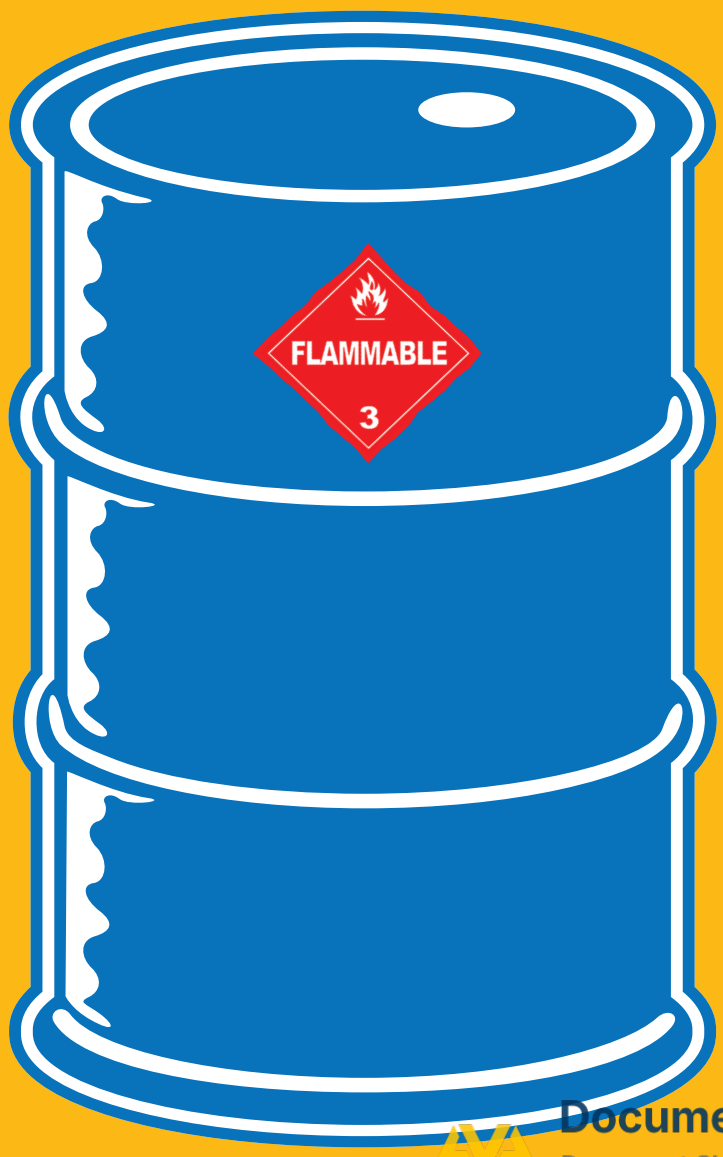
NFPA® 30

Flammable and Combustible Liquids Code

2015 Edition



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NFPA® 30

Flammable and Combustible Liquids Code

2015 Edition

This edition of NFPA 30, *Flammable and Combustible Liquids Code*, was prepared by the Technical Committee on Fundamentals, the Technical Committee on Operations, the Technical Committee on Storage and Warehousing of Containers and Portable Tanks, and the Technical Committee on Tank Storage and Piping Systems and released by the Correlating Committee on Flammable and Combustible Liquids. It was issued by the Standards Council on April 29, 2014, with an effective date of May 19, 2014, and supersedes all previous editions.

This edition of NFPA 30 was approved as an American National Standard on May 19, 2014.

Origin and Development of NFPA 30

From 1913 to 1957, this document was written as a model municipal ordinance known as the *Suggested Ordinance for the Storage, Handling, and Use of Flammable Liquids*. In 1957, the format was changed to a code, although the technical requirements and provisions remained the same. Since its inception numerous revised editions have been published as dictated by experience and advances in technology.

A brief review of the major changes adopted since 1981 follows. In 1984, the chapter on automotive and marine service stations was removed from NFPA 30 and was replaced with a new document, NFPA 30A, *Automotive and Marine Service Station Code*, now titled *Code for Motor Fuel Dispensing Facilities and Repair Garages*. In 1987, Chapter 5 (Industrial Plants), Chapter 6 (Bulk Plants and Terminals), Chapter 7 (Process Plants), and Chapter 8 (Refineries, Chemical Plants, and Distilleries) were combined into a single chapter on operations. In 1990, a new section was added to address hazardous materials storage lockers, and more detailed guidance was added to address ventilation of enclosed process areas and for estimation of fugitive emissions. In 1993, the chapter on tank storage was amended to allow combined remote impounding and diking systems and to provide relief from the spill control requirements for certain secondary containment–type tanks. Also, the chapter on container and portable tank storage was completely rewritten so that its requirements were presented more clearly, especially for mercantile occupancies.

In 1996, the following major changes were incorporated: requirements for temporary and permanent closure of underground storage tanks; requirements for tightness testing of tanks of specific design; recognition of intermediate bulk containers; and mandatory fire protection design criteria for inside storage of liquids in storage rooms and liquid warehouses.

In 2000, the following major changes were incorporated: complete editorial rewrites of Chapter 2, Tank Storage, and Chapter 3, Piping Systems; requirements for vaults for aboveground tanks and for protected aboveground tanks; recognition of certain nonmetallic intermediate bulk containers for storage of Class II and Class III liquids, along with fire protection system design criteria for them; simplified spill containment and drainage requirements; new fire protection design criteria for a number of flammable and combustible liquid commodities; expansion of the requirements for construction and separation of process buildings; a new section addressing recirculating heat transfer fluid heating systems; a new section addressing solvent recovery distillation units; and consolidation of all requirements for hazardous location electrical area classification into a single chapter.

The 2003 edition of NFPA 30 incorporated the following changes:

(1) Numerous occupancy definitions were either added or corrected to correlate with NFPA 1, *Uniform Fire Code*™; NFPA *101*®, *Life Safety Code*®; and *NFPA 5000*®, *Building Construction and Safety Code*®.
(2) Separation distance requirements for protected aboveground tanks were reduced, and separation distance requirements for tanks in vaults were eliminated.
(3) Special operating requirements were added for shop-fabricated aboveground tanks with abnormally long vertical piping for fill and/or vent lines.

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(4) New criteria were added to Chapter 6, Container and Portable Tank Storage, for maximum allowable capacities of acceptable container sizes.
(5) Fire protection design criteria for unsaturated polyester resins were added.
(6) Section D.5, Recommended Fire Protection Design Criteria for High-Expansion Foam Fire Protection for Nonmiscible Liquids, was added.
(7) Revisions were made to the spacing requirements and construction requirements for process buildings.
(8) Special requirements were added for insulated piping for recirculating heat transfer systems.
(9) Permanent interconnections between fire water systems and process water systems were prohibited.

The 2008 edition of NFPA 30 incorporated a complete editorial revision of the prior edition to implement NFPA's hazardous materials template, a formatting scheme intended to integrate a common organization and common outline for all NFPA codes and standards that address the various types of hazardous materials. As a result of the implementation of the template, the eight chapters that the 2003 edition of NFPA 30 comprised were subdivided and rearranged into 29 shorter, more narrowly focused chapters. Requirements that are generally applicable to all facilities that store, handle, and use flammable and combustible liquids were relocated to the beginning of the code. Chapters dealing with bulk storage and bulk handling of liquids were moved to the end of the code, based on the reasoning that not all codes and standards dealing with hazardous materials include provisions for bulk storage.

In addition to the editorial revision, the 2008 edition of NFPA 30 incorporated the following technical changes:

(1) Several new definitions were added to assist the user in applying the requirements of the code. Some existing definitions in Chapter 3 were changed to read the same as the preferred definitions in the NFPA *Glossary of Terms*. Where possible, secondary definitions were moved to appropriate chapters.
(2) Chapter 6, Container and Portable Tank Storage, was replaced by Chapters 9 through 16 of the 2008 edition. These new chapters regulated storage of containers, portable tanks, and intermediate bulk containers in a manner that is consistent with model building codes, such as *NFPA 5000®, Building Construction and Safety Code®*, and model fire prevention codes, such as NFPA 1, *Uniform Fire Code™*, and incorporated the concepts of maximum allowable quantities (MAQs), control areas, and protection levels.
(3) Fire protection design criteria for inside storage areas were expanded to include requirements for small plastic containers of Class IB, IC, II, and III liquids in corrugated cartons and for Class IIIB liquids in corrugated cardboard intermediate bulk containers with plastic inner liners. The flowcharts and tables that contain these design criteria were reformatted to present the information more consistently.
(4) New corrosion protection requirements were added for nonmetallic tanks.
(5) New requirements for periodic testing, maintenance, inspection, and repair of aboveground storage tanks were added.
(6) Overfill prevention requirements were revised so that they apply to all tanks larger than 1320 gal (5000 L) capacity.
(7) Additional requirements for fire-resistant tanks were added.
(8) The maximum capacity for secondary containment–type tanks storing Class II and Class IIIA liquids was increased from 12,000 gal (45,000 L) to 20,000 gal (76,000 L).
(9) The requirements for construction of storage tank vaults were improved for clarity.
(10) Special requirements for marine piping systems were added.

The 2012 edition of NFPA 30 incorporated the following technical changes:

(1) Use and installation of alcohol-based hand rub dispensers were exempted from the code.
(2) NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* was added to Section 1.5 as one of the NFPA codes and standards deemed equivalent to the code for purposes of installation of fuel tanks for diesel-driven fire pumps.
(3) Definitions for the various building occupancies were amended to correlate with the preferred definitions as found in NFPA *101®, Life Safety Code®*.
(4) The definitions of *fire-resistant tank* and *protected aboveground tank* were relocated to Chapter 22, Storage of Liquids in Tanks — Aboveground Storage Tanks.
(5) New provisions were added to require that Class II and Class III liquids that are stored, handled, processed, or used at temperatures at or above their flash points follow all applicable requirements in the code for Class I liquids, unless an engineering evaluation deems otherwise. Supplementary information was included in Annex A. In addition, direct reference to this provision was added at appropriate locations in subsequent chapters.
(6) An annex item was added to 6.5.1 to explain that use of spark-resistant tools must be evaluated on a case-by-case basis.
(7) New Section 6.10 and the accompanying Annex G were added to address management of facility security by means of a mandatory security and vulnerability assessment. Annex G provides an outline of a suggested assessment process.
(8) Annex guidance was added to 9.5.4.2 for selecting a safe location to which a flammable liquids storage cabinet can be vented.
(9) The provisions for flammable liquids storage cabinets were amended to incorporate more extensive marking requirements.
(10) A footnote was added to Table 9.9.1, Fire Resistance Ratings for Liquid Storage Areas, to indicate that no fire resistance rating is required for separation walls for accessory use areas of small floor area.

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(11) Section 13.3 was revised to more clearly establish the required separation between detached unprotected liquids storage buildings and both protected and unprotected exposed properties.
(12) Numerous minor amendments were made to clarify application of the provisions of Chapter 16.
(13) A new subsection, 17.3.7, was added to address process vessels used to heat liquids to temperatures at or above their flash points, as suggested by the U.S. Chemical Safety and Hazard Investigation Board.
(14) An Annex A item was added to 18.6.3 to provide guidance for selecting a safe location to which a flammable liquids dispensing area can be vented.
(15) Subsection 21.4.3, Normal Venting for Storage Tanks, was amended to clarify its application. An Annex A item was included to clarify that the interstitial space of a secondary containment tank does not require normal venting.
(16) A new 21.5.2.1 was added to clarify that tightness testing is not required for an interstitial space of a secondary containment tank that maintains factory-applied vacuum.
(17) A note and Annex A item were added to Table 22.4.2.1, Minimum Shell-to-Shell Spacing of Aboveground Storage Tanks, to explain the term *sum of adjacent diameters* and its determination.
(18) Subsection 22.17.4 was amended to provide additional guidance on handling floating roof pontoons that have been breached by liquids or vapors.
(19) Section 23.14 was amended so that it no longer allows the use of water ballast to secure underground tanks in areas subject to flooding.

The 2015 edition of NFPA 30 incorporates the following major amendments:

(1) The definition of "safety can" has been amended to incorporate a screen/strainer in each fill and pour opening. This recognizes the actual construction of safety cans as currently manufactured and listed.
(2) A 12-ft (3.6-m) storage height restriction has been imposed on unprotected storage in mercantile occupancies, to be consistent with the storage height restriction already in place for mercantile occupancies protected in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems,* for ordinary hazard Group 2.
(3) Numerous amendments have been made to Chapter 16 to clarify intent, to eliminate certain inconsistencies between NFPA 30 and NFPA 13, and to correlate with terminology used in and specific requirements of NFPA 13.
(4) Subsection 17.4.3 and Table 17.4.3 have been amended to increase the required separation distances between process vessels and adjacent important buildings, adjacent property lines, and the near and far sides of public ways. The amendments address recommendations submitted by the U.S. Chemical Safety and Hazard Investigation Board.
(5) A new subsection, 18.4.4, has been added to address hand-operated pumps to dispense liquids that function using compressed air.
(6) New Section 19.7 has been added to address the installation of cooking oil storage and dispensing systems for use in commercial kitchens, such as restaurants and prepared food production facilities.
(7) Section 22.7 has been amended to eliminate the use of a weak roof-to-shell seam as an allowed means of emergency venting for ANSI/UL 142 steel aboveground storage tanks.
(8) Subsection 22.11.4 has been amended to set a 50,000 gal maximum capacity for all secondary containment-type storage tanks for all Class I, Class II, and Class IIIA liquids.
(9) Subsection 27.4.4 has been amended to strengthen the provisions regarding the use of low melting point piping materials. The amendments address recommendations submitted by the U.S. Chemical Safety and Hazard Investigation Board.
(10) Section 28.11 has been amended by adding certain operating requirements for the person responsible for loading or unloading tank vehicles. These correlate with the provisions of NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids.*
(11) A new Annex A item, A.21.7.2.2, has been added to address security of storage tanks in remote unattended locations. This addresses recommendations submitted by the U.S. Chemical Safety and Hazard Investigation Board.

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NFPA 30

Flammable and Combustible Liquids Code

2015 Edition

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Information on referenced publications can be found in Chapter 2 and Annex I.

Chapter 1 Administration

1.1 Scope.

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

1.1.2 This code shall not apply to the following:

(1)*Any liquid that has a melting point of 100°F (37.8°C) or greater
(2)*Any liquid that does not meet the criteria for fluidity given in the definition of *liquid* in Chapter 3 and in the provisions of Chapter 4
(3) Any cryogenic fluid or liquefied gas, as defined in Chapter 3
(4)*Any liquid that does not have a flash point, but which is capable of burning under certain conditions
(5)*Any aerosol product
(6) Any mist, spray, or foam
(7)*Transportation of flammable and combustible liquids as governed by the U.S. Department of Transportation
(8)*Storage, handling, and use of fuel oil tanks and containers connected with oil-burning equipment
(9)*Use and installation of alcohol-based hand rub (ABHR) dispensers

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.

1.3 Application. The requirements in this code shall apply to users, producers, distributors, and others who are involved with the storage, handling, or use of flammable and combustible liquids.

1.3.1 Chapters 1 through 7 shall apply to all facilities where flammable or combustible liquids are stored, handled, or used.

1.3.2 Chapters 9 through 12 shall apply to the storage of flammable or combustible liquids in containers, portable tanks, and intermediate bulk containers in the occupancies covered by the scope of each chapter.

1.3.3 Chapter 13 shall apply to the storage of flammable or combustible liquids in containers, portable tanks, and intermediate bulk containers in detached unprotected buildings.

1.3.4 Chapter 14 shall apply to the storage of flammable or combustible liquids in containers, portable tanks, and intermediate bulk containers in hazardous materials storage lockers.

1.3.5 Chapter 15 shall apply to the outdoor storage of flammable or combustible liquids in containers, portable tanks, and intermediate bulk containers.

1.3.6 Chapter 16 shall apply to fire protection design criteria used to protect storage of flammable or combustible liquids in containers, portable tanks, and intermediate bulk containers.

1.3.7 Chapter 17 shall apply to the design and construction of facilities where flammable or combustible liquids are processed or used.

1.3.8 Chapter 18 shall apply to the general requirements related to handling, dispensing, transfer, and use of flammable or combustible liquids.

1.3.9 Chapter 19 shall apply to specific equipment and specific operations that use flammable or combustible liquids.

1.3.10 Chapters 21 through 25 shall apply to bulk storage of flammable or combustible liquids in tanks.

1.3.11 Chapter 27 shall apply to piping systems for transferring flammable or combustible liquids.

1.3.12 Chapter 28 shall apply to loading and unloading systems associated with bulk storage of flammable or combustible liquids in tanks.

1.3.13 Chapter 29 shall apply to wharves associated with bulk handling of flammable or combustible liquids.

1.4 Retroactivity. The provisions of this code reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this code at the time the code was issued.

1.4.1 Unless otherwise specified, the provisions of this code shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the code. Where specified, the provisions of this code shall be retroactive.

1.4.2* In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portion of this code deemed appropriate.

1.4.3 The retroactive requirements of this code shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

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1.5 Equivalency. Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency. The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.5.1 The provisions of this code shall be permitted to be altered at the discretion of the authority having jurisdiction after consideration of special situations, such as topographical conditions of the site, presence or absence of protective features (e.g., barricades, walls, etc.), adequacy of building exits, the nature of the occupancy, proximity to buildings or adjoining property and the construction of such buildings, capacity and construction of proposed storage tanks and the nature of the liquids to be stored, the nature of the process, the degree to which private fire protection is provided, and the capabilities of the local fire department. Such alternate arrangements shall provide protection at least equivalent to that required by this code.

1.5.2 The provisions of this code shall also be permitted to be altered at the discretion of the authority having jurisdiction in cases where other regulations, such as those for environmental protection, impose requirements that are not anticipated by this code. Such alternate arrangements shall provide protection at least equivalent to that required by this code.

1.5.3 Installations made in accordance with the applicable requirements of the following standards shall be deemed to be in compliance with this code:

(1) NFPA 1, *Fire Code*
(2) NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*
(3) NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*
(4) NFPA 31, *Standard for the Installation of Oil-Burning Equipment*
(5) NFPA 32, *Standard for Drycleaning Plants*
(6) NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
(7) NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*
(8) NFPA 35, *Standard for the Manufacture of Organic Coatings*
(9) NFPA 36, *Standard for Solvent Extraction Plants*
(10) NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*
(11) NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*
(12) NFPA 99, *Health Care Facilities Code*
(13) NFPA *101*, *Life Safety Code*

1.6 Symbols, Units, and Formulas.

1.6.1 The units of measure in this code are presented first in U.S. customary units (inch-pound units). SI units (International System of Units) follow the inch-pound units in parentheses.

1.6.2 Either system of units shall be acceptable for satisfying the requirements in the code.

1.6.3 Users of this code shall apply one system of units consistently and shall not alternate between units.

1.6.4 The values presented for measurements in this code are expressed with a degree of precision appropriate for practical application and enforcement. It is not intended that the application or enforcement of these values be more precise than the precision expressed.

1.6.5 Where extracted text contains values expressed in only one system of units, the values in the extracted text have been retained without conversion to preserve the values established by the responsible technical committee in the source document.

1.6.6 If a value for measurement given in this standard is followed by an equivalent value in other units, the first stated shall be regarded as the requirement. The given equivalent value shall be considered to be approximate.

1.7 Code Adoption Requirements. (Reserved)

1.8 Permits. (Reserved)

1.9 Enforcement. This code shall be administered and enforced by the authority having jurisdiction designated by the governing authority. *(See Annex H for sample wording for enabling legislation.)*

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this code and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code,* 2015 edition.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2010 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2011 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 2009 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2013 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2012 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems,* 2011 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2013 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection,* 2013 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2013 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2014 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages,* 2015 edition.

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products,* 2015 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2011 edition.

NFPA 32, *Standard for Drycleaning Plants,* 2011 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials,* 2011 edition.

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NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids,* 2011 edition.

