Welcome

• Instructor introduction
• Exits
• Breaks and Schedule
• Cell Phones
• Student Introductions

Objectives

1. Explain the fundamental provisions of the 2021 IFC
2. Understand the intent and scope of the 2021 IFC
3. Identify common fire hazards and understand how the 2021 IFC addresses correction, mitigation or elimination of the hazards
Objectives

4. Understand how life safety and fire protection issues are addressed in building design and construction
5. Understand how the 2021 IFC applies to maintenance of building design and components to maintain fire and life safety
6. Understand how the 2021 IFC addresses hazardous materials

Guide to a successful class:
• Slides contain some text and images to help you learn
• Follow along in the course handout
• Ask Questions, ask questions, ASK QUESTIONS!!!!

Prerequisite Understanding

• Occupancy classifications are based on the use and character of the building
• Requirements are based on the occupancy classification

A – Assembly
- A-1 fixed seating for entertainment
- A-2 drinking and dining establishments
- A-3 general assembly classification
- A-4 indoor sports facility
- A-5 outdoor sports facility

I – Institutional
- I-1 custodial care
- I-2 hospital
- I-3 detention facilities
- I-4 day care

R – Residential
- R-1 transient stay
- R-2 nontransient stay
- R-3 general residential
- R-4 group home

S – Storage
- S-1 moderate hazard
- S-2 low hazard

H – Hazardous
- H-1 detonation potential
- H-2 deflagration potential
- H-3 significant hazard
- H-4 health hazard
- H-5 semiconductor fabrication

F – Factory/Industrial
- F-1 moderate hazard factory
- F-2 low hazard factory

U – Utility and Miscellaneous
The International Fire Code

- Major themes of the IFC
  - Protection of the occupants
  - Protection of the public
  - Protection of the emergency responders
- The IFC addresses various hazards
  - Building use and operation
  - Storage and use of combustible materials
  - Storage and handling of hazardous materials
  - Fire department access
  - Water supplies
ICC Code Development Cycle

- New code published every 3 years
- 12 month code change cycles
- Codes divided into 2 groups
  - IBC, IFC, IMC, IPC, IPMC, IPSDC, IRC, ISPSC, IWUIC
  - Admin, IBC-S, IEBC, IECC, IgCC, IFC-B

Code change cycle as of March 1, 2018

New edition published

IBC – International Building Code

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

IRC – International Residential Code

- Regulates 1- and 2-family dwellings, and townhouses
- Designed to be a stand-alone code for residential construction
- Combines all of the regulations for the building, energy, mechanical, fuel gas, plumbing and electrical into one document
- IFC is applicable to the exterior elements of IRC regulated buildings
  - Premises identification
  - Fire apparatus access
  - Water supplies
IWUIC – International Wildland-Urban Interface Code
- Provides requirements for geographical areas where structures and development meet or intermingle with wildland or vegetative fuels
- Applies to mitigation of the risk to life and property loss from wildland fire
- Requires defensible space to protect the wildland from structure fires, and protect structures from wildland fires

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

IGFC – International Fuel Gas Code
- Regulates the design, installation, maintenance, alteration and inspection of appliances that utilize natural gas and liquefied petroleum gas (LPG), gaseous hydrogen systems, and related accessories
IPMC – International Property Maintenance Code

- Provides for the maintenance of existing buildings and properties
- Provides minimum requirements for premises, structures, equipment, and facilities
- Addresses lighting, ventilation, space, heating, sanitation, life safety, and safety from fire and other hazards and for safe and sanitary maintenance

IFC – International Fire Code

- Provides a reasonable level of life safety and property protection from the hazards of fire, explosion or dangerous conditions in new and existing buildings and facilities
- Addresses design, construction, installation, testing and maintenance of fire protection systems
- Contains regulations for the safety of firefighters and emergency responders during emergency operations

Navigating the IFC

- 7 major parts to the IFC

<table>
<thead>
<tr>
<th>Part</th>
<th>Title</th>
<th>Chapters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Administrative</td>
<td>1 – 2</td>
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<table>
<thead>
<tr>
<th>IFC Chapter</th>
<th>Subject</th>
<th>IBC Chapter</th>
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<tbody>
<tr>
<td>7</td>
<td>Fire &amp; Smoke Protection Features</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>Interior Finish, Decorative Materials &amp; Furnishings</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>Fire Protection &amp; Life Safety Systems</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>Means of Egress</td>
<td>10</td>
</tr>
<tr>
<td>33</td>
<td>Fire Safety During Construction &amp; Demolition</td>
<td>33</td>
</tr>
</tbody>
</table>
Applicability
§102.1
• IFC construction requirements apply to:
  • Structures, facilities and conditions that arise after the code is adopted
  • Existing structures, facilities and conditions not legally in existence at the time the code is adopted
  • Facilities and conditions when required by Chapter 11
  • Existing structures, facilities and conditions which, in the opinion of the FCO, constitute a distinct hazard to life or property

IF the appendices are adopted:
Appendix K (ambulatory care facilities)
Appendix M (sprinklers in high-rise)

Retroactive Application of Construction Requirements
• §102.1 Item 3 refers to Ch 11
• Ch 11 contains retroactive construction requirements for existing buildings
• Ch 11 establishes minimum safety requirements for existing buildings
  • Protection of open vertical shafts
  • Installation of a fire alarm system in buildings which represent a high life safety risk
  • Provide minimum egress door widths
• Ch 11 requirements are less restrictive than new construction requirements
• Ch 11 is designed to mitigate specific life hazards in existing buildings
Change of Use or Occupancy
§102.3
• The C of O can be used to verify the building’s occupancy or use has not changed
• IFC generally prohibits a change of occupancy or use unless the change is done in conformance with the IBC
• Some changes are allowed when:
  • It does not change the overall use or character of a building
  • It reduces the hazard

Historic Buildings
§102.6
• Historic buildings generally must be maintained in their original condition
• Historic buildings may lack fire safety features normally required for new buildings having the same occupancy classification
• Unless the building is a distinct hazard, the IFC requires that historic structures be provided with fire protection and life safety features based on an approved fire protection plan

Codes and Standards
§102.7
• “Codes” are documents that are adopted
  • Requirements in the code supersede the requirements in the referenced standard
  • It does not matter which is more ‘restrictive’
  • It is based on the hierarchy of the codes
• “Standards” are documents referenced in the codes
  • Tell people how to achieve what must be done
  • Referenced standards are in Ch 80
CHAPTER 2

Legal Aspects, Permits and Inspections

Appendices

§101.2.1

• Developed the same as main body of the code
• Some are designed to be adopted
• Some are intended as additional information
• May provide guidelines, examples of recommended practices, or supplemental information
• May assist in the determination of alternative materials or methods
• Appendices have no legal status until specifically recognized in the adopting ordinance or legislation

• Appendix A Board of Appeals
• Appendix B Hazardous Materials
• Appendix C Hazard Ranking
• Appendix D Cryogenic Conversions
• Appendix E Building Information Signs
• Appendix F Ambulatory Care Facilities
• Appendix G Fire Fighter Air Replenishment Systems
• Appendix H Sprinklers in Existing High-rise
• Appendix I Indoor Trade Shows and Exhibitions

Authority §104

• Local jurisdiction creates the Department of Fire Prevention
• A Fire Code Official (FCO) is appointed to manage the fire prevention office
• Reviews plans, issues permits, inspects work to comply with code and plans
• Interprets code requirements
• Develops policies and procedures to clarify local application of the code
Technical Assistance §104.8.2
- The code allows the FCO to obtain technical assistance when a plan or project involves a design or system that is complicated or technically challenging.
- FCOs can use third-party assistance to:
  - Review design drawings and specifications
  - Verify a design complies with the IFC
- Cost of the review and any reports is the responsibility of the permit applicant.
- Final approval rests with the FCO.

Alternate Materials and Methods §104.10
- The designer can submit a request to meet the code requirements using Alternate Materials and Methods.
- The FCO reviews alternate designs and products to determine if they comply with the code.
- The alternative must be at least equivalent in quality, strength, effectiveness, fire resistance, durability, and safety.
- ICC Evaluation Service (ICC-ES) reviews products and provides reports (ESR) to assist in the evaluation process.

Permits §105
- A permit is required to:
  - Perform certain hazardous operations
  - Construct or alter fire protection systems
  - Install equipment for storage, handling or use of hazardous materials
- 2 types of permits:
  - Operational (105.5):
    - 52 operational permits
  - Construction (105.6):
    - 24 construction permits
    - Place of assembly
    - Storage or use of haz mat
    - High-piled combustible storage
    - Security gates on access roads
Permits §105

- It is very common for a particular facility or regulated use to require both a construction permit and an operational permit

- Installation of explosives magazine
- Storage, use and handling of explosives
- Installation of aboveground storage tanks
- Dispensing of flammable and combustible liquids

Permit Application §105.2.4

- The FCO reviews the plans for compliance with the code and other applicable laws of the jurisdiction
- FCO can perform inspections of buildings, processes or systems before the permit is issued
  - This inspection may establish any operational constraints or limits
  - If the plans have discrepancies, a plan review report (compliance list) is provided to the applicant

Construction Documents §106

- Drawings
- Specifications
- Prepared by a registered design professional where required by the statutes of the state or jurisdiction
  - FCO can waive this requirement
  - when the work does not require
    - a registered design professional
  - Manufacturer’s installation instructions
Inspections §108

- Inspectors check the installation to confirm conformance with the approved design documents
- Inspectors evaluate fire protection systems to confirm installation according to design standards
- An inspection may be required for licensing of day care and health care occupancies
- An inspection is required before an operational permit can be issued

Right of Entry

- Permission to perform the inspection must be obtained from the property owner, tenant or an agent

  1. Identify yourself – carry ID in addition to uniform
  2. Obtain permission and consent from a responsible individual with access to the site
  3. Inform the individual of the basis for inspection
  4. A business may request a copy of the legal basis for an inspection – IFC §106 and §104.3
  5. Once consent is granted, the inspection can proceed

Testing and Operation §109.2

- Fire protection and life safety systems are inspected, tested and approved at initial installation
- Owner is responsible to maintain the operational readiness of the system
  - Many systems require annual inspection or testing
  - Owner must maintain records
- Records must be available for review by FCO
Unsafe Buildings
§114
• The FCO has the authority to require corrections to bring a building or system into compliance when a serious fire or life safety threat is found.
• This authority extends to systems or items regulated by the IFC.
• If the violation constitutes an imminent danger, the FCO is authorized to require the partial or complete evacuation of the building and prohibit re-entry.

