, *Fixed Ladders*. The hatch must be not less than 16 ft^2 in area, with a minimum dimension of 2 ft. At least one stairway must terminate at a standard door opening leading onto the roof surface, unless the roof has a slope greater than 4 in 12.

- **Fire Department (Emergency Vehicle) Access.** All buildings greater than 5,000 sq ft, or more than two stories in height must have at least one means of all-weather ground access to allow emergency vehicles unimpeded access to the building. All-weather ground access must be paved, start from the road, and terminate no farther than 33 ft from the building.

- **Access to Residential Facilities.** Residential facilities must be provided with all-weather ground access to 3 sides, with a minimum of 2 sides having access to sleeping rooms.

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Building Materials and Design….

Roof and Fire Department Access

- **Vehicle Access.** All protection equipment, such as bollards or gates, must not require more than one person to remove or open. Access may require fire apparatus to drive over a curb. Any locking device controlling vehicle access must be under control of the fire department or 24-hour security personnel located at the specific facility. Dimensions of fire lanes and turnarounds must comply with NFPA 1, Uniform Fire Code.

- **Aerial Apparatus Access.** New facilities four stories or more in height and all new warehouses must be provided with suitable all-weather ground access surface for aerial apparatus on a minimum of two sides of the perimeter of the structure.

- **Fire Department Connection.** Facilities with fire department connections for sprinkler or standpipe systems must be provided with suitable all-weather ground access surface for pumper apparatus within 150 ft of such fire department connections.

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Building Materials and Design….

Air Handling

- **Design Requirements.** Air handling, heating, ventilation and exhaust systems must comply with the requirements of NFPA 90A.

- **Corridors.** Egress corridors must not be used as a portion of a supply, return, or exhaust air system serving adjoining areas. Air transfer opening(s) must not be permitted in walls or in doors separating egress corridors from adjoining areas. *Exception*: Toilet rooms, bathrooms, shower rooms, sink closets, and similar auxiliary spaces may have air transfer openings, unless prohibited by NFPA 101, such as in residential occupancies.

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Building Materials and Design….

Air Handling

- **Plenums.** Plenums may be used as an integral part of an air handling system only if they conform to the requirements of NFPA 90A. Under no circumstances may combustible materials be located within the plenum space. Electrical wiring passing through the space, including telephone and communication wiring, must be plenum rated or must be in metal conduit. Rooms or areas that form a plenum space or that are used as a plenum must not be occupied for any purpose except during repairs or maintenance operations to the air handling equipment.

- **Smoke and Heat Vents.** Smoke and heat vents may be considered in buildings where a high rate of heat release is anticipated during a fire. In buildings without automatic sprinklers, smoke and heat vents must be arranged to operate automatically in accordance with NFPA 204, *Smoke and Heat Venting*. In buildings with automatic sprinkler protection, smoke and heat vents must be arranged to operate in the manual mode only. Skylights are the preferred method of providing manual smoke and heat vents.

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Building Materials and Design….

Plastic Pipe and Conduit

Penetrations by plastic pipe or conduit through fire-rated walls, partitions, shafts, and floors must be fire-stopped by an approved or listed method in accordance with ASTM E814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops* or UL 1479, *Fire Tests of Through-Penetration Firestops*. Plastic pipe and conduit must not be installed in exit stair enclosures, or in air plenum spaces unless specifically listed for that application.

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Now we will look at….

B.Water Supply

1. Demand for sprinklered facilities
2. Demand for unsprinklered facilities
3. Pressure requirements
4. Required quantities and on-site storage
5. Fire pumps
6. Distribution systems

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Water Supply….

Demand for Sprinklered Facilities

- **Factors Influencing the Water Demand for Sprinklers.** The water demand required for sprinkler protection depends upon occupancy, discharge density, design area, and type of sprinkler system (wet or dry), type of construction, and other building features.

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Water Supply….

Demand for Sprinklered Facilities

Water Demand for Sprinklers. The water demand required for sprinklers must be determined from Figure 2. (Figure 2 is, *as always*, for illustration purposes only. Applicable codes and regulations must be used.)

Design Densities. Design densities indicated in Figure 2 are minimum densities, and each sprinkler in the design area must discharge at least the flow rate required to produce the stipulated density.

Design Areas. Design areas shown in Figure 2 are the hydraulically most remote areas. Hose streams are needed concurrently with sprinkler discharge in order to effect final extinguishment or to wet down adjacent structures.

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Water Supply….

Demand for Sprinklered Facilities

- **Hose Stream.** The hose stream demand for sprinklered occupancies must be determined from Figure 2.

- **Total Water Demand.** The total water demand for sprinklered occupancies is equal to the sum of the domestic/industrial demand plus the sprinkler system(s) water demand and the hose stream(s) demand. The total demand must be available at the sprinkler system connection to the underground main, and at the pressure necessary to produce the required sprinkler density over the required hydraulically most remote area of sprinkler operation.