NFPA 35, *Standard for the Manufacture of Organic Coatings,* 2011 edition.

NFPA 36, *Standard for Solvent Extraction Plants,* 2013 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 2015 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals,* 2011 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2014 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG),* 2013 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2013 edition.

NFPA 69, *Standard on Explosion Prevention Systems,* 2014 edition.

NFPA 70®, National Electrical Code®, 2014 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2013 edition.

NFPA 85, *Boiler and Combustion Systems Hazards Code,* 2011 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,* 2010 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations,* 2014 edition.

NFPA 99, *Health Care Facilities Code,* 2015 edition.

NFPA *101®, Life Safety Code®,* 2015 edition.

NFPA 220, *Standard on Types of Building Construction,* 2015 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2015 edition.

NFPA 303, *Fire Protection Standard for Marinas and Boatyards,* 2011 edition.

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves,* 2011 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair,* 2010 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations,* 2013 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response,* 2012 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2015 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2012 edition.

NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

2.3 Other Publications.

2.3.1 API Publications. American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.

API Specification 12B, *Bolted Tanks for Storage of Production Liquids,* 15th edition, 2008.

API Specification 12D, *Field Welded Tanks for Storage of Production Liquids,* 11th edition, 2008.

API Specification 12F, *Shop Welded Tanks for Storage of Production Liquids,* 12th edition, 2008.

API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* 11th edition, Addendum 2, 2010.

API Standard 650, *Welded Steel Tanks for Oil Storage,* 11th edition, Addendum 2, 2009.

API Standard 653, *Tank Inspection, Repair, Alteration, and Reconstruction,* 4th edition, 2012.

API Standard 2000, *Venting Atmospheric and Low-Pressure Storage Tanks,* 5th edition, 1998.

API 2350, *Overfill Protection for Storage Tanks in Petroleum Facilities,* 4th edition, 2012.

2.3.2 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME *Boiler and Pressure Vessel Code,* 2010.

ASME B31, *Code for Process Piping,* 2012.

ASME *Code for Unfired Pressure Vessels,* 2010.

2.3.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A 395/A395M,, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures,* 1999 (reaffirmed 2009).

ASTM D 5/D5M, *Standard Test Method for Penetration of Bituminous Materials,* 2013.

ASTM D 56, *Standard Test Method for Flash Point by Tag Closed Cup Tester,* 2005 (reaffirmed 2010).

ASTM D 86, *Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure,* 2012.

ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester,* 2012b.

ASTM D 93, *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester,* 2012.

ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method),* 2008.

ASTM D 3278, *Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus,* 1996 (reaffirmed 2011).

ASTM D 3828, *Standard Test Methods for Flash Point by Small Scale Closed Cup Tester,* 2012a.

ASTM D 4359, *Standard Test for Determining Whether a Material is a Liquid or a Solid,* 1990 (reaffirmed 2012).

ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials,* 2012a.

ASTM F 852, *Standard Specification for Portable Gasoline Containers for Consumer Use,* 2008.

ASTM F 976, *Specification for Portable Kerosine and Diesel Containers for Consumer Use,* 2008.

2.3.4 CSA America Publications. Canadian Standards Association, 5060 Spectrum Way, Mississauga, ON, L4W 5N6, Canada.

CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code,* 2009.

2.3.5 FM Publications. FM Global, 1301 Atwood Avenue, P.O. Box 7500, Johnston, RI 02919.

Approval Standard for Intermediate Bulk Containers, Class Number 6020, December 2010.

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Approval Standard for Plastic Plugs for Steel Drums, Class Number 6083, October 2006.

2.3.6 NMFTA Publications. National Motor Freight Traffic Association, 1001 North Fairfax Street, Suite 600, Alexandria, VA 22314.

National Motor Freight Classification (NMFC), 2012.

2.3.7 NRFC Publications. National Railroad Freight Committee, 222 South Riverside Plaza, Chicago, IL 60606-5945.

Uniform Freight Classification (UFC), 2005.

2.3.8 STI Publications. Steel Tank Institute, 570 Oakwood Road, Lake Zurich, IL 60047.

STI SP001, *Standard for the Inspection of Aboveground Storage Tanks,* 5th edition, 2011.

2.3.9 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 30, *Standard for Metal Safety Cans*, 1995, Revised 2009.

UL 58, *Standard for Steel Underground Tanks for Flammable and Combustible Liquids*, 1996, Revised 1998.

ANSI/UL 80, *Standard for Steel Tanks for Oil -Burner Fuels and Other Combustible Liquids*, 2007, Revised 2009.

ANSI/UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*, 2006, Revised 2010.

UL 971, *Standard for Nonmetallic Underground Piping for Flammable Liquids*, 1995, Revised 2006.

ANSI/UL 499, *Electric Heating Appliances*, 2008.

ANSI/UL 1313, *Standard for Nonmetallic Safety Cans for Petroleum Products*, 1993, Revised 2007.

ANSI/UL 1316, *Standard for Glass-Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures*, 2006.

ANSI/UL 1746, *Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks*, 2007.

UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*, 2000.

ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*, 1997, Revised 2010.

ANSI/UL 2208, *Standard for Solvent Distillation Units*, 2005, Revised 2011.

ANSI/UL 2245, *Standard for Below-Grade Vaults for Flammable Liquid Storage Tanks*, 2006.

UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*, 2012.

2.3.10 UN Publications. United Nations, Headquarters, New York, NY 10017.

Recommendations on the Transport of Dangerous Goods, 17th revised edition, 2011.

2.3.11 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 33, Code of Federal Regulations, "Navigation and Navigable Waters," Parts 154, 155, and 156.

Title 46, Code of Federal Regulations, "Shipping," Parts 30, 32, 35, and 39.

Title 49, Code of Federal Regulations, "Transportation," Parts 100–199.

2.3.12 Other Publications. *Merriam-Webster's Collegiate Dictionary,* 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 52, *Vehicular Gaseous Fuel Systems Code,* 2013 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2013 edition.

NFPA 77, *Recommended Practice on Static Electricity,* 2014 edition.

NFPA *101®, Life Safety Code®,* 2015 edition.

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves,* 2011 edition.

NFPA 400, *Hazardous Materials Code,* 2013 edition.

NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this code. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

3.2.4 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.5* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

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3.3 General Definitions.

3.3.1 Alcohol-Based Hand Rub (ABHR). An alcohol-containing preparation designed for application to the hands for reducing the number of visible microorganisms on the hands and containing ethanol or isopropanol in an amount not exceeding 95 percent by volume.

3.3.2 Area.

3.3.2.1 ***Control Area.*** For the purpose of this code, a building or portion of a building within which flammable and combustible liquids are allowed to be stored, dispensed, and used or handled in quantities that do not exceed the maximum allowable quantity (MAQ). *(See also 3.3.38, Maximum Allowable Quantity.)*

3.3.2.2 ***Fire Area.*** An area of a building separated from the remainder of the building by construction having a fire resistance of at least 1 hour and having all communicating openings properly protected by an assembly having a fire resistance rating of at least 1 hour.

3.3.2.3 ***Inside Liquid Storage Area.*** A room or building used for the storage of liquids in containers or portable tanks, separated from other types of occupancies.

3.3.3 Barrel. A unit of volume used in the petroleum industry that is equal to 42 gal (159 L).

3.3.4 Basement. For the purposes of this code, a story of a building or structure having one-half or more of its height below ground level and to which access for fire-fighting purposes is restricted.

3.3.5 Boiling Point. The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure.

3.3.6* Boil-Over. An event in the burning of certain oils in an open-top tank when, after a long period of quiescent burning, there is a sudden increase in fire intensity associated with expulsion of burning oil from the tank.

3.3.7 Bonding. For the purpose of controlling static electric hazards, the process of connecting two or more conductive objects together by means of a conductor so that they are at the same electrical potential, but not necessarily at the same potential as the earth. [**77,** 2014]

3.3.8 Building. Any structure used or intended for supporting or sheltering any use or occupancy.

3.3.8.1* ***Important Building.*** A building that is considered not expendable in an exposure fire.

3.3.8.2 ***Storage Tank Building.*** A three-dimensional space that is enclosed by a roof and walls that cover more than one-half of the possible area of the sides of the space, is of sufficient size to allow entry by personnel, will likely limit the dissipation of heat or dispersion of vapors, and restricts access for fire fighting.

3.3.9 Building Code. The building or construction code adopted by the jurisdiction. [**55,** 2013]

3.3.10 Chemical Plant. A large integrated plant or that portion of such a plant, other than a refinery or distillery, where liquids are produced by chemical reactions or used in chemical reactions.

3.3.11 Closed-Top Diking. A dike with a cover intended to minimize the entrance of precipitation into the diked area.

3.3.12* Container. Any vessel of 119 gal (450 L) or less capacity used for transporting or storing liquids.

3.3.12.1 ***Closed Container.*** A container as herein defined, so sealed by means of a lid or other device that neither liquid nor vapor will escape from it at ordinary temperatures.

3.3.12.2 ***Intermediate Bulk Container.*** Any closed vessel having a liquid capacity not exceeding 3000 L (793 gal) and intended for storing and transporting liquids, as defined in Title 49, Code of Federal Regulations, Parts 100 through 199 or in Part 6 of the United Nations' *Recommendations on the Transport of Dangerous Goods.*

3.3.12.3* ***Nonmetallic Container.*** A container as defined in 3.3.12, constructed of glass, plastic, fiber, or a material other than metal.

3.3.12.4* ***Nonmetallic Intermediate Bulk Container.*** An intermediate bulk container, as defined in 3.3.12.2, constructed of glass, plastic, fiber, or a material other than metal.

3.3.13 Crude Petroleum. Hydrocarbon mixtures that have a flash point below 150°F (65.6°C) and that have not been processed in a refinery.

3.3.14 Cryogenic Fluid. A fluid with a boiling point lower than –130°F (–90°C) at an absolute pressure of 14.7 psi (101.325 kPa). [**55,** 2013]

3.3.15 Damage-Limiting Construction. For the purposes of this code, any set of construction elements, used individually or in combination, which will act to limit damage from an explosion, including open structures, pressure relieving construction, or pressure resistant construction.

3.3.16 Distillery. A plant or that portion of a plant where liquids produced by fermentation are concentrated and where the concentrated products are also mixed, stored, or packaged.

3.3.17 Dwelling.

3.3.17.1 ***Multifamily Dwelling.*** A building that contains three or more dwelling units.

3.3.17.2 ***One-Family Dwelling.*** A building that consists solely of one dwelling unit.

3.3.17.3 ***Two-Family Dwelling.*** A building that consists solely of two dwelling units.

3.3.18 Dwelling Unit. One or more rooms arranged for complete, independent housekeeping purposes, with space for eating, living, and sleeping; facilities for cooking; and provisions for sanitation. [**5000,** 2015]

3.3.19 Fire Code. The fire code referenced in Chapter 2 of this code.

3.3.20 Fire Point. The lowest temperature at which a liquid will ignite and achieve sustained burning when exposed to a test flame in accordance with ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester.*

3.3.21 Flash Point. The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitible mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in Section 4.4.

3.3.22* Fugitive Emissions. Releases of flammable vapor that continuously or intermittently occur from process equipment during normal operations.

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3.3.23 Grounding. The process of bonding one or more conductive objects to the ground, so that all objects are at zero (0) electrical potential; also referred to as *earthing*. [**77,** 2014]

3.3.24* Hazardous Material or Hazardous Chemical. Material presenting dangers beyond the fire problems relating to flash point and boiling point.

3.3.25 Hazardous Materials Storage Locker. A movable prefabricated structure, manufactured primarily at a site other than the final location of the structure and transported completely assembled or in a ready-to-assemble package to the final location, and intended to meet local, state, and federal requirements for outside storage of hazardous materials.

3.3.26* Hazardous Reaction or Hazardous Chemical Reaction. Reactions that result in dangers beyond the fire problems relating to flash point and boiling point of either the reactants or of the products.

3.3.27 Heat Transfer Fluid (HTF). A liquid that is used as a medium to transfer heat energy from a heater or vaporizer to a remote heat consumer (e.g., injection molding machine, oven, or dryer, or jacketed chemical reactor).

3.3.28 High Hazard Level 2 Contents. Contents that present a deflagration hazard or a hazard from accelerated burning. For the purposes of this code, this includes Class I, Class II, or Class IIIA liquids that are used or stored in normally open containers or systems, or in closed containers or systems at gauge pressures 15 psi (103 kPa) or greater.

3.3.29 High Hazard Level 3 Contents. Contents that readily support combustion or that present a physical hazard. For the purposes of this code, this includes Class I, Class II, or Class IIIA liquids that are used or stored in normally closed containers or in closed systems at gauge pressures of less than 15 psi (103 kPa).

3.3.30 Hotel. A building or groups of buildings under the same management in which there are sleeping accommodations for more than 16 persons and primarily used by transients for lodging with or without meals. [***101,*** 2015]

3.3.31 Incidental Liquid Use or Storage. Use or storage as a subordinate activity to that which establishes the occupancy or area classification.

3.3.32 Liquefied Gas. A gas, other than in solution, that in a packaging under the charged pressure exists both as a liquid and a gas at a temperature of 68°F (20°C).

3.3.33 Liquid. Any material that (1) has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D 5, *Standard Test Method for Penetration of Bituminous Materials*, or (2) is a viscous substance for which a specific melting point cannot be determined but that is determined to be a liquid in accordance with ASTM D 4359, *Standard Test for Determining Whether a Material is a Liquid or a Solid.*

3.3.33.1 ***Combustible Liquid.*** Any liquid that has a closed-cup flash point at or above 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4. Combustible liquids are classified according to Section 4.3.

3.3.33.2* ***Flammable Liquid.*** Any liquid that has a closed-cup flash point below 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4, and a Reid vapor pressure that does not exceed an absolute pressure of 40 psi (276 kPa) at 100°F (37.8°C), as determined by ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*. Flammable liquids are classified according to Section 4.3.

3.3.33.3 ***Stable Liquid.*** Any liquid not defined as unstable.

3.3.33.4* ***Unstable Liquid.*** A liquid that, in the pure state or as commercially produced or transported, will vigorously polymerize, decompose, undergo condensation reaction, or become self-reactive under conditions of shock, pressure, or temperature.

3.3.33.5* ***Water-Miscible Liquid.*** A liquid that mixes in all proportions with water without the use of chemical additives, such as emulsifying agents.

3.3.34 Liquid Storage Room. A room that is used for the storage of liquids in containers, portable tanks, or intermediate bulk containers, has a floor area that does not exceed 500 ft^2 (46 m^2), and might be totally enclosed within a building — that is, the room might have no exterior walls.

3.3.35 Liquidtight. The ability of an enclosure or device to prevent the unintended release of liquids at normal operating temperature and pressure ranges.

3.3.36 Liquid Warehouse. See 3.3.62.2.

3.3.37 Lower Flammable Limit (LFL). That concentration of a flammable vapor in air below which ignition will not occur. Also known as the lower explosive limit (LEL).

3.3.38* Maximum Allowable Quantity (MAQ). For the purposes of this code, the quantity of flammable and combustible liquid permitted in a control area.

3.3.39 Occupancy. The purpose for which a building or other structure, or part thereof, is used or intended to be used. [***101,*** 2015]

3.3.39.1 ***Ambulatory Health Care Occupancy.*** [A building or portion thereof] used to provide services or treatment simultaneously to four or more patients that provides, on an outpatient basis, one or more of the following: (1) treatment for patients that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others; (2) anesthesia that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others; (3) emergency or urgent care for patients who, due to the nature of their injury or illness, are incapable of taking action for self-preservation under emergency conditions without the assistance of others. [***101,*** 2015]

3.3.39.2 ***Assembly Occupancy.*** An occupancy (1) used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses; or (2) used as a special amusement building, regardless of occupant load. [***101,*** 2015]

3.3.39.3 ***Business Occupancy.*** An occupancy used for the transaction of business other than mercantile. [***101,*** 2015]

3.3.39.4 ***Day-Care Occupancy.*** An occupancy in which four or more clients receive care, maintenance, and supervision, by other than their relatives or legal guardians, for less than 24 hours per day. [***101,*** 2015]

3.3.39.5 ***Detention and Correctional Occupancy.*** An occupancy used to house [four] or more persons under varied

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degrees of restraint or security where such occupants are mostly incapable of self-preservation because of security measures not under the occupants' control. [***101,*** 2015]

3.3.39.6 ***Educational Occupancy.*** An occupancy used for educational purposes through the twelfth grade by six or more persons for 4 or more hours per day or more than 12 hours per week. [***101,*** 2015]

3.3.39.7 ***Health Care Occupancy.*** An occupancy used to provide medical or other treatment or care simultaneously to four or more patients on an inpatient basis, where such patients are mostly incapable of self-preservation due to age, physical or mental disability, or because of security measures not under the occupants' control. [***101,*** 2015]

3.3.39.8 ***Industrial Occupancy.*** An occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted. [***101,*** 2015]

3.3.39.9 ***Mercantile Occupancy.*** An occupancy used for the display and sale of merchandise. [***101,*** 2015]

3.3.39.10 ***Residential Occupancy.*** An occupancy that provides sleeping accommodations for purposes other than health care or detention and correctional. [***101,*** 2015]

3.3.39.11 ***Residential Board and Care Occupancy.*** An occupancy used for lodging and boarding of four or more residents, not related by blood or marriage to the owners or operators, for the purpose of providing personal care services. [***101,*** 2015]

3.3.39.12 ***Storage Occupancy.*** An occupancy used primarily for the storage or sheltering of goods, merchandise, products, or vehicles. [***101,*** 2015]

3.3.40 Occupancy Classification. The system of defining the predominant operating characteristic of a portion of a building or plant for purposes of applying relevant sections of this code.

3.3.40.1 ***Outdoor Occupancy Classification.*** The system of defining the predominant operating characteristic of an outdoor operation that is not enclosed in a building or shelter for purposes of applying relevant sections of this code.

3.3.41* Operating Unit (Vessel) or Process Unit (Vessel). The equipment in which a unit operation or unit process is conducted. *(See also 3.3.53, Unit Operation or Unit Process.)*

3.3.42 Operations. A general term that includes, but is not limited to, the use, transfer, storage, and processing of liquids.

3.3.43* Pier. A structure, usually of greater length than width and projecting from the shore into a body of water with direct access from land, that can be either open deck or provided with a superstructure. [**307,** 2011]

3.3.44 Pressure Vessel. A container or other component designed in accordance with the ASME *Boiler and Pressure Vessel Code* or CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code.* [**52,** 2013]

3.3.45* Process or Processing. An integrated sequence of operations.

3.3.46 Protection for Exposures. Fire protection for structures on property adjacent to liquid storage that is provided by (1) a public fire department or (2) a private fire brigade maintained on the property adjacent to the liquid storage, either of which is capable of providing cooling water streams to protect the property adjacent to the liquid storage.

3.3.47 Refinery. A plant in which flammable or combustible liquids are produced on a commercial scale from crude petroleum, natural gasoline, or other hydrocarbon sources.

3.3.48* Safety Can. A listed container of not more than 5.3 gal (20 L) capacity having a screen or strainer in each fill and pour opening and having a spring-closing lid and spout cover designed to safely relieve internal pressure when exposed to fire.

3.3.49 Solvent Distillation Unit. An appliance that distills a flammable or combustible liquid to remove contaminants and recover the liquid.

3.3.50 Staging. Temporary storage in a process area of liquids in containers, intermediate bulk containers, and portable tanks.

3.3.51 Tank.

3.3.51.1 ***Aboveground Tank.*** A storage tank that is installed above grade, at grade, or below grade without backfill.

3.3.51.2* ***Atmospheric Tank.*** A storage tank that has been designed to operate at pressures from atmospheric through a gauge pressure of 1.0 psi (6.9 kPa) (i.e., 760 mm Hg through 812 mm Hg) measured at the top of the tank.

