# BUILDING CODE REQUIREMENTS FOR STORAGE & HANDLING OF FLAMMABLE & COMBUSTIBLE LIQUIDS

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June 12, 2019

## THE COST OF FIRE AND FIRE PREVENTION IN 2014

"For 2014, the total [cost of fire] is $328.5 billion, which was 1.9% of the U.S. GDP. The expenditures constitute $273.1 billion (83.1% of total) and the losses constitute $55.4 billion (16.9% of total). **The fire safety costs in building construction is the largest component at $57.4 billion (17.5% of total)"** *[emphasis added].*

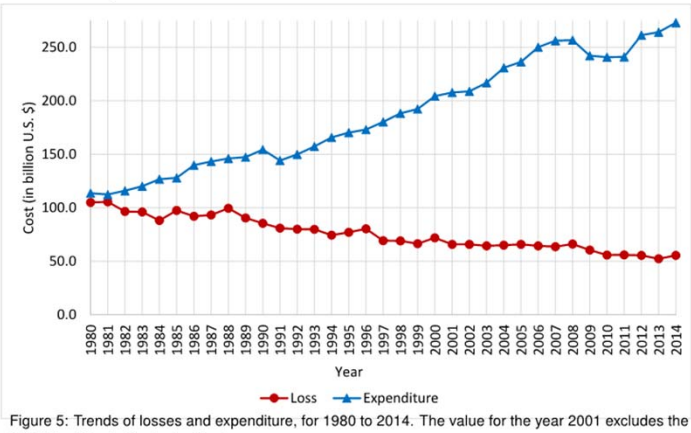
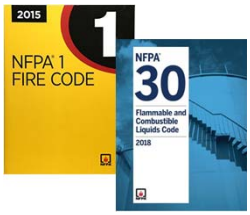



Figure 5: Trends of losses and expenditure, for 1980 to 2014. The value for the year 2001 excludes the 9/11 Word Trade Center incident.

Jun Zhuang, Vineet Payyappalli, Adam Behrendt, and Kathryn Lukasiewicz, "Total Cost of Fire in the United States." Buffalo, NY October 2017
NFPA Fire Protection Research Foundation

# APPLICABLE CODES

- 780 CMR, 9th EDITION - MASSACHUSETTS **BUILDING CODE**
  (2015 International Building Code with Mass. Amendments)
- 527 CMR - MASSACHUSETTS COMPREHENSIVE **FIRE CODE**
  (NFPA 1-2015 Adopted by Reference with Amendments)
- (Portions of the) 2015 INTERNATIONAL FIRE CODE
- **NFPA 30 – FLAMMABLE AND COMBUSTIBLE LIQUIDS CODE**
- **NFPA 45 – FIRE PROTECTION FOR LABORATORIES USING CHEMICALS**
- NFPA 704 – IDENTIFICATION OF THE HAZARDS OF MATERIALS FOR EMERGENCY RESPONSE
- MGL Title XX "Public Safety", Chapter 148 is Fire Prevention
  Section 9 and Section 13 Deal with flammables
- LOCAL CODES – DON'T FORGET THE LOCAL CODES!





# 780 CMR - MA Amendments to the IBC

**101.4.5 Fire Prevention.** Reference to sections of the International Fire Code (IFC) for fire prevention requirements shall be considered reference to **527 CMR**: Board of Fire Prevention Regulations. Reference to sections of the International Fire Code ("IFC") for building code requirements are adopted, except that retroactive requirements of the IFC are not adopted.

**102.4 Referenced Codes and Standards**. The codes and standards referenced in 780 CMR shall be considered part of the requirements of 780 CMR to the prescribed extent of each such reference. **Where differences occur** between provisions of 780 CMR and referenced codes and standards, **780 CMR shall apply.**

**Section 427 Bulk Merchandising Retail Buildings**

**427.11 Flammable/Combustible Liquids.** The display, storage, protection, and maximum allowable quantities of flammable and combustible liquids permitted in **mercantile display** areas shall be in accordance with NFPA 30.

# 527 CMR - MA Amendments to NFPA 1-2015

**1.04 Adoption by Reference** - NFPA® 1- 2015 edition as modified by 527 CMR 1.05.

**1.05 Modifications to NFPA® 1- 2015 Edition** - on a Chapter by Chapter basis…

**1.3.3 Conflicts.**

**1.3.3.1** When a requirement differs between this Code and a referenced document, the requirement of this Code shall apply.

**1.3.3.2** When a conflict between a general requirement and a specific requirement occurs, the specific requirement shall apply.

**1.3.3.3** When the requirements of this Code conflict with any other applicable regulation, or ordinance, the provisions which establish the higher standard for the promotion and protection of safety and welfare shall prevail.

**Chapter 66 Flammable and Combustible Liquids**

**66.1.1** The storage, handling, and use of flammable and combustible liquids, including waste liquids…shall comply with this chapter; **NFPA 30,** *Flammable and Combustible Liquids Code*; Sections 60.1 through 60.4 of this Code; and NFPA 35 *Standards for the Manufacture of Organic Coatings*, as applicable.