Stop Work Order
§113
• The FCO is authorized to issue a Stop Work Order.
• In the IFC, Stop Work Orders can be issued for:
  • Work performed without obtaining the required Operational or Construction permits.
  • Work that has concealed components which have not yet been inspected.
  • Work regulated by the IFC.
• Stop Work Orders are an immediate order to stop.

Board of Appeals
§109
• The FCO is responsible for interpretation of the IFC.
• A property or business owner has the right to legally challenge those interpretations.
• The Board of Appeals evaluates the information regarding the property or business owner’s interpretation of the code section.
• The appellant must claim the FCO has erred in interpreting the code or has wrongly applied a code section.
• The Board of Appeals cannot waive code requirements.
Part I – Code Administration & Enforcement

1. T F The design and use of a building or property can never stray from the requirements found in the IFC.
   - False
   - The design and operation must meet the intent of the code; alternate methods approved by the fire code official are allowed.

2. T F All of the I-Codes work separately and independently of each other.
   - False
   - The I-Codes work as a set of codes, each applying to a specific portion of the facility.

3. After a building receives a Certificate of Occupancy, how often does the IFC require fire inspections to be conducted?
   - As often as deemed necessary
   - IFC §108.2

4. When the FCO arrives to conduct an inspection, the building owner refuses to allow the inspection. Does the FCO have the authority to demand the inspection? What options are there?
   - Owner has the right to refuse the inspection
   - FCO cannot demand inspection
   - FCO can obtain an inspection warrant (administrative warrant)
   - IFC §104.3

PART II

General Safety Requirements

Chapter 3: General Precautions Against Fire
Chapter 4: Emergency Planning and Preparedness
CHAPTER 3

General Precautions Against Fire

Combustible Waste Materials

§304

• Orderly storage
• Located away from ignition sources
• Separation from means of egress
• Separation from concealed spaces
• Dumpsters located ≥5' from combustible construction, wall openings and combustible roof eaves

Outdoor Pallet Storage

§315

• Wood pallets
  • Table 315.7.6(1)
• Plastic pallets
  • Table 315.7.6(2)
• Listed plastic pallets should be considered under the table for wood pallets
Open Flames
§308
• Separation of uses and activities involving potential sources of open flames from combustible materials
  • Pour 1 ounce at a time
  • In the immediate vicinity of the table being served
  • Not transported or carried while burning
  • Wet towel immediately available
  • Liquid- or solid-fueled lighting devices of >8 oz. must self-extinguish if tipped over
  • Devices must not leak at a rate >0.25 teaspoon per minute if tipped over
    - IFC §308.3.1

Vacant Premises
§311
• Safeguarding vacant buildings
  • Openings into the structure are protected from unauthorized entry
  • Hazardous materials removed
  • Fire protection systems should be maintained in service
    - 24" x 24"
    - Red background
    - White reflective stripes
    - White reflective border
    - Date of inspection
    - IFC §311.5

Indoor Display of Vehicles
§314
• ≤5 gallons or ¼ tank of fuel
• Fuel tank fill opening closed and sealed
• No fueling or defueling inside building
• Batteries disconnected?
  • Depends on vehicle and built-in safety features

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Hazards to Fire Fighters
§316

• Trap doors must be closed
• Shaftway markings
• Obstructions <7’ above the surface of a roof:
  • Must not create an obstruction, or
  • Must be protected or identified to emergency responders

Methods of protection:
• 2" white protective collar
• Physical barrier

The provision applies to roofs with a slope of ≤30°

Rooftop Gardens and Landscaped Roofs
§317

• Landscaped portion of the roof is limited in size
  • Maximum area of 15,625 ft²
  • Maximum dimension of 125’
• Additional landscaped areas
  • Separated by 6’
  • Roof rating of separation must be Class A

• When a standpipe is already provided in the building, it must be available to all landscaped areas
• Landscape maintenance plan required

Mobile Food Preparation Vehicles
§319

• Permit required
• Cooking oil storage
  • Metallic tanks or listed nonmetallic
• Fire-extinguishing system if grease-laden vapors are produced
• Fuel gas storage
CHAPTER 4

Emergency Planning and Preparedness

CHAPTER 4

Public Assemblies and Events

§403

• Public assemblies and events can occur inside buildings or outdoors
• Public assemblies in other than Group A or E, the FCO can require a public safety plan
  • Fire apparatus access
  • Emergency medical response
  • Law enforcement
  • Fire watch
  • Crowd Managers

Crowd managers required when:
• OL >500 inside a building
• OL >1,000 for place of religious worship
• OL >1,000 for outdoor event

Fire Safety and Evacuation Plans

§404

• Fire Safety & Evacuation Plans are required in:
  • Group A except for place of religious worship with OL of <2,000
  • Group B ambulatory care facility
  • Group B, F and M with an OL ≥500 or an OL >100 above or below the level of exit discharge
  • Group F – if required in pallet manufacturing or recycling facility
  • Group E, H, I, R-1, R-2 college & university buildings, and R-4
  • Covered malls and open malls >50,000 ft²
  • Underground buildings
  • Group A, E or M with an atrium
  • High-rise buildings of any occupancy
  • Buildings using occupant evacuation elevators
  • High-piled storage >500,000 Class I – IV, >300,000 high-hazard
Table 405.2 – Fire and Evacuation Drill Frequency and Participation

<table>
<thead>
<tr>
<th>GROUP OR OCCUPANCY</th>
<th>FREQUENCY</th>
<th>PARTICIPATION</th>
</tr>
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<tbody>
<tr>
<td>Group A</td>
<td>Quarterly</td>
<td>Staff</td>
</tr>
<tr>
<td>Group B</td>
<td>Quarterly</td>
<td>All occupants</td>
</tr>
<tr>
<td>Group B (ICF)</td>
<td>Quarterly</td>
<td>Staff</td>
</tr>
<tr>
<td>Group B (clinic, hospital)</td>
<td>Annually</td>
<td>All occupants</td>
</tr>
<tr>
<td>Group E</td>
<td>Monthly ¹</td>
<td>Staff</td>
</tr>
<tr>
<td>Group F</td>
<td>Annually ²</td>
<td>Employees</td>
</tr>
<tr>
<td>Group R-1</td>
<td>Quarterly</td>
<td>Staff</td>
</tr>
<tr>
<td>Group R-2</td>
<td>Semiannually</td>
<td>All occupants</td>
</tr>
<tr>
<td>Group R-3</td>
<td>Quarterly</td>
<td>Staff</td>
</tr>
<tr>
<td>Group R-4</td>
<td>Semiannually</td>
<td>All occupants</td>
</tr>
</tbody>
</table>

¹ Emergency evacuation drills are required in Group B buildings having an occupant load ≥ 500 persons or >100 persons above or below the lowest level of exit discharge.
² Emergency evacuation drills in Group R-2 college and university buildings shall be in accordance with §403.9.2.1. Other Group R-2 occupancies shall be in accordance with §403.9.2.2.

Part II
General Safety Requirements

1. **T/F** Open flame devices are prohibited in sleeping units of Group R-2 dormitories.

   ![True](IFC §308.4.1)

2. The fuel tanks in vehicles on display in a mall are limited to \( \frac{5}{4} \) gallons, or \( \frac{5}{4} \) capacity of the tank.

   ![ICF §314.4](IFC §314.4)

3. A Fire Safety and Evacuation Plan is required in a Group F occupancy when the total occupant load in the building is \( 500 \) or more, or when there are \( 100 \) or more above or below the level of exit discharge.

   ![IFC §403.5](IFC §403.5)

4. In the above Group F occupancy, evacuation drills are required **annually**, and all **employees** must participate in the drill.

   ![ICF Table 405.3](IFC Table 405.3)
Fire Apparatus Access Roads
§503

- A fire apparatus access road is the road from the fire station to a facility, building or location
- Access road requirements are typically applied to private property
- Public roads are typically constructed to specifications developed by Public Works or Transportation Engineering department
Fire Apparatus Access Roads
§503.1
• Fire apparatus access roads are required for any facility, building or portion of a building constructed or moved into the jurisdiction
  • Located ≤150' of all portions of the facility and the exterior walls of the 1st story of the building as measured by an approved route

Fire Apparatus Access Roads
§503
• Modifications to the 150' distance
  • Sprinklers
  • Alternative protection because of topography limitations
    • ≤2 Group R-3 or U occupancies

Fire Apparatus Access Roads
§503
• Design and construction
  • Appendix D
<table>
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<tr>
<th>Requirement</th>
<th>Chapter 5</th>
<th>Appendix D</th>
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<tbody>
<tr>
<td>Minimum road width</td>
<td>20</td>
<td>20; 26 for aerial apparatus access</td>
</tr>
<tr>
<td>Maximum grade</td>
<td>As required by FCO</td>
<td>10%</td>
</tr>
<tr>
<td>Minimum turning radius</td>
<td>As required by FCO</td>
<td>As required by FCO</td>
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<tr>
<td>Turnaround design</td>
<td>Must be approved</td>
<td>Specific design criteria</td>
</tr>
<tr>
<td>Angle of approach/Departure</td>
<td>As required by FCO</td>
<td>As required by FCO</td>
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<tr>
<td>Road surface</td>
<td>All weather</td>
<td>Asphalt, concrete or other approved surface</td>
</tr>
<tr>
<td>Road design</td>
<td>Support load of the apparatus</td>
<td>Designed for vehicles with a weight of 75,000 pounds</td>
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<tr>
<td>Aerial apparatus access</td>
<td>Not specified</td>
<td>Buildings ≥50' in height</td>
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<tr>
<td>Fire lane signs</td>
<td>Must be approved</td>
<td>Minimum size, reflective background, specific design</td>
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<tr>
<td>Multiple access into subdivisions</td>
<td>When required by FCO</td>
<td>&gt;30 units unless sprinklered</td>
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Many of the specific dimensions can be included in Appendix D... if it is adopted.
Access to Buildings

§504
• Required exterior doors or openings must be maintained accessible for use by FD
  • Identification of riser rooms, electrical and mechanical rooms
• Key box – approved by the FCO
  • Location of the key box
  • Number of keys
  • Manufacturer of the key box
• Stairway to roof
  • Required when ≥4 stories
  • Stairway must be identified

Hazards to Firefighters

§504, §316
• Doors to shaftways must be marked
  • Interior doors
  • Exterior doors
• Security devices which could harm or injure FF are prohibited
• Trapdoors or scuttles must be closed when not in use

Fire Protection Water Supplies

§507
• As part of construction, facilities or buildings require a fire water supply capable of delivering the required fire flow for manual fire-fighting operations
• Determining required water supply
  • Appendix B
    • IWUIC
    • NFPA 1142
    • Iowa State University
    • National Fire Academy
Water Supply

- Relationship of fire sprinkler requirements and fire-flow requirements are addressed in Appendix B
  - Both must be met
  - Do not combine
  - Water supply must be able to provide both, but not simultaneously

Water Source

§507

- Tank, reservoir, pressurized water system
- Hydrant (or tank connection) within 400' of the 1st floor exterior walls of the building
  - Sprinklered buildings ≤600'
  - Group R-3 and U ≤600'
  - Add hydrants

Water Source

- System must be tested and maintained
- NFPA 25
  - Annual flow test and maintenance of private fire hydrants
  - Flow test private fire protection water mains every 5 years
- Minimum 3' clearance around hydrants
- Protection of hydrants required where subject to vehicle impact
Emergency Responder Radio Coverage
§510

• Emergency responder radio coverage provisions are concerned with the reliability of portable radios used inside buildings
• Requires that all buildings have approved radio coverage in 95% of the building
  • Digital audio quality is evaluated
  • DAQ 3.0 (Delivered Audio Quality)
• If radio signals are not adequate, owner must install equipment to enhance signal.