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Water Supply….

Demand for Sprinklered Facilities

FIGURE 2
SPRINKLER SYSTEM AND WATER SUPPLY DESIGN REQUIREMENTS FOR SPRINKLERED FACILITIES

Occupancy Classification	Sprinkler System		Hose Stream Allowance, GPM	Duration of Supply, minutes
	Design Density, GPM/SF	Design Area, SF		
Light Hazard	0.01	3000	250	60
Ordinary Hazard, Group 1	0.15	3000	500	60
Ordinary Hazard, Group 2	0.20	3000	500	90
Extra Hazard, Group 1	0.30	3000	750	120
Extra Hazard, Group 2	0.40	3000	750	120

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Water Supply….

Demand for Unsprinklered Facilities

Water demands for buildings and facilities that are not fully sprinklered are based on fire department hose stream requirements. The following factors affect the water demand and duration and must be considered to determine the specific demand and duration within a given range.

- Occupancy classification
- Response time by fire department
- Type of construction
- Number of stories
- Separation distances
- Building floor area
- Firefighting access

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Water Supply….

Demand for Unsprinklered Facilities

A recognized procedure determining demand uses weighted factors as follows:

- Response time by fire department
  - Less than 2 miles - 2
  - More than 2 miles - 3
- Type of construction
  - Type I (IBC) 1
  - Type II 2
  - Type III 3
  - Type IV 2
  - Type V 5
- Number of stories
  - Single 1
  - Two or more 2

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Water Supply….

Demand for Unsprinklered Facilities

- Building floor area
  - 7500 SF or less - 1
  - 7501 to 15000 SF - 2
  - 15001 to 25000 SF - 3
  - 25001 to 40000 SF - 4
  - Greater than 40000 SF - 5
- Separation distances
  - More than 60 feet - 1
  - 21 to 59 feet - 2
  - Less than 20 feet - 4
- Maximum hose layout (first 3 stories)
  - 180 feet or less - 1
  - 181 to 230 feet - 2
  - More than 230 feet - 4

Demand is then determined from Figure 3.

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Water Supply….

Demand for Unsprinklered Facilities

Figure 3
Water Demand for Unsprinklered Facilities

Occupancy Hazard Classification	Fire Flows, GPM @ 20 PSI residual pressure			Duration, Minutes		
	Weighted Values			Weighted Values		
	6-10	11-15	>16	6-10	11-15	>16
Light	750	1125	1500	60	90	120
Ordinary Group 1	1000	1500	2000	90	120	150
Ordinary Group 2	1500	2250	3000	90	120	150
Extra	2500	3750	5000	150	195	240

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Water Supply….

Petroleum/Oil/Lubricant (POL) Storage

Areas where POL materials are stored require special consideration. Figure 4 shows required fire flow rates for above ground atmospheric POL tanks. Figure 5 shows required fire flow rates for above ground pressurized POL tanks.

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Water Supply….

Petroleum/Oil/Lubricant (POL) Storage

Figure 4
Atmospheric POL Tank Cooling Water

Tank Diameter, Inches	Fire Flow Rate, GPM
0 – 64	500
65 – 119	750
120 -154	1000
155 – 199	1250
200 or greater	1500
Minimum duration: 240 minutes	

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Water Supply….

Petroleum/Oil/Lubricant (POL) Storage

Figure 5
Pressurized POL Tank Cooling Water

Tank Group Size	Fire Flow Rate, GPM
Single tank less than 30,000 gallons capacity	250
Single tank more than 30,000 gallons capacity	500
2 to 6 tanks, one or more tanks greater than 30,000 gallons capacity	500
2 to 6 tanks, each greater than 30,000 gallons capacity	1000
7 or more tanks, each tank less than 30,000 gallons capacity	1000
7 or more tanks, one or more tanks greater than 30,000 gallons capacity	1500
Minimum duration: 240 minutes	

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Water Supply….

Water Supply Pressure Requirements

Pressure required for sprinklered facilities must be the most demanding pressure of the domestic/industrial demand, sprinkler demand, or hose stream demand and must be determined by hydraulic calculations.

Water Supply….

Quantities of Water Required

Requirements for fire protection water storage are based on the assumption that there will be only one fire at a time. The quantity of water required is equal to the product of the fire protection water demand and the required duration. This quantity represents fire protection requirements only, and must be available at all times. Water supply for domestic, industrial, and other demands must be added to these requirements to determine the total amount of water that is necessary at a facility.

- **Total Storage Capacity.** The total supply stored for fire protection purposes must be sufficient to meet the maximum required fire flow demand for the durations specified in applicable codes and regulations.