3.3.51.3 ***Low-Pressure Tank.*** For the purposes of this code, a storage tank designed to withstand an internal pressure above a gauge pressure of 1.0 psi (6.9 kPa) but not more than a gauge pressure of 15 psi (103 kPa) measured at the top of the tank.

3.3.51.4 ***Portable Tank.*** Any vessel having a liquid capacity over 60 gal (230 L) intended for storing liquids and not intended for fixed installation.

3.3.51.4.1* ***Nonmetallic Portable Tank.*** A portable tank, as herein defined, constructed of plastic, fiber, or a material other than metal.

3.3.51.5 ***Secondary Containment Tank.*** A tank that has an inner and outer wall with an interstitial space (annulus) between the walls and that has a means for monitoring the interstitial space for a leak.

3.3.51.6 ***Storage Tank.*** Any vessel having a liquid capacity that exceeds 60 gal (230 L), is intended for fixed installation, and is not used for processing.

3.3.52 Terminal. That portion of a property where liquids are received by tank vessel, pipelines, tank car, or tank vehicle and are stored or blended in bulk for the purpose of distributing such liquids by tank vessel, pipeline, tank car, tank vehicle, portable tank, or container.

3.3.53 Unit Operation or Unit Process. A segment of a physical or chemical process that might or might not be integrated with other segments to constitute the manufacturing sequence.

3.3.54 Vapor Pressure. The pressure, measured in pounds per square inch, absolute (psia), exerted by a liquid, as determined by ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method).*

3.3.55 Vapor Processing Equipment. Those components of a vapor processing system designed to process vapors or liquids captured during transfer or filling operations.

3.3.56* Vapor Processing System. A system designed to capture and process vapors displaced during transfer or filling operations by use of mechanical or chemical means.

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3.3.57* Vapor Recovery System. A system designed to capture and retain, without processing, vapors displaced during transfer or filling operations.

3.3.58 Vaportight. The ability of an enclosure or device to prevent the unintended release of flammable vapor at normal operating temperature and pressure ranges.

3.3.59 Vault. An enclosure consisting of four walls, a floor, and a top for the purpose of containing a liquid storage tank and not intended to be occupied by personnel other than for inspection, repair, or maintenance of the vault, the storage tank, or related equipment.

3.3.60 Vent.

3.3.60.1 ***Emergency Relief Vent.*** An opening, construction method, or device that will automatically relieve excessive internal pressure due to an exposure fire.

3.3.60.2 ***Normal Vent.*** An opening, construction method, or device that allows the relief of excessive internal pressure or vacuum during normal storage and operations.

3.3.61* Ventilation. For the purpose of this code, movement of air that is provided for the prevention of fire and explosion.

3.3.62* Warehouse.

3.3.62.1 ***General-Purpose Warehouse.*** A separate, detached building or portion of a building used only for warehousing-type operations and classified as a "storage — low hazard" or "storage — ordinary hazard" occupancy by the building code and by NFPA *101*, *Life Safety Code*.

3.3.62.2 ***Liquid Warehouse.*** A separate, detached building or an attached building that is used for warehousing-type operations for liquids and whose exterior wall comprises at least 25 percent of the building perimeter.

3.3.63* Wharf. A structure at the shoreline that has a platform built along and parallel to a body of water with either an open deck or a superstructure. [**307,** 2011]

Chapter 4 Definition and Classification of Liquids

4.1 Scope.

4.1.1 This chapter shall establish a uniform system of defining and classifying flammable and combustible liquids for the purpose of proper application of this code.

4.1.2 The definitions and classifications of this chapter shall apply to any liquid within the scope of and subject to the requirements of this code.

4.2 Definitions Specific to Chapter 4. For the purposes of this chapter and this code, the terms in this section shall have the definitions given.

4.2.1* Boiling Point. The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure.

4.2.1.1 For purposes of defining the boiling point, atmospheric pressure shall be considered to be an absolute pressure of 14.7 psi (101.4 kPa).

4.2.1.2 For mixtures that do not have a constant boiling point, the 20 percent evaporated point of a distillation performed in accordance with ASTM D 86, *Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure*, shall be considered to be the boiling point.

4.2.2 Combustible Liquid. Any liquid that has a closed-cup flash point at or above 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4. Combustible liquids are classified according to Section 4.3.

4.2.3 Flammable Liquid. Any liquid that has a closed-cup flash point below 100°F (37.8°C), as determined by the test procedures and apparatus set forth in Section 4.4 and a Reid vapor pressure that does not exceed an absolute pressure of 40 psi (276 kPa) at 100°F (37.8°C), as determined by ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*. Flammable liquids are classified according to Section 4.3. *(See A.3.3.33.2.)*

4.2.4* Flash Point. The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitible mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in Section 4.4.

4.2.5 Liquid. Any material that (1) has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D 5, *Standard Test Method for Penetration of Bituminous Materials,* or (2) is a viscous substance for which a specific melting point cannot be determined but that is determined to be a liquid in accordance with ASTM D 4359, *Standard Test for Determining Whether a Material is a Liquid or a Solid.*

4.2.6* Vapor Pressure. The pressure, measured in pounds per square inch, absolute (psia), exerted by a liquid, as determined by ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method).*

4.3* Classification of Liquids. Any liquid within the scope of this code and subject to the requirements of this code shall be classified in accordance with this section.

4.3.1 Flammable liquids, as defined in 3.3.33.2 and 4.2.3, shall be classified as Class I liquids and shall be further subclassified in accordance with the following:

(1) Class IA Liquid — Any liquid that has a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C)
(2) Class IB Liquid — Any liquid that has a flash point below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C)
(3) Class IC Liquid — Any liquid that has a flash point at or above 73°F (22.8°C), but below 100°F (37.8°C)

4.3.2 Combustible liquids, as defined in 3.3.33.1 and 4.2.2, shall be classified in accordance with the following:

(1) Class II Liquid — Any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C)
(2) Class III Liquid — Any liquid that has a flash point at or above 140°F (60°C)
    (a) Class IIIA Liquid — Any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C)
    (b) Class IIIB Liquid — Any liquid that has a flash point at or above 200°F (93°C)

4.4 Determination of Flash Point. The flash point of a liquid shall be determined according to the methods specified in 4.4.1 through 4.4.4.

4.4.1 Except as specified in 4.4.1.1, the flash point of a liquid having a viscosity below 5.5 centiStokes at 104°F (40°C) or

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below 9.5 centiStokes at 77°F (25°C) shall be determined in accordance with ASTM D 56, *Standard Test Method for Flash Point by Tag Closed Cup Tester*.

4.4.1.1 Cut-back asphalts, liquids that tend to form a surface film, and liquids that contain suspended solids shall not be tested in accordance with ASTM D 56, even if they otherwise meet the viscosity criteria. Such liquids shall be tested in accordance with 4.4.2.

4.4.2 The flash point of a liquid having a viscosity of 5.5 centiStokes or more at 104°F (40°C) or 9.5 centiStokes or more at 77°F (25°C) or a flash point of 200°F (93.4°C) or higher shall be determined in accordance with ASTM D 93, *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*.

4.4.3 As an alternative, ASTM D 3278, *Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus*, shall be permitted to be used for paints, enamels, lacquers, varnishes, and related products and their components that have flash points between 32°F (0°C) and 230°F (110°C) and viscosities below 150 Stokes at 77°F (25°C).

4.4.4 As an alternative, ASTM D 3828, *Standard Test Methods for Flash Point by Small Scale Closed Cup Tester*, shall be permitted to be used for materials other than those for which ASTM D 3278 is specifically required.

4.5 Relationship to Other Classification Systems. (Reserved)

Chapter 5 Reserved

Chapter 6 Fire and Explosion Prevention and Risk Control

6.1* Scope. This chapter shall apply to the hazards associated with storage, processing, handling, and use of liquids. This chapter shall also apply when specifically referenced by another chapter.

6.2 Definitions Specific to Chapter 6. (Reserved)

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 Hazards Analysis.

6.4.1 General. Operations involving flammable and combustible liquids shall be reviewed to ensure that fire and explosion hazards are addressed by fire prevention, fire control, and emergency action plans.

Exception No. 1: Operations where liquids are used solely for on-site consumption as fuels.

Exception No. 2: Operations where Class II or Class III liquids are stored in atmospheric tanks or transferred at temperatures below their flash points.

Exception No. 3: Mercantile occupancies, crude petroleum exploration, drillings, and well servicing operations, and normally unoccupied facilities in remote locations.

6.4.1.1* The extent of fire prevention and control that is provided shall be determined in consultation with the authority having jurisdiction or by means of an engineering evaluation of the operation and application of sound fire protection and process engineering principles. This evaluation shall include, but not be limited to, the following:

(1) Analysis of the fire and explosion hazards of the operation
(2) Analysis of emergency relief from process vessels, taking into consideration the properties of the materials used and the fire protection and control measures taken
(3) Analysis of applicable facility design requirements in Chapters 17, 18, 19, 28, and 29
(4) Analysis of applicable requirements for liquid handling, transfer, and use, as covered in Chapters 17, 18, 19, 28, and 29
(5) Analysis of local conditions, such as exposure to and from adjacent properties and exposure to floods, earthquakes, and windstorms
(6) Analysis of the emergency response capabilities of the local emergency services

6.4.1.2* Storage, processing, handling, and use of Class II and Class III liquids heated at or above their flash point shall follow the requirements for Class I liquids, unless an engineering evaluation conducted in accordance with Chapter 6 justifies following the requirements for some other liquid class.

6.4.2 Management of Change. The hazards analysis shall be repeated whenever the hazards leading to a fire or explosion change significantly. Conditions that might require repeating a review shall include, but are not limited to, the following:

(1) When changes occur in the materials in process
(2) When changes occur in process equipment
(3) When changes occur in process control
(4) When changes occur in operating procedures or assignments

6.5 Control of Ignition Sources.

6.5.1 General. Precautions shall be taken to prevent the ignition of flammable vapors by sources such as the following:

(1) Open flames
(2) Lightning
(3) Hot surfaces
(4) Radiant heat
(5) Smoking
(6) Cutting and welding
(7) Spontaneous ignition
(8)*Frictional heat or sparks
(9) Static electricity
(10) Electrical sparks
(11) Stray currents
(12) Ovens, furnaces, and heating equipment

6.5.2 Smoking. Smoking shall be permitted only in designated and identified areas.

6.5.3* Hot Work.

6.5.3.1 Welding, cutting, and similar spark-producing operations shall not be permitted in areas containing flammable liquids until a written permit authorizing such work has been issued.

6.5.3.2 The permit shall be issued by a person in authority following inspection of the area to ensure that permit require-

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ments have been implemented and will be followed until the job is completed.

6.5.4* Static Electricity.

6.5.4.1 All equipment such as tanks, machinery, and piping shall be designed and operated to prevent electrostatic ignitions.

6.5.4.2 All metallic equipment such as tanks, machinery, and piping where the potential exists for an ignitible mixture to be present shall be bonded and grounded.

6.5.4.3 The bond and ground shall be physically applied or shall be inherently present by the nature of the installation.

6.5.4.4 Any electrically isolated section of metallic piping or equipment shall be bonded and grounded to prevent hazardous accumulation of static electricity.

6.5.4.5 All nonmetallic equipment and piping where the potential exists for an ignitible mixture to be present shall be designed and operated to prevent electrostatic ignition.

6.5.5 Electrical Systems. Design, selection, and installation of electrical wiring and electrical utilization equipment shall meet the requirements of Chapter 7.

6.6 Detection and Alarm Systems and Procedures.

6.6.1* An approved means for prompt notification of fire or emergency to those within the plant and to the available public or mutual aid fire department shall be provided.

6.6.2 Those areas, including buildings, where a potential exists for a flammable liquid spill shall be monitored as appropriate. The following methods shall be permitted to be used:

(1) Personnel observation or patrol
(2) Process-monitoring equipment that would indicate a spill or leak could have occurred
(3) Provision of gas detectors to continuously monitor the area where facilities are unattended

6.7 Fire Protection and Fire Suppression Systems.

6.7.1* This section identifies recognized fire protection and fire suppression systems and methods used to prevent or minimize the loss from fire or explosion in liquid-processing facilities. The application of one or a combination of these systems and methods as well as the use of fire-resistive materials shall be determined in accordance with Sections 6.3 and 6.4.

6.7.2 A reliable water supply or other suitable fire control agent shall be available in pressure and quantity to meet the fire demands indicated by the specific hazards of liquids-processing operations, storage, or exposure.

6.7.3* Permanent connections between the fire water system and any process system shall be prohibited, to prevent contamination of fire water with process fluids.

6.7.4 Where required by this chapter, hydrants, with or without fixed monitor nozzles, shall be provided in accordance with NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*. The number and placement shall depend on the hazards of the facility.

6.7.5 Where the need is indicated by the hazards of liquid processing, storage, or exposure as determined by Section 6.4, fixed protection shall be provided.

6.7.6 Where provided, fire control systems shall be designed, installed, and maintained in accordance with the following NFPA standards, as applicable:

(1) NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
(2) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
(3) NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
(4) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(5) NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
(6) NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
(7) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
(8) NFPA 750, *Standard on Water Mist Fire Protection Systems*
(9) NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

6.7.7 Where required by this chapter, standpipe and hose systems shall be installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, or hose connections from sprinkler systems using combination spray and straight stream nozzles, shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

6.7.8* Where required by this chapter, listed portable fire extinguishers shall be provided in such quantities, sizes, and types as are needed for the specific hazards of operation and storage.

6.7.9 Where provided, mobile foam apparatus and supplies of foam concentrate shall be appropriate to the specific hazards.

6.8 Emergency Planning and Training.

6.8.1 A written emergency action plan that is consistent with available equipment and personnel shall be established to respond to fires and related emergencies. This plan shall include the following:

(1) Procedures to be followed in case of fire or release of liquids or vapors, such as sounding the alarm, notifying the fire department, evacuating personnel, and controlling and extinguishing the fire
(2) Procedures and schedules for conducting drills of these procedures
(3) Appointment and training of personnel to carry out assigned duties, including review at the time of initial assignment, as responsibilities or response actions change, and whenever anticipated duties change
(4) Procedures for maintenance and operation of (a) fire protection equipment and systems, (b) drainage and containment systems, and (c) dispersion and ventilation equipment and systems
(5) Procedures for shutting down or isolating equipment to reduce, mitigate, or stop the release of liquid or vapors, including assigning personnel responsible for maintaining critical plant functions or shutdown of plant processes and safe start-up following isolation or shutdown
(6) Alternate measures for the safety of occupants

6.8.2 Personnel responsible for the use and operation of fire protection equipment shall be trained in the use of that equipment. Refresher training shall be conducted at least annually.

6.8.3 Planning of effective fire control measures shall be coordinated with local emergency response agencies.

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6.8.4 Procedures shall be established to provide for safe shutdown of operations under emergency conditions and for safe start-up following cessation of emergencies. Provisions shall be made for training of personnel in shutdown and start-up procedures, and in activation, use, and deactivation of associated alarms, interlocks, and controls. Procedures shall also be established and provisions shall also be made for inspection and testing of associated alarms, interlocks, and controls.

6.8.5 The emergency procedures shall be kept readily available in the operating areas and shall be updated when conditions change, as identified in 6.4.2.

6.8.5.1 Where premises are likely to be unattended for considerable periods of time, a summary of the emergency plan shall be posted or located in a strategic and accessible location.

6.9 Inspection and Maintenance.

6.9.1 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 recommendations. Water-based fire protection systems shall be inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

6.9.2 Maintenance and operating practices shall be established and implemented to control leakage and prevent spillage of flammable and combustible liquids.

6.9.3 Combustible waste material and residues in operating areas shall be kept to a minimum, stored in covered metal containers, and disposed of daily.

6.9.4 Ground areas around facilities where liquids are stored, handled, or used shall be kept free of weeds, trash, or other unnecessary combustible materials.

6.9.5 Aisles established for movement of personnel shall be kept clear of obstructions to permit orderly evacuation and ready access for manual fire-fighting activities.

6.10 Management of Security.

6.10.1 Scope.

6.10.1.1 This section shall apply to the management methodology used to identify, evaluate, and control the security hazards involved in the processing and handling of flammable and combustible liquids.

6.10.1.2 These hazards include, but are not limited to, vulnerability to terrorist or other malicious attacks.

6.10.2 General. The methodology used shall incorporate a risk-based approach to site security and shall have the following objectives:

(1) Identification and evaluation of security risks
(2) Evaluation of the security performance of the facility
(3) Evaluation of protection for employees, the facility itself, the surrounding communities, and the environment. *(See Annex G for more detailed information.)*

6.10.3 Specific Requirements.

6.10.3.1 Operations involving flammable and combustible liquids shall be reviewed to ensure that security vulnerabilities identified during the security vulnerability analysis (SVA) are addressed in a facility security program, with corresponding fire prevention and emergency action plans and drills.

6.10.3.2 The balance of physical, electronic, and personnel techniques used to respond to the SVA shall be determined by means of an engineering evaluation of the operation and application of sound security principles. This evaluation shall include, but not be limited to, the following:

(1) Assessing overall facility
(2) Evaluating vulnerabilities
(3) Assessing threats/consequences
(4) Assessing physical factors/attractiveness
(5) Identifying mitigation factors
(6) Conducting security assessment or gap analysis

6.10.3.3 A written emergency action plan that is consistent with available equipment and personnel shall be established to respond to fires, security, and related emergencies. This plan shall include the following:

(1) Procedures to be followed such as initiating alarms, notifying appropriate agencies, evacuating personnel, and controlling and extinguishing the fire
(2) Procedures and schedules for conducting drills of these procedures
(3) Appointment and training of personnel to carry out assigned duties
(4) Maintenance of fire protection and response equipment
(5) Procedures for shutting down or isolating equipment to reduce the release of liquid
(6) Alternate measures for the safety of occupants

6.10.3.4 Specific duties of personnel shall be reviewed at the time of initial assignment, as responsibilities or response actions change, and whenever anticipated duties change.

6.10.3.5 The security management review conducted in accordance with this section shall be repeated under the following conditions:

(1) For an initial review of all new relevant facilities and assets
(2) When substantial changes to the threat or process occur
(3) After a significant security incident
(4) For periodic revalidation of the SVA

Chapter 7 Electrical Systems

7.1 Scope. This chapter shall apply to areas where Class I liquids are stored or handled and to areas where Class II or Class III liquids are stored or handled at or above their flash points.

7.2 Definitions Specific to Chapter 7. (Reserved)

7.3 General Requirements.

7.3.1 Electrical utilization equipment and wiring shall not constitute a source of ignition for any ignitible vapor that might be present under normal operation or because of a spill. Compliance with 7.3.2 through 7.3.7.1 shall be deemed as meeting the requirements of this section.

7.3.2 All electrical utilization equipment and wiring shall be of a type specified by and installed in accordance with *NFPA 70, National Electrical Code.*

7.3.3* Table 7.3.3 shall be used to delineate and classify areas for the purpose of installation of electrical utilization equipment and wiring under normal operating conditions.