**66.1.4** Installations made in accordance with the applicable requirements …shall be deemed to be in compliance with this Code except that the **maximum allowable quantities…**hazardous materials are limited to the quantities listed in the Building Code and **Table 60.4.2.1.1.3** of this Code: (***Table 60.4.2.1.1.3 aligns with the MAQs in IBC***)



# STRATEGIES FOR DEALING WITH HAZARDOUS MATERIALS

**Identify the Hazards**

- Types of Hazards. IBC deals with two types: Physical and Health
- Classification of flammable and combustible materials
- Differentiate between USE / STORAGE, OPEN / CLOSED systems
- Temperature and pressure

**Institute Preventative Measures.**

- Limit quantities, Develop Process Flow plans for material movement
- EH&S Audits
- Store in approved containers and storage cabinets
- Detection (e.g. LEL detectors) and Ventilation (remove vapors)
- Electrically Classified Spaces (e.g. explosion proof electrical devices)

**Design Buildings to Minimize the Effects of the hazard if it occurs.**

- Fire proof construction; fire separation barriers; compartmentalization
- Separation distances – between hazards or buildings
- Automatic Sprinkler systems; wet, dry, foam
- Spill containment; Explosion venting
- Fire department access

# IDENTIFY THE HAZARD

## FLAMMABLE AND COMBUSTIBLE LIQUIDS DEFINED

**Flammable Liquid** - A liquid having a closed cup flash point below 100°F (37.8°C). Flammable liquids are further categorized into a group known as Class I liquids. The Class I category is subdivided as follows.

- Class IA - Liquids having a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C).
- Class IB - Liquids having a flash point below 73°F (23°C) and a boiling point at or above 100°F (37.8°C).
- Class IC - Liquids having a flash point at or above 73°F (23°C) and below 100°F (37.8°C)

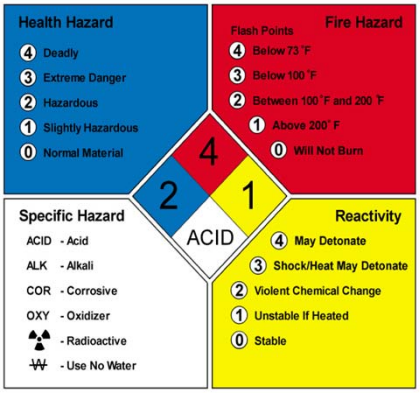
**Combustible Liquid** - A liquid having a closed cup flash point at or above 100°F (38°C). Combustible liquids shall be subdivided as follows.

- Class II - Liquids having a closed cup flash point at or above 100°F (37.8°C) and below 140°F (60°C).
- Class IIIA - Liquids having a closed cup flash point at or above 140°F (60°C) and below 200°F (93°C).
- Class IIIB - Liquids having a closed cup flash point at or above 200°F (93°C).



# IDENTIFY THE HAZARD

## HAZARD IDENTIFICATION – NFPA 704




**Flammability Hazards**

**4.** Materials that rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air and burn readily. **Class 1A**.

**3.** Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials is this degree produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions. **Class 1B and 1C**.

**2.** Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under moderate heating could release vapor in sufficient quantities to produce hazardous atmospheres with air. **Class II and IIIA**.

**1.** Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur. **Class IIIB**.

# IDENTIFY THE HAZARD

## COMMONLY USED FLAMMABLE AND COMBUSTIBLE LIQUIDS

Acetone, NF.....IB
Acetaldehyde.....IA
Acetonitrile .....IB
Acrylonitrile.....IB
Benzene .....IB
tert-Butyl Alcohol.....IB
Cyclohexene.....IB
Dithiothreitol.....IIIB
Ethylacetate.....IB
Ethyl Ether.....IA
Glacial Acetic Acid.....II
Hexane.....IB
Isopropanol.....IB
Methanol.....IB
Methyl Ethyl Keytone.....IB
Pentane.....IA
Propyl Alcohol.....IC
Pyridine.....IB
Tetrahydrofuran Anhydrous.....IB
Toluene.....IB
Triethylamine.....IB

**Properties of Ethyl Alcohol Solutions**

| Percent Ethyl Alcohol In Water | 100% (200 Proof) | 96% | 95% | 80% | 70% | 60% | 50% (100 Proof) | 40% | 30% | 20% | 10% | 5% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flash Point °F (°C) | 55 (13) | 62 (17) | 63 (17) | 68 (20) | 70 (21) | 72 (22) | 75 (24) | 79 (26) | 85 (29) | 97 (36) | 120 (49) | 144 (62) |
| NFPA Class | IB | IB | IB | IB | IB | IB | IC | IC | IC | IC | II | IIIA |



# MAQ – MAXIMUM ALLOWABLE QUANTITIES

- Code Prescribed limits for each type of hazard within a ***Control Area***
  - Staying within the MAQs keeps the building in “ordinary” Use Groups – i.e. (A) Assembly, (B) Business, (F) Manufacturing, or (S) Storage.
  - Exceeding the MAQ of any hazardous material causes the building or portion of the building to be classified as a **High Hazard Use Group**.
- **High Hazard Use Groups** have building implications and stricter requirements for:
  - Reduced Building Area and Height
  - Shorter Egress Distances
  - Building Layout – location of hazardous material storage and use
  - Building Construction – Fire Rating of building components
  - Fire Protection
  - Spill Containment
  - Ventilation
  - Explosion Prevention and/or Venting