- **Reduction in Storage Capacity.** In computing the fire protection storage requirement, a reduction in storage capacity is acceptable if an adequate replenishment source is available. Factors that must be evaluated include the reliability of the makeup facility, its sustained flow capacity, its method of operation (automatic or manual), and flow limitations imposed by the capacity of treatment operations.

- **Replenishment of Storage.** The water storage must be self-replenishing. It must reach required volume during normal consumption within 48 hours, and within 24 hours curtailing normal consumption.

Water Supply….

Water for Fire Protection

One or more of the following reliable means shall provide water to an installation for fire protection:

- Multiple connections to looped or gridded public water distribution system(s) arranged so that during any single-point failure, at least 50% of the maximum required fire flow demand plus 100% of domestic demand can still be supplied to the activity / facility.

- A single connection to a public water distribution system, plus on-site storage that is adequate to supply domestic demand for 24 hours plus the maximum required fire flow demand in the event the connection to the public system is lost.

- One or more on-site sources, such as wells or open bodies of water, with treated water storage capacity adequate to supply domestic demand for 24 hours plus the maximum required fire flow demand.

- For a small, non-essential activity, a single connection to a looped or gridded public water distribution system, capable of providing concurrent domestic and fire flow demands to the facility, is acceptable.

Water Supply….

On-Site Storage

Where on-site storage is part of a sole-source water supply, or is needed to provide the required fire flow, the storage facilities must be divided into two or more approximately equal capacity tanks or reservoir sections, arranged so that at least one-half of the water supply will always be available during tank or reservoir maintenance. The discharge or suction line(s) from each individual tank or reservoir section shall be sized to deliver the maximum required fire flow.

Water Supply….

Water Distribution Systems

- **Distribution Mains.** The distribution system must be sized to accommodate fire flows plus domestic and industrial or flushing demands that cannot be restricted during fires. Distribution must be looped to provide at least 50 percent of the required fire flow in case of a single break. Dead-end mains must be avoided. Distribution systems must be designed in accordance with American Water Works Association Manual M31 *Distribution System Requirements for Fire Protection*, NFPA 24, *Installation of Private Fire Service Mains and Their Appurtenances*.

- **Valves.** Control valves must be provided in each source of water supply, such as tanks and pumps. Control valves must be either post-indicating or outside-stem-and-yoke types. A sufficient number of sectional valves must be provided so that not more than a combined total of five hydrants and sprinkler systems, or not more than three sprinkler systems must be out of service due to a single break. Sectional valves may be key-operated type. New valves must open by counter-clockwise rotation of the stem.

Water Supply….

Water Distribution Systems

- **Hydrants.** Fire hydrants must be UL listed, FM approved, or listed or classified by an NRTL and must have two 65 mm (2-1/2-inch) hose outlets and one 115m (4-1/2-inch) suction connection with national standard fire hose threads in accordance with NFPA 24 and NFPA 1963, *Fire Hose Connections*. Wet-barrel or California-type hydrants are preferable in areas where there is no danger of freezing. Dry barrel or traffic-type hydrants must be used in areas where there is a danger of freezing. Hydrants must be aboveground type.
.
- **Hydrants Installation**. Hydrants must be installed adjacent to paved areas, accessible to fire department apparatus. Hydrants must not be closer than 3 ft nor farther than 7 ft from the roadway shoulder or curb line. Hydrants must be installed with not less than 6-inch connection to the supply main, and valved at the connection. Barrels must be long enough to permit at least 18-inch clearance between the center of the 4-1/2-inch suction connection and grade. The ground must be graded so that any surface drainage is away from the hydrant. Installation must be in accordance with NFPA 24, except as modified by this UFC. Suction connection should be perpendicular to the street to allow straight lined connection to the pumper.

Now we will look at….

C.Fire Extinguishing Systems

1. Automatic sprinkler systems
2. Foam (AFFF) systems
3. Standpipes
4. Dry chemical systems
5. Carbon dioxide systems
6. Halon 1301 and clean agent systems
7. Portable extinguishers

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Fire Extinguishing Systems….

Automatic Sprinkler Systems

- **Characteristics.** Properly engineered and installed automatic sprinkler systems are designed to detect the presence of fire, activate both local and remote (fire department) alarms, and distribute water in sufficient quantity to either control or extinguish the fire.
- **Design Requirements.** Sprinkler systems must use equipment and devices listed by a nationally recognized testing laboratory (NRTL).
- **Sprinkler Density and Hose Stream Requirements.** Building and structures requiring sprinkler protection must be provided with sprinkler systems that are designed using the Area/Density Method of NFPA 13.
- **Quick Response Automatic Sprinklers.** The use of quick response automatic sprinklers (QRAS) is limited to wet pipe systems.

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Fire Extinguishing Systems….