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Table 7.3.3 Electrical Area Classifications

Location	*NEC* Class I Division	*NEC* Class I Zone	Extent of Classified Area
Indoor equipment installed in accordance with Section 7.3 where flammable vapor–air mixtures can exist under normal operation	1	0	The entire area associated with such equipment where flammable gases or vapors are present continuously or for long periods of time
	1	1	Area within 5 ft of any edge of such equipment, extending in all directions
	2	2	Area between 5 ft and 8 ft of any edge of such equipment, extending in all directions; also, space up to 3 ft above floor or grade level within 5 ft to 25 ft horizontally from any edge of such equipment[1]
Outdoor equipment of the type covered in Section 7.3 where flammable vapor–air mixtures can exist under normal operation	1	0	The entire area associated with such equipment where flammable gases or vapors are present continuously or for long periods of time
	1	1	Area within 3 ft of any edge of such equipment, extending in all directions
	2	2	Area between 3 ft and 8 ft of any edge of such equipment, extending in all directions; also, space up to 3 ft above floor or grade level within 3 ft to 10 ft horizontally from any edge of such equipment
Tank storage installations inside buildings	1	1	All equipment located below grade level
	2	2	Any equipment located at or above grade level
Tank — aboveground, fixed roof	1	0	Inside fixed-roof tank
	1	1	Area inside dike where dike height is greater than the distance from the tank to the dike for more than 50 percent of the tank circumference
	2	2	Within 10 ft from shell, ends, or roof of tank; also, area inside dike up to top of dike wall
	1	0	Area inside of vent piping or vent opening
	1	1	Within 5 ft of open end of vent, extending in all directions
	2	2	Area between 5 ft and 10 ft from open end of vent, extending in all directions
Tank — aboveground, floating roof			
With fixed outer roof	1	0	Area between the floating and fixed-roof sections and within the shell
With no fixed outer roof	1	1	Area above the floating roof and within the shell
Tank vault — interior	1	1	Entire interior volume, if Class I liquids are stored within
Underground tank fill opening	1	1	Any pit, box, or space below grade level, if any part is within a Division 1 or 2 or Zone 1 or 2 classified location
	2	2	Up to 18 in. above grade level within a horizontal radius of 10 ft from a loose fill connection and within a horizontal radius of 5 ft from a tight fill connection
Vent — discharging upward	1	0	Area inside of vent piping or opening
	1	1	Within 3 ft of open end of vent, extending in all directions
	2	2	Area between 3 ft and 5 ft of open end of vent, extending in all directions
Drum and container filling — outdoors or indoors	1	0	Area inside the drum or container
	1	1	Within 3 ft of vent and fill openings, extending in all directions
	2	2	Area between 3 ft and 5 ft from vent or fill opening, extending in all directions; also, up to 18 in. above floor or grade level within a horizontal radius of 10 ft from vent or fill opening
Pumps, bleeders, withdrawal fittings			
Indoor	2	2	Within 5 ft of any edge of such devices, extending in all directions; also, up to 3 ft above floor or grade level within 25 ft horizontally from any edge of such devices
Outdoor	2	2	Within 3 ft of any edge of such devices, extending in all directions; also, up to 18 in. above grade level within 10 ft horizontally from any edge of such devices

(continues)

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Table 7.3.3 *Continued*

Location	*NEC* Class I Division	*NEC* Class I Zone	Extent of Classified Area
Pits and sumps			
Without mechanical ventilation	1	1	Entire area within a pit or sump if any part is within a Division 1 or 2 or Zone 1 or 2 classified location
With adequate mechanical ventilation	2	2	Entire area within a pit or sump if any part is within a Division 1 or 2 or Zone 1 or 2 classified location
Containing valves, fittings, or piping, and not within a Division 1 or 2 or Zone 1 or 2 classified location	2	2	Entire pit or sump
Drainage ditches, separators, impounding basins			
Outdoor	2	2	Area up to 18 in. above ditch, separator, or basin; also, area up to 18 in. above grade within 15 ft horizontally from any edge
Indoor			Same as pits and sumps
Tank vehicle and tank car[2]			
Loading through open dome	1	0	Area inside of the tank
	1	1	Within 3 ft of edge of dome, extending in all directions
	2	2	Area between 3 ft and 15 ft from edge of dome, extending in all directions
Loading through bottom connections with atmospheric venting	1	0	Area inside of the tank
	1	1	Within 3 ft of point of venting to atmosphere, extending in all directions
	2	2	Area between 3 ft and 15 ft from point of venting to atmosphere, extending in all directions; also, up to 18 in. above grade within a horizontal radius of 10 ft from point of loading connection
Loading through closed dome with atmospheric venting	1	1	Within 3 ft of open end of vent, extending in all directions
	2	2	Area between 3 ft and 15 ft from open end of vent, extending in all directions; also, within 3 ft of edge of dome, extending in all directions
Loading through closed dome with vapor control	2	2	Within 3 ft of point of connection of both fill and vapor lines, extending in all directions
Bottom loading with vapor control or any bottom unloading	2	2	Within 3 ft of point of connections, extending in all directions; also, up to 18 in. above grade within a horizontal radius of 10 ft from point of connections
Storage and repair garage for tank vehicles	1	1	All pits or spaces below floor level
	2	2	Area up to 18 in. above floor or grade level for entire storage or repair garage
Garages for other than tank vehicles	Ordinary		If there is any opening to these rooms within the extent of an outdoor classified location, the entire room shall be classified the same as the area classification at the point of the opening
Outdoor drum storage	Ordinary		
Inside rooms or storage lockers used for the storage of Class I liquids	2	2	Entire room or locker
Indoor warehousing where there is no flammable liquid transfer	Ordinary		If there is any opening to these rooms within the extent of an indoor classified location, the classified location shall extend through the opening to the same extent as if the wall, curb, or partition did not exist
Office and rest rooms	Ordinary		If there is any opening to these rooms within the extent of an indoor classified location, the room shall be classified the same as if the wall, curb, or partition did not exist
Piers and wharves			See Figure 29.3.22.

For SI units, 1 in. = 25 mm; 1 ft = 0.3 m.

[1]The release of Class I liquids can generate vapors to the extent that the entire building, and possibly an area surrounding it, should be considered a Class I, Division 2, or Zone 2 location.

[2]When classifying extent of area, consideration should be given to the fact that tank cars or tank vehicles can be spotted at varying points. Therefore, the extremities of the loading or unloading positions should be used.

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7.3.4 A classified area shall not extend beyond a floor, wall, roof, or other solid partition that has no openings within the classified area.

7.3.5 The designation of classes, divisions, and zones shall be as defined in Chapter 5 of *NFPA 70, National Electrical Code*.

7.3.6 The area classifications listed in Table 7.3.3 are based on the premise that all applicable requirements of this code have been met; if this is not the case, the authority having jurisdiction shall have the authority to classify the extent of the area.

7.3.7* Where the provisions of 7.3.1 through 7.3.6 require the installation of electrical equipment suitable for Class I, Division 1 or 2, or Zone 1 or 2 locations, ordinary electrical equipment, including switchgear, shall be permitted to be used if installed in a room or enclosure that is maintained under positive pressure with respect to the classified area.

7.3.7.1 Ventilation make-up air shall be taken from an uncontaminated source.

7.4 Application of Area Classification.

7.4.1 Area classification is used to assure that fixed electrical utilization equipment, electrical fixtures, and wiring are properly installed within Class I, Division 1; Class I, Zone 1; Class I, Division 2; or Class I, Zone 2 designated areas, as defined by Article 500 of *NFPA 70®*, *National Electrical Code®*.

Chapter 8 Reserved

Chapter 9 Storage of Liquids in Containers — General Requirements

9.1 Scope.

9.1.1 This chapter shall apply to the storage of flammable and combustible liquids in:

(1) Drums or other containers that do not exceed 119 gal (450 L) individual capacity
(2) Portable tanks that do not exceed 660 gal (2500 L) individual capacity
(3) Intermediate bulk containers that do not exceed 793 gal (3000 L)

9.1.2 This chapter shall also apply to limited transfer of liquids incidental thereto.

9.1.3 This chapter shall also apply to overpack drums when used for temporary containment of containers that do not exceed 60 gal (230 L) capacity. Such overpack containers shall be treated as containers as defined in 3.3.12.

9.1.4 This chapter shall not apply to the following:

(1) Containers, intermediate bulk containers, and portable tanks that are used in operations areas, as covered by Chapter 17
(2) Liquids in the fuel tanks of motor vehicles, aircraft, boats, or portable or stationary engines
(3) Beverages where packaged in individual containers that do not exceed 1.3 gal (5 L) capacity
(4) Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50 percent by volume of water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn and where packaged in individual containers that do not exceed 1.3 gal (5 L) capacity
(5) Liquids that have no fire point when tested in accordance with ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*, up to the boiling point of the liquid or up to a temperature at which the liquid shows an obvious physical change
(6) Liquids with a flash point greater than 95°F (35°C) in a water-miscible solution or water-miscible dispersion with a water and noncombustible solids content of more than 80 percent by weight, and which does not sustain combustion when tested in accordance with "Method of Testing for Sustained Combustibility," in accordance with 49 CFR 173, Appendix H, or the UN publication, *Recommendations on the Transport of Dangerous Goods*
(7) Distilled spirits and wines in wooden barrels or casks

9.2 Definitions Specific to Chapter 9. (Reserved)

9.3 General Requirements.

9.3.1 The general requirements of this chapter shall be applicable to the storage of liquids in liquid storage areas as covered in Chapters 10 through 14, regardless of the quantities being stored.

Exception: Where more stringent requirements are set forth in Chapters 10 through 14, those requirements shall take precedence.

9.3.2 For the purposes of Chapters 9 through 16, unstable liquids shall be treated as Class IA liquids.

9.3.3 Means of egress shall meet applicable requirements of NFPA *101, Life Safety Code*.

9.3.3.1 Storage of liquids shall not physically obstruct a means of egress.

9.3.4 For the purposes of this chapter and Chapters 10, 12, and 16, *protected storage* shall mean storage installed after January 1, 1997 that is protected in accordance with Chapter 16. All other storage shall be considered to be unprotected storage unless an alternative means of protection has been approved by the authority having jurisdiction. *(See 16.3.5 and Section 16.9.)*

9.3.5 Wood of at least 1 in. (25 mm) nominal thickness shall be permitted to be used for shelving, racks, dunnage, scuffboards, floor overlay, and similar installations.

9.3.6 Class I liquids shall not be permitted to be stored in basements as defined in 3.3.4.

9.3.7 Class II and Class IIIA liquids shall be permitted to be stored in basements as defined in 3.3.4, provided the basement is protected in accordance with Chapter 16.

9.3.8 Class IIIB liquids shall be permitted to be stored in basements as defined in 3.3.4.

9.3.9 Where containers, intermediate bulk containers, or portable tanks are stacked, they shall be stacked so that stability is maintained and excessive stress on container walls is prevented.

9.3.9.1 Portable tanks and intermediate bulk containers stored more than one high shall be designed to stack securely, without the use of dunnage.

9.3.9.2 Materials-handling equipment shall be capable of handling containers, portable tanks, and intermediate bulk containers that are stored at all storage levels.

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9.3.9.3* Power-operated industrial trucks used to move Class I liquids shall be selected, operated, and maintained in accordance with NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations.*

9.3.10 Containers, intermediate bulk containers, and portable tanks in unprotected liquid storage areas shall not be stored closer than 36 in. (915 mm) to the nearest beam, chord, girder, or other roof or ceiling member.

9.3.11 Liquids used for building maintenance, painting, or other similar infrequent maintenance purposes shall be permitted to be stored in closed containers outside of storage cabinets or inside liquid storage areas, if limited to an amount that does not exceed a 10-day supply at anticipated rates of use.

9.3.12 Storage, handling, and use of Class II and Class III liquids heated at or above their flash point shall follow the requirements for Class I liquids, unless an engineering evaluation conducted in accordance with Chapter 6 justifies following the requirements for some other liquid class. *(See 6.4.1.2 and A.6.4.1.2.)*

9.4 Acceptable Containers.

9.4.1* Only the following approved containers, intermediate bulk containers, and portable tanks shall be used for Class I, Class II, and Class IIIA liquids:

(1) Metal containers, metal intermediate bulk containers, and metal portable tanks meeting the requirements of and containing products authorized by the U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199, or by Part 6 of the UN *Recommendations on the Transport of Dangerous Goods*

(2) Plastic or metal consumer-use containers meeting the requirements of, and used within the scope of, one or more of the following specifications:
   (a) ASTM F 852, *Standard Specification for Portable Gasoline Containers for Consumer Use*
   (b) ASTM F 976, *Standard Specification for Portable Kerosene and Diesel Containers for Consumer Use*

(3) Nonmetallic or metallic commercial/industrial safety cans meeting the requirements of, and used within the scope of, one or more of the following specifications:
   (a) ANSI/UL 30, *Standard for Metal Safety Cans*
   (b) ANSI/UL 1313, *Standard for Nonmetallic Safety Cans for Petroleum Products*
   (c) FM Global *Approval Standard for Safety Containers and Filling, Supply, and Disposal Containers* — Class Number 6051 and 6052

(4) Plastic containers that meet requirements set by, and contain products authorized by, the following:
   (a) The U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199, or by Part 6 of the UN publication, *Recommendations on the Transport of Dangerous Goods*
   (b) Items 256 or 258 of the National Motor Freight Classification (NMFC) for liquids that are not classified as hazardous by the U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199, or by Part 6 of the UN publication *Recommendations on the Transport of Dangerous Goods*

(5) Fiber drums that meet the following:
   (a) Requirements of Items 294 and 296 of the *National Motor Freight Classification* (NMFC) or of Rule 51 of the Uniform Freight Classification (UFC), for Types 2A, 3A, 3B-H, 3B-L, or 4A
   (b) Requirements of, and containing liquid products authorized by, either the U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Chapter I, or by the U.S. Department of Transportation exemption

(6)*Rigid nonmetallic intermediate bulk containers that meet requirements set by, and contain products authorized by, the following:
   (a) The U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199, or by Part 6 of the UN publication, *Recommendations on the Transport of Dangerous Goods,* for Classes 31H1, 31H2, and 31HZ1
   (b) The *National Motor Freight Classification* (NMFC), or the International Safe Transit Association for liquids that are not classified as hazardous by the U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199, or by Part 6 of the UN publication *Recommendations on the Transport of Dangerous Goods*

(7) Glass containers up to the capacity limits stated in Table 9.4.3 and in accordance with U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199

9.4.1.1 For protected storage, rigid nonmetallic intermediate bulk containers, as described in 9.4.1(6), shall be subjected to a standard fire test that demonstrates acceptable inside storage fire performance and shall be listed and labeled.

9.4.1.2 Medicines, beverages, foodstuffs, cosmetics, and other common consumer products, where packaged according to commonly accepted practices for retail sales, shall be exempt from the requirements of 9.4.1 and 9.4.3.

9.4.2 Each portable tank or intermediate bulk container shall be provided with one or more devices installed in the top with sufficient emergency venting capacity to limit internal pressure under fire exposure conditions to a gauge pressure of 10 psi (70 kPa) or 30 percent of the bursting pressure of the portable tank, whichever is greater.

9.4.2.1 The total venting capacity shall be not less than that specified in 22.7.3.2 or 22.7.3.4.

9.4.2.2 At least one pressure-actuated vent having a minimum capacity of 6000 ft^3 (170 m^3) of free air per hour at an absolute pressure of 14.7 psi (101 kPa) and 60°F (15.6°C) shall be used. The vent shall be set to open at not less than a gauge pressure of 5 psi (35 kPa).

9.4.2.3 If fusible vents are used, they shall be actuated by elements that operate at a temperature not exceeding 300°F (150°C). Where plugging of a pressure-actuated vent can occur, such as when used for paints, drying oils, and similar materials, fusible plugs or venting devices that soften to failure at a maximum of 300°F (150°C) under fire exposure shall be permitted to be used for the entire emergency venting requirement.

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9.4.3 The maximum allowable size of a container, intermediate bulk container, or metal portable tank for Class I, Class II, and Class IIIA liquids shall not exceed that specified in Table 9.4.3.

Exception: As provided for in Section 9.1, 9.4.3.1, 9.4.3.2, and 9.4.3.3.

9.4.3.1 Class IB and Class IC water-miscible liquids shall be permitted to be stored in plastic containers up to 60 gal (230 L) in size, if stored and protected in accordance with Table 16.5.2.7.

9.4.3.2 Class IA and Class IB liquids shall be permitted to be stored in glass containers of not more than 1.3 gal (5 L) capacity if the required liquid purity (such as American Chemical Society analytical reagent grade or higher) would be affected by storage in metal containers or if the liquid can cause excessive corrosion of a metal container.

9.4.3.3 Leaking or damaged containers up to 60 gal (230 L) capacity shall be permitted to be stored temporarily in accordance with this chapter and Chapters 10 through 12, provided they are enclosed in overpack containers.

9.4.3.3.1 To be considered protected storage as defined in 9.3.4 and in accordance with Chapter 16, an overpack container shall be constructed of the same material as the leaking or damaged container.

9.4.3.3.2 Metal overpack containers shall be considered non-relieving style containers.

9.5* Flammable Liquids Storage Cabinets.

9.5.1 The volume of Class I, Class II, and Class IIIA liquids stored in an individual storage cabinet shall not exceed 120 gal (460 L).

9.5.2 The total aggregate volume of Class I, Class II, and Class IIIA liquids in a group of storage cabinets shall not exceed the maximum allowable quantity of flammable and combustible liquids per control area based on the occupancy where the cabinets are located.

9.5.3 Storage cabinets that meet at least one of the following sets of requirements shall be acceptable for storage of liquids:

(1) Storage cabinets designed and constructed to limit the internal temperature at the center of the cabinet and 1 in. (25 mm) from the top of the cabinet to not more than 325°F (163°C), when subjected to a 10-minute fire test that simulates the fire exposure of the standard time–temperature curve specified in ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, shall be acceptable. All joints and seams shall remain tight and the door shall remain securely closed during the test.

Table 9.4.3 Maximum Allowable Size — Containers, Intermediate Bulk Containers (IBCs), and Portable Tanks

	Flammable Liquids			Combustible Liquids	
Container Type	**Class IA**	**Class IB**	**Class IC**	**Class II**	**Class IIIA**
Glass	1 pt (0.5 L)	1 qt (1 L)	1.3 gal (5 L)	1.3 gal (5 L)	5.3 gal (20 L)
Metal (other than drums) or approved plastic	1.3 gal (5 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)
Safety cans	2.6 gal (10 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)	5.3 gal (20 L)
Metal drum (e.g., UN 1A1/1A2)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)	119 gal (450 L)
Approved metal portable tanks and IBCs	793 gal (3000 L)	793 gal (3000 L)	793 gal (3000 L)	793 gal (3000 L)	793 gal (3000 L)
Rigid plastic IBCs (UN 31H1 or 31H2) and composite IBCs with rigid inner receptacle (UN31HZ1)	NP	NP	NP	793 gal (3000 L)	793 gal (3000 L)
Composite IBCs with flexible inner receptacle (UN31HZ2) and DOT/UN-approved flexible IBCs	NP	NP	NP	NP	NP
Non-bulk Bag-in-Box	NP	NP	NP	NP	NP
Polyethylene UN1H1 and UN1H2, or as authorized by DOT exemption	1.3 gal (5 L)	5.3 gal (20 L)*	5.3 gal (20 L)*	119 gal (450 L)	119 gal (450 L)
Fiber drum NMFC or UFC Type 2A; Types 3A, 3B-H, or 3B-L; or Type 4A	NP	NP	NP	119 gal (450 L)	119 gal (450 L)

NP: Not permitted for the container categories so classified unless a fire protection system is provided that is developed in accordance with 16.3.6 and is approved for the specific container and protection against static electricity is provided.

*See 9.4.3.1.

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(2) Metal storage cabinets constructed in the following manner shall be acceptable:
   (a) The bottom, top, door, and sides of the cabinet shall be at least No. 18 gauge sheet steel and shall be double-walled, with 1½ in. (38 mm) air space.
   (b) Joints shall be riveted, welded, or made tight by some equally effective means.
   (c) The door shall be provided with a three-point latch arrangement, and the door sill shall be raised at least 2 in. (50 mm) above the bottom of the cabinet to retain spilled liquid within the cabinet.
(3) Wooden cabinets constructed in the following manner shall be acceptable:
   (a) The bottom, sides, and top shall be constructed of exterior grade plywood that is at least 1 in. (25 mm) thick and of a type that will not break down or delaminate under fire conditions.
   (b) All joints shall be rabbetted and shall be fastened in two directions with wood screws.
   (c) Where more than one door is used, there shall be a rabbetted overlap of not less than 1 in. (25 mm).
   (d) Doors shall be equipped with a means of latching, and hinges shall be constructed and mounted in such a manner as to not lose their holding capacity when subjected to fire exposure.
   (e) A raised sill or pan capable of containing a 2 in. (50 mm) depth of liquid shall be provided at the bottom of the cabinet to retain spilled liquid within the cabinet.
(4) Listed storage cabinets that have been constructed and tested in accordance with 9.5.3(1) shall be acceptable.