Emergency Responder Radio Coverage
§510

• IFC provides performance criteria for complying with radio coverage requirements
  • Does not specify solution, but allows use of any appropriate technology
• Secondary power required
• Testing and maintenance requirements
• Must meet FCC compliance

Delivered Audio Quality (DAQ)

DAQ 1: Transmission is unusable. Speech is present but unreadable.

DAQ 2: Speech is understandable with considerable effort. Frequent repetition is needed due to noise or distortion.

DAQ 3: Speech is understandable with slight effort. Occasional repetition is needed due to noise or distortion.

DAQ 3.5: Speech is understandable with slight effort. Occasional repetition is needed due to infrequent noise or distortion.

DAQ 4: Speech is easily understood. There is occasional noise or distortion.

DAQ 4.5: Speech is easily understood. There is infrequent noise or distortion.

DAQ 5: Speech is easily understood.
Fuel-Fired Appliances
§605

- Apparatus or device using fuel gas or fuel oil
- Equipment must be installed in accordance with manufacturer’s instructions
- Modifications must be in accordance with manufacturer’s requirements
- Access is required so equipment can be maintained

Waste oil is used as the fuel in these burners

Fuel Oil Inside Buildings
§605.4.2

- Aggregate fuel oil storage ≤660 gallons is allowed inside building in
  - Tanks allowed by Ch 57, or
  - Tanks integral to fuel burning equipment

- ≥660 and ≤1,320 gallons
  - Tank listed to: • UL 142, or • UL 2085 AND building is sprinklered with NFPA 13 system

- >1,320 and ≤3,000 gallons
  - Tank listed to: • UL 2085 AND room is sprinklered with NFPA 13 system

- >3,000 gallons
  - Tank listed to: • UL 2085 AND building is sprinklered with NFPA 13 system
Fuel-fired Appliances *Inside* Buildings

§605.5

- Portable unvented fuel-fired appliances inside buildings
  - Prohibited in Groups A, E, I and R
  - Listed and approved heaters allowed in 1- and 2-family dwellings
  - Cannot be located inside sleeping rooms, bathrooms or closets

---

Portable Gas-Fired Heaters *Outside* Buildings

- Portable outdoor heaters allowed in outdoor locations
- Listed to ANSI Z83.26 Standard for Gas-Fired Outdoor Infrared Patio Heaters
  - Requires CGA 790 gas valve
  - 5’ separation to:
    - Exits, or exit discharge
    - Building wall
    - Combustible decorations

---

Mechanical Refrigeration §608

- IFC regulates refrigeration systems with
  - Toxic refrigerants
  - Ammonia
  - Flammable refrigerants
    - New – Class 2L
    - "Lower flammability"
    - Still treated as flammable
Elevators
§604

- Elevator required in new buildings with ≥4 stories above or below the LED.
- Phase I and II required for all new elevators.
- If elevators are ‘required’, then standby power is required.
- If elevators are ‘required’, then 1 is sized for gurney.

Commercial Kitchen Hoods
§607

- Commercial cooking appliances require a local exhaust ventilation system to remove heat, vapors, steam, smoke and odors.
- Type I hoods are designed to also remove of grease-laden vapors and smoke.
- Extinguishing system is required when Type I hood is required.

Commercial Hood Maintenance
Table 606.3.3.1

<table>
<thead>
<tr>
<th>Type of Cooking Operation</th>
<th>Frequency of Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-volume cooking operations such as 24-hour cooking, charbroiling, or wok cooking</td>
<td>3 months</td>
</tr>
<tr>
<td>Low-volume cooking operations such as places of religious worship, seasonal businesses, and senior centers</td>
<td>12 months</td>
</tr>
<tr>
<td>Cooking operations utilizing solid-fuel burning cooking appliances</td>
<td>1 month</td>
</tr>
<tr>
<td>All other cooking operations</td>
<td>6 months</td>
</tr>
</tbody>
</table>
### Commercial Kitchen Cooking Oil Storage

**§607**

- **Storage of cooking oil in commercial cooking operations** shall comply with Ch 57.
- Systems storing cooking oils in >60 gallon above-ground tanks requires UL 142 or UL 80 listed aboveground storage tank.
- Each tank to have a normal and emergency vent.

*Courtesy of Darling International Inc., Irving, TX*

Nonmetallic tanks ≤200 gallons can be listed without emergency vent.

### Emergency/Stand by Power Systems

**§1203**

<table>
<thead>
<tr>
<th>Emergency Power System</th>
<th>Standby Power System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency alarms</td>
<td>Elevators and platform lifts</td>
</tr>
<tr>
<td>Emergency visual alarm communication systems</td>
<td>Emergency responder radio coverage</td>
</tr>
<tr>
<td>Exit signs</td>
<td>High-rise buildings — depending on electric load function</td>
</tr>
<tr>
<td>Gas detection systems</td>
<td>Hydrogen fuel gasrooms</td>
</tr>
<tr>
<td>Essential systems in Group I-2</td>
<td>Membrane structures — inflation systems in permanent membrane structures</td>
</tr>
<tr>
<td>Power operated locks and doors in Group I-2</td>
<td></td>
</tr>
<tr>
<td>Highly toxic and toxic materials</td>
<td></td>
</tr>
<tr>
<td>High rise buildings – depending on function</td>
<td></td>
</tr>
</tbody>
</table>

**Emergency power**
- Serious life safety hazard, or critical systems
- Transfer within 10 seconds

**Standby power**
- Possible life safety hazard, or interruption of firefighting
- Transfer within 60 seconds

*Emergency/Stand by Power Systems*  

- **Power source**
  - Batteries
  - Generator
- **Automatic transfer switch**
- **Maintenance**
  - Operate transfer switch
  - Run generators
  - Use generators
- **Protection of essential and standby power**

*Courtesy of Pentair Thermal Management, Houston, TX* 

- Protected by 1-HR assembly
- UL 2196 listed cable
Solar Photovoltaic Power Systems
§1205
• Addresses installation of solar PV power systems on buildings and ground-mounted
• Compliance with IFC, IBC and NEC®
• Size of PV array:
  • Maximum 22,500 ft²
  • Maximum dimension of 150'
• Clear space around panel array
  • to provide firefighter walkways:
    • 3' wide for residential buildings
    • 6' wide for commercial buildings

Rapid Shutdown for Solar PV Systems
§1205.4.3
• NEC requires rapid shut down on new solar PV systems
• Rapid shutdown reduces the power in the array…it does NOT shut the system down entirely
• Rapid shutdown switch
  Within 3' of the service disconnect

Electrical Energy Storage Systems
§1206
• Stationary storage battery systems
  • Indoor installation
  • Outdoor installations

  • Flow batteries
  • Sodium batteries
  • Lead-acid batteries
  • Nickel-cadmium (Ni-Cd)
CHAPTER 7

Interior Finish and Decorative Material

Interior Wall/Ceiling Finish and Trim

Table 803.3

Flame spread requirements are based on:
- Occupancy
- Sprinklers
- Location in the building

<table>
<thead>
<tr>
<th>Group</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1, A-2</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>A-3, A-4, A-5</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>B, C, D, E, M, R-1, R-4</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>For example</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>A</td>
<td>C</td>
</tr>
</tbody>
</table>

For example

Interior finishes and furnishings

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Number of latitudes</th>
<th>Number of injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhythm Night Club, Natchez, MS</td>
<td>April 13, 1941</td>
<td>339</td>
<td>Unknown</td>
</tr>
<tr>
<td>Cocomar Grove Night Club, Boston, MA</td>
<td>November 28, 1942</td>
<td>492</td>
<td>Unknown</td>
</tr>
<tr>
<td>Beverly Hills Supper Club, Southgate, KY</td>
<td>May 26, 1977</td>
<td>165</td>
<td>&gt; 200</td>
</tr>
<tr>
<td>Station Nightclub, Warwick, RI</td>
<td>February 9, 2003</td>
<td>190</td>
<td>&gt; 200</td>
</tr>
</tbody>
</table>
Dangers of Flashover

\[ \text{Hot gas and smoke layer} \]

4 Phases of Growth and Decay

1. incipient
2. pre-flashover
3. flashover
4. post-flashover

- Flashover occurs at approximately 1,100°F and is driven primarily by radiant energy within the fire’s hot gas and smoke layer.

Testing

- The test results are reported as a material’s flame spread index (FSI) and smoke-developed index (SDI).

<table>
<thead>
<tr>
<th>Material class</th>
<th>Flame spread index</th>
<th>Smoke-developed index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A</td>
<td>0-98</td>
<td>0-450</td>
</tr>
<tr>
<td>Class B</td>
<td>10-75</td>
<td>0-450</td>
</tr>
<tr>
<td>Class C</td>
<td>76-590</td>
<td>0-450</td>
</tr>
</tbody>
</table>
The Steiner Tunnel Test referred to in ASTM E84 measures a material's flame spread and smoke-developed indexes. (Courtesy of Underwriters Laboratories, Northbrook, IL)

Testing

- NFPA 286, Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

<table>
<thead>
<tr>
<th>TABLE 803.3</th>
<th>INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY</th>
</tr>
</thead>
</table>

- Class C interior finish materials shall be allowed for wainscotting or paneling of not more than 1,000 square feet of applied surface area in the grade lobby where applied directly to a noncombustible base or over furring strips applied to a noncombustible base and fireblocked as required by Section 803.11.1 of the International Building Code.