# MAQ – IBC 2015 TABLE 307.1

TABLE 307.1(1)
MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD[a, j, m, n, p]

| MATERIAL | CLASS | GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED | STORAGE[b] | | | USE-CLOSED SYSTEMS[b] | | | USE-OPEN SYSTEMS[b] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Solid pounds (cubic feet) | Liquid gallons (pounds) | Gas cubic feet at NTP | Solid pounds (cubic feet) | Liquid gallons (pounds) | Gas cubic feet at NTP | Solid pounds (cubic feet) | Liquid gallons (pounds) |
| Combustible dust | NA | H-2 | See Note q | NA | NA | See Note q | NA | NA | See Note q | NA |
| Combustible fiber[q] | Loose<br>Baled[c] | H-3 | (100)<br>(1,000) | NA | NA | (100)<br>(1,000) | NA | NA | (20)<br>(200) | NA |
| Combustible liquid[c, i] | II<br>IIIA<br>IIIB | H-2 or H-3<br>H-2 or H-3<br>NA | NA | 120[d, e]<br>330[d, e]<br>13,200[e, f] | NA | NA | 120[d]<br>330[d]<br>13,200[f] | NA | NA | 30[d]<br>80[d]<br>3,300[f] |
| Consumer fireworks | 1.4G | H-3 | 125[e, f] | NA | NA | NA | NA | NA | NA | NA |
| Cryogenic flammable | NA | H-2 | NA | 45[g] | NA | NA | 45[g] | NA | NA | 10[g] |
| Cryogenic inert | NA | NA | NA | NA | NL | NA | NA | NL | NA | NA |
| Cryogenic oxidizing | NA | H-3 | NA | 45[g] | NA | NA | 45[g] | NA | NA | 10[g] |
| Explosives | Division 1.1<br>Division 1.2<br>Division 1.3<br>Division 1.4<br>Division 1.4G<br>Division 1.5<br>Division 1.6 | H-1<br>H-1<br>H-1 or H-2<br>H-3<br>H-3<br>H-1<br>H-1 | 1[e, g]<br>1[e, g]<br>5[e, g]<br>50[e, g]<br>125[e, e, i]<br>1[e, g]<br>1[e, g] | (1)[e, g]<br>(1)[e, g]<br>(5)[e, g]<br>(50)[e, g]<br>NA<br>(1)[e, g]<br>NA | NA | 0.25[g]<br>0.25[g]<br>1[g]<br>50[g]<br>NA<br>0.25[g]<br>NA | (0.25)[g]<br>(0.25)[g]<br>(1)[g]<br>(50)[g]<br>NA<br>(0.25)[g]<br>NA | NA | 0.25[g]<br>0.25[g]<br>1[g]<br>NA<br>NA<br>0.25[g]<br>NA | (0.25)[g]<br>(0.25)[g]<br>(1)[g]<br>NA<br>NA<br>(0.25)[g]<br>NA |
| Flammable gas | Gaseous<br>Liquefied | H-2 | NA | NA<br>(150)[d, e] | 1,000[d, e]<br>NA | NA | NA<br>(150)[d, e] | 1,000[d, e]<br>NA | NA | NA |
| Flammable liquid[c] | IA<br>IB and IC | H-2<br>or H-3 | NA | 30[d, e]<br>120[d, e] | NA | NA | 30[d]<br>120[d] | NA | NA | 10[d]<br>30[d] |
| Flammable liquid, combination (IA, IB, IC) | NA | H-2<br>or H-3 | NA | 120[d, e, h] | NA | NA | 120[d, h] | NA | NA | 30[d, h] |

*(continued)*



# MAQ – IBC 2015 TABLE 307.1 - FOOTNOTES (partial list)

a. For use of control areas, see Section 414.2.

b. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

c. The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited provided the liquids are packaged in individual containers not exceeding 1.3 gallons. In retail and wholesale sales occupancies, the quantities of medicines, foodstuffs, consumer products, and cosmetics, containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solutions not being flammable, shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.

d. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1. *Where Note e also applies, the increase for both notes shall be applied accumulatively.*

e. Maximum allowable quantities shall be increased 100 percent when stored in approved storage cabinets, day boxes, gas cabinets, gas rooms or exhausted enclosures or in listed safety cans in accordance with Section 5003.9.10 of the *International Fire Code. Where Note d also applies, the increase for both notes shall be applied accumulatively.*

f. Quantities shall not be limited in a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1

g. Allowed only in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1

h. Containing not more than the maximum allowable quantity per control area of Class IA, IB, or IC flammable liquids

*...(cont)*

# MAQ – IBC 2015 TABLE 307.1 – FOOTNOTES

## Maximum Quantities in Control Areas

### 100%

Control Area with no additional provision

***Use Footnote 'a'***

### 200%

Control Area with sprinklers

***Use Footnote 'a'+'d'***

*or*

Control Area with flammables storage cabinet

***Use Footnote 'a'+'e'***

### 400%

Control Area with flammables storage cabinet and sprinklers

***Use Footnote 'a'+'d'+'e'***

+

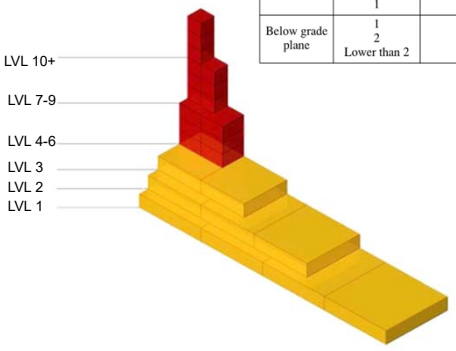


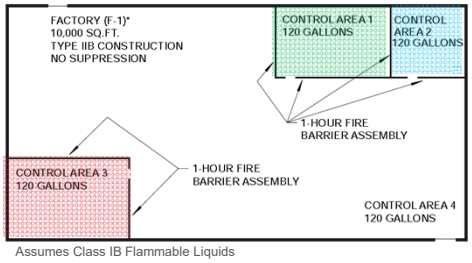
# CONTROL AREAS

IBC Section 202 Definitions - ***Control Areas*** - Spaces within a building where quantities of hazardous materials not exceeding the maximum allowable quantities per *control area are stored, dispensed, used or* handled