Automatic Sprinkler Systems

- **Hydraulic Calculations.** New sprinkler systems protecting areas of 1,500 ft² and greater must be designed using hydraulic calculations. Use of pipe schedule designs is discouraged for any sprinkler system. Calculations must follow the format of NFPA 13. Pipe friction losses and equivalent lengths of pipe for fittings and valves must be in accordance with NFPA 13.
- **Sprinkler Coverage.** In buildings protected by automatic sprinklers, sprinklers must provide coverage throughout 100 percent of the building except as permitted by NFPA 13. This includes, but is not limited to, telephone rooms, electrical equipment rooms, boiler rooms, switchgear rooms, transformer rooms, and other electrical and mechanical spaces. Coverage per sprinkler must be in accordance with NFPA 13.

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Fire Extinguishing Systems….

Automatic Sprinkler Systems

- **Interconnection of Risers.** For facilities four (4) stories and taller, there must be a combination sprinkler/standpipe riser in at least two stairwells that are interconnected on each floor. Each floor control valve assembly for the sprinkler connection must include a check valve. See Figure 6. The sprinkler system must be hydraulically calculated using the most hydraulically demanding riser. The calculations must not assume the use of both risers simultaneously.

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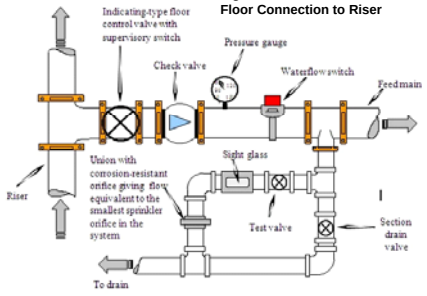
Fire Extinguishing Systems….

Automatic Sprinkler Systems

Figure 6
Floor Connection to Riser



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Fire Extinguishing Systems….

Water Spray Systems

Design requirements for water spray systems must conform to NFPA 15, *Water Spray Fixed Systems for Fire Protection*.

Foam Systems (Aqueous Foam Film Forming – AFFF)

Foam installations must be in accordance with NFPA 11, *Low-, Medium-, and High-Expansion Foam,* and NFPA 16, *Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*. For additional information, the NFPA *Fire Protection Handbook* and FM Global Data Sheets contain data and information concerning installation and arrangement of foam systems for various types of flammable and combustible liquids hazards.

Dry Chemical Extinguishing Systems

Fixed dry chemical extinguishing systems are appropriate for the protection of certain types of special occupancies, hazards, and facilities such as dip tanks, and other operations involving flammable liquids. Dry chemical extinguishing systems must conform to NFPA 17, *Dry Chemical Extinguishing Systems*. Dry chemical agents should not be used to protect sensitive electronics. Dry chemical extinguishing systems are no longer UL listed or FM approved for the protection of cooking equipment.

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Fire Extinguishing Systems….

Carbon Dioxide Systems

Carbon dioxide (CO_2) systems are normally effective against flammable liquid (Class B) and electrical (Class C) fires. New total flooding systems are not authorized in normally occupied areas. Carbon dioxide systems must conform to NFPA 12, *Carbon Dioxide Extinguishing Systems*. Carbon dioxide systems must conform to NFPA 12, *Carbon Dioxide Extinguishing Systems*.

Halon 1301 Systems

Gas extinguishing systems are highly desirable in facilities containing high-value electronic equipment because the gases do not damage the equipment. A major challenge with gas extinguishing systems, however, in facilities where people are present is that they rely on depleting the oxygen supply in order to smother the fire. Halon 1301 was a proprietary chemical system that effectively addressed this issue because, coupled with an annunciation (alarm) system, provided a safe environment that allowed time for personnel to evacuate the fire zone. Regrettably, Halon 1301 was a fluorocarbon, and its use is now banned on environmental grounds. Thus, installation of new Halon 1301 systems is now prohibited. The only current replacement technology for this type of facility is carbon dioxide, which is much riskier for people who are present. Most if not all Halon 1301 systems have now been de-commissioned.

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Fire Extinguishing Systems….

Portable Fire Extinguishers

Portable fire extinguishers must be provided where required by NFPA 101, *Life Safety Code*. Portable fire extinguishers must be located and installed in accordance with NFPA 10, *Portable Fire Extinguishers*.

Wet Chemical Extinguishing Systems

Fixed wet chemical systems are suitable for protection of certain types of special occupancies, hazards, and facilities, such as cooking surfaces, cooking exhaust systems, and dip tanks. Wet chemical systems must conform to NFPA 17A, *Wet Chemical Extinguishing Systems*.