- In exit enclosures of buildings less than three stories in height of other than Group I-3, Class B interior finish for nonsprinklered buildings and Class C for sprinklered buildings shall be permitted.

- Requirements for rooms and enclosed spaces shall be based upon spaces enclosed by partitions. Where a fire-resistance rating is required for structural elements, the enclosing partitions shall extend from the floor to the ceiling. Partitions that do not comply with this shall be considered as enclosing spaces and the rooms or spaces on both sides shall be considered as one. In determining the applicable requirements for rooms and enclosed spaces, the specific occupancy thereof shall be the governing factor regardless of the group classification of the building or structure.

- Lobby areas in Group A-1, A-2 and A-3 occupancies shall not be less than Class B materials.

- Class C interior finish materials shall be allowed in Group A occupancies with an occupant load of 300 persons or less.

- In places of religious worship, wood used for ornamental purposes, trusses, paneling or chancel furnishing shall be allowed.

- Class B material is required where the building exceeds two stories.

- Class C interior finish materials shall be allowed in administrative spaces.

- Class C interior finish materials shall be allowed in rooms with a capacity of four persons or less.

- Class B materials shall be allowed as wainscotting extending not more than 48 inches above the finished floor in corridors.

- Finish materials as provided for in other sections of this code.

- Applies when the vertical exits, exit passageways, corridors, or rooms and spaces are protected by an approved automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.

- Corridors in ambulatory care facilities shall have a Class B or better interior finish material.
In Summary

• Interior wall and ceiling finish requirements were developed so that selected materials contribute little fuel to a fire.
• The requirements in the IFC are based on the FSI and SDI of a material.
• As an alternative to the ASTM E84 test, the IFC allows the use of a roomcorner test, which offers a realistic assessment of a material's fire behavior.

Foam Plastics

• The foam plastic trim used to create the columns and cornice around the window cannot exceed 10 percent of the wall area.

Limits to Combustibles based on Occupancy

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Maximum surface area covered Sprinklered</th>
<th>Nonsprinklered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>75%</td>
<td>10%</td>
</tr>
<tr>
<td>Group B, C, D</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Group E, I, II, IV</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Group I-2 dormitories</td>
<td>50%</td>
<td>10%</td>
</tr>
<tr>
<td>Group E, I-1</td>
<td>50%</td>
<td>10%</td>
</tr>
<tr>
<td>All others</td>
<td>10%</td>
<td>Not Limited</td>
</tr>
</tbody>
</table>

Na = not allowed.
1. Percentage only allowed in auditoriums of Group A.
2. The amount of ceiling area covered is not limited if the material meets the fire test criteria for UL 905 or 904.
3. Percentage only allowed in dormitories of Group I-2. [Ref. 307.2, 607.3]
Part III
Site and Building Services

1. How often must the exhaust system over a gas-fired commercial cooking appliance be inspected in a restaurant open 7 days/week for lunch and dinner only? 
   - At least every 6 months (IFC Table 609.3.3.1)

2. In a stairway of a Group B high-rise, the new wall and ceiling finishes must have a flame spread rating of Class B or better. 
   - Class B (IFC Table 803.3)

Module III
Site and Building Services

3. Fire apparatus access roads must be provided to within 150 feet of all exterior portions of the building. 
   - IFC §503.1.1, some exceptions

4. Fire hydrants, or fire-fighting water supply, must be available within 400 feet of all exterior portions of a non-sprinklered building or facility. 
   - 600' if sprinklered (IFC §507.5.1)

PART IV
Fire/Life Safety Systems
And Features

Chapter 8: Requirements for All Fire Protection Systems
Chapter 9: Automatic Sprinkler Systems
Chapter 10: Fire Alarm and Detection Systems
Chapter 11: Means of Egress
CHAPTER 8
Requirements for All Fire Protection Systems

When are Fire Protection Systems Required?

- Fire protection systems thresholds based on:
  - Occupancy of the building
  - Size of fire area
  - Occupant load
  - Height of the building
  - Area of the building
  - Quantity of hazardous materials stored or used
  - Use or processes

For example – all Group H
For example – Group F-1 >12,000 ft²
For example – Group A-3 ≥300
For example – high-rise
For example – allowable area increase
For example – MAQ increase
For example – high-piled storage

Additional Fire Protection §901.4.4

- Where process or hazards are especially challenging to emergency responders or to FD resources, the FCO can require additional fire protection safeguards
  - Fire protection systems
  - Detection systems
  - Flow control
  - Automatic shut-down
Fire Protection System Impairment

§901.7

• FD and FCO must be informed when fire protection systems are impaired

• Scheduled impairment

• Unscheduled impairment

• FCO can require:
  1. Evacuation of building,
  2. Fire watch

Impairment Coordinator

1. Identify the extent and duration of impairment
2. Inspect areas that will be affected and identify any processes to be discontinued
3. Notify the FD, FCO, fire alarm system monitoring station, and required notifications within the organization
4. Assemble the necessary tools and materials
5. Implement the impairment tag program
6. Ensure system is back in operation
7. Notify FD, FCO and all affected parties

Fire Watch could be:

1. FD personnel
2. Owner or designated employee
3. Hired 3rd party company
4. Option must be approved by FCO

Impaired system

Impairment Tag

Fire Protection System Monitoring

§903.4, §907.6.6

• Sprinkler system monitoring
  • Main control valves
  • Floor control valves
  • Water flow
  • Trouble

• Fire alarm system monitoring
  • Alarm activation
  • Trouble

• Cancellation
  • Supervising company must notify FCO

Exempt:

1. Sprinkler systems with <20 sprinklers
2. 1- and 2-family dwellings
3. NFPA 13R installations with combined domestic and sprinkler piping

Exempt:

1. 1- and 2-family dwellings
2. Smoke alarms in Groups I-3 and R

Automatic Sprinkler Systems

CHAPTER 9

107
Automatic Fire Sprinkler Systems

• Most reliable fire protection system
• Many modifications can occur in the building based on the installation of a fire sprinkler system
  • IFC
  • IBC
• System must be designed and maintained properly

IFC:
• Increased haz mat quantities
• Reduction in fire flow
• Increased distance to access road
• Relaxed interior finish flame spread rating

IBC:
• Increased height and area
• Increased exit access travel distance
• Reduced fire-resistance-rating of fire barriers
• Unlimited building size for certain occupancies

Level of Exit Discharge and Fire Area

• Level of exit discharge
• Fire area
  • Fire-resistance-rated construction between areas
    • IFC Table 508.4
    • IFC Table 707.3.10
• For example
  • If the floor assemblies are fire rated, each floor becomes a fire area

Design and Installation Standards

<table>
<thead>
<tr>
<th>Design Consideration</th>
<th>NFPA 13</th>
<th>NFPA 13R</th>
<th>IBC Section 903.4.18</th>
<th>NFPA 13A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent of Protection</td>
<td>Throughout the entire building</td>
<td>Occupied spaces</td>
<td>Occupied spaces</td>
<td>Occupied spaces</td>
</tr>
<tr>
<td></td>
<td>(Section 903.1.1)</td>
<td>(Section 903.1.2)</td>
<td>(Section 903.1.3)</td>
<td>(Section 903.1.3)</td>
</tr>
<tr>
<td>Applicability</td>
<td>All occupancies</td>
<td>Group R ≤ 4 stories</td>
<td>1- and 2-family dwellings and boardrooms ≤ 5 stories</td>
<td>All listed and approved sprinklers</td>
</tr>
<tr>
<td>Design Methods</td>
<td>Pipe schedule</td>
<td>Control mode – density/design area</td>
<td>Control mode – specific application</td>
<td>Suppression mode</td>
</tr>
<tr>
<td></td>
<td>Control mode – specific application</td>
<td>Control mode – specific application</td>
<td>Control mode – specific application</td>
<td>Control mode – specific application</td>
</tr>
<tr>
<td></td>
<td>Occupied spaces</td>
<td>IRC P2904 – Prescriptive design; NFPA 13D – 2 sprinklers in the hydraulic remote compartment</td>
<td>IRC P2904 – Prescriptive design; NFPA 13D – 2 sprinklers in the hydraulic remote compartment</td>
<td>IRC P2904 – Prescriptive design; NFPA 13D – 2 sprinklers in the hydraulic remote compartment</td>
</tr>
<tr>
<td>Sprinkler heads</td>
<td>All listed and approved sprinklers</td>
<td>Listed residential sprinklers</td>
<td>Listed residential sprinklers</td>
<td>Listed residential sprinklers</td>
</tr>
<tr>
<td>Minimum Water Supply Gallons</td>
<td>30 to 120 minutes depending on the risk and design</td>
<td>30 minutes</td>
<td>IRC Section 903.4.18 – 1 to 10 gallons depending on dwelling size and stories; NFPA 13D – 30 gallons</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>

- Control mode sprinkler design
- Suppression mode sprinkler design
Automatic Sprinkler Systems

- NFPA 13 recognizes 4 types of sprinkler systems:
  - Wet-pipe sprinkler system
  - Dry-pipe sprinkler system
  - Pre-action sprinkler system
  - Deluge sprinkler system

These systems are designed for use inside buildings with temperatures ≤40°F. Water does not enter the system until activation of the detection device and sprinkler.

Occupancies Requiring Automatic Fire Sprinkler Protection

- **Groups A-1, A-3 and A-4**
  - Fire area >12,000 ft²
  - OL ≥300
  - Floor other than the LED
  - Multi-theater

- **Group A-2**
  - Fire area >5,000 ft²
  - OL ≥100
  - Floor other than the LED

3rd floor does not require sprinklers provided it is a separate fire area.

Additional requirements for Group A

§903.2.1.6

- Assembly on rooftop – install sprinklers to LED
Additional requirements for Group A §903.2.1.7

- Multiple Group A fire areas
  - With 2-HR separation each Group A is considered separately and creates separate fire area
  - 2-HR fire barriers
  - Multiple Group A occupancies share egress system so aggregate OL is considered
  - If aggregate OL >300, then sprinkler system is required

Occupancies Requiring Automatic Fire Sprinkler Protection

- Group B
  - Ambulatory health care facilities
  - OL ≥30 on a floor ≥55’ above LLFDVA
  - Group B ACFs require the entire floor to be sprinklered and all floors below that floor
  - When sprinklers are required because of the height of the building, the entire building must be sprinklered

Occupancies Requiring Automatic Fire Sprinkler Protection

- Group E
  - Fire area >12,000 ft²
  - All portions below LED
  - Sprinklers not required in areas below LED where each classroom has at least one exterior exit door at ground level
Occupancies Requiring Automatic Fire Sprinkler Protection

- Groups F-1, M and S-1
  - Fire area >12,000 ft²
  - Aggregate fire area >24,000 ft²
  - Above the 3rd story
- Special hazards
  - Woodworking >2,500 ft²
  - Manufacture or storage of upholstered furniture or mattresses >2,500 ft²
  - Retail sale of upholstered furniture or mattresses >5,000 ft²
  - High-piled storage
  - Distilled Spirits / F-1

Group F, M and S require the entire building to be sprinklered

Occupancies Requiring Automatic Fire Sprinkler Protection

- Group H
  - All subgroups

Group H requires the occupancy to be sprinklered

- Group I, R
  - All subgroups
  - Some exceptions for Group I-4

Group I and R require the entire building to be sprinklered

“Sprinklers Installed Throughout”

- Often the code states “…equipped throughout with an automatic sprinkler system.
- What does “throughout the building” mean?
- Exempt locations in §903.3.1.1.