9.5.4* Storage cabinets shall not be required by this code to be ventilated for fire protection purposes.

9.5.4.1 If a storage cabinet is not ventilated, the vent openings shall be sealed with the bungs supplied with the cabinet or with bungs specified by the cabinet manufacturer.

9.5.4.2* If a storage cabinet is ventilated for any reason, the vent openings shall be ducted directly to a safe location outdoors or to a treatment device designed to control volatile organic compounds (VOCs) and ignitible vapors in such a manner that will not compromise the specified performance of the cabinet and in a manner that is acceptable to the authority having jurisdiction.

9.5.5* Storage cabinets shall include the following marking:

FLAMMABLE
KEEP FIRE AWAY

9.5.5.1 The minimum letter height for FLAMMABLE (signal word) shall be 2.0 in. (50 mm) and the minimum letter height for KEEP FIRE AWAY (message) shall be 1.0 in. (25 mm).

9.5.5.2 All letters shall be uppercase and in contrasting color to the background.

9.5.5.3 The marking shall be located on the upper portion of the cabinet's front door(s) or frame.

9.5.5.4 Use of other languages, the international symbol for "flammable" (a flame in a triangle), the international symbol for "keep fire away" (a burning match in "no" circle) shall be permitted.

9.6 Maximum Allowable Quantities (MAQs) per Control Area.

9.6.1 General Occupancy Limits. The maximum allowable quantities (MAQs) of liquids allowed in each control area shall not exceed the amounts specified in Table 9.6.1.

Exception: As modified by 9.6.2 and Chapters 10 through 14.

Table 9.6.1 MAQ of Flammable and Combustible Liquids per Control Area

	Liquid Class(es)	Quantity gal	Quantity L	Notes
Flammable liquids	IA	30	115	1, 2
	IB and IC	120	460	1, 2
	IA, IB, IC combined	120	460	1, 2, 3
Combustible liquids	II	120	460	1, 2
	IIIA	330	1,265	1, 2
	IIIB	13,200	50,600	1, 2, 4

Notes:
(1) Quantities are permitted to be increased 100 percent where stored in approved flammable liquids storage cabinets or in safety cans in accordance with the fire code. Where Note 2 also applies, the increase for both notes is permitted to be applied accumulatively.
(2) Quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*. Where Note 1 also applies, the increase for both notes is permitted to be applied accumulatively.
(3) Containing not more than the maximum allowable quantity per control area of Class IA, Class IB, or Class IC flammable liquids, individually.
(4) Quantities are not limited in a building equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and designed in accordance with the protection criteria contained in Chapter 16 of this code.

9.6.2 Special Occupancy Limits.

9.6.2.1 For the following occupancies, the MAQs per control area shall not exceed the amounts specified in Table 9.6.2.1:

(1) Assembly
(2) Ambulatory health care
(3) Business
(4) Day care
(5) Detention and correctional
(6) Educational
(7) Health care
(8) Residential

9.6.2.2 For the occupancies specified in 9.6.2.1, storage in excess of 10 gal (38 L) of Class I and Class II liquids combined or in excess of 60 gal (227 L) of Class IIIA liquids shall be permitted where stored in flammable liquids storage cabinets and where the total aggregate quantity does not exceed 180 gal (680 L).

9.6.2.3 Fuel in the tanks of operating mobile equipment shall be permitted to exceed the quantities specified in Table 9.6.1, where the equipment is operated in accordance with the fire code.

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Table 9.6.2.1 MAQs — Special Occupancy Limits

Liquid Class(es)	Quantity	
	gal	L
I and II	10	38
IIIA	60	227
IIIB	120	454

9.6.2.4 For ambulatory health care, day care, educational, and health care occupancies, the MAQ for Class IIIB liquids shall be permitted to be increased 100 percent if the building is protected throughout with an automatic sprinkler system installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

9.7 Control Areas.

9.7.1 For the purpose of this code, a control area shall be a space within a building where quantities of liquids that do not exceed the maximum quantities allowed by Table 9.6.1 or Table 9.6.2.1 are stored.

9.7.2 Control areas shall be separated from each other by fire barriers in accordance with Table 9.7.2. [**5000:**34.2.5.1.1]

Table 9.7.2 Design and Number of Control Areas

Floor Level	Maximum Allowable Quantity per Control Area (percent)*	Number of Control Areas per Floor	Fire Resistance Rating for Fire Barriers (hr)†
Above grade plane			
>9	5	1	2
7–9	5	2	2
4–6	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	NA	NA	NA

NA: Not allowed.

*Percentages represent the maximum allowable quantities per control area shown in Table 9.6.1, with all of the increases permitted in the footnotes of that table.

†Fire barriers are required to include floors and walls, as necessary, to provide a complete separation from other control areas.

[**400:** Table 5.2.2.1]

9.7.3 Control areas located below grade that are considered basements, as defined in 3.3.4, shall not be utilized for the storage of Class I liquids.

9.8 Classification of Occupancies That Exceed the Maximum Allowable Quantities of Liquids per Control Area.

9.8.1* Occupancy Classifications. Buildings and portions of buildings where liquids are stored shall be classified as Protection Level 2 or Protection Level 3, as established in this section, when the MAQs per control area are exceeded.

9.8.1.1 Protection Level 2. Buildings and portions thereof storing quantities of liquids that are considered as High-Hazard Level 2 liquids and that exceed the maximum allowable quantities per control area shall be classified as Protection Level 2 occupancies.

9.8.1.2 Protection Level 3. Buildings and portions thereof storing quantities of liquids that are considered as High-Hazard Level 3 liquids and that exceed the maximum allowable quantities per control area shall be classified as Protection Level 3 occupancies.

9.8.2* Requirements for Specific Occupancies. Liquids stored in Protection Level 2 or Protection Level 3 occupancies shall meet the applicable requirements for storage in a liquid storage room or liquid warehouse as defined in this code and in *NFPA 5000, Building Construction and Safety Code.*

9.9 Construction Requirements.

9.9.1 Storage areas shall be constructed to meet the fire resistance ratings specified in Table 9.9.1. Construction assemblies shall comply with the test specifications given in ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials.*

Table 9.9.1 Fire Resistance Ratings for Liquid Storage Areas

Type of Storage Area	Fire Resistance Rating (hr)		
	Interior Walls[a], Ceilings, Intermediate Floors	Roofs	Exterior Walls
Liquid storage room			
Floor area ≤ 150 ft^2	1	—	—
Floor area > 150 ft^2, but ≤ 500 ft^2	2	—	—
Liquid warehouse[b,c,g]	4[d]	—	2[e], 4[f]

For SI units, 1 ft^2 = 0.09 m^2.

[a]Between liquid storage areas and any adjacent areas not dedicated to liquid storage.

[b]Fire resistance ratings for liquid warehouses storing only Class IIIB liquids, which are not heated above their flash point, are permitted to be reduced to 2 hours.

[c]Fire resistance ratings for liquid warehouses protected in accordance with Chapter 16 are permitted to be reduced to 2 hours.

[d]This shall be a fire wall as defined in NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls.*

[e]For exposing walls that are located more than 10 ft (3 m) but less than 50 ft (15 m) from an important building or line of adjoining property that can be built upon.

[f]For exposing walls that are located 10 ft (3 m) or less from an important building or line of adjoining property that can be built upon.

[g]For accessory use areas in protected liquid warehouses, such as offices and restrooms, whose combined area is less than 10 percent of the area of the warehouse, no fire resistance rating shall be required for the interior walls and ceilings.

9.9.2 Openings in interior walls to adjacent rooms or buildings and openings in exterior walls with fire resistance ratings shall be provided with normally closed, listed fire doors with

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fire protection ratings that correspond to the fire resistance rating of the wall as specified in Table 9.9.2.

Table 9.9.2 Protection Ratings for Fire Doors

Fire Resistance Rating of Wall as Required by Table 9.9.1 (hr)	Fire Protection Rating of Door (hr)
1	¾
2	1½
4	3*

*One fire door required on each side of interior openings for attached liquid warehouses.

9.9.2.1 Such doors shall be permitted to be arranged to stay open during material-handling operations if the doors are designed to close automatically in a fire emergency by provision of listed closure devices.

9.9.2.2 Fire doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives.*

9.9.3 Exterior walls shall be constructed to provide ready access for fire-fighting operations by means of access openings, windows, or lightweight, noncombustible wall panels.

Exception: This requirement does not apply to liquid storage rooms totally enclosed within a building.

9.10 Fire Protection.

9.10.1 Protected Storage. Fire protection requirements for protected storage shall meet the requirements of 9.10.2 and Chapter 16.

9.10.2 Manual Fire Protection.

9.10.2.1 Portable fire extinguishers shall be provided in accordance with NFPA 10, *Standard for Portable Fire Extinguishers,* and this code.

9.10.2.2 Portable fire extinguishers shall meet the following requirements:

(1) At least one portable fire extinguisher having a capability of not less than 40:B shall be located outside of, but not more than 10 ft (3 m) from, the door opening into a liquid storage area.
(2) At least one portable fire extinguisher having a capability of not less than 40:B shall be located within 30 ft (9 m) of any Class I or Class II liquids located outside of a liquid storage area or at least one portable fire extinguisher having a capacity of 80:B located within 50 ft (15 m) of such a storage area.

9.10.2.3 Where provided, hose connections supplied from sprinkler systems shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

9.10.2.4 Where provided, hose connections supplied by a standpipe system shall be installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems.*

9.10.2.5 Where provided, hose connections shall also meet the following requirements:

(1) Hose connections shall be provided in protected general-purpose warehouses and in protected liquid warehouses.
(2) Where preconnected hose is provided, it shall be either 1½ in. (38 mm) lined fire hose or 1 in. (25 mm) hard rubber hose, using combination spray and straight stream nozzles.

9.10.2.6 Where hose connections are provided, the water supply shall be sufficient to meet the fixed fire protection demand plus a total of at least 500 gpm (1900 L/min) for inside and outside hose connections for at least 2 hours, unless otherwise specified in Chapter 16.

9.11 Emergency Control Systems. (Reserved)

9.12 Electrical Systems.

9.12.1 Electrical area classification shall not be required for liquid storage areas where all containers, intermediate bulk containers, and portable tanks are sealed and are not opened, except as provided for in 9.12.2.

9.12.2 For liquid storage rooms that are totally enclosed within the building, electrical wiring and utilization equipment for Class I liquid storage shall be Class I, Division 2 (Zone 2), and electrical wiring and utilization equipment in inside rooms used for the storage of Class II and Class III liquids shall be suitable for ordinary purpose.

Exception: Class I, Division 2 (Zone 2) requirements apply to Class II and Class III liquids when stored at temperatures above their flash points.

9.13* Containment, Drainage, and Spill Control.

9.13.1 Storage areas shall be designed and operated to prevent the discharge of liquids to public waterways, public sewers, or adjoining property, unless such discharge has been specifically approved.

9.13.1.1 Where the drainage system discharges to private or public sewers or waterways, the drainage system shall be equipped with traps and separators.

9.13.2 Where individual containers exceed 10 gal (38 L), curbs, scuppers, drains, or other suitable means shall be provided to prevent flow of liquids under emergency conditions into adjacent building areas.

9.13.3 Containment or drainage to an approved location shall be provided.

9.13.3.1 Where a drainage system is used, it shall also have sufficient capacity to carry the expected discharge of water from fire protection systems.

9.13.4 Where only Class IIIB liquids are stored, spill control, containment, and drainage shall not be required.

9.13.5 Where only unsaturated polyester resins (UPRs) containing not more than 50 percent by weight of Class IC, Class II, or Class IIIA liquid constituents are stored and are protected in accordance with 16.5.2.11, spill control, containment, and drainage shall not be required.

9.13.6 Where storage is protected in accordance with Chapter 16, spill control, containment, and drainage shall also meet the requirements of Section 16.8.

9.14 Ventilation. Liquid storage areas where dispensing is conducted shall be provided with ventilation that meets the requirements of Section 18.6.

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9.15 Exhausted Enclosures. (Reserved)

9.16 Explosion Control.

9.16.1* Where Class IA liquids are stored in containers larger than 1 gal (4 L), areas shall be provided with a means of explosion control that meets the requirements of NFPA 69, *Standard on Explosion Prevention Systems*. An approved engineered damage limiting construction design shall also be permitted.

Exception: This does not apply to a liquid storage room totally enclosed within a building.

9.16.2* Where unstable liquids are stored, an approved engineered construction method that is designed to limit damage from a deflagration or detonation, depending on the liquid stored, shall be used.

9.17 Separation from Incompatible Materials.

9.17.1 Except as provided for in 9.17.3, liquids shall be separated from incompatible materials where the stored materials are in containers having a capacity of more than 5 lb (2.268 kg) or ½ gal (1.89 L).

9.17.1.1 Separation shall be accomplished by one of the following methods:

(1) Segregating incompatible materials storage by a distance of not less than 20 ft (6.1 m)
(2) Isolating incompatible materials storage by a noncombustible partition extending not less than 18 in. (460 mm) above and to the sides of the stored materials
(3) Storing liquid materials in flammable liquids storage cabinets in accordance with Section 9.5

9.17.2 Liquids shall be separated from Level 2 and Level 3 aerosols in accordance with NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*.

9.17.3 Flammable and combustible liquids shall be separated from oxidizers by at least 25 ft (7.6 m).

9.17.4 Materials that are water-reactive, as described in NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, shall not be stored in the same control area with liquids.

9.18 Dispensing, Handling, and Use of Liquids in Storage Areas.

9.18.1 Dispensing, handling, and use of liquids shall meet all applicable requirements of Chapter 18.

9.18.2 Dispensing of Class I liquids or Class II and Class III liquids at temperatures at or above their flash points shall not be permitted in storage areas that exceed 1000 ft^2 (93 m^2) in floor area unless the dispensing area is separated from the storage areas in accordance with Table 9.9.1 and meets all other requirements of Section 9.9.

9.19 Outdoor Storage of Liquids. Storage of liquids outside of buildings shall meet the requirements of Chapter 14 or Chapter 15, whichever is applicable.

Chapter 10 Storage of Liquids in Containers — Mercantile Occupancies

10.1 Scope.

10.1.1 This chapter shall apply to mercantile occupancies that handle, store, and display liquids in containers that do not exceed 119 gal (450 L) individual capacity.

10.1.2 This chapter shall also apply to limited dispensing of liquids incidental to mercantile operations.

10.1.3 This chapter shall not apply to the following:

(1) Containers, intermediate bulk containers, and portable tanks that are used in operations, as covered by Chapter 17
(2) Liquids in the fuel tanks of motor vehicles, aircraft, boats, or portable or stationary engines
(3) Beverages where packaged in individual containers that do not exceed 1.3 gal (5 L) capacity
(4) Medicines, foodstuffs, cosmetics, and other consumer products that contain not more than 50 percent by volume of water-miscible flammable or combustible liquids, with the remainder of the product consisting of components that do not burn and where packaged in individual containers that do not exceed 1.3 gal (5 L) capacity
(5) Liquids that have no fire point when tested in accordance with ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*, up to the boiling point of the liquid or up to a temperature at which the liquid shows an obvious physical change
(6) Liquids with a flash point greater than 95°F (35°C) in a water-miscible solution or in dispersion with a water and noncombustible solids content of more than 80 percent by weight, and which do not sustain combustion when tested in accordance with "Method of Testing for Sustained Combustibility," Title 49 Code of Federal Regulations, Part 173, Appendix H, or the UN publication *Recommendations on the Transport of Dangerous Goods*
(7) Distilled spirits and wines in wooden barrels or casks

10.2 Definitions Specific to Chapter 10. (Reserved)

10.3 General Requirements.

10.3.1 For the purposes of this chapter, unstable liquids shall be treated as Class IA liquids.

10.3.2 Maximum allowable quantities of liquids for display and storage shall comply with Table 10.7.1, based on the level of protection provided.

10.3.3 The design, construction, and capacity of containers shall comply with the applicable provisions of Section 9.4.

10.3.4 Commonly accepted packagings for medicines, beverages, foodstuffs, cosmetics, and other common consumer products shall be exempt from the requirements of 9.4.1 and 9.4.3.

10.3.5 Where utilized within a mercantile occupancy, the design, construction, and capacity of storage cabinets shall comply with the applicable provisions of Section 9.5.

10.3.6* Where utilized within a mercantile occupancy, the design, construction, and operation of a separate liquid storage room or a hazardous material storage locker used as a separate inside liquid storage area shall comply with the applicable provisions of Chapter 9.

10.4 Reserved.

10.5 Reserved.

10.6 Reserved.

10.7 Control Areas.

10.7.1 The maximum allowable quantities of liquids in each control area and in display and storage arrangements shall meet the requirements of this subsection and shall be as set forth in Table 10.7.1.

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Table 10.7.1 MAQs for Storage and Display in Mercantile Occupancies

		Liquid Classification		
Level of Protection	**Storage Limits**	**IA[a]**	**IB, IC, II, and IIIA — Any Combination**	**IIIB**
Unprotected [b]	MAQ [c]	60 gal	3750 gal per control area; a maximum of two control areas permitted per occupancy when separation is provided by a minimum 1-hour-rated fire separation wall	15,000 gal
	Maximum storage density		2 gal/ft^2 in storage and display areas and adjacent aisles	
NFPA 13, ordinary hazard (group 2) sprinkler system [b]	MAQ [c]	120 gal	7500 gal per control area; a maximum of two control areas permitted per occupancy when separation is provided by a minimum 1-hour-rated fire separation wall	Unlimited
	Maximum storage density		4 gal/ft^2 in storage and display areas and adjacent aisles	
NFPA 30, Chapter 16	MAQ [c]	120 gal	30,000 gal per occupancy	Unlimited

For SI units, 1 gal = 3.8 L; 1 ft^2 = 0.09 m^2.
[a]Ground-level floor only.
[b]For storage heights that do not exceed 12 ft (3.6 m).
[c]Does not include liquids exempted by 10.1.3.

10.7.2 Existing unprotected mercantile occupancies in place prior to January 1, 1997, shall be permitted to store or display up to 7500 gal (28,400 L) of Class IB, IC, II, and IIIA liquids (any combination) in each control area.

10.8 Specific Restrictions.

10.8.1 On floors above the ground level, storage or display of Class I and Class II liquids shall be limited to 60 gal (230 L) in unprotected occupancies and 120 gal (454 L) in protected occupancies.

10.8.2 Class I and Class II liquids shall not be stored, displayed, or dispensed in basements.

10.8.3 Liquids in containers of greater than 6 gal (23 L) capacity shall not be stored or displayed in areas normally accessible to the public.

10.8.4 The total aggregate quantity of Class I and Class II liquids that are not water-miscible and are packaged in plastic containers of 1 gal (3.8 L) capacity or greater shall be limited as follows:

(1) A maximum total quantity of 30 gal (115 L) per display or storage array
(2) A maximum total quantity of 60 gal (230 L) per display or storage array that is protected by an automatic sprinkler system having a design density of 0.60 gpm/ft^2 (24 mm/min/m^2) over 2500 ft^2 (232 m^2) and using high-temperature, K11.2 or larger quick-response sprinklers
(3) A maximum total quantity of 60 gal (230 L) per display or storage array where stored in listed flammable liquids storage cabinets

10.8.4.1 Adjacent displays or storage arrays shall be separated by a minimum distance of 50 ft (15 m).

10.9 Construction Requirements.

10.9.1 Separation walls between control areas shall meet the requirements of Table 10.7.1.

10.9.2 Where utilized within a mercantile occupancy, the construction of a separate liquid storage room or a hazardous material storage locker used as a separate inside liquid storage room shall comply with the applicable provisions of Chapter 9. *(See A.10.3.6.)*

10.10 Fire Protection.

10.10.1 Where provided, automatic sprinkler systems shall be designed in accordance with Table 10.7.1.

10.10.2 Protection systems for storage and display of liquids that are designed and developed based on full-scale tests performed at an approved test facility shall be considered an acceptable alternative to the protection criteria set forth in Chapter 16. Such alternative protection systems shall be approved by the authority having jurisdiction.