Clean Agent Fire Extinguishing Systems

Clean agent fire extinguishing systems are suitable for protection of certain types of special occupancies, hazards, and facilities. Clean agent fire extinguishing systems are not a substitute for required automatic sprinkler systems. Clean agent fire extinguishing systems must conform to NFPA 2001, *Clean Agent Fire Extinguishing Systems*.

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Fire Extinguishing Systems….

Water Mist Fire Protection Systems

Water mist fire protection systems are suitable for protection of certain types of special occupancies, hazards, and facilities. Water mist fire protection systems are not a substitute for required automatic sprinkler systems. Water mist fire protection systems must conform to NFPA 750, *Water Mist Fire Protection Systems*.

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Now we will look at….

D. Fire Alarm Systems

1. Detection Systems
2. Reporting Systems
3. Evacuation Systems

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Fire Alarm Systems….

Detection Systems

- Fire detection systems must conform to the applicable provisions of NFPA72, and the Americans with Disabilities Act (*ADA).* Detection systems must be arranged to alert building occupants and to transmit a signal to a constantly attended location. Fire detection systems must be independent, stand-alone systems that are not an integral part of a security system, or other building management, energy/utility management systems. Fire detection systems may be connected to security systems or building management, energy/utility management systems for monitoring purposes only, but must in no way rely on any components of those other systems for operation.

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Fire Alarm Systems….

Detection Systems

- Detection systems, especially smoke detection systems, require significant maintenance. It is critical that the required detectors are properly installed and maintained. Providing detectors in locations that are not required increases the already high maintenance costs of alarm systems and strains the maintenance program for critical detection systems. If a facility warrants protection and criteria does not require detection, protection should be accomplished by a wet pipe sprinkler system. Wet pipe sprinklers provide superior protection with little maintenance.

- The area of protection for smoke detection devices permitted by NFPA 72 must be reduced by 50 percent where ceiling fans are used (i.e., this may require additional smoke detectors for that area being protected).

 60

Fire Alarm Systems….

Reporting Systems

Fire alarm reporting systems are reporting systems that connect the building fire alarm control panel(s) to the fire department. Required systems are to be digital, telephonic, radio, or supervised conductor types. Consider compatibility of extensions of fire reporting systems with existing equipment. Alarm reporting systems must conform to NFPA 72, *National Fire Alarm Code*, NFPA 70, *National Electric Code*.

 61

Fire Alarm Systems….

Evacuation Systems

Fire alarm evacuation systems must be provided in the following locations:

- Buildings required by NFPA 101.
- Buildings requiring automatic detection or suppression systems.

These systems consist primarily of initiating devices and notification appliances. Manual pull stations must be provided where fire alarm evacuation systems are required. Automatic alarm initiating devices such as detectors and water flow alarms must be connected to these systems when provided. Fire alarm systems must be connected to a central alarm location, fire department, or alarm monitoring location. Building fire alarm evacuation systems must be installed in accordance with NFPA 72. Fire alarm systems must be independent, stand-alone systems that are not an integral part of a security, an energy monitoring and control system (EMCS), or other system, except that a fire alarm system may be combined with a building mass notification system or with a combination building mass notification and public address system. Fire alarm systems may be connected to security systems or an EMCS for monitoring purposes only, but must in no way rely on any components of those other systems for operation. Wireless interior fire alarms are not permitted.

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Now we will look at….

E. Special Occupancies and Hazards

1. In general
2. Food preparation areas
3. Medical facilities
4. Detention facilities
5. Electronics and telecommunications facilities
6. High rise buildings

 63

Special Occupancies and Hazards….

In General

There are many, many special occupancies and hazards, each of which is typically regulated by a special code or sections of a code. Following are just a few for illustration purposes.

 64

Special Occupancies and Hazards….

Food Preparation Areas

- Hood and duct systems for commercial cooking equipment that produces smoke or grease-laden vapors must comply with NFPA 96, *Ventilation Control and Fire Protection of Commercial Cooking Operations.* Limit kitchen-extinguishing systems to wet chemical or automatic sprinklers installed in accordance with NFPA 96. Install fire suppression systems that sound a general building fire alarm and transmit a signal to the fire department or to a constantly monitored location.

- Areas, other than dwelling units, that are provided with residential type range top cooking surfaces must be equipped with an approved residential range top extinguishing system. The range top extinguishing system must be connected to the building fire alarm system to sound a general building fire alarm and must automatically shut off all sources of fuel and electric power that produce heat to the equipment being protected by that unit.

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Special Occupancies and Hazards….

Medical Facilities

Medical facilities include hospitals, composite medical facilities, ambulatory health care centers, occupational health clinics, outpatient clinics, dental clinics, flight medicine clinics, medical logistics facilities, biological safety and medical laboratories, and similar facilities. There are many special requirements for medical facilities called for by applicable codes and regulations. A discussion of these requirements is far beyond the scope of this introduction to fire protection engineering principles.