1. Rooms where application of water constitutes a serious life or fire hazard
2. Rooms where sprinklers are considered undesirable
3. Generator and transformer rooms separated from the remainder of the building by 2-HR fire-resistance-rated construction
4. Rooms that are of noncombustible construction with wholly noncombustible contents
5. Fire service access elevator machine rooms and machinery spaces
6. Machine rooms, machinery spaces, control rooms and control spaces associated with occupant evacuation elevators

1. Soffits, eaves and overhangs <4’ wide
2. Concealed spaces with limited access and no storage
3. Certain pipe chases and concealed spaces with <6” clearance

But the building is considered fully sprinklered

1. Attic spaces without fuel-fired appliances
2. Small bathrooms
3. Closets
4. Garages

Bottom line…the building is considered fully sprinklered when the sprinkler system is installed in accordance with the standard as modified by the code.
**Fire Department Connection**

§912

- FDC required for most sprinkler and standpipe systems
- Must be identified and labeled
- Signs required if not visible
- Cannot obstruct access to the building
- Located on the street side of the building
- Must be easily recognized from the FD access roadway

**CHAPTER 10**

Fire Alarm and Detection Systems

- Design, construction and maintenance requirements in NFPA 72
- Notification methods
  - Audible
  - Visible
  - Text
  - Supervisory signals
- Distinctive signal that cannot be used for any other purpose
  - Closing of a main water supply control valve
  - Low air pressure on a dry-pipe system
  - Any condition that takes a fire protection system off-line
**Fire Safety Functions**

§907.3

- Close fire and smoke dampers
- Release fire doors
- Shutdown HVAC
- Recall elevators
- Activate extinguishing systems

---

**Fire Alarm Components**

- Fundamental components:
  - Fire alarm control unit
  - Primary and secondary electrical power supply
  - Initiating devices
  - Occupant notification devices

  - Receives input from automatic and manual alarm initiating devices
  - Actuates notification devices
  - Operates fire safety functions
  - Audible and visual
  - Receives signal from FACU
  - Audible above ambient noise
  - Primary power is building utility service
  - Dedicated fire alarm circuit
  - Secondary power is battery backup, typically
  - 24-HR standby with 5 minutes of alarm
  - Automatic or manual
  - Detect a “change of state” condition
  - Send signal to FACU

---

**Occupancies Requiring Fire Alarm and Detection Systems**

- **Group A**
  - OL ≥300
  - If OL ≥1,000 must have emergency alarm/voice communication system

- **Groups B and M**
  - OL ≥500
  - OL ≥100 on a floor other than level of exit discharge
  - Group B ambulatory care facility

---
Occupancies Requiring Fire Alarm and Detection Systems

• **Group E**
  - OL >50
  - If OL >100 must have emergency alarm/voice communication system

• **Group I**
  - All subgroups
  - Private mode signaling
  - Corridor smoke detection
  - Groups I-1 and I-2

Manual fire alarm boxes can be eliminated when:
1. Smoke detectors in interior corridors,
2. Fire detection in auditoriums, cafeteria, gym, shops and labs,
3. Manual alarm activation from a central point

- Must be approved by the FCO
- Audible alarm is not required

Courtesy of Cooper Notification Inc.

• Not required in I-3 when building has fire sprinklers
• Not required in I-2 when sleeping rooms have smoke alarms

• **Group R**
  - Groups R-1 and R-4 require a manual fire alarm system
  - Group R-2 requires a manual fire alarm system when:
    - >16 dwelling units
    - Smoke detection in common areas when the Group R-2 is part of a college or university

Automatic smoke detection required in all interior corridors that serve sleeping units in Group R-1

In Groups R-1 and R-4, all but 1 manual fire alarm box can be eliminated when the building is protected throughout by a NFPA 13 or 13R fire sprinkler system

In Group R-2, all manual fire alarm boxes can be eliminated when the building is protected throughout by a NFPA 13 or 13R fire sprinkler system

Carbon Monoxide Alarms §915

• CO alarms required in Group I and R if:
  - The building contains a fuel-burning appliance
  - The building has an attached garage
  - Single station CO alarms must be listed to UL 2034
  - CO detectors must be listed to UL 2075
Gas Detection Systems

§916

• This section does not require gas detection
• Other sections require gas detection
• This section provides criteria

• Thresholds
  • 25% LEL
  • 50% IDLH

Means of Egress (MOE)

CHAPTER 11

Means of Egress

• 3 means of egress components
  • Exit
  • Exit access
  • Exit discharge
  • Safe dispersal area
    - 5 ft² per person
    - 50’ from building
    - Identified as ‘Safe Dispersal Area’

The portion of a MoE system that leads from any occupied portion of a building or structure to an exit.

The portion of a MoE system that leads from any occupied portion of a building or structure to an exit.

That portion of a MoE system between the exit access and the exit discharge or public way.
Means of Egress
Minimum Features

- Exit components require minimum width
- Total width of all exit access components must equal or exceed the requirements based on OL
- The distance to an exit is limited — this is the exit access travel distance
- Any change of elevation is accomplished using ramps, stairs or steps
- Illumination and identification is required
- Exit and exit access components have more restrictive interior finish requirements
- Doors, corridors, stairways and ramps have minimum width requirement
- Minimum required widths may need to be increased based on OL
- Exit access travel distances can be increased by providing fire sprinklers or in some cases fire-resistance-rated construction
- Exit signs required when 22 exits are required
- When 22 exits are required, emergency power is required for exit signs and egress path illumination
- Often ≥2 egress paths are required
- Spatially remote from one another
- Exit signs required when ≥2 exits are required
- Emergency power is required for exit signs and egress path illumination
- ≥2 exits are required, emergency power is required for exit signs and egress path illumination
- ≥2 exits are required
- Emergency power is required for exit signs and egress path illumination
- ≥2 exits are required

Occupant Load
§1004

- The potential number of people in a building is determined by calculating the design occupant load
- Gross floor area is the entire floor area within the exterior walls, exclusive of vent shafts and courts
- Net floor area is the normally occupied area within the exterior walls
- Includes unoccupied accessory uses including corridors, stairways, toilets, mechanical rooms and closets
- Areas with fixed seating — count the seats
- Areas without fixed seating — use the OL factor in Table 1004.5
- OL posted in Group A occupancies
- Occupancy
- §1004
- Areas with fixed seating — count the seats
- Areas without fixed seating — use the OL factor in Table 1004.5
- OL posted in Group A occupancies
**Egress Width §1005**

- Calculation of minimum egress width
  - 0.3”/person for stairways
  - 0.2”/person for level areas or ramps

- Obstructions to egress width

  *When the building is equipped with a fire sprinkler system AND an emergency voice/alarm communication system the egress widths are reduced to:*
  - 0.2”/person for stairways
  - 0.15”/person for other areas

---

**Egress Width §1005**

- **Given:** A portion of the egress system serves 200 occupants in an unsprinklered Group B building.

- **Determine:** The minimum required width of each egress component.
  - Stair width = 60”
  - Door width = 40”
  - Corridor width = 44”

- **Given:**
  - 200 occupants
  - 0.22” per occupant

  - 44” required width

---

**Exit Access §1016**

- Egress through an adjacent area or room is allowed provided the exit path is direct and obvious so that the occupant can recognize the exit path.

- Cannot pass through closets, storage rooms or kitchens

  *Exception for Group M*
Exit Access Travel Distance
Table 1017.2

- Exit access travel distance is measured to:
  - An exit passageway
  - A horizontal exit
  - The door of a vertical exit enclosure
  - An exterior exit ramp or stairway
  - An exterior exit door

<table>
<thead>
<tr>
<th>Occupancy</th>
<th>Without sprinkler system (feet)</th>
<th>With sprinkler system (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, E, F-1, M, R, E-1</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td>I-1</td>
<td>Not Permitted</td>
<td>250</td>
</tr>
<tr>
<td>B</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>F-2, S-2, U</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>H-1</td>
<td>Not Permitted</td>
<td>75</td>
</tr>
<tr>
<td>H-2</td>
<td>Not Permitted</td>
<td>150</td>
</tr>
<tr>
<td>H-3</td>
<td>Not Permitted</td>
<td>150</td>
</tr>
<tr>
<td>H-4</td>
<td>Not Permitted</td>
<td>175</td>
</tr>
<tr>
<td>I-2, I-3</td>
<td>Not Permitted</td>
<td>200</td>
</tr>
<tr>
<td>I-4</td>
<td>150</td>
<td>200</td>
</tr>
</tbody>
</table>

Exit and Exit Access Doorway Arrangement

- When 2 exits are required, they shall be separated at least ½ of the diagonal of the room or building served.

When sprinklered, the separation distance is 1/3 the maximum diagonal.

Exit Signs and Means of Egress Illumination

- Illumination of the exit and exit access is required, except:
  - Group U
  - Aisles in Group A
  - Dwelling and sleeping units in Groups I, R-1, R-2 & R-3
  - When ≥2 exits or exit access doors are required, emergency power is required for egress path illumination
  - 90 minute duration
### Exit Signs §1013

- Required at all exit and exit access doors, except:
  - Rooms or areas with 1 exit or exit access
  - Main exterior exit doors that are clearly identifiable as exits when approved by the BCO
  - Group U occupancies and individual sleeping units or dwelling units in Groups R-1, R-2 or R-3
  - Dayrooms, sleeping rooms or dormitories in Group I-3
  - On the seating side of vomitories in Groups A-4 and A-5

- Internally or externally illuminated
- Signs spaced in accordance with their listing
- Indicate direction to exit
- Signs located at changes in direction
- All doors into corridors must have visible exit sign within 100’

### Maintenance of MoE §1032

- Cannot obstruct, block or disable MoE components
- Maintained to prevent conditions that can cause confusion or obscure the means of egress

### Egress Calculation Loretta's Honky Tonk

- Given: Existing building with
  - Group A-2
  - Fire sprinkler system
- Determine OL
  - Fixed seats: 420 + 7 = 60
  - Dance floor: 60
  - Bar service area: 1
  - Exit aisles: 34
- Total OL = 185

1. Exit width is not adequate
2. Exit is required
3. Panic hardware is required
4. Main door could have key-operated lock instead of panic hardware
5. Exit signs are required
6. Egress illumination required
Part IV – Fire/Life Safety Systems and Features

1. What standard is referenced by the IFC for the design and installation of a CO2 fire extinguishing system?

   NFPA 12 Carbon Dioxide Extinguishing Systems
   IFC §904.8

2. An existing tenant space on the 3rd floor of a building is being renovated into a restaurant with full bar. Are fire sprinklers required?