10.10.3 Portable fire extinguishers shall be provided where liquids are stored.

10.10.4 Hoseline connections shall be provided where required by NFPA 13, *Standard for the Installation of Sprinkler Systems.*

10.11 Emergency Control Systems. (Reserved)

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10.12 Electrical Systems.

10.12.1 Electrical wiring and utilization equipment shall meet the requirements of Chapter 7.

10.12.2 Electrical area classification shall not be required for liquid storage areas where all containers, intermediate bulk containers, and portable tanks are sealed and are not opened, except as provided for in 9.12.2.

10.12.3 Electrical area classification shall not be required for dispensing of quantities that do not exceed 16 oz (0.5 L) including, but not limited to, tinting of paints and coatings.

10.13 Containment, Drainage, and Spill Control.

10.13.1 Where individual containers exceed 10 gal (38 L) and protection has been provided in accordance with Chapter 16, containment and drainage shall be provided, in accordance with Section 16.8. *(See also Section 9.13.)*

10.13.2 Where utilized within a mercantile occupancy, spill containment for separate liquid storage rooms and for hazardous material storage lockers used as separate liquid storage rooms shall meet applicable requirements of Section 9.13. *(See A.10.3.6.)*

10.14 Ventilation. Liquid storage areas where dispensing is conducted shall be provided with either a gravity ventilation system or a continuous mechanical exhaust ventilation system that meets the requirements of Section 18.6. Mechanical ventilation shall be used if Class I liquids are dispensed within the room.

10.15 Exhausted Enclosures. (Reserved)

10.16 Explosion Control. (Reserved)

10.17 Separation from Incompatible Materials. The provisions of Section 9.17 shall apply.

10.18 Dispensing, Handling, and Use of Liquids in Mercantile Occupancies. Dispensing, handling, and use of liquids shall meet applicable requirements of Chapter 18.

Exception: This requirement does not apply to dispensing of quantities that do not exceed 16 oz (0.5 L) including, but not limited to, tinting of paints and coatings.

10.19 Outdoor Storage of Liquids. Storage outside of buildings at mercantile occupancies shall meet the requirements of Chapter 14 or Chapter 15, whichever is applicable.

Chapter 11 Storage of Liquids in Containers — Industrial Occupancies

11.1 Scope. This chapter shall apply to the storage of flammable and combustible liquids in industrial occupancies in the following:

(1) Containers that do not exceed 119 gal (450 L) individual capacity
(2) Portable tanks that do not exceed 660 gal (2500 L) individual capacity
(3) Intermediate bulk containers that do not exceed 793 gal (3000 L)

11.2 Definitions Specific to Chapter 11. (Reserved)

11.3 General Requirements. The storage of liquids shall comply with either Chapter 9 or Section 18.5 of this code.

Chapter 12 Storage of Liquids in Containers — Storage Occupancies

12.1 Scope. This chapter shall apply to the storage of liquids in liquid storage rooms, liquid warehouses, and general purpose warehouses in the following:

(1) Drums or other containers that do not exceed 119 gal (450 L) individual capacity
(2) Portable tanks that do not exceed 660 gal (2500 L) individual capacity
(3) Intermediate bulk containers that do not exceed 793 gal (3000 L) individual capacity

12.2 Definitions Specific to Chapter 12. (Reserved)

12.3 General Requirements.

12.3.1 A general-purpose warehouse that stores liquids in quantities that exceed the maximum allowable quantities permitted in control areas by Table 9.6.1, but do not exceed the amounts permitted by Section 12.8 shall meet the requirements of Section 12.8.

12.3.2 A general-purpose warehouse that stores liquids in quantities that exceed the amounts permitted by Section 12.8 shall meet the requirements for a liquid storage room or liquid warehouse, whichever is applicable.

12.3.3 Facilities covered by this chapter shall meet the requirements of Section 9.3.

12.3.4 For the purposes of this chapter, protected storage shall mean storage installed after January 1, 1997, that is protected in accordance with Chapter 16. All other storage shall be considered unprotected storage unless an alternate means of protection has been approved by the authority having jurisdiction. *(See 16.3.5 and Section 16.9.)*

12.3.5 Protected and unprotected solid pile and palletized storage shall be provided with aisles that are arranged so that no container, portable tank, or intermediate bulk container is more than 20 ft (6 m) from an aisle.

12.3.6 Protected solid pile and palletized storage and protected storage on racks shall be provided with minimum 6 ft (1.8 m) aisles between adjacent piles or adjacent rack sections, unless otherwise specified in Chapter 16.

12.3.7 Unprotected solid pile and palletized storage shall be provided with minimum 4 ft (1.2 m) aisles between adjacent piles. Main aisles shall be a minimum of 8 ft (2.4 m) wide.

Exception: For Class IIIB liquids stored in containers at temperatures below their flash points, the distance between piles is permitted to be reduced from 4 ft (1.2 m) to 2 ft (0.6 m) in proportion to commensurate reductions in the maximum storage height and maximum quantity per pile as given in Table 12.6.2.2.

12.3.8 Unprotected rack storage shall be provided with minimum 4 ft (1.2 m) aisles between adjacent rack sections and adjacent storage of liquids. Main aisles shall be a minimum of 8 ft (2.4 m) wide.

12.3.9 Storage of empty or idle combustible pallets inside protected liquid storage areas shall comply with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

12.3.10 Storage of empty or idle combustible pallets inside unprotected liquid storage areas shall be limited to a maximum pile size of 2500 ft^2 (230 m^2) and to a maximum storage height of 6 ft (1.8 m).

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12.3.11 Storage of empty or idle combustible pallets shall be separated from storage of liquids by minimum 8 ft (2.4 m) aisles.

12.3.12 Limited quantities of combustible commodities, as defined in NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall be permitted to be stored in liquid storage areas if the ordinary combustibles, other than those used for packaging the liquids, are separated from the liquids in storage by a minimum of 8 ft (2.4 m) horizontally, either by aisles or by open racks, and if protection is provided in accordance with Chapter 16.

12.4 Reserved.

12.5 Reserved.

12.6 Maximum Allowable Quantities and Maximum Storage Heights.

12.6.1 Liquid Storage Rooms.

12.6.1.1 Storage of liquids in liquid storage rooms shall meet the requirements specified in Table 12.6.1.1.

Table 12.6.1.1 Quantity Limitations for Liquid Storage Rooms

Total Floor Area (ft^2)	Automatic Fire Protection Provided?*	Total Allowable Quantity (gal/ft^2 of floor area)
≤150	No	2
	Yes	5
>150 and ≤500	No	4†
	Yes	10

For SI units, 1 ft^2 = 0.09 m^2; 1 gal = 3.8 L.

*The fire protection system can be automatic sprinklers, water spray, carbon dioxide, dry chemical, or other approved system. *(See Chapter 16.)*

†Total allowable quantities of Class IA and IB liquids cannot exceed the quantities permitted in Table 12.6.2.2 or those permitted by 12.6.2.3.

12.6.1.2 Containers over 30 gal (115 L) capacity that contain Class I or Class II liquids shall not be stacked more than one container high unless protected in accordance with Chapter 16.

Exception: This requirement does not apply to liquid storage rooms and hazardous materials storage lockers that are located in a liquid warehouse and are provided with equal or greater fire protection than is provided for the warehouse itself.

12.6.2 Liquid Warehouses.

12.6.2.1 The total quantity of liquid stored in a protected liquid warehouse shall not be limited.

12.6.2.2 Except as provided for in Chapter 9 and Chapter 13, unprotected liquid warehouses shall be as specified in Table 12.6.2.2.

12.6.2.3 Where two or more classes of liquids are stored in a single pile or rack section, the following shall apply:

(1) The maximum quantity per pile or rack section and the maximum storage height permitted shall be the smallest of the individual maximum quantities per pile or rack section and maximum storage heights for the specific classes present, respectively.
(2) The maximum quantity per pile or rack section shall be limited to the sum of the proportional amounts that each class of liquid present bears to the maximum quantity per pile or rack section allowed for its respective class.
(3) The sum of the proportional amounts shall not exceed 100 percent.

12.7 Control Areas. Control areas shall be in accordance with Section 9.7.

12.8 General-Purpose Warehouses.

12.8.1* Class IB and IC liquids in containers of 1.3 gal (5 L) or less capacity, Class II liquids in containers of 5.3 gal (20 L) or less capacity, Class IIIA liquids in containers of 60 gal (230 L) or less capacity, and Class IIIB liquids in containers, intermediate bulk containers, or portable tanks of 275 gal (1040 L) or less capacity shall be permitted to be stored in warehouses that handle combustible commodities, as defined in NFPA 13, *Standard for the Installation of Sprinkler Systems*, provided that the storage area for liquids is protected with automatic sprinklers in accordance with either of the following:

(1) The applicable provisions of NFPA 13 for 20 ft (6 m) high storage of Class IV commodities based on the storage configuration of the liquids
(2) The provisions of Chapter 16

12.8.2 The quantities and height of liquid storage are limited to the following:

(1) Class IA liquids: not permitted
(2) Class IB and IC liquids: 660 gal (2500 L), maximum 5 ft (1.5 m) high pile stored on floor, with no rack or other storage above
(3) Class II liquid: 1375 gal (5200 L), maximum 5 ft (1.5 m) high pile stored on floor, with no rack or other storage above
(4) Class IIIA liquid: 2750 gal (10,400 L), maximum 10 ft (3 m) high pile stored on floor, with no rack or other storage above or in storage racks to a maximum height of 10 ft (3 m)
(5) Class IIIB liquid: 13,750 gal (52,000 L), maximum 15 ft (4.6 m) high pile stored on floor, with no rack or other storage above or in storage racks to a maximum height of 15 ft (4.6 m)

12.8.3 Where two or more classes of liquids are stored in a single pile or rack section, the following shall apply:

(1) The maximum total quantity and maximum storage height permitted shall be the smallest of the individual maximum total quantities and maximum storage heights for the specific classes present, respectively.
(2) The maximum total quantity permitted shall be limited to the sum of the proportional amounts that each class of liquid present bears to the maximum total quantity permitted for its respective class.
(3) The sum of the proportional amounts shall not exceed 100 percent.

12.8.4* Liquids in Plastic Containers. Class I and Class II liquids in plastic containers shall not be stored in a general-purpose warehouse but shall be stored in a liquid storage room or liquid storage warehouse that meets the requirements of this chapter.

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Table 12.6.2.2 Quantity Limitations for Unprotected Liquid Warehouses

	Containers			Metal Portable Tanks and Metal IBCs			Rigid Nonmetallic IBCs and Composite IBCs		
Liquid Class	Maximum Storage Height (ft)	Maximum Total Quantity per Pile or Rack Section (gal)	Maximum Total Quantity (gal)	Maximum Storage Height (ft)	Maximum Total Quantity per Pile or Rack Section (gal)	Maximum Total Quantity (gal)	Maximum Storage Height (ft)	Maximum Total Quantity per Pile or Rack Section (gal)	Maximum Total Quantity (gal)
IA	5	660	660	NP	NP	NP	NP	NP	NP
IB	5	1,375	1,375	7	2,000	2,000	NP	NP	NP
IC	5	2,750	2,750	7	4,000	4,000	NP	NP	NP
II	10	4,125	8,250	7	5,500	11,000	7	4,125	8,250
IIIA	15	13,750	27,500	7	22,000	44,000	7	13,750	27,500
IIIB	15	13,750	55,000	7	22,000	88,000	7	13,750	55,000

For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L.
NP: Not permitted.

Exception No. 1: The following liquids, packaged in plastic containers, are permitted to be stored in general-purpose warehouses in accordance with the protection and storage limitations specified in Section 12.8 as follows:

(1) Products containing not more than 50 percent by volume of water-miscible liquids, with the remainder of the product consisting of components that do not burn and where packaged in individual containers
(2) Products containing more than 50 percent water-miscible liquids in individual containers not exceeding 16 oz (0.5 L) capacity in cartons

Exception No. 2: Class I and Class II liquids in plastic containers are permitted to be stored in a general-purpose warehouse if the packaging systems are listed and labeled for use with these commodities. All other provisions of Section 12.8 also apply.

12.8.5 The following shall apply to the storage of liquids and ordinary combustible commodities in general purpose warehouses:

(1) Liquids shall not be stored in the same pile or in the same rack sections as ordinary combustible commodities. Where liquids are packaged together with ordinary combustibles, as in kits, the storage shall be considered on the basis of whichever commodity predominates.
(2) Except as provided for in 12.8.5(1), ordinary combustible commodities shall be separated from liquids in containers by a minimum distance of 8 ft (2.4 m).

12.9 Construction Requirements. Storage areas shall be constructed in accordance with Section 9.9.

12.10 Fire Protection. Fire protection for protected storage shall be in accordance with Chapter 16.

12.11 Emergency Control Systems. (Reserved)

12.12 Electrical Systems. Installation of electrical wiring and utilization equipment shall meet the requirements of Chapter 7 and Section 9.12.

12.13 Containment, Drainage, and Spill Control. Where individual containers exceed 10 gal (38 L), spill control shall be in accordance with Section 9.13.

12.14 Ventilation. Liquid storage areas where dispensing is conducted shall be provided with ventilation that meets the requirements of Section 18.6.

12.15 Exhausted Enclosures. (Reserved)

12.16 Explosion Control. Where required by Section 9.16, explosion control shall be provided and shall meet the requirements of that section.

12.17 Separation from Incompatible Materials. The provisions of Section 9.17 shall apply.

12.18 Dispensing, Handling, and Use of Liquids in Storage Occupancies. Dispensing, handling, and use in storage areas shall be in accordance with Chapter 18.

12.19 Outdoor Storage of Liquids. Storage outside of buildings shall meet the requirements of Chapter 14 or Chapter 15, whichever is applicable.

Chapter 13 Storage of Liquids in Containers — Detached, Unprotected Buildings

13.1 Scope. This chapter shall apply to the storage of liquids in detached, unprotected buildings, in the following:

(1) Drums or other containers that do not exceed 119 gal (450 L) individual capacity
(2) Portable tanks that do not exceed 660 gal (2500 L) individual capacity
(3) Intermediate bulk containers that do not exceed 793 gal (3000 L)

13.2 Definitions Specific to Chapter 13. (Reserved)

13.3 General Requirements.

13.3.1* The building shall have a horizontal separation of at least 200 ft (60 m) [100 ft (30 m) where protection for exposures is provided] from exposed business, industrial, mercantile, and storage occupancies on the same property as well as from any property line that is or can be built upon.

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13.3.2* The building shall have a horizontal separation of at least 1000 ft (300 m) [500 ft (150 m) where protection for exposures is provided] from exposed occupancies other than business, industrial, mercantile, and storage on the same property as well as from any property line that is or can be built upon.

13.3.3 Means of egress from the building shall not exceed 75 ft (23 m).

13.3.4 Rack storage shall be arranged with minimum 4 ft (1.2 m) wide aisles between adjacent rack sections and between liquid storage and any adjacent storage.

13.3.5 Solid pile and palletized storage shall be arranged so that piles are separated from each other by at least 4 ft (1.2 m). Aisles shall be provided and arranged so that no container or portable tank is more than 20 ft (6 m) from an aisle.

Exception: For Class IIIB liquids stored in containers at temperatures below their flash points, the distance between piles is permitted to be reduced from 4 ft (1.2 m) to 2 ft (0.6 m) in proportion to commensurate reductions in maximum quantity per pile and maximum storage height, as given in Table 12.6.2.2.

13.3.6 Limited quantities of combustible commodities, as defined in NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall be permitted to be stored in liquid storage areas if the ordinary combustibles, other than those used for packaging the liquids, are separated from the liquids in storage by a minimum of 8 ft (2.4 m) horizontally either by aisles or by open racks.

13.3.7 Storage of empty or idle combustible pallets shall be limited to a maximum pile size of 2500 ft^2 (230 m^2) and to a maximum storage height of 6 ft (1.8 m).

13.3.7.1 Pallet storage shall be separated from liquid storage by aisles that are at least 8 ft (2.4 m) wide.

13.3.8 Containers, intermediate bulk containers, and portable tanks shall not be stored closer than 36 in. (915 mm) to the nearest beam, chord, girder, or other roof member.

13.4 Reserved.

13.5 Reserved.

13.6 Maximum Allowable Quantities and Maximum Storage Heights.

13.6.1 The total quantity of liquids stored in a detached unprotected liquid storage building shall not be limited.

13.6.2 Storage of liquids in piles or racks in a detached, unprotected liquid storage building shall not exceed the maximum storage height and maximum quantity per pile or rack section allowed by Table 12.6.2.2.

13.6.3 Where two or more classes of liquids are stored in a single pile or rack section, the following shall apply:

(1) The maximum quantity per pile or rack section and the maximum storage height permitted shall be the smallest of the individual maximum quantities per pile or rack section and maximum storage heights for the specific classes present, respectively.
(2) The maximum quantity per pile or rack section shall be limited to the sum of the proportional amounts that each class of liquid present bears to the maximum quantity per pile or rack section allowed for its respective class.
(3) The sum of the proportional amounts shall not exceed 100 percent.

13.7 Control Areas. (Reserved)

13.8 Reserved.

13.9 Construction Requirements.

13.9.1 The building shall not exceed one story in height.

13.9.2 The building shall not have basements, crawl spaces, or other accessible underfloor areas.

13.10 Fire Protection.

13.10.1 Automatic fire protection systems shall not be required.

13.10.2 Manual fire-fighting equipment needed for incipient-level fire protection shall be provided in accordance with 9.10.2.

13.11 Emergency Control Systems. (Reserved)

13.12 Electrical Systems. Installation of electrical wiring and utilization equipment shall meet the requirements of Chapter 7 and Section 9.12.

13.13 Containment, Drainage, and Spill Control.

13.13.1 Where individual containers exceed 10 gal (38 L), spill control shall be provided in accordance with Section 9.13.

13.13.2 Containment or drainage shall be provided in accordance with Section 9.13.

Exception: Containment or drainage need not be provided for fire protection water if the building does not have a water-based fire protection system.

13.14 Ventilation. Liquid storage areas where dispensing is conducted shall be provided with ventilation that meets the requirements of Section 18.6.

13.15 Exhausted Enclosure. (Reserved)

13.16 Explosion Control. Where required by Section 9.16, explosion control shall be provided and shall meet the requirements of that section.

13.17 Separation from Incompatible Materials. The provisions of Section 9.17 shall apply.

13.18 Dispensing, Handling, and Use of Liquids in Detached, Unprotected Buildings. Dispensing, handling, and use in storage areas shall be in accordance with Chapter 18.

13.19 Outdoor Storage of Liquids. Storage outside of buildings shall meet the requirements of Chapter 14 or Chapter 15, whichever is applicable.

Chapter 14 Hazardous Materials Storage Lockers

14.1* Scope. This chapter shall apply to the storage of liquids in movable, modular, prefabricated storage lockers, also known as hazardous materials storage lockers (hereinafter referred to as lockers), specifically designed and manufactured for storage of hazardous materials, in the following:

(1) Containers that do not exceed 119 gal (450 L) individual capacity
(2) Portable tanks that do not exceed 660 gal (2500 L) individual capacity
(3) Intermediate bulk containers that do not exceed 793 gal (3000 L) individual capacity

14.2 Definitions Specific to Chapter 14. (Reserved)

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14.3 General Requirements.

14.3.1 Lockers that are used as liquid storage rooms shall meet the requirements of Chapters 9 and 12 and Sections 14.4 and 14.6.

14.3.2 Lockers that are located outside shall meet the requirements of Sections 14.4 through 14.6.

14.4 Design and Construction of Hazardous Materials Storage Lockers.

14.4.1 The design and construction of a locker shall meet all applicable local, state, and federal regulations and requirements and shall be subject to the approval of the authority having jurisdiction.