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Special Occupancies and Hazards….

Detention Facilities

Comply with NFPA 101 and the following:

- Individual fire areas must not exceed 50,000 ft^2.
- Construction type must not be less that Type I - A, as defined in the *IBC*.
- Provide a minimum separation from other structures and public ways of 20 ft.
- Provide complete automatic sprinkler protection. Design must utilize institutional (breakaway) type sprinklers. Sprinkler piping in inmate areas must be concealed.
- Provide smoke detection in all areas as required by NFPA 101and American Correctional Association's (ACA) *Planning and Design Guide for Secure Adult and Juvenile Facilities*.
- Provide an automatic smoke removal system in cell areas. In addition, provide manual system activation controls at a continuously manned position outside of the cell area.

Special Occupancies and Hazards….

Detention Facilities

- Provide for constant visual supervision of cell areas. If this supervision is by direct line of sight, it must be separated by not less than one-hour fire rated construction.
- Provide mechanical or closed circuit electrical gang release devices whenever 10 or more locks must be operated to release prisoners confined in cells. Require gang release devices to open doors necessary to evacuate prisoners to an area of refuge. Require heavy, identically keyed, prison-type locks for exit and corridor doors not requiring gang release devices that must be opened for evacuation in the event of fire.
- Interior finish including padded cells must be Class A flame spread (i.e., 25 or less) and must have a SD rating not exceeding 50 when tested in accordance with ASTM E 84.

Special Occupancies and Hazards….

Electronics and Telecommunications Facilities

- These areas include major automatic data processing (ADP) areas, communication centers, command and control systems, and other mission critical systems. Incidental electronic equipment such as word processing stations, printers, and systems; desk top computers; office automation systems; individual data output stations (e.g., printers, etc.); individual computer work stations; telephones; video conference centers; administrative telephone rooms; reproduction equipment; and similar equipment do not require protection under this section.
- Construct and protect electronic equipment installations in accordance with NFPA 75, *Protection of Information Technology Equipment*.

Special Occupancies and Hazards….

Electronics and Telecommunications Facilities

- Electronic equipment installations must be located in buildings protected by wet-pipe automatic sprinklers. Provide complete coverage throughout the building including electronic equipment areas. Protect electrical equipment installations by disconnecting the power upon activation of the fire protection system.
- Consideration may be given to the use of a supplementary clean agent fire extinguishing system inside the electronic equipment units or a total flooding system for the room and raised floor. Supplementary clean agent fire extinguishing systems will augment the wet-pipe automatic sprinkler system and will not be considered as a substitute.
- Power and communication (data) cabling installed in spaces above ceilings or below raised floors must be plenum rated or installed in metallic conduit. If this cannot be achieved, the spaces must be protected by an automatic fire suppression system.

Special Occupancies and Hazards….

High Rise Buildings

- High rise buildings must comply with NFPA 101.
- The central control station must have exterior and interior access, a 1-hour fire rated barrier, and must be a minimum of 96 ft^2 with a minimum dimension of 8 ft.
- The central control station must also include air-handling system status indicators and controls, a fire department control panel for smoke control systems (includes visual status indicators and controls), and schematic building plans indicating the typical floor plan and detailing the building core, means of egress, fire protection systems, fire-fighting equipment and fire department access.

Now we will look at….

F. Occupancy Hazard Classification System

1. Light Hazard Occupancies
2. Ordinary Hazard, Group 1
3. Ordinary Hazard, Group 2
4. Special Occupancies

Occupancy Hazard Classification System

The principal occupancy classifications are light hazard, ordinary hazard, and extra hazard. Listed below are the classifications with examples of common occupancies listed under each. The basic hazard classification of occupancy does not define the fire hazard present in all areas of that occupancy. If more hazardous processes or areas exist within a given occupancy, protect these areas in accordance with the fire protection requirements pertaining to the hazard classification of that area. Determine the classification for unlisted occupancies from the definitions or by comparison with one of the listed occupancies.

Light Hazard Occupancies
Occupancies or portions of occupancies where the quantity and combustibility of the contents are low and fires with relatively low rates of heat release are expected. Small, scattered amounts of flammable liquids in closed containers are allowable in quantities not exceeding 5 gal per fire area. Examples of this classification include: offices, churches, gymnasiums, and child development centers.

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Occupancy Hazard Classification System

Ordinary Hazard, Group 1
Occupancies or portions of occupancies where combustibility is low, quantity of combustibles is moderate, stockpiles of combustibles do not exceed 8 ft, and fires with moderate rates of heat release are expected. Modest, scattered amounts of flammable liquid, in closed containers are allowable in quantities not to exceed 20 gal per fire area. Examples of this classification include: kitchens and bakeries, sheet metal shops, laundries, parking garages, theatres and auditoriums.