**[F] TABLE 414.2.2**
**DESIGN AND NUMBER OF CONTROL AREAS**

| FLOOR LEVEL | | PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA[a] | NUMBER OF CONTROL AREAS PER FLOOR | FIRE-RESISTANCE RATING FOR FIRE BARRIERS IN HOURS[b] |
|---|---|---|---|---|
| Above grade plane | Higher than 9 | 5 | 1 | 2 |
| | 7-9 | 5 | 2 | 2 |
| | 6 | 12.5 | 2 | 2 |
| | 5 | 12.5 | 2 | 2 |
| | 4 | 12.5 | 2 | 2 |
| | 3 | 50 | 2 | 1 |
| | 2 | 75 | 3 | 1 |
| | 1 | 100 | 4 | 1 |
| Below grade plane | 1 | 75 | 3 | 1 |
| | 2 | 50 | 2 | 1 |
| | Lower than 2 | Not Allowed | Not Allowed | Not Allowed |



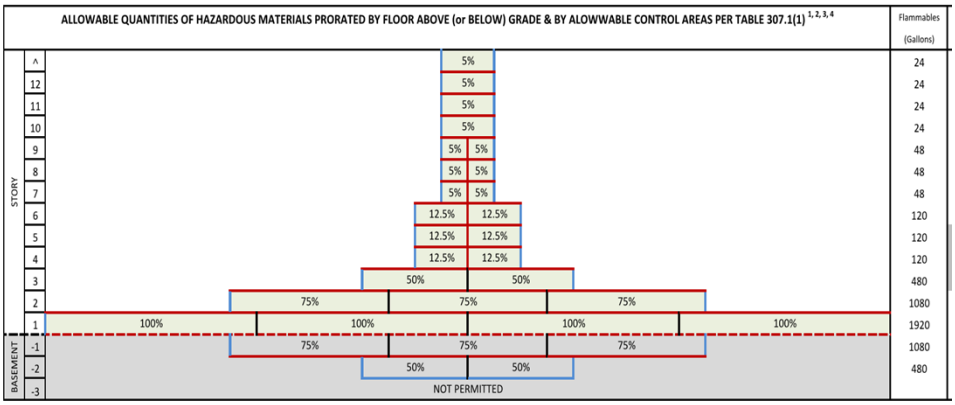

Assumes Class IB Flammable Liquids

# CONTROL AREAS

## Graphic of ratings and reduction in permitted chemical quantities

**NOTES:**

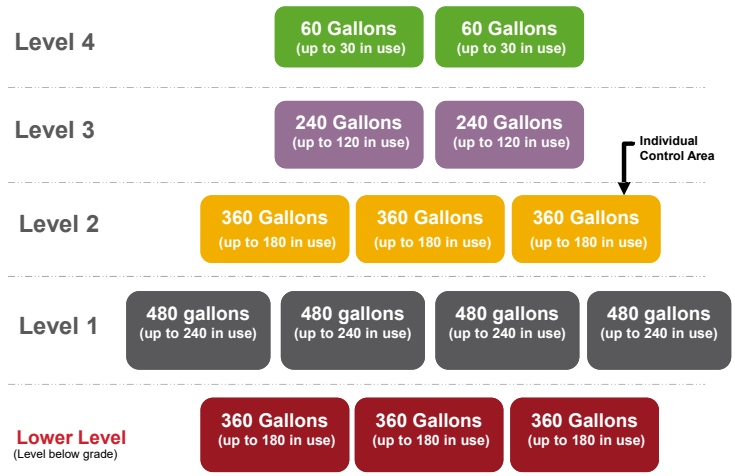
1. First floor is considered as first floor above GRADE
2. Fire Rated Separations both Horizontally & Vertically: **RED = 2 Hour Assembly; BLACK = 1 Hour Assembly;** BLUE = 0 Rating
3. Numbers indicate the prorated percentages of Table 307.1(1) Quantities per Control Area
4. Quantities per control area includes both raw and waste material quantities






# CONTROL AREAS

## Example - Combined Limit of Class 1A, 1B & 1C Flammable Liquids




In-Use: Any open bottles connected to a running experiment / equipment; chemicals within secondary containers for immediate use; cleaning squirt bottles; waste cans.

Stored: Any closed original or secondary containers for later use located within flammable liquid storage cabinet.

Class 1A liquids: have additional limits within these amounts.

***Flammables/Combustibles shown for sample purposes. All IBC/ IFC Chemicals to be tracked & controlled**

## WHAT HAPPENS IF THE MAQs ARE EXCEEDED?




## HIGH HAZARD OCCUPANCIES

### IBC 2015 Section 307

**High-Hazard Group H** - High hazard Group H occupancy includes, among others, the use of a building or structure, or portion thereof, that involves the manufacturing, processing, generation or storage of materials that constitute a physical or health hazard in quantities in excess of those allowed in control areas complying with Section 414, based on the maximum allowable quantity limits for control areas set forth in Tables 307.1(1) and 307.1(2). Hazardous occupancies are classified in Groups H-1, H-2, H-3, H-4 and H-5.

Group H occupancies are required to be separated from other Use Groups by Fire Barriers or Fire Walls

**Fire Barrier**. A fire-resistance-rated wall assembly of materials designed to restrict the spread of fire in which continuity is maintained.

**Fire Wall**. A fire-resistance-rated wall having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.

# HIGH HAZARD OCCUPANCIES

## IBC 2015 Section 307


**High-hazard Group H-1.** Buildings and structures containing materials that pose a detonation hazard shall be classified as Group H-1.Such materials shall include, but not be limited to, the following:

- Detonable pyrophoric materials
- Explosives

**High-hazard Group H-2.** Buildings and structures containing materials that pose a deflagration hazard or a hazard from accelerated burning shall be classified as Group H-2.