14.4.2 Movable prefabricated structures that have been examined, listed, or labeled by an organization acceptable to the authority having jurisdiction for use as a hazardous materials storage facility shall be acceptable.

14.4.3 Lockers shall not exceed 1500 ft^2 (140 m^2) gross floor area.

14.4.4 Vertical stacking of lockers shall not be permitted.

14.4.5 Where electrical wiring and electrical utilization equipment are required, they shall comply with Chapter 7 and Section 9.12.

14.4.6 Where dispensing or filling is permitted inside a locker, operations shall comply with the provisions of Chapter 18.

14.4.7 Ventilation shall be provided in accordance with Section 18.6.

14.4.8 Lockers shall include a spill containment system to prevent the flow of liquids from the structure under emergency conditions.

14.4.8.1 The containment system shall have sufficient capacity to contain 10 percent of the volume of containers allowed in the locker or the volume of the largest container, whichever is greater.

14.5 Designated Sites for Hazardous Materials Storage Lockers.

14.5.1 Lockers shall be located on a designated approved site on the property.

14.5.2 The designated site shall be arranged to provide the minimum separation distances specified in Table 14.5.2 between individual lockers, from locker to property line that is or can be built upon, and from locker to nearest side of public ways or to important buildings on the same property.

14.5.3 Once the designated site is approved, it shall not be changed without the approval of the authority having jurisdiction.

14.5.4 More than one locker shall be permitted on a designated site, provided that the separation distance between individual lockers is maintained in accordance with Table 14.5.2.

14.5.5 Where the approved designated storage site is accessible to the general public, it shall be protected from tampering or trespassing.

14.6 Storage Requirements.

14.6.1 Containers of liquid in their original shipping packages shall be permitted to be stored either palletized or solid piled.

14.6.2 Unpackaged containers shall be permitted to be stored on shelves or directly on the floor of the locker.

Table 14.5.2 Designated Sites

	Minimum Separation Distance (ft)		
Area of Designated Site[a] (ft^2)	**Between Individual Lockers**	**From Locker to Property Line That Is or Can Be Built Upon[b]**	**From Locker to Nearest Side of Public Ways or to Important Buildings on Same Property[b,c]**
≤100	5	10	5
>100 and ≤500	5	20	10
>500 and ≤1500[d]	5	30	20

For SI units, 1 ft = 0.3 m; 1 ft^2 = 0.09 m^2.

Note: If the locker is provided with a fire resistance rating of not less than 4 hours and deflagration venting is not required in accordance with Section 9.16, all distances required by Table 14.5.2 are permitted to be waived.

[a]Site area limits are intended to differentiate the relative size and thus the number of lockers that are permitted in one designated site.

[b]Distances apply to properties that have protection for exposures, as defined. If there are exposures and such protection for exposures does not exist, the distances should be doubled.

[c]When the exposed building has an exterior wall, facing the designated site, that has a fire resistance rating of at least 2 hours and has no openings to above grade areas within 10 ft (3 m) horizontally and no openings to below grade areas within 50 ft (15 m) horizontally of the designated area, the distances can be reduced to half of those shown in the table, except they should never be less than 5 ft (1.5 m).

[d]When a single locker has a gross single story floor area that will require a site area limit of greater than 1500 ft^2 (140 m^2) or when multiple units exceed the area limit of 1500 ft^2 (140 m^2), the authority having jurisdiction should be consulted for approval of distances.

14.6.3 Containers over 30 gal (114 L) capacity storing Class I or Class II liquids shall not be stored more than two containers high.

14.6.4 In all cases, the storage arrangement shall provide unrestricted access to and egress from the locker.

14.6.5 Miscellaneous combustible materials, including but not limited to idle pallets, excessive vegetation, and packing materials, shall not be permitted within 5 ft (1.5 m) of the designated site approved for lockers.

14.6.6 Warning signs for lockers shall be in accordance with applicable local, state, and federal regulations or with NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response.*

Chapter 15 Outdoor Storage

15.1 Scope. This chapter shall apply to the storage of liquids outdoors in the following:

(1) Drums or other containers that do not exceed 119 gal (450 L) individual capacity
(2) Portable tanks that do not exceed 660 gal (2500 L) individual capacity
(3) Intermediate bulk containers that do not exceed 793 gal (3000 L) individual capacity

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15.2 Definitions Specific to Chapter 15. (Reserved)

15.3 General Requirements. Outdoor storage of liquids in containers, intermediate bulk containers, and portable tanks shall comply with Table 15.3 and with all applicable requirements of this chapter.

15.3.1 Where two or more classes of liquids are stored in a single pile, the maximum quantity permitted in that pile shall be that of the most hazardous class of liquid present.

15.3.2 No container, intermediate bulk container, or portable tank in a pile shall be more than 200 ft (60 m) from a minimum 20 ft (6 m) wide access way to permit approach of fire control apparatus under all weather conditions.

15.3.3 The distances specified in Table 15.3 shall apply to properties that have protection for exposures as defined. If there are exposures and protection for exposures does not exist, the distance to the property line that is or can be built upon shall be doubled.

15.3.4 Where total quantity stored does not exceed 50 percent of the maximum quantity per pile, as specified in Table 15.3, the distances to a property line that is or can be built upon and to streets, alleys, or public ways shall be permitted to be reduced by 50 percent but in no case to less than 3 ft (0.9 m).

15.3.5 The storage area shall be graded in a manner to divert possible spills away from buildings or other exposures or shall be surrounded by a curb at least 6 in. (150 mm) high.

15.3.5.1 Where curbs are used, provisions shall be made to drain accumulations of groundwater or rainwater or spills of liquids. Drains shall terminate at a safe location and shall flow freely under fire conditions.

15.3.6 When accessible to the public, the storage area shall be protected against tampering and trespassing.

15.3.7 The storage area shall be kept free of weeds, debris, and other combustible materials not necessary to the storage for a distance of at least 10 ft (3 m)around the perimeter of the stored materials.

15.3.8 The storage area shall be permitted to be protected from the weather by a canopy or roof that does not limit the dissipation of heat or dispersion of flammable vapors and does not restrict fire-fighting access and control.

15.4 Outdoor Storage Adjacent to a Building.

15.4.1 A maximum of 1100 gal (4160 L) of liquids in containers, intermediate bulk containers, or portable tanks shall be permitted to be stored adjacent to a building under the same management, provided the following conditions apply:

(1) The adjacent building wall has an exterior fire resistance rating of 2 hours.
(2) The adjacent building wall has no openings at grade or above grade that are within 10 ft (3 m) horizontally of the storage.
(3) The adjacent building wall has no openings directly above the storage.
(4) The adjacent building wall has no openings below grade within 50 ft (15 m) horizontally of the storage.

15.4.2 The provisions of 15.4.1(1) through 15.4.1(4) shall be permitted to be waived, subject to the approval of the authority having jurisdiction, if the building in question is one story, is of fire-resistive or noncombustible construction, and is devoted principally to the storage of liquids.

15.4.3 The quantity of liquid stored adjacent to a building that meets the conditions of 15.4.1(1) through 15.4.1(4) shall be permitted to exceed that permitted in 15.4.1, provided the maximum quantity per pile does not exceed 1100 gal (4160 L) and each pile is separated by a 10 ft (3 m) minimum clear space along the common wall.

Table 15.3 Storage Limitations for Outside Storage

	Containers		Portable Tanks and Metal IBCs		Rigid Plastic and Composite IBCs		Minimum Separation Distance (ft)		
Liquid Class	Maximum Quantity per Pile (gal)[a,b,c]	Maximum Storage Height (ft)	Maximum Quantity per Pile (gal)	Maximum Storage Height (ft)	Maximum Quantity per Pile (gal)[a,c]	Maximum Storage Height (ft)	Between Piles or Rack Sections	To Property Line That Is or Can Be Built Upon[b,d]	To Street, Alley, or Public Way[b]
IA	1,100	10	2,200	7	NP	NP	5	50	10
IB	2,200	12	4,400	14	NP	NP	5	50	10
IC	4,400	12	8,800	14	NP	NP	5	50	10
II	8,800	12	17,600	14	8,800	14	5	25	5
III	22,000	18	44,000	14	22,000	18	5	10	5

For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L.
NP: Not permitted.
[a]See 15.3.1 regarding mixed-class storage.
[b]See 15.3.4 for smaller pile sizes.
[c]For storage in racks, the quantity limits per pile do not apply, but the rack arrangements should be limited to a maximum of 50 ft (15 m) in length and two rows or 9 ft (2.7 m) in depth.
[d]See 15.3.3 regarding protection for exposures.

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15.4.4 The quantity of liquid stored shall be permitted to exceed the 1100 gal (4160 L) quantity specified by 15.4.1 where a minimum distance equal to that specified by Table 15.3 for distance to property line shall be maintained between buildings and the nearest container or portable tank.

15.4.5 Where the provisions of 15.4.1 cannot be met, a minimum distance equal to that specified by Table 15.3 for distance to property line shall be maintained between buildings and the nearest container or portable tank.

Chapter 16 Automatic Fire Protection for Inside Liquid Storage Areas

16.1 Scope.

16.1.1* This chapter shall apply to automatic fire protection systems for all inside storage of flammable and combustible liquids in containers, intermediate bulk containers, and portable tanks as specified in Section 9.4.

16.1.2* This chapter shall not apply to Class IA flammable liquids or to unstable flammable or combustible liquids.

16.1.3 Storage of liquids that is protected in accordance with the applicable requirements of this chapter shall be considered protected, as defined in 16.2.2. All other storage shall be considered unprotected unless an alternate means of protection has been approved by the authority having jurisdiction.

16.2 Definitions Specific to Chapter 16. For the purposes of this chapter, the terms in this section shall have the definitions given.

16.2.1 IBC. Where used in this chapter, *IBC* refers to intermediate bulk containers.

16.2.2 Protected Storage. Flammable and combustible liquids storage that is protected in accordance with this chapter.

16.2.3* Relieving-Style Container. A metal container, a metal intermediate bulk container, or a metal portable tank that is equipped with at least one pressure-relieving mechanism at its top that is designed, sized, and arranged to relieve the internal pressure generated due to exposure to fire so that violent rupture is prevented.

16.2.4* Unsaturated Polyester Resin (UPR). A resin that contains up to 50 percent by weight of Class IC, Class II, or Class III liquid, but no Class IA or Class IB liquid.

16.2.5 Viscous Liquid. A liquid that gels, thickens, or solidifies when heated or whose viscosity at room temperature versus weight percent content of Class I, Class II, or Class III liquid is in the shaded portion of Figure 16.2.5.

16.2.6 Water-Miscible Liquid. A liquid that mixes in all proportions with water without the use of chemical additives, such as emulsifying agents.

16.3 General Requirements.

16.3.1 Where different classes of liquids, container types, and storage configurations are stored in the same protected area, protection shall meet either of the following:

(1) Requirements of this chapter for the most severe storage fire hazard present
(2) Where areas are not physically separated by a barrier or partition capable of delaying heat from a fire in one hazard area from fusing sprinklers in an adjacent hazard area, the required protection for the more demanding hazard shall:
  (a) Extend 20 ft (6 m) beyond its perimeter, but not less than the required minimum sprinkler design area
  (b) Be provided with means to prevent the flow of burning liquid under emergency conditions into adjacent hazard areas
  (c) Provide containment and drainage as required by Section 16.8

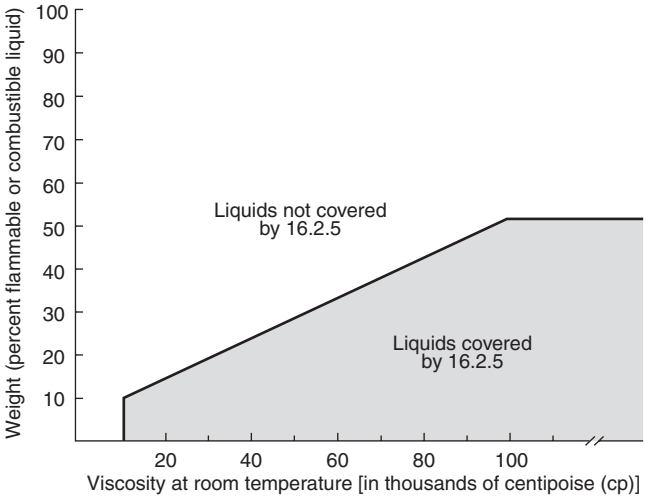

FIGURE 16.2.5 Viscous Liquid: Viscosity Versus Weight Percent Flammable or Combustible Component.

16.3.2 Unless otherwise specified in this chapter, single-row racks shall not be more than 4.5 ft (1.4 m) in depth and double-row racks shall not be more than 9 ft (2.8 m) in depth.

16.3.3 When applying the fire protection criteria of this chapter, a minimum aisle space of 6 ft (1.8 m) shall be provided between adjacent piles or adjacent rack sections, unless otherwise specified in the tables in Section 16.5.

16.3.4 Viscous liquids, as defined in 16.2.5, shall be permitted to be protected using one of the following:

(1) For metal containers, the criteria for Class IIIB liquids, as determined by Figure 16.4.1(a)
(2) For nonmetallic containers, the criteria for Class IIIB liquids, as determined by Figure 16.4.1(b)
(3) For nonmetallic containers, the criteria for cartoned unexpanded Group A plastics in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, as indicated in Figure 16.4.1(b)

16.3.5 Protection systems that are designed and developed based on full-scale fire tests performed at an approved test facility or on other engineered protection schemes shall be considered an acceptable alternative to the protection criteria set forth in this chapter. Such alternative protection systems shall be approved by the authority having jurisdiction.

16.3.6 For relieving-style containers of greater than 6.6 gal (25 L) and up to 119 gal (450 L) capacity, the following shall apply:

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(1) The pressure-relieving mechanism shall be listed and labeled in accordance with FM Global *Approval Standard for Plastic Plugs for Steel Drums,* Class Number 6083, or equivalent.
(2) The pressure-relieving mechanism shall not be painted, and cap seals, if used, shall be made of thermoplastic material.
(3) For metal containers greater than 6.6 gal (25 L) capacity, the pressure-relieving mechanism shall be unobstructed or an additional pressure-relieving mechanism shall be provided.

16.3.7 To be considered protected by Table 16.5.2.9 and Table 16.5.2.10, rigid nonmetallic intermediate bulk containers shall be subjected to a standard fire test that demonstrates acceptable inside storage fire performance and shall be listed and labeled.

16.4 Automatic Sprinkler and Foam-Water Sprinkler Fire Protection Systems.

16.4.1 Where automatic sprinkler systems or low-expansion foam-water sprinkler systems are used to protect storage of liquids, Figure 16.4.1(a), Figure 16.4.1(b), or Figure 16.4.1(c), whichever is applicable, and the appropriate table in Section 16.5 shall be used to determine protection criteria.

16.4.1.1 Figure 16.4.1(a) shall be used for miscible and nonmiscible flammable and combustible liquids in metal containers, metal portable tanks, and metal intermediate bulk containers.

16.4.1.2 Figure 16.4.1(b) shall be used for miscible and nonmiscible flammable and combustible liquids in nonmetallic containers and in nonmetallic intermediate bulk containers.

16.4.1.3 Figure 16.4.1(c) shall be used for water-miscible flammable and combustible liquids in nonmetallic containers and in nonmetallic intermediate bulk containers.

16.4.2 Automatic sprinkler and foam-water fire protection systems shall be wet pipe, deluge, or preaction systems.

16.4.2.1 If a preaction system is used, it shall be designed so that water or foam solution will immediately discharge from the sprinkler upon sprinkler actuation.

16.4.2.2 A foam-water sprinkler system that meets any of the design criteria specified in the water sprinkler tables in this section shall be acceptable, provided that the system is installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems.*

16.4.3 Water-based fire protection systems shall be inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

16.5 Fire Protection System Design Criteria.

16.5.1 General. Paragraphs 16.5.2.1 through 16.5.2.12 and their related tables, Table 16.5.2.1 through Table 16.5.2.12, shall be used to determine the protection criteria and storage arrangement for the applicable liquid class, container type, and storage configuration, as described in 16.5.2.1 through 16.5.2.12 and subject to the provisions of 16.5.1.

16.5.1.1 Table 16.5.2.1 through Table 16.5.2.12 shall apply only to stable liquids.

16.5.1.1.1 The protection criteria in Table 16.5.2.1 through Table 16.5.2.12 shall only be used with ceilings having a pitch of 2 in 12 or less.

16.5.1.2 When foam or foam-water fire protection systems are provided, discharge densities shall be determined based on the listing criteria of the foam discharge devices selected, the foam concentrate, the specific liquids to be protected, and the criteria in the appropriate table in this chapter. Where the discharge densities given in the tables differ from those in the listing criteria for the discharge devices, the greater of the two shall be used.

16.5.1.3 In-rack sprinklers shall be installed in accordance with the provisions of NFPA 13, *Standard for the Installation of Sprinkler Systems.* In addition, the following modifications shall apply:

(1) In-rack sprinklers shall be laid out in accordance with 16.5.1.10 and Section 16.6, as applicable.
(2) Sprinklers in multiple-level in-rack sprinkler systems shall be provided with water shields unless they are separated by horizontal barriers or are specifically listed for installation without water shields.
(3) A vertical clear space of at least 6 in. (150 mm) shall be maintained between the sprinkler deflector and the top tier of storage.
(4) Sprinkler discharge shall not be obstructed by horizontal rack structural members.
(5) Where in-rack sprinklers are installed below horizontal barriers, the deflector shall be located a maximum of 7 in. (180 mm) below the barrier.
(6) Longitudinal and transverse flue spaces of at least 6 in. (150 mm) shall be maintained between each rack load.

16.5.1.4 Ceiling sprinklers shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems,* and shall be permitted to have the following maximum head spacing:

(1) Classes I, II, and IIIA liquids: 100 ft^2 (9.3 m^2) per sprinkler
(2) Class IIIB liquids: 120 ft^2 (11.1 m^2) per sprinkler

16.5.1.4.1 Ordinary or intermediate temperature–rated K-25 extended-coverage sprinklers shall be permitted to be used as standard response high-temperature sprinklers at greater than 144 ft^2 (13 m^2) coverage, with 12 ft (3.7 m) minimum spacing and a maximum coverage area of 196 ft^2 (18 m^2) coverage.

16.5.1.5 The ceiling heights given in Table 16.5.2.1 through Table 16.5.2.12, excluding Table 16.5.2.8, shall be permitted to be increased by a maximum of 10 percent if an equivalent percent increase in ceiling sprinkler design density is provided.

16.5.1.6 Foam-water sprinkler systems shall be designed and installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems.*

16.5.1.6.1 Foam-water sprinkler systems shall have at least 15 minutes of foam concentrate, based on the required design flow rate.

16.5.1.6.2* Foam-water sprinkler systems shall provide foam solution at the minimum required concentration with as few as four sprinklers flowing.

16.5.1.7 When relieving-style containers are used, both ¾ in. (20 mm) and 2 in. (50 mm) listed and labeled pressure-relieving mechanisms are required on containers greater than 6 gal (23 L) capacity.

16.5.1.8 For the purposes of Section 16.5, a rigid nonmetallic intermediate bulk container is one that meets the maximum allowable capacity criteria of Table 9.4.3 and has been listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids,* or equivalent.