   YES – IFC §903.2.1.2, Item 3
   Group A-2 occupancy on a floor other than the LED requires sprinklers on that floor and all floors to the LED

3. The restaurant dining area will be 6,000 ft². Is a fire alarm system required?

   Yes
   DL = 450; manual fire alarm system required
   IFC §907.2.1

4. Is an automatic fire extinguishing system required to protect the cooking appliances?

   Yes…unless they are just serving steamed hot dogs
   IFC §904.2.2

Part V

Special Processes and Building Uses

- Chapter 12: Motor Fuel-Dispensing Facilities and Repair Garages
- Chapter 13: Flammable Finishes
- Chapter 14: High-Piled Combustible Storage
- Chapter 15: Other Special Uses and Processes
Motor Fuel-dispensing Facilities

• Regulation based on fuel type

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Applicable IFC Requirements</th>
<th>Applicable NFPA Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline, Diesel Fuel, Ethanol mixtures</td>
<td>§2209; Ch. 57</td>
<td>NFPA 30; NFPA 30A</td>
</tr>
<tr>
<td>Hydrogen – Compressed</td>
<td>§2209; §5303</td>
<td>NFPA 55</td>
</tr>
<tr>
<td>Hydrogen – Liquefied</td>
<td>§2209; §5806</td>
<td>NFPA 55</td>
</tr>
<tr>
<td>Liquefied Petroleum Gas</td>
<td>§2207; Ch. 53; Ch. 61</td>
<td>NFPA 58</td>
</tr>
<tr>
<td>Natural Gas – Compressed</td>
<td>§2208; Ch. 53</td>
<td>NFPA 52</td>
</tr>
<tr>
<td>Natural Gas – Liquefied</td>
<td>Ch. 58</td>
<td>NFPA 50; NFPA 57; NFPA 59A</td>
</tr>
</tbody>
</table>

Dispensing Operations and Devices: Requirements for All Fuels

• Dispensing operation
  • Attended
    • Attendant's responsibilities
    • Unattended
      • Owner's responsibilities
      • Signs

At least one person is on site to supervise, control and observe the fuel-dispensing operations.

• Control dispensing operation
  • No attendant available

• Daily visit to the facility
  • Daily reconciliation of fuel sales
  • Inspection of dispensing area

• Oversee dispensing operations
  • Must be able to view dispensing operations
Dispensing Operations and Devices Arrangement

- Minimum separation to property lines, buildings, openings in building and fixed ignition sources
- Vehicle receiving fuel and the dispensing equipment must be on same property
- Clearly identified emergency disconnect switch

Vehicle delivering fuel must be on same property

Portable fire extinguishers

- No closer than 20'; no further than 100'
- Liquid tight and vapor tight for tanks >1,000 gallons

Minimum 2A:20B:C

No further than 75'

Flammable and Combustible Liquid Motor Fuel-dispensing

- Fuels
  - Gasoline
  - Biodiesel
  - #2 diesel fuel
  - Alcohol-blended gasoline
- Storage tanks
  - Underground storage tank (UST)
  - Above-ground storage tank (AST)
  - Protected above-ground storage tank (PAST)
  - Above-ground tank in a vault
  - Class I, II and III liquids
  - Leak detection required
  - Daily reconciliation of product

Flammable and Combustible Liquid Dispensing Operations

- All openings must be through the top of the tank
- Fuel is pumped to the dispenser
- Listed components
- Emergency
- Heat responsive device
- Automatic closing
- Bonding connection to fill neck on vehicle
- Designed to remain engaged to fill connection
- Anti-siphon valve required when pump or dispenser is below liquid level

Class I Flammable
Class II Combustible
Class II Flammable
Flammable and Combustible Liquid Alcohol-blended Fuel

- E10 = 10% ethanol and 90% unleaded gasoline
- E85 = 85% ethanol and 15% unleaded gasoline

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Lower flammable limit (percent volume in air)</th>
<th>Upper flammable limit (percent volume in air)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unleaded gasoline</td>
<td>1.4%</td>
<td>7.6%</td>
</tr>
<tr>
<td>E85 alcohol-blended</td>
<td>1.4%</td>
<td>18.0%</td>
</tr>
</tbody>
</table>

- Components must be listed
  - Ethanol potentially increases corrosion
  - This can create a concern when an existing motor fuel-dispensing facility changes from gasoline to E85

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Upper flammable limit (percent volume in air)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unleaded gasoline</td>
<td>7.6%</td>
</tr>
<tr>
<td>E85 alcohol-blended fuel</td>
<td>18.0%</td>
</tr>
</tbody>
</table>

Liquefied Petroleum Gas Dispensing Operations

- Excess flow control valve at tank
- At dispenser, either
  - 2nd excess flow control valve, or
  - Differential backpressure valve
- Pressure relief valve
- Listed quick-action shutoff valve

Required where liquid LP-gas can be trapped

Liquid LP-gas cannot flow unless positive connection is made
Hydrogen Fuel Gas Room
§5808.1
- Hydrogen gas detectors at high points in the room
- Air supply inlets low in an exterior wall, or ducted to within 12" of the floor
- Ventilation outlets in roof/ceiling, or high in exterior wall
- Audible/visible alarms inside and outside room
- Standby power for:• Mechanical ventilation system
  • Hydrogen gas detection system
- Fire-resistance rating of walls and ceiling:• Comply with IBC Table 509, and
  • 1-HR minimum

NO SMOKING signs

On-demand Mobile Fueling
§5707
- Vehicle must comply with NFPA 385 or carry ≤60 gallons
- Safety and emergency response plan
- Fueling location ≥25' from buildings, property lines, combustible storage, storm drains
- Spill prevention
- Permit required

Chapter 13
Flammable Finishes
Flammable Finishes  
Ch 24

- Application of "finishes that are flammable"
  - Spray applied liquids
  - Dip tanks
  - Powder coating
  - Fiber glass
- Hazards
  - Atomized liquid particles
  - Combustible dusts
  - Vapor release in open top tanks

Types of Flammable Finishing Processes

- Spray finishing uses flammable or combustible liquids pressurized and dispersed via a spray nozzle
- Powder coating is the application of plastic powders onto metal
- Fiber-reinforced plastics
- Common catalyst is methyl ethyl ketone peroxide (MEKP)
  Suspension of the powder in air represents the greatest hazard

Spray Booth and Spray Room Construction

- §2404.3.1 – spray room
  - Permanent construction
  - Fire-resistance rated construction
- §2404.3.3 – spray booth
  - Considered an "appliance"
  - Noncombustible construction
  - Required interlocks
  - Fire extinguishing system

161

162

163
Limited Spraying Spaces

§2404.9

• FCO can approve limited spraying spaces
  • Area is designated for spraying operations
  • Aggregate surface area sprayed ≤ 9 ft²
  • Spraying operations cannot be continuous
  • Mechanical ventilation providing 6 air changes per hour is required
  • Electrical wiring within 10' of the floor and 20' horizontally of the limited spraying space shall be designed for Class I, Division 2

Mechanical Ventilation

§2404.7

• Mechanical ventilation system safely removes flammable vapors or combustible dusts and exhausts them to a safe location
  • Designed to maintain the atmosphere
    • <25% of the lower flammable limit for liquids
    • <50% of the minimum explosive concentration for combustible dusts

Minimum air flow for open-face spray booth:
  • 100 ft/min through the openings
  • 50 ft/min for electrostatic spraying

Ventilation point of termination:
  • 30' from property lines
  • 10' from openings into buildings
  • 6' above exterior walls and roofs
  • 30' from combustible walls
  • 10' above adjoining grade

Illumination

§2404.6.2

• Portable electric lamps are prohibited
  • Portable lamps can be used for cleaning or repair operations and only when approved for hazardous atmospheres

• Fixed luminaires
  • External to spray area
    • Located outside of the classified area
    • Ordinary electrical
**Interlocks**

§2404.7.1

- Ventilation system is interlocked with the spraying apparatus
- Solenoid in air supply line connected to ventilation system motor
- Differential pressure switch
  - Measures pressure on each side of exhaust filters

**Fire Protection**

§2404.4

- Automatic fire extinguishing system required in spray booths and spray rooms
  - Fire sprinkler system
  - Dry chemical extinguishing system
    - Can be used even when the rest of the building is protected with a fire sprinkler system
High-piled Combustible Storage

- Storage of combustible materials in closely packed piles or combustible materials on pallets, in racks or on shelves where the top of storage is >12' in height
- Where required by the FCO, high-piled combustible storage also includes certain high-hazard commodities, such as rubber tires, Group A plastics, flammable liquids, idle pallets and similar commodities, where the top of storage is >6' in height

Commodity Classification

§3203

- Commodity classification based on heat release rate of products
- Includes products, packing materials and containers
- 5 classifications
  - Class I
  - Class II
  - Class III
  - Class IV
  - High-hazard

Plastics

§3203.7

- Classifications:
  - Group A
  - Group B
  - Group C
- Geometry:
  - Expanded
  - Unexpanded
  - Free-flowing
Table 3206.2
General Fire Protection and Life Safety Requirements

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I–IV</td>
<td>75,000</td>
<td>30</td>
<td>50</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>501 – 2,500</td>
<td>75,000</td>
<td>30</td>
<td>50</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Not open to the public (Option 1)</td>
<td>50,000</td>
<td>20</td>
<td>50</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Not open to the public (Option 2)</td>
<td>75,000</td>
<td>30</td>
<td>50</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>&gt;500,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Footnote c. Piles shall be separated by aisles complying with §3206.9.

Footnote b. For aisles, see §3206.9.

Footnote d. For storage exceeding 30 feet in height, Option 1 shall be used.

Footnote e. For storage exceeding 30 feet in height, Option 1 shall be used.