Ordinary Hazard, Group 2
Occupancies or portion of occupancies where quantity and combustibility of contents is moderate, stockpiles do not exceed 12 ft, and fires with moderate rate of heat release are expected. Moderate, scattered amounts of flammable liquids in closed containers are allowable in quantities not exceed 50 gal per fire area. Small amounts of flammable liquids may be exposed as required by normal operations. Examples of this classification include: department stores, supermarkets, electrical maintenance shops, laboratories and switchgear rooms.

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Occupancy Hazard Classification System

Special Occupancies
Special occupancies are facilities or areas that cannot be assigned a specific classification because of special protection requirements. Refer to the appropriate NFPA codes and standards. Examples of this classification include: warehouses and aircraft hangars.

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Now we will provide a list of ….

G. Codes and Professional Resources

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Codes and Professional Resources

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ADAAG, *Americans with Disabilities Act Accessibility Guidelines*, United States Access Board, http://www.access-board.gov/adaag/html/adaag.htm

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AR 385-64, *Explosives Safety Program*, Department of the Army, Standardization Documents Order Desk, 700 Robbins Avenue, Bldg 4D, Philadelphia, PA, 19111-5094

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FMDS 1-23, *Protection of Openings in Fire Subdivisions*, Factory Mutual Global (FM), 1301 Atwood Ave., PO Box 7500, Johnston, RI, 02919

FMDS 1-53, *Anechoic Chambers*, Factory Mutual Global (FM), 1301 Atwood Ave., PO Box 7500, Johnston, RI, 02919

FMDS 5-4, *Transformers*, Factory Mutual Global (FM), 1301 Atwood Ave., PO Box 7500, Johnston, RI, 02919

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Guidance for Family Housing Master Plans, (memorandum) 14 January 2002, Office of the Under Secretary of Defense,

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Manual M31, *Distribution System Requirements for Fire Protection*, American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO, 80235

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NAVSEA OP-5, *Ammunition and Explosives Ashore Safety Regulations for Handling, Storing, Production, Renovation, and Shipping*,

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NFPA 10, *Portable Fire Extinguishers*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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NFPA 11A, *Medium- and High-Expansion Foam Systems*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 12, *Carbon Dioxide Extinguishing Systems*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 13, *Installation of Sprinkler Systems*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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NFPA 13D, *Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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NFPA 30, *Flammable and Combustible Liquids Code*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 37, *Installation and Use of Stationary Combustion Engines and Gas Turbines*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 51, *Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 54, *National Fuel Gas Code*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 55, *Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, cylinders, and Tanks*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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NFPA 70, *National Electric Code*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 72, *National Fire Alarm Code*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 75, *Protection of Electronic Computer/Data Processing Equipment*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 80, *Fire Doors and Fire Windows*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 80A, *Protection of Buildings From Exterior Fire Exposures*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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NFPA 90A, *Installation of Air-Conditioning and Ventilating Systems*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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NFPA 99, *Health Care Facilities*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 99B, *Hypobaric Facilities*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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NFPA 101, *Life Safety Code*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 102, *Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 211, *Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

NFPA 220, *Types of Building Construction*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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NFPA 241, *Safeguarding Construction, Alteration, and Demolition Operations*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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NFPA 501A, *Fire Safety Criteria for Manufactured Home Installations, Site and Communities*, National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA, 02269-9101, www.nfpa.org

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Codes and Professional Resources

UFC 4-152-01, *Piers and Wharves*, Unified Facilities Criteria Program, http://dod.wbdg.org

UFC 4-159-01N, *Hyperbaric Facilities*, Unified Facilities Criteria Program, http://dod.wbdg.org

UFC 4-213-10, *Graving Drydocks*, Unified Facilities Criteria Program, http://dod.wbdg.org

UFC 4-213-12, *Drydocking Facilities Characteristics*, Unified Facilities Criteria Program, http://dod.wbdg.org

UFC 4-442-01N, *Covered Storage*, Unified Facilities Criteria Program, http://dod.wbdg.org

UFC 4-451-10N, *Hazardous Waste Storage*, Unified Facilities Criteria Program, http://dod.wbdg.org

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UL 790, *Safety Tests for Fire Resistance of Roof Covering Materials*, Underwriters Laboratory (UL), 333 Pfingsten Rd., Northbrook, IL, 30062-2096

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Counsel, http://uscode.house.gov/

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And now, an editorial….

H. An Afterword: The NFPA/ICC issue

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The NFPA/ICC Issue

The NFPA was formed in 1896 by a group of insurance companies for the purpose of standardizing the new market of fire sprinkler systems. The scope of the NFPA's activities expanded over time to also include building electrical systems and other aspects of building design and construction.