- Class I,II or IIIA flammable or combustible liquids which are used or stored in normally open containers or systems, or in closed containers or systems pressurized at more than 15psi gage.

**High-hazard Group H-3.** Buildings and structures containing materials that readily support combustion or that pose a physical hazard shall be classified as Group H-3.

- Class I,II or IIIA flammable or combustible liquids that are used or stored in normally closed containers or systems pressurized at15psi or less.

**High-hazard Group H-4.** Buildings and structures which contain materials that are health hazards shall be classified as Group H-4.

- Corrosives
- Highly Toxic and Toxic materials



# HIGH HAZARD OCCUPANCIES

## IBC 2015 Section 307

**TABLE 508.4**
**REQUIRED SEPARATION OF OCCUPANCIES (HOURS)**

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

**TABLE 707.3.10**
**FIRE-RESISTANCE RATING REQUIREMENTS FOR FIRE BARRIER ASSEMBLIES OR HORIZONTAL ASSEMBLIES BETWEEN FIRE AREAS**

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

# HIGH HAZARD OCCUPANCIES

## IBC 2015 Section 504 – Allowable Building Heights and Number of Stories

TABLE 504.3[a]
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE

| OCCUPANCY CLASSIFICATION | SEE FOOTNOTES | TYPE OF CONSTRUCTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | TYPE I | | TYPE II | | TYPE III | | TYPE IV | TYPE V | |
| | | A | B | A | B | A | B | HT | A | B |
| A, B, E, F, M, S, U | NS[b] | UL | 160 | 65 | 55 | 65 | 55 | 65 | 50 | 40 |
| | S | UL | 180 | 85 | 75 | 85 | 75 | 85 | 70 | 60 |
| H-1, H-2, H-3, H-5 | NS[c,d] | UL | 160 | 65 | 55 | 65 | 55 | 65 | 50 | 40 |
| | S | | | | | | | | | |
| H-4 | NS[c,d] | UL | 160 | 65 | 55 | 65 | 55 | 65 | 50 | 40 |
| | S | UL | 180 | 85 | 75 | 85 | 75 | 85 | 70 | 60 |

TABLE 504.4[a, b]
ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE

| OCCUPANCY CLASSIFICATION | SEE FOOTNOTES | TYPE OF CONSTRUCTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | TYPE I | | TYPE II | | TYPE III | | TYPE IV | TYPE V | |
| | | A | B | A | B | A | B | HT | A | B |
| H-1 | NS[c,d] | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | NP |
| | S | | | | | | | | | |
| H-2 | NS[c,d] | UL | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 1 |
| | S | | | | | | | | | |
| H-3 | NS[c,d] | UL | 6 | 4 | 2 | 4 | 2 | 4 | 2 | 1 |
| | S | | | | | | | | | |
| H-4 | NS[c,d] | UL | 7 | 5 | 3 | 5 | 3 | 5 | 3 | 2 |
| | S | UL | 8 | 6 | 4 | 6 | 4 | 6 | 4 | 3 |



# HIGH HAZARD OCCUPANCIES

## IBC 2015 Section 506 – Allowable Building Area

TABLE 506.2[a, b]
ALLOWABLE AREA FACTOR ($A_t$ = NS, S1, S13R, or SM, as applicable) IN SQUARE FEET

| OCCUPANCY CLASSIFICATION | SEE FOOTNOTES | TYPE OF CONSTRUCTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | TYPE I | | TYPE II | | TYPE III | | TYPE IV | TYPE V | |
| | | A | B | A | B | A | B | HT | A | B |
| B | NS | UL | UL | 37,500 | 23,000 | 28,500 | 19,000 | 36,000 | 18,000 | 9,000 |
| | S1 | UL | UL | 150,000 | 92,000 | 114,000 | 76,000 | 144,000 | 72,000 | 36,000 |
| | SM | UL | UL | 112,500 | 69,000 | 85,500 | 57,000 | 108,000 | 54,000 | 27,000 |
| E | NS | UL | UL | 26,500 | 14,500 | 23,500 | 14,500 | 25,500 | 18,500 | 9,500 |
| | S1 | UL | UL | 106,000 | 58,000 | 94,000 | 58,000 | 102,000 | 74,000 | 38,000 |
| | SM | UL | UL | 79,500 | 43,500 | 70,500 | 43,500 | 76,500 | 55,500 | 28,500 |
| F-1 | NS | UL | UL | 25,000 | 15,500 | 19,000 | 12,000 | 33,500 | 14,000 | 8,500 |
| | S1 | UL | UL | 100,000 | 62,000 | 76,000 | 48,000 | 134,000 | 56,000 | 34,000 |
| | SM | UL | UL | 75,000 | 46,500 | 57,000 | 36,000 | 100,500 | 42,000 | 25,500 |
| F-2 | NS | UL | UL | 37,500 | 23,000 | 28,500 | 18,000 | 50,500 | 21,000 | 13,000 |
| | S1 | UL | UL | 150,000 | 92,000 | 114,000 | 72,000 | 202,000 | 84,000 | 52,000 |
| | SM | UL | UL | 112,500 | 69,000 | 85,500 | 54,000 | 151,500 | 63,000 | 39,000 |
| H-1 | NS[c] | 21,000 | 16,500 | 11,000 | 7,000 | 9,500 | 7,000 | 10,500 | 7,500 | NP |
| | S1 | | | | | | | | | |
| H-2 | NS[c] | 21,000 | 16,500 | 11,000 | 7,000 | 9,500 | 7,000 | 10,500 | 7,500 | 3,000 |
| | S1 | | | | | | | | | |
| | SM | | | | | | | | | |
| H-3 | NS[c] | UL | 60,000 | 26,500 | 14,000 | 17,500 | 13,000 | 25,500 | 10,000 | 5,000 |
| | S1 | | | | | | | | | |
| | SM | | | | | | | | | |
| H-4 | NS[c,d] | UL | UL | 37,500 | 17,500 | 28,500 | 17,500 | 36,000 | 18,000 | 6,500 |
| | S1 | UL | UL | 150,000 | 70,000 | 114,000 | 70,000 | 144,000 | 72,000 | 26,000 |
| | SM | UL | UL | 112,500 | 52,500 | 85,500 | 52,500 | 108,000 | 54,000 | 19,500 |