Footnote g. Not required where a fire sprinkler system is designed and installed to protect the high-piled storage area in accordance with §3207 and §3208.

Footnote h. Not required where storage areas are protected by ESFR or CMSA sprinkler systems with RTI ≤ 50 and listed for control of fire with ≤ 12 sprinklers.

Footnote i. Not required in frozen food warehouses with Class I or II commodities.

Footnote a. When fire sprinklers are required for other reasons, the portion of the sprinkler system protecting the high-piled storage area shall be designed and installed in accordance with §3207 and §3208.

Footnote f. When required by the FCO, special fire protection provisions shall be provided, including but not limited to:
- fire protection of exposed steel columns
- increased sprinkler density
- additional in-rack sprinklers, without associated reductions in ceiling sprinkler density
- additional fire department hose connections

Storage Methods

• Solid-piled storage
• Palletized storage
  • Plastic pallets?
Other Considerations

- Table 3208.3 – flue spaces
  - Longitudinal flue
  - Transverse flue
- Automated storage
  - §3209
  - When >500 ft²:
    - Fire detection system, OR
    - Dead-man switch controls

Other Special Uses and Processes

Chapter 15

Combustible Dust Producing Operations

Ch 22

- Combustible dust is a finely divided solid material which is ≤420 microns (0.0165") in diameter
- When dispersed in air in the proper proportions, it can be ignited
- Combustible dust will pass through a U.S. number 40 sieve
- Dust Hazard Analysis

<table>
<thead>
<tr>
<th>Material</th>
<th>Size (microns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White granulated sugar</td>
<td>450–600</td>
</tr>
<tr>
<td>Sand</td>
<td>50 and greater</td>
</tr>
<tr>
<td>Natural powder</td>
<td>10</td>
</tr>
<tr>
<td>Mold spores</td>
<td>10–30</td>
</tr>
<tr>
<td>Human hair</td>
<td>40–300</td>
</tr>
<tr>
<td>Wheat, corn, or soybean flour</td>
<td>1–100</td>
</tr>
</tbody>
</table>

- Dust collection
- Control of ignition sources

Housekeeping
**Fire Safety During Construction/Demolition**
Ch 33

- Temporary heating
- Precautions against fire
- Storage of hazardous materials
- Maintenance of fire protection systems
- Fire prevention plan
- Clearance to combustibles
- Flammable finishes
- Quantities limited
- Location of storage
- Generation of ignitables
  - Standpipe required when in height
  - Standpipe available to floor below working level
  - Systems restored at end of day
- Training
- Planned response to fire
- Identification and mitigation of hazards
- Fire Prevention Program
  - Superintendent is responsible for implementation of plan

**Welding and Other Hot Work**
Ch 35

- Welding
- Cutting
- Torch-applied roofing
- Hot Work Program Permit
- Inspect site
- Fire watch
- Management of equipment
- Document work
- "Person-in-Charge" is identified
- Trained on-site person that oversees hot work operations
- Company provides internal review and safety evaluation before hot work commences
- Identify combustibles
- Evaluate safe operation
- Identify hazards
- Available for FCO review
- During hot work
- 30 minutes after hot work is completed

**Higher Education Laboratories**
Ch 38

- College or university level
- Group B building
- Laboratory suites – different than control areas
- Allowable quantities – different than MAQ per control area
Plant Processing and Extraction
Ch 39

• Prohibited in buildings containing Group A, E, I or R occupancies
• Listed extraction equipment or technical report
• Gas detection
  • Extraction room
  • CO₂ enriched atmosphere

Distilled Spirits and Wines
Ch 40

• Beverages greater than 16 percent alcohol content present some level of combustibility
• Distilling process is classified as a F-1
• Storage is classified as a S-1
• Storage exceeding 16%, is classified as an S-2
• Occupancies protected with Automatic Sprinkler Systems in accordance with Chapter 9.

Part V – Special Processes and Building Uses

1. Continuous flammable finish spray operations must be conducted in a spray room in which occupancies?

2. What types of storage tanks can be used for the dispensing of gasoline into motor vehicles?
Part V – Special Processes and Building Uses

3. What fire protection requirements apply to 25,000 ft² of 18' high rack storage of polyethylene cups in cardboard boxes?

4. What is the purpose of flue spaces in high-piled rack storage?

Part VI

Hazardous Materials

Chapter 16: General Requirements for Hazardous Materials
Chapter 17: Compressed Gases
Chapter 18: Flammable and Combustible Liquids
General Concepts

- Storage, handling, use and dispensing of hazardous materials is regulated in Ch 50 through Ch 67
- General requirements in Ch 50 are used with requirements in Ch 51 – 67 which contain hazard specific requirements
- Some exceptions to Ch 50 address items covered elsewhere in the IFC

Material Classification

- Materials are classified based on hazard characteristics
- Materials can possess more than 1 hazard
- All hazards must be addressed

Classification resources:
- Nationally recognized standards
- SDS (Safety Data Sheets)
- IFC Appendix E (Hazard Categories)

Common uses:
- Sulfuric Acid
  - Concentration in water
  - Fertilizer manufacturing; cleaning of semiconductor wafers
  - Water Reactive, Corrosive, Toxic Liquid
  - 98%
  - Electrolyte in wet-cell automobile batteries
  - Class 1 Water Reactive, Corrosive Liquid
  - 32–38%
- Cutting an onion releases an amino acid known as a sulfoxide. When the sulfoxide mixes with the water in a human eye, it forms a weak solution of sulfuric acid.
- Nonhazardous
  - 3%

HMEX (Hazardous Materials Expert Assistant)

- Storage
- Use
  - Use-open
  - Use-closed

- Solid
- Liquid
- Gas

- Physical hazard
- Health hazard

- Gas
  - Use-open
  - Use-closed

- Common uses
  - Etching; cleaning of semiconductor
  - Used in battery manufacturing
  - Used in the production of fertilizer
  - Used in the production of batteries

- Nonhazardous
  - Used in the production of fertilizer
  - Used in the production of batteries

- Health hazard

- Physical hazard
Material Classification

• Physical hazard
  • Explosives 1.1, 1.2, 1.3, 1.4, 1.5, 1.6
  • Combustible liquids II, IIIA, IIIIB
  • Flammable liquids IA, IB, IC
  • Flammable solids and gases
  • Organic peroxide I, II, III, IV V, Unclassified Detonable
  • Oxidizers 1, 2, 3, 4
  • Pyrophoric
  • Unstable (reactive) 1, 2, 3, 4
  • Water-reactive 1, 2, 3
  • Cryogenic fluids

• Health hazard
  • Corrosive
  • Highly toxic
  • Toxic

• Many of the materials have subclasses
• Based on the relative hazard

Material Classification

• Acrolein is used in the manufacturing of a number of plastics.
  • Flash point of 15°F
  • Boiling point of 127°F
  • Absorption LD50 value of 200 Mg/Kg
  • Ingestion LD50 value of 26 Mg/Kg

• What is its classification?

Acrolein is:
  • Class I-B flammable liquid
  • Highly toxic liquid

Hazardous Materials Reporting
§5001.5

• When required by the FCO, owner must provide:
  • Hazardous Materials Management Plan (HMMP)
  • Hazardous Materials Inventory Statement (HMIS)
### Storage and Use

**§202**

- **Storage**
- **Use**
  - **Use-closed**
  - **Use-open**

Use of a solid or liquid hazardous material involving a closed vessel or system that remains closed during:

Material that is placed into action by the propellant or fuel or system and the product is not exposed to the atmosphere during normal operations, and all uses of compressed gases.

- **Keeping, retention or leaving of hazardous materials in closed containers, tanks, cylinders, or similar vessels; or vessels supplying operations through closed connections to the vessel**

- **Use of a solid or liquid hazardous material involving a vessel or system that is continuously open to the atmosphere during normal operations and where vapors are liberated, or the product is exposed to the atmosphere during normal operations**

- **Use of a solid or liquid hazardous material involving a closed vessel or system that remains closed during normal operations where vapors emitted by the product are not liberated outside of the vessel or system and the product is not exposed to the atmosphere during normal operations; and all uses of compressed gases**

---

### Hazardous Materials

**Maximum Allowable Quantities**

Excerpt from Table 5003.1.1(1) Maximum Allowable Quantity per Control Area of Hazardous Materials Posing a Physical Hazard

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Group when the MAQ is Exceeded</th>
<th>Storage*</th>
<th>Use-Closed System*</th>
<th>Use-Open Systems*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Liquid (gallons)</td>
<td>Liquid (cubic feet)</td>
<td>Liquid (cubic feet)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Solid (pounds)</td>
<td>Gas (cubic feet at NTP)</td>
<td>Solid (cubic feet)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combustible liquid</td>
<td>II or III</td>
<td>N/A</td>
<td>25</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Oxidizer</td>
<td>2</td>
<td>H-3</td>
<td>250</td>
<td>N/A</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Workbook Page 211**

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### Hazardous Materials

**Maximum Allowable Quantities**

- **Read** the Footnotes

Table 5003.1.1(1) Maximum Allowable Quantity per Control Area of Hazardous Materials Posing a Physical Hazard

<table>
<thead>
<tr>
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<th>Class</th>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combustible liquid</td>
<td>II or III</td>
<td>N/A</td>
<td>120</td>
<td>N/A</td>
<td>120</td>
</tr>
<tr>
<td>Oxidizer</td>
<td>2</td>
<td>H-3</td>
<td>250</td>
<td>N/A</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Workbook Page 211**

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Footnotes to Table 5003.1.1(1)

• b – aggregate quantity shall not exceed storage
• d – increase 100% for sprinklers
• e – increase 100% for cabinets, day boxes, exhausted enclosures, listed safety cans
• f – not limited in sprinklered buildings
• g – not permitted in unsprinklered buildings
• k – 220 lbs. or 22 gallons of Oxidizer 3 for maintenance or operation of equipment

Footnotes d and e can be used together if the building complies.

Footnotes to Table 5003.1.1(1)

• l – fireworks 1.4G based on 25% of gross weight
• m – 1 gallon = 10 lbs.
• n – storage and display in M, storage in S
• p – situations not included
• q – combustible dusts when the concentration and conditions create a fire or explosion hazard

MAQ Footnote b

• Class IIIA combustible liquid
• MAQ for storage = 330 gallons
• MAQ for use-open = 80 gallons

Actual quantities
• Storage = 250 gallons
• Use-open = 80 gallons
• Aggregate = 330 gallons
Control Areas

• Control area is a space where the quantity of hazardous materials stored, used, handled or dispensed does not exceed the MAQ.
• The MAQ is allowed in each control area.