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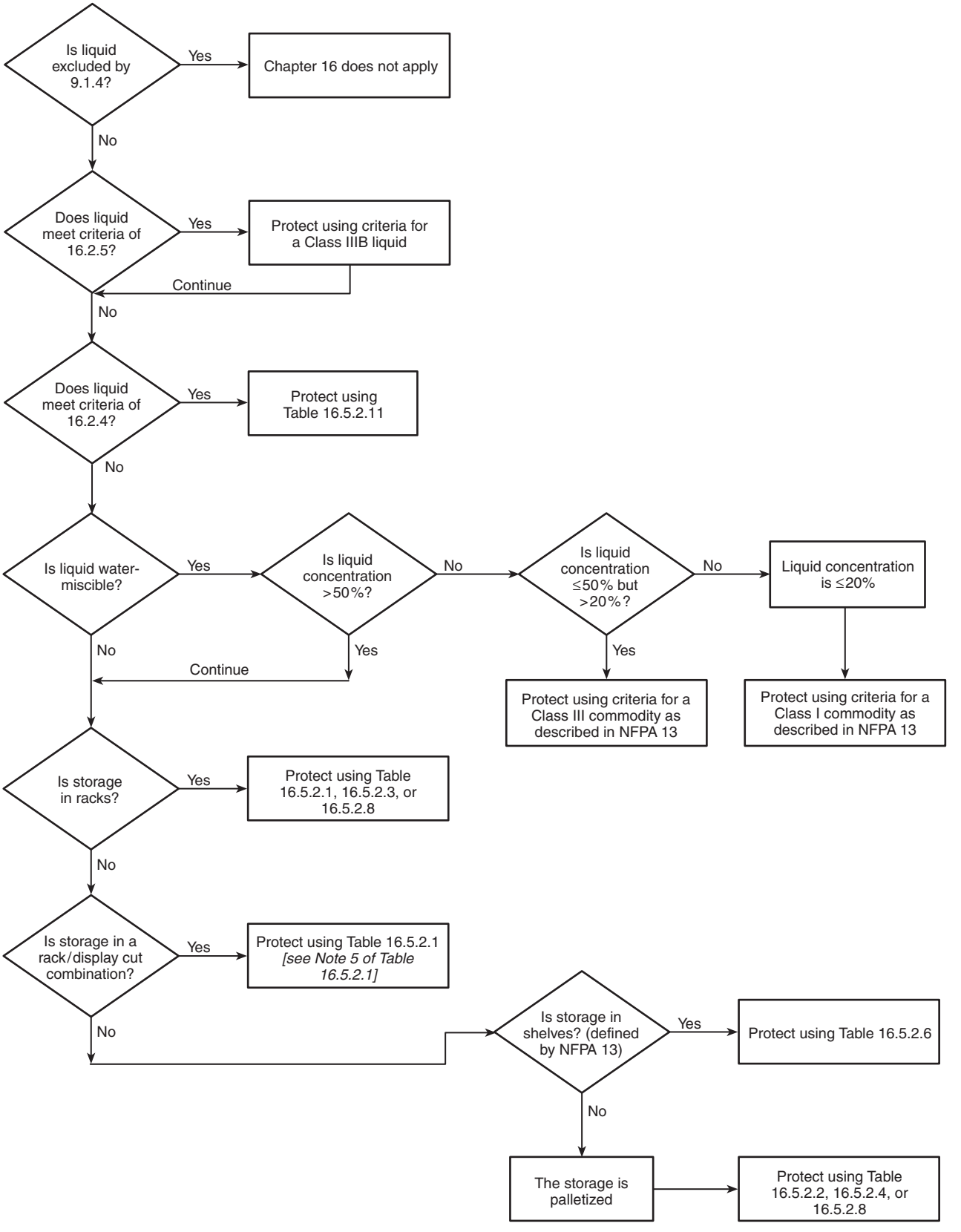

FIGURE 16.4.1(a) Fire Protection Criteria Decision Tree for Miscible and Nonmiscible Flammable and Combustible Liquids in Metal Containers.

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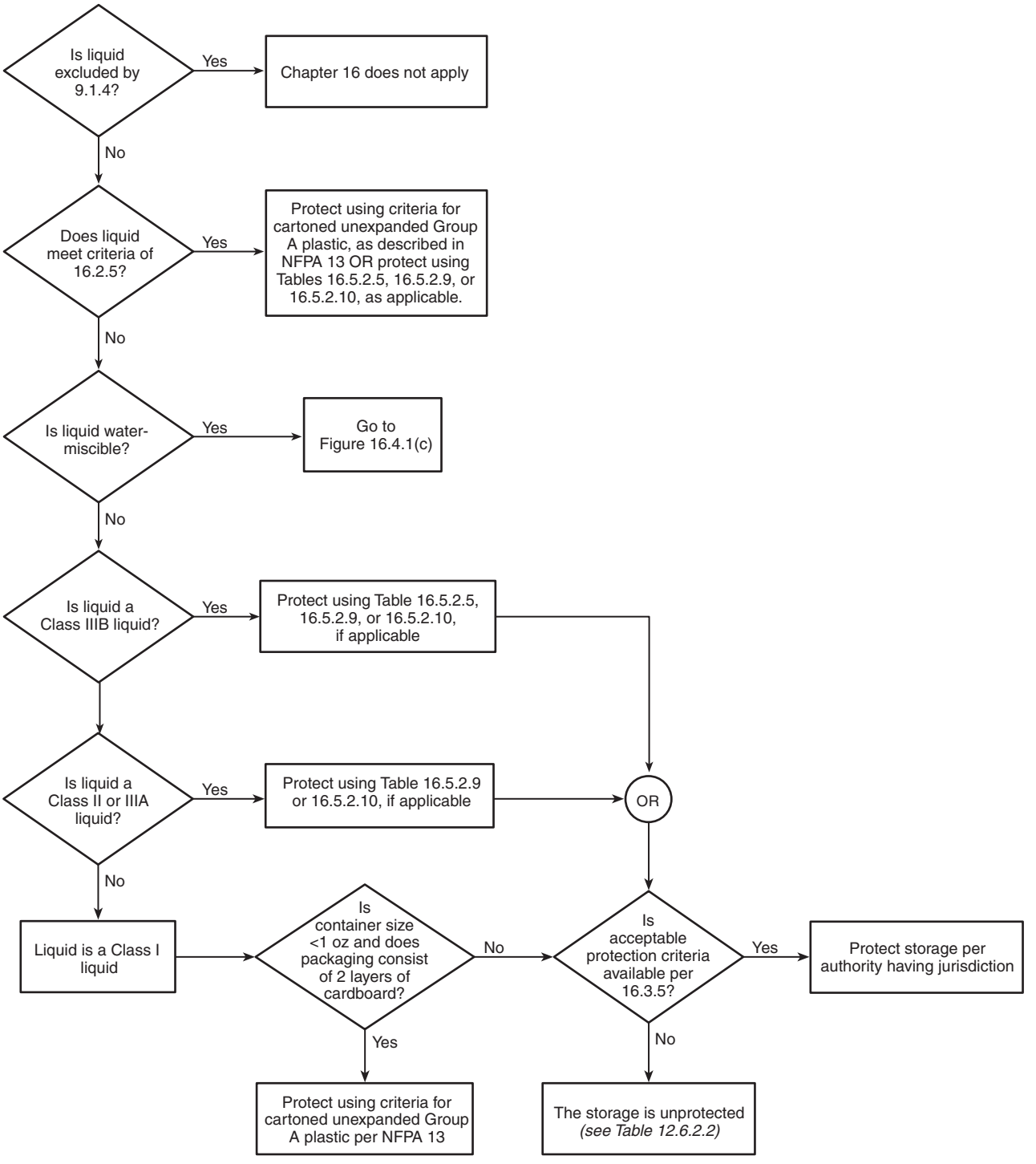

FIGURE 16.4.1(b) Fire Protection Criteria Decision Tree for Miscible and Nonmiscible Flammable and Combustible Liquids in Nonmetallic Containers.

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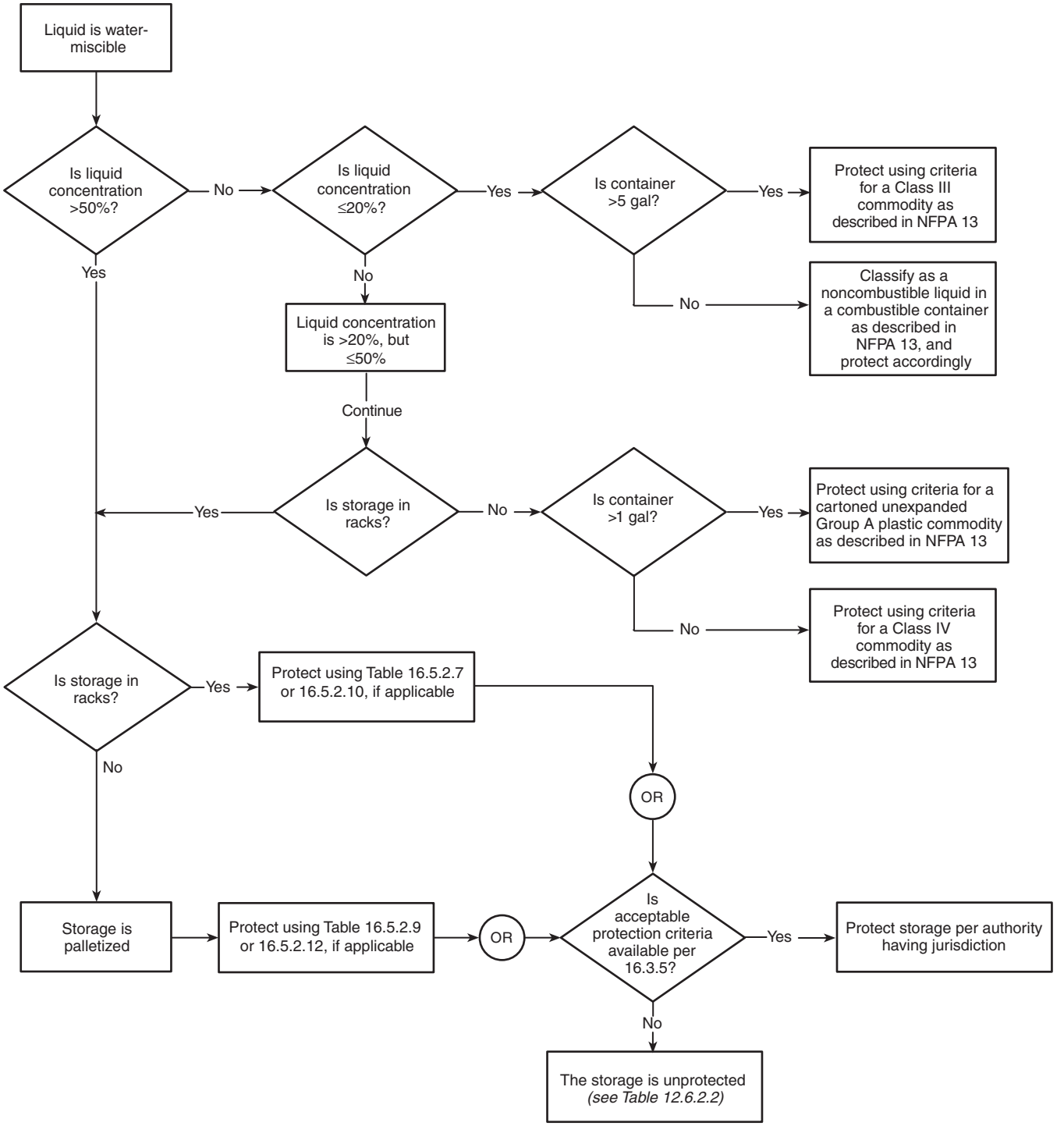

Note: For SI units, 1 gal = 3.8 L.

FIGURE 16.4.1(c) Fire Protection Criteria Decision Tree for Miscible Flammable and Combustible Liquids in Nonmetallic Containers.

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16.5.1.9 For the purposes of Section 16.5, the following shall apply:

(1) 1 gal = 3.8 L; 1 ft = 0.3 m; 1 ft^2 = 0.09 m^2
(2) 1 gpm/ft^2 is equivalent to 40.7 L/min/m^2 or 40.7 mm/min
(3) A gauge pressure of 1 psi is equivalent to a gauge pressure of 6.9 kPa
(4) SR = standard response sprinkler; QR = quick response sprinkler; ESFR = early suppression fast-response sprinkler; OT = ordinary temperature; HT = high temperature
(5) Where an ordinary-temperature sprinkler is indicated, an intermediate-temperature sprinkler shall be used where ambient conditions require.

16.5.1.10 For the purposes of Section 16.5, the following shall apply to the in-rack sprinkler design layouts specified in Table 16.5.2.1 through Table 16.5.2.12:

(1) Layout 1, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers 8 ft (2.4 m) above the floor in the longitudinal flue space, with sprinklers spaced not more than 10 ft (3 m) on center.
(2) Layout 2, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers 6 ft (1.8 m) above the floor and one line of in-rack sprinklers 12 ft (3.6 m) above the floor in the longitudinal flue space, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically.
(3) Layout 3, as referenced in Table 16.5.2.1 and Table 16.5.2.3, shall mean one line of in-rack sprinklers in the longitudinal flue space at every storage level above the floor except above the top tier, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
(4) Layout 4, as referenced in Table 16.5.2.1 and Table 16.5.2.3, shall mean one line of in-rack sprinklers in the longitudinal flue space at every other storage level, except above the top tier, beginning above the first storage level, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
(5) Layout 5, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every storage level above the floor except above the top tier and face sprinklers at the first storage level at each rack upright. In-rack sprinklers shall be spaced not more than 9 ft (2.7 m) on center and shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
(6) Layout 6, as referenced in Table 16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every other storage level above the first storage level except the top tier and face sprinklers at the first storage level at each rack upright. In-rack sprinklers shall be spaced not more than 10 ft (3 m) on center and shall be staggered vertically, where more than one level of in-rack sprinklers is installed.
(7) Layout 7, as referenced in Table 16.5.2.8, shall be as shown in Figure 16.6.4(a).
(8) Layout 8, as referenced in Table 16.5.2.8, shall be as shown in Figure 16.6.4(b) or Figure 16.6.4(c).
(9) Layout 9, as referenced in Table 16.5.2.8, shall be as shown in Figure 16.6.4(d) or Figure 16.6.4(e).

16.5.1.11 The "Fire Test Ref." number given for each entry in Table 16.5.2.1 through Table 16.5.2.12 shall be used to identify in Section D.2 the information on the fire tests on which the protection criteria for that entry are based.

16.5.1.12 The water supply shall be sufficient to meet the fixed fire protection demand plus a total of at least 500 gpm (1900 L/min) for inside and outside hose connections for at least 2 hours, unless otherwise specified in this chapter.

16.5.2 Specific Design Criteria.

16.5.2.1 Table 16.5.2.1 shall apply to the following:

(1) Automatic sprinkler protection
(2) Single- or double-row rack storage
(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Metal containers, metal portable tanks, metal intermediate bulk containers
(5) Relieving- or nonrelieving-style containers

16.5.2.2 Table 16.5.2.2 shall apply to the following:

(1) Automatic sprinkler protection
(2) Palletized or stacked storage
(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Metal containers, metal portable tanks, metal intermediate bulk containers
(5) Relieving- or nonrelieving-style containers

16.5.2.3 Table 16.5.2.3 shall apply to the following:

(1) Foam-water sprinkler protection
(2) Single- or double-row rack storage
(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Metal containers, metal portable tanks, metal intermediate bulk containers
(5) Relieving- or nonrelieving-style containers

16.5.2.4 Table 16.5.2.4 shall apply to the following:

(1) Foam-water sprinkler protection
(2) Palletized or stacked storage
(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Metal containers, metal portable tanks, metal intermediate bulk containers
(5) Relieving- or nonrelieving-style containers

16.5.2.5 Table 16.5.2.5 shall apply to the following:

(1) Automatic sprinkler protection
(2) Single-, double-, or multiple-row rack storage
(3) Class IIIB nonmiscible liquids and Class IIIB miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Nonmetallic containers or intermediate bulk containers
(5) Cartoned or uncartoned

16.5.2.6 Table 16.5.2.6 shall apply to the following:

(1) Automatic sprinkler protection
(2) Shelf storage
(3) Nonmiscible liquids and miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
(4) Nonrelieving-style metal containers

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Table 16.5.2.1 Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Liquids in Metal Containers, Portable Tanks, and IBCs

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection: Sprinkler Type	Ceiling Sprinkler Protection: Sprinkler Response	Ceiling Sprinkler Protection: Design Density (gpm/ft^2)	Ceiling Sprinkler Protection: Design Area (ft^2)	In-Rack Sprinkler Protection: Sprinkler Type	In-Rack Sprinkler Protection: Sprinkler Response	In-Rack Sprinkler Protection: Minimum Discharge Flow (gpm)	In-Rack Sprinkler Protection: Layout *(See 16.5.1.10)*	Notes	Fire Test Ref. *[See Table D.2(a)]*
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA												
≤1	16	30	K≥11.2	QR (HT)	0.60	2000	K≥5.6	QR(OT)	30	1	1, 2, 7	1
	20	30	K≥11.2	SR or QR (HT)	0.60	2000	K≥5.6	QR(OT)	30	2	1, 2, 7	2
≤5	25	30	K≥8.0	SR or QR (HT)	0.30	3000	K≥5.6	QR(OT)	30	3	1, 7	3
>5 and ≤60	25	30	K≥11.2	SR (HT)	0.40	3000	K≥5.6	QR or SR(OT)	30	5	1, 7	5
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB												
≤5	40	50	K≥8.0	SR or QR (HT)	0.30	2000	K≥5.6	QR(OT)	30	4	1, 3, 7	4
>5 and ≤60	40	50	K≥8.0	SR (HT)	0.30	3000	K≥5.6	QR(OT)	30	4	1, 3, 7	6
RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA												
≤5	14	18	K≥11.2 pendent only	QR (HT)	0.65	2000	No in-rack sprinklers required				4	7
	25	30	K≥8.0	SR or QR (HT)	0.30	3000	K≥5.6	QR(OT)	30	4	1, 5, 7	8
>5 and ≤60	25	30	K≥11.2	SR (HT)	0.60	3000	K≥5.6	QR(OT)	30	6	1, 7	10
Portable tanks and IBCs	25	30	K≥11.2	SR (HT)	0.60	3000	K≥5.6	QR or SR(OT)	30	5	1, 7	12
RELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB												
≤ 5 gal	40	50	K≥8.0	SR or QR (HT)	0.30	2000	K≥5.6	QR(OT)	30	4	1, 7	9
>5 and ≤60	40	50	K≥8.0	SR (HT)	0.30	3000	K≥5.6	QR(OT)	30	4	1, 3, 7	11
Portable tanks and IBCs	40	50	K≥8.0	SR (HT)	0.30	3000	K≥5.6	QR(OT)	30	4	1, 6, 7	13

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft^2 = 0.09 m^2, 1 gpm/ft^2 = 40.7 L/min/m^2 = 40.7 mm/min.

For definitions of abbreviations used in the Response column, see 16.5.1.9(4). See also 16.5.1.9(5).

Notes:

(1) In-rack sprinkler design shall be based on the following:

(a) Where one level of in-rack sprinklers is installed, the design shall include the 8 most hydraulically remote sprinklers.

(b) Where two levels of in-rack sprinklers are installed, the design shall include the 6 most hydraulically remote sprinklers on each level.

(c) Where three or more levels of in-rack sprinklers are installed, the design shall include the 6 most hydraulically remote sprinklers on the top three levels.

(2) Protection for uncartoned or case-cut nonsolid shelf display up to 6.5 ft (2 m) and storage above on pallets in racking and stored on shelf materials, including open wire mesh, or 2 in. × 6 in. (50 mm × 150 mm) wooden slats, spaced a minimum of 2 in. (50 mm) apart.

(3) Increase ceiling density to 0.60 if more than one level of storage exists above the top level of in-rack sprinklers.

(4) Double-row racks limited to maximum 6 ft (1.8 m) depth.

(5) For K=8.0 and larger ceiling sprinklers, increase ceiling density to 0.60 over 2000 ft^2 if more than one level of storage exists above the top level of in-rack sprinklers.

(6) Reduce in-rack sprinkler spacing to maximum 9 ft (2.7 m) centers.

(7) The minimum in-rack discharge pressure shall not be less than 10 psi.

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