# IBC 2015 Section 601 Construction Classification

## Impact to High Hazard Occupancies and Control Areas?

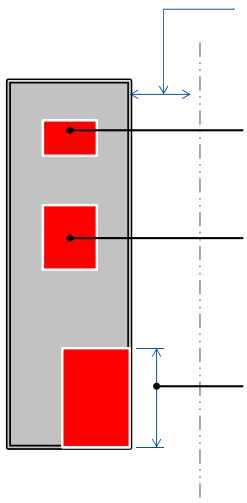
**TABLE 601**
**FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)**

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



# IBC 2015 Section 601 Construction Classification

## Impact to High Hazard Occupancies and Control Areas?



**415.6.1.2 Group H-2.** Areas > 1,000 sq.ft. must be 30-feet from lot line

**415.6 Exception 1:**
Liquid use, dispensing and mixing room having a floor area of not more than **500 square feet** need not be located on the outer perimeter of the building where they are in accordance with the International Fire Code and NFPA 30

**415.6 Exception 2:**
Liquid storage rooms having a floor are of not more than **1,000 square feet** need not be located on the outer perimeter of the building where they are in accordance with the International Fire Code and NFPA 30

**415.6 Fire Separation Distance:**
Group H-2 and H-3 occupancies shall have **not less than 25%** of their **perimeter** located on an exterior wall

# IBC 2015 Section 601 Construction Classification

## Impact to High Hazard Occupancies and Control Areas?

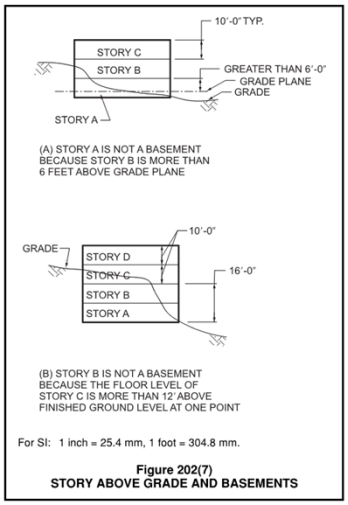



**Figure 202(7)**
**STORY ABOVE GRADE AND BASEMENTS**

**202 Definitions – Story Above Grade Plane:**
Any story having its finished floor surface entirely above grade plane, or in which the finished floor surface of the next floor above is (1) more than 6 feet above grade plane or (2) more than 12 feet above finished ground level at any point

**TABLE 504.4[a, b]**
**ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE**

| OCCUPANCY CLASSIFICATION | SEE FOOTNOTES | TYPE OF CONSTRUCTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | TYPE I | | TYPE II | | TYPE III | | TYPE IV | TYPE V | |
| | | A | B | A | B | A | B | HT | A | B |
| H-1 | NS[c, d] | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | NP |
| | S | | | | | | | | | |
| H-2 | NS[c, d] | UL | 3 | 2 | 1 | 2 | 1 | 2 | 1 | 1 |
| | S | | | | | | | | | |
| H-3 | NS[c, d] | UL | 6 | 4 | 2 | 4 | 2 | 4 | 2 | 1 |
| | S | | | | | | | | | |



# NFPA 30 – Flammable and Combustible Liquids

**1.1.1 Scope.** This code shall apply to the storage, handling, and use of flammable and combustible liquids, including waste liquids.

**1.2 Purpose.** The purpose of this code shall be to provide fundamental safeguards for the storage, handling, and use of flammable and combustible liquids.

**Content.** As related to the storage and handling of flammable and combustible liquids

- Facilities – Indoor, Outdoor and Detached
- Fire Prevention and Fire Risk Control
- Containers, Tanks and Bulk Containers
- Handling, Dispensing, Transfer and Use
- Specific Equipment and Operations
- Bulk Storage
- Piping Systems
- Loading and Unloading
- Wharves

## NFPA 30 – Fire Prevention and Fire Risk Control

**6.1 Scope.** This chapter shall apply to the hazards associated with processing and handling of liquids.

**6.3 Management of Fire and Explosion Hazards.** This chapter shall apply to the management methodology used to identify, evaluate, and control the hazards involved in the processing and handling of flammable and combustible liquids. These hazards include, but are not limited to, preparation, separation, purification, and change of state, energy content, or composition.

**6.4 Hazard Analysis.** Operations involving flammable and combustible liquids shall be reviewed to ensure that fire and explosion hazards resulting from loss of containment of liquids are provided with corresponding fire prevention, fire control, and emergency action plans.



## NFPA 30 – Fire Prevention and Fire Risk Control

**6.8 Emergency Planning and Training.**

Written emergency action plan consistent with available equipment and personnel.