Can be reduced to 1-HR for buildings of Type IIA, IIIA and VA construction provided that the building is equipped with a fire sprinkler system and ≤ 3 stories in height.

Table 5003.8.3.2

- Number of control areas based on floor level
- Modified MAQ as the floor level moves away from grade
- Fire-resistance-rating based on floor level

<table>
<thead>
<tr>
<th>Floor Level</th>
<th>Percentage of MAQ per Control Area</th>
<th>Number of Control Areas Per Floor</th>
<th>Fire-Resistance Rating in Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above grade plane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher than 9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below grade plane</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Control Area 1

Control Area 2

Control Area 3

Control Area 4

Control Area 5

Control Area 6

Control Area 7

Application of Control Area Concept

- Manufacturer of specialized optics
- 2 story Group F-1, Type IIA construction, sprinklered
- Storage and use of liquid Class II organic peroxide

Company asks:
• What is the maximum number control areas?
• What is the MAQ in each control area?
• What is the total volume of organic peroxide inside the building?

1st floor = 4 control areas
2nd floor = 3 control areas
Total in building = 7 control areas
1st floor = 50 lbs × 2 = 100 lbs per control area
2nd floor = 50 lbs × 2 × 75% = 75 lbs per control area
1st floor = 400 lbs
2nd floor = 225 lbs
Total in building = 625 lbs

2-HR floor ceiling assembly
1-HR if sprinklered AND IIA, IIIA or VA

1st floor = 400 lbs
2nd floor = 225 lbs
Total in building = 625 lbs
Hazard Identification Signs

- Required on:
  - Buildings
  - Tanks
  - Entrances to facilities
- Ranking of 0 → 4
  - Blue – health hazards
  - Red – flammable hazards
  - Yellow – chemical instability
  - White – special hazards

Hazard Identification Signs

- NFPA 704 placard
- Appendix F – excerpts

<table>
<thead>
<tr>
<th>Hazard Category</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible liquid Class II</td>
<td></td>
</tr>
<tr>
<td>Flammable liquid Class IB</td>
<td></td>
</tr>
<tr>
<td>Unstable reactive Class 2</td>
<td></td>
</tr>
<tr>
<td>Toxic gas</td>
<td></td>
</tr>
<tr>
<td>Corrosive liquid</td>
<td></td>
</tr>
<tr>
<td>Highly toxic liquid</td>
<td></td>
</tr>
</tbody>
</table>

Separation of Incompatible Materials

§5003.9.8

- Separation required when:
  - >5 lbs.
  - >1/2 gallon
  - All compressed gases
- Determine incompatibility
  - SDS
  - HMEX program can assist
- Methods of separation
  - 20’
  - Haz mat storage cabinets
  - Gas storage cabinets
  - Physical barrier
Compressed Gases

Chapter 17

Compressed Gases

Gas categories

Requirements in Ch 53

Provides for the safe use and handling of compressed gases

Requirements in Ch 50

If applicable based on gas

Requirements in chapters on specific materials

- Toxic – Ch 60, LPG – Ch 61, Oxidizer – Ch 63, etc.

Compressed gas containers

- Constructed to a safety standard

- US Department of Transportation

- ASME

- Flammable gas

- Pressure

- Corrosive gas

- Temperature

- Oxidizing gas

- Gas characteristics

- Standard to which cylinder was constructed

- Contents

- Hazards of the gas

- Pressure

- Temperature

- Standard to which cylinder was constructed

- Contents

- Hazards of the gas

- Temperature

- Pressure

- Standard to which cylinder was constructed

- Contents

- Hazards of the gas

- Pressure

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- Standard to which cylinder was constructed

- Contents

- Hazards of the gas

- Pressure

- Temperature

- Standard to which cylinder was constructed

- Contents

- Hazards of the gas
Pressure Relief Devices
§5303.3

• Pressure relief device is required to prevent catastrophic failure of gas containers
  • Some exceptions based on hazards of specific gas
  • Internal PRD
  • External PRD
  • Burst disc for PRD
  • Fusible plugs

Security
§5303.5

• Compressed gas containers must be:
  • Provided with security when outdoors

Exhausted Enclosures and Gas Cabinets

• Appliances designed to capture and exhaust a leak from a gas container or its piping system
  • Gas Cabinet
    • Noncombustible
    • Noncombustible location
    • Top, sides and back
    • Mechanical ventilation
    • Maximum 3 cylinders/cabinet
  • Enclosure
    • Noncombustible
    • Top, sides and back
    • Mechanical ventilation
    • Hazardous material

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LP-gas Cylinder Exchange
§6109.15
• Basic purpose is to remove unsafe LP-gas cylinders from use
• Provide overfill prevention devices
• Automated LP-gas cylinder exchange station

Defective cylinders removed from service

CO₂ for Beverage Dispensing
§5307
• Liquid, or refrigerated CO₂ used in beverage dispensing >100 lbs requires permit
• Mechanical ventilation required
  • Operates continuously, or
  • Activated by gas detection
    • Low-level alarm at 5,000 ppm (PEL)
    • High-level alarm at 30,000 ppm (TLV-STEL)

Flammable and Combustible Liquids
Chapter 18
Flammable and Combustible Liquids

Ch 57

• Ch 57 contains the main regulations for flammable and combustible liquids, but other regulations in:
  • Ch 6 for Fuel-fired Appliances
  • Ch 20 for Aviation Facilities
  • Ch 21 for Dry Cleaning
  • Ch 23 for Motor Fuel-dispensing & Repair Garages
  • Ch 24 for Application of Flammable Finishes
  • Ch 27 for Semiconductor Fabrication Facilities
  • Ch 29 for Manufacture of Organic Coatings
  • Ch 33 for Fire Safety During Construction and Demolition
  • Ch 36 for Marinas
  • Ch 38 for Higher Education Laboratories
  • Ch 39 for Processing and Extraction Facilities

Classification of Liquids

• Closed-cup flash point testing provides a repeatable result

<table>
<thead>
<tr>
<th>Classification</th>
<th>Flash Point Temperature</th>
<th>Boiling Point Temperature</th>
<th>Example Liquids By Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class IA</td>
<td>&lt;73°F</td>
<td>≥100°F</td>
<td>N-Pentane, Ethyl Ether</td>
</tr>
<tr>
<td>Class IB</td>
<td>≥73°F and &lt;100°F</td>
<td>Not Applicable</td>
<td>Gasoline, Isopropyl Alcohol</td>
</tr>
<tr>
<td>Class IC</td>
<td>≥100°F and &lt;140°F</td>
<td>Not Applicable</td>
<td>Methyl Ethyl Ketone</td>
</tr>
<tr>
<td>Class II</td>
<td>≥100°F and &lt;140°F</td>
<td>Not Applicable</td>
<td>No. 2 Diesel fuel, Kerosene</td>
</tr>
<tr>
<td>Class IIIA</td>
<td>≥140°F and &lt;200°F</td>
<td>Not Applicable</td>
<td>Turpentine, No. 3 Fuel Oil</td>
</tr>
<tr>
<td>Class IIIB</td>
<td>≥200°F</td>
<td>Not Applicable</td>
<td>Motor Oil, Cooking Oil, No.6 (bunker) Fuel Oil</td>
</tr>
</tbody>
</table>

Containers and Portable Tanks

• “Containers” are a maximum of 60 gallons
• “Portable tanks” are more than 60 gallons capacity and designed for transportation
• Intermediate bulk containers manufactured of glass, steel or plastic
• Glass is limited in volume based on its contents
• NFPA 30 limits size to 793 gallons
Stationary Tanks
§5704.2

• Stationary tanks are designed for permanent installation
• Stationary tanks can be installed:
  • Above ground
  • Below ground
  • Inside buildings
  • In vaults
• Tanks can be field-erected or fabricated in a shop

Design and Construction of Storage Tanks

• Material of construction must be chemically compatible with the liquid
• Tank must have a normal vent
• Nameplate is attached to the tank that indicates the standard to which it was constructed

Location of Above-ground Tanks for Dispensing – Table 2306.2.3

<table>
<thead>
<tr>
<th>Class of liquid and tank type</th>
<th>Individual tank capacity (gallons)</th>
<th>Minimum distance from lot line that is or can be built upon, including the opposite side of a public way (feet)</th>
<th>Minimum distance from nearest side of any public way (feet)</th>
<th>Minimum distance from nearest fuel dispenser (feet)</th>
<th>Minimum distance from important building on same property (feet)</th>
<th>Minimum distance between tanks (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected above-ground tanks</td>
<td>≤6,000</td>
<td>15</td>
<td>25</td>
<td>15</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>&gt;6,000</td>
<td>15</td>
<td>25</td>
<td>15</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Tanks in vaults</td>
<td>0 – 20,000</td>
<td>0</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Separately compartment required for each tank</td>
<td></td>
</tr>
<tr>
<td>Other tanks</td>
<td>All</td>
<td>50</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>3</td>
</tr>
</tbody>
</table>
PAST for Fuel Dispensing

- UL 2085 tank
- Requirements in Ch 57 and Ch 23
- Overfill prevention
- Spill container

Minimum 5 gallon capacity

- Slows filling operation at 90% capacity
- Stops filling operation at 95% capacity

Manual drain back into tank

Storage Tank Openings

- Connections are needed for filling and withdrawing liquid
- Valve on all connections below liquid level
- Normal vent

Class I liquids require a pressure-vacuum cap on the normal vent

Minimum 5'

Minimum 12'

Emergency Vent

- Emergency vent required on all ASTs

Emergency vents

- This installation should be checked to ensure that the rain cap and screen are designed as part of the emergency vent
- Any obstruction or restriction could negate the effectiveness of the emergency vent

Long bolt cover

Internal pressure reaches 2.5 PSI

Rain cap and screen
1. A factory sprays wood and metal products with lacquer (Class IC flammable liquid). What is the occupancy classification if they use 5 gallons at a time and store 80 gallons maximum?

Group F-1
Does not exceed the MAQ
IFC Table 5003.1.1(1)

2. Does the facility above need to separate the lacquer from incompatible materials?

Yes – incompatible materials over ½ gal. or 5 lbs. must be separated
IFC §5003.9.8

3. The 1-story factory wants to create another control area to double their production. What is the minimum fire-resistance-rating between the control areas?

1-HR
IFC Table 5003.8.3.2

4. The factory uses a 3,000 gallon Protected Above-ground Storage Tank for vehicle fueling. What is the required separation to the building?

5 feet
IFC Table 2306.2.3

Discussion Activity
Final Reflection

Reflect on the day. What will you take back to the job and apply?

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

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