The International Code Council (ICC) was established in 1994 as a nonprofit organization dedicated to developing a single set of comprehensive and coordinated national model construction codes. The founders of the ICC are Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International, Inc. (SBCCI). Since the early part of the last century, these nonprofit organizations developed the three separate sets of model codes used throughout the United States. Although regional code development has been effective and responsive to our country's needs, the time came for a single set of codes. The nation's three model code groups responded by creating the International Code Council and by developing codes without regional limitations the International Codes.

So the set of codes you need to use depends on which set has been adopted by the jurisdiction in which your project is located. When will this confusion be resolved? Who knows.

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The NFPA/ICC Issue

Notably absent from the group of the IBC developers was NFPA. NFPA joined ICC in a collective effort to develop the International Fire Code (IFC). This effort however fell apart at the completion of the first draft of the document. Subsequent efforts by ICC and NFPA to reach agreement on this and other documents have been unsuccessful.

The result is all sorts of conflicts and confusion in the industry. For example Figure 8 shows there is not even agreement on basic building construction type definitions between the ICC's IBC and NFPA 220 (as well as the earlier widely used Uniform Building Code (UBC).

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The NFPA/ICC Issue

Figure 7

IBC	UBC	NFPA 220
	Type I – FR	Type I (443)
Type I-A	Type II - FR	Type I (332)
Type I-B		Type II (222)
Type II-A	Type II – 1 Hour	Type II (111)
Type II-B	Type II – N	Type II (000)
Type III-A	Type III – 1 Hour	Type III (211)
Type III-B	Type III - N	Type III (200)
Type IV (HT)	Type IV (HT)	Type IV (2HH)
Type V-A	Type V - 1 Hour	Type V (111)
Type V-B	Type V - N	Type V (000)

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The NFPA/ICC Issue

So the set of codes you need to use depends on which set has been adopted by the jurisdiction in which your project is located. When will this confusion be resolved?

Who knows.

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And now, we will run through the….

Quiz

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1. Which of the following is not a fundamental element of fire protection engineering:

   a. Structural analysis
   b. Building materials and design
   c. Water supply
   d. Fire extinguishing systems
   e. Fire alarm systems

2. The first step in the fire protection engineering process is:

   a. Environmental review
   b. Cost-benefit analysis
   c. Design analysis
   d. Value engineering
   e. Constructability review

3. Basic criteria for building and life safety is found in:

   a. International Building Code (IBC)
   b. NFPA 101
   c. Neither of the above
   d. Both of the above

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4. All buildings larger than _____ or more than 2 stories in height must have at least one means of all-weather ground access for emergency vehicles.

   a. 5,000 SF
   b. 10,000 SF
   c. 25,000 SF
   d. 50,000 SF

5. Which of the following may not be located in air handling system plenums:

   a. Combustible materials
   b. Electrical wires
   c. Domestic water piping
   d. All of the above
   e. None of the above

6. Petroleum/oil/lubricant (POL) storage facilities are classified as:

   a. Light Hazard
   b. Ordinary Hazard, Group 1
   c. Ordinary Hazard, Group 2
   d. May be any of the above depending on quantities stored
   e. None of the above

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7. On-site storage of water for fire suppression:

   a. May not be used
   b. May not be used if a public water distribution system is available
   c. May be used
   d. May be used only with a looped or gridded public water distribution system

8. Factors that influence water demand for sprinklers are:

   a. Occupancy and discharge density
   b. Type of construction and type of sprinkler system
   c. Design area and occupancy
   d. All of the above
   e. None of the above

9. The Design Area used in sprinkler system design is _____ for Extra Hazard, Group 2 occupancy:

   a. 1,000 SF
   b. 3,000 SF
   c. 5,000 SF
   d. 10,000 SF

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10. The Design Area used in sprinkler system design is _____ for Light Hazard occupancy:

    a. 10,000 SF
    b. 5,000 SF
    c. 3,000 SF
    d. 1,000 SF

11. Halon 1301 systems are not used in computer rooms because:

    a. they can catastrophically damage sensitive electronic equipment
    b. AFFF systems are more effective in suppressing computer room fires with less damage
    c. of environmental concerns
    d. they are prohibitively expensive

12. Carbon dioxide extinguishing systems are normally appropriate for suppressing fires:

    a. in hospitals
    b. in computer rooms
    c. involving explosive solids
    d. involving flammable liquids

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13. Water demand for unsprinklered buildings is based on:

    a. fire department hose stream requirements
    b. sprinkler density
    c. design area
    d. design density

14. Limiting interior fire spread requires consideration of:

    a. Door openings
    b. Roof covering
    c. Smoke exhaust
    d. Evacuation routes

15. Fire alarm systems must conform to:

    a. NFPA 11
    b. NFPA 15
    c. NFPA 30
    d. NFPA 72
    e. NFPA 220

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That's all folks!

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