- Procedures to be followed in case of fire – sounding alarm, notifying the fire department, evacuating personnel, controlling and extinguishing the fire.
- Procedures and schedules for conducting drills.
- Appointing and training of personnel to carry out assigned duties
- Maintenance of fire protection equipment.
- Procedures for shutting down or isolating equipment to reduce the release of liquid.
- Alternate measures for the safety of occupants.

**6.9 Inspection and Maintenance.** All fire protection equipment shall be properly maintained, and periodic inspections and tests shall be done in accordance with both standard practice and the equipment manufacturer's recommendation.

## Spill Containment and Secondary Containment

- Containment of spills and fire water
- Provide for wheeled traffic during normal operations
- Do not impede egress

Grating over recessed pit

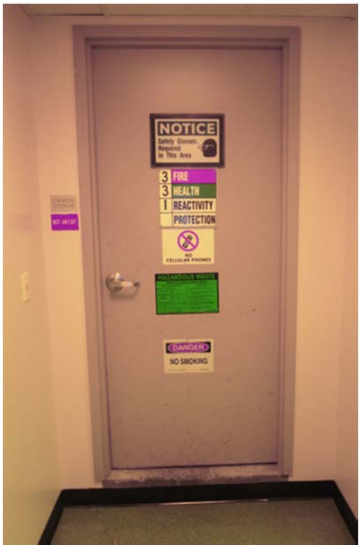
Grating and trench drains



## Spill Containment and Secondary Containment

- Containment at Doors and openings
- Provide for wheeled traffic
- Do not impede egress

*Automatic spill containment*




*Raised curb at doorway*

# Explosion Control Per IFC 911 (Table 911.1)

## Flammable Liquids - Deflagration Venting or Deflagration Prevention

**414.5.1 Explosion Control** – Provided per IFC and Table 414.5.1 *(Same as Table 911)*

TABLE 911.1
EXPLOSION CONTROL REQUIREMENTS[f]

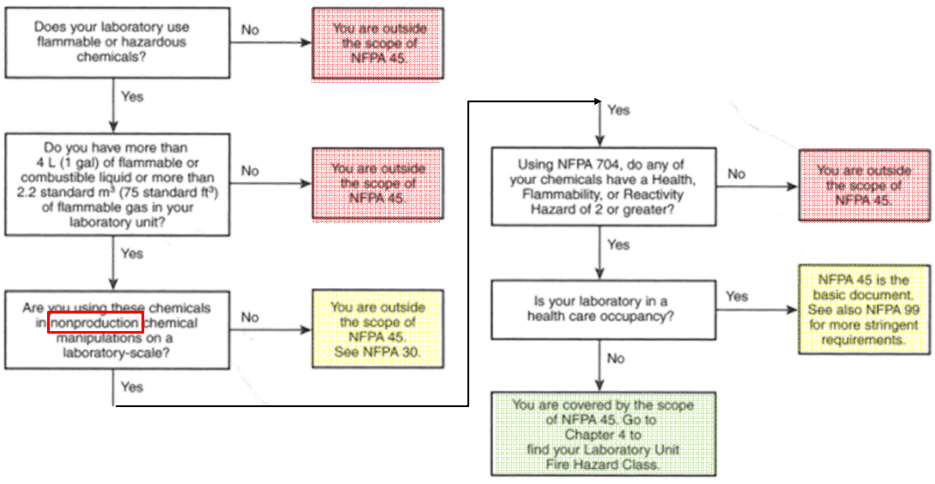
| MATERIAL | CLASS | EXPLOSION CONTROL METHODS | |
|---|---|---|---|
| | | Barricade construction | Explosion (deflagration) venting or explosion (deflagration) prevention systems |
| Hazard Category | | | |
| Flammable liquids | IA[b]<br>IB[c] | Not required<br>Not required | Required<br>Required |
| Where explosion hazards exist[d] | Detonation<br>Deflagration | Required<br>Not required | Not permitted<br>Required |

- Vents may be wall panels, hatch covers, swinging doors, roof panels, or listed venting devices.
- Vents designed to release at 20 lbs/SF (except consider wind pressure?) Other construction shall resist at least 100 PSF. Vent size shall be designed such that the design pressure is not exceeded.
- 50 foot minimum unoccupied space between the vent and the property line, except 20 feet if the vent is designed to remain attached to the building.
- LEL (Lower Explosive Limit) The lowest concentration of a vapor in air that will ignite in the presence of an ignition source. Same as lower flammable limit (LFL) or flammability limit or explosive limit.
- Detector can be used to shut down process, sound alarm, increase ventilation, etc.
- Deflagration prevention requirements are found in NFPA 69



# NFPA 45 – Fire Protection for Laboratories Using Chemicals

## When Does it Apply



## NFPA 45 – Fire Protection for Laboratories Using Chemicals

**1.1.1 Scope.** This standard shall apply to laboratory buildings, laboratory units, and laboratory work areas whether located above or below grade… in which chemicals, as defined… are handled or stored.

**1.2.4 Purpose.** The objectives of this standard shall be as follows

1) Limit injury to the occupants at the point of fire origin.
2) Limit injury to emergency response personnel
3) Limit property loss to a maximum of a single laboratory unit.

**3.3.32 Laboratory.** A facility where the containers used for reactions, transfers, and other handling of chemicals are designed to be easily and safely manipulated by one person. A laboratory is a workplace where chemicals are used or synthesized on a **nonproduction** basis

**Classification of Flammable and Combustible Liquids are extracted from NFPA 30 .**

- Aligns with Building Code



## NFPA 45 – Laboratories Units Hazard Classification

**Implications.** Laboratory units are classified to determine the hazard associated with the unit, various sections of NFPA 45 refer to the classification for the requirements of the design and construction. Examples:

**Table 5.1.1 Separation Requirements and Height Allowances for Laboratory Units**

| Laboratory Unit[a] | Area of Lab Unit | Fire Separation[b] | Permitted Stories Above Grade | Permitted Stories Below Grade |
|---|---|---|---|---|
| A | ≤929 m² (≤10,000 ft²) | 2 hours | 1–3 | Not permitted |
| | >929 m² (>10,000 ft²) | Not permitted[c] | | |
| B | ≤929 m² (≤10,000 ft²) | 1 hour | 1–3 | 1 |
| | ≤929 m² (≤10,000 ft²) | 2 hours | 4–6 | |
| | >929 m² (>10,000 ft²) | Not permitted[c] | | |
| C | Any size | Not required | 1–3 | 1–2 |
| | Any size | 1 hour | 4–6 | |
| | Any size | 2 hours | Over 6 | |
| D | Any size | Not required | No limit | No limit |

**5.3.1** Class A, B, and C laboratory units shall be classified as industrial occupancies in accordance with NFPA *101, Life Safety Code.*

***5.3.3.*** Instructional laboratories and Class D laboratories shall be classified as business occupancies in accordance with NFPA *101, Life Safety Code.*

**5.4.2** The required exit access doors of all laboratory work areas within Class A or Class B laboratory units shall swing in the direction of exit travel.

# NFPA 45 – Laboratories Units Hazard Classification

**4.2.1.1** Laboratory units shall be classified as Class A (high fire Hazard), Class B (moderate fire hazard), Class C (low fire hazard), or Class D (minimal fire hazard), according to the quantities of flammable and combustible liquids specified in Table 9.1.1(a) and Table 9.1.1(b).

**Table 9.1.1(b) Maximum Quantities of Flammable and Combustible Liquids in Laboratory Units Outside of Inside Liquid Storage Areas (U.S. Customary Units)**

| | | Quantities in Use[a] | | Quantities in Use and Storage[a] | |
|---|---|---|---|---|---|
| Laboratory Unit Fire Hazard Class | Flammable and Combustible Liquid Class[a] | Maximum Quantity[b] per 100 ft² of Laboratory Unit[c] (gal) | Maximum Quantity[b] per Laboratory Unit (gal) | Maximum Quantity[b] per 100 ft² of Laboratory Unit[c] (gal) | Maximum Quantity[b] per Laboratory Unit (gal) |
| A | I | 10 | 480 | 20 | 480 |
| (high fire hazard) | I, II, and IIIA | 20 | 800 | 40 | 1600 |
| B[d] | I | 5 | 300 | 10 | 480 |
| (moderate fire hazard) | I, II, and IIIA | 10 | 400 | 20 | 800 |
| C[e] | I | 2 | 150 | 4 | 300 |
| (low fire hazard) | I, II, and IIIA | 4 | 200 | 8 | 400 |
| D[e] | I | 1 | 75 | 2 | 150 |
| (minimal fire hazard) | I, II, and IIIA | 1 | 75 | 2 | 150 |



# NFPA 45 – Laboratories Units

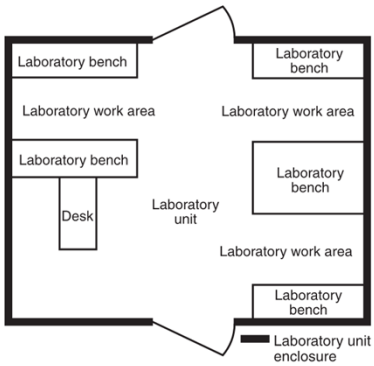



**Figure D.2.4 (b)**
Laboratory Unit without Partitioning

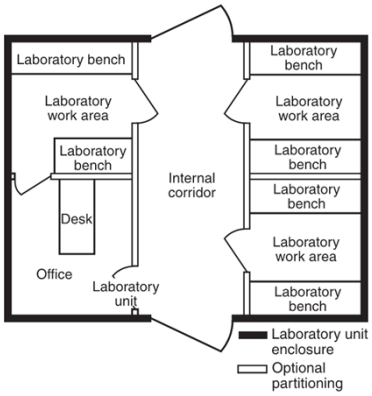



**Figure D.2.4 (c)**
Laboratory Unit with Optional Partitioning

# NFPA 45 – Laboratories Units

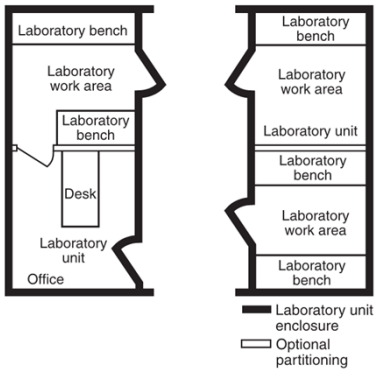



**Figure D.2.4 (d)**
Laboratory Units Separated by Exit Passageway

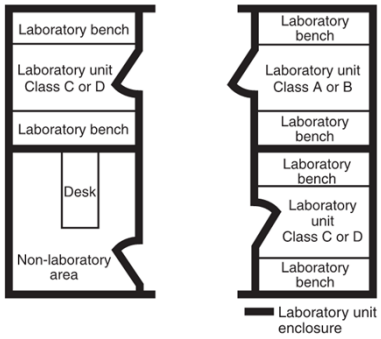



**Figure D.2.4 (e)**
Separation of Lab Units and Non Lab Units