

- (1) Consumer fireworks shall be displayed in a manner that prevents the fireworks from being handled by persons other than those operating, supervising, or working in the temporary CFRS stand.
- (2) The handling requirements of 65.10.6.4.6(1) shall not apply to packaged assortments, boxes, or similarly packaged containers of one or more items, regardless of type. [1124:7.6.4.6]

Chapter 66 Flammable and Combustible Liquids

66.1 General.

66.1.1* The storage, handling, and use of flammable and combustible liquids, including waste liquids, as herein defined and classified, shall comply with this chapter; NFPA 30, *Flammable and Combustible Liquids Code*; and Sections 60.1 through 60.4 of this *Code*.

66.1.2 Where the provisions of this chapter or NFPA 30 conflict with the provisions of Chapter 60, the provisions of this chapter and NFPA 30 shall apply.

66.1.3 This chapter 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 3.3.30 of NFPA 30 and Chapter 4 of NFPA 30
- (3) Any cryogenic fluid or liquefied gas, as defined in 3.3.138.8
- (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.

[30:1.1.2]

66.1.4 Installations made in accordance with the applicable requirements of the following standards shall be deemed to be in compliance with this *Code*:

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

(11) NFPA 99, *Health Care Facilities Code*

(12) NFPA 101, *Life Safety Code*

[30:1.5.3]

66.1.5 Permits. Permits, where required, shall comply with Section 1.12.

66.2 Reserved.

66.3 Definitions.

66.3.1 (Reserved)

66.3.2 (Reserved)

66.3.3 General Definitions.

66.3.3.1 Alcohol-Based Hand Rub. See 3.3.10.

66.3.3.2 Area.

66.3.3.2.1 Fire Area. See 3.3.14.4.

66.3.3.2.2 Inside Liquid Storage Area. See 3.3.14.7.

66.3.3.3 Barrel. See 3.3.21.

66.3.3.4 Basement. See 3.3.23.

66.3.3.5 Boiling Point. See 3.3.28.

66.3.3.6* Boil-Over. See 3.3.29.

66.3.3.7 Building.

66.3.3.7.1* Important Building. See 3.3.30.7.

66.3.3.7.2 Storage Tank Building. See 3.3.30.11.

66.3.3.8 Chemical Plant. See 3.3.45.

66.3.3.9 Closed-Top Diking. See 3.3.52.

66.3.3.10 Container. Any vessel of 119 gal (450 L) or less capacity used for transporting or storing liquids. [30, 2012]

66.3.3.10.1 Closed Container. See 3.3.74.2.

66.3.3.10.2 Intermediate Bulk Container. See 3.3.74.6.

66.3.3.11 Control Area. For the purposes of this chapter, 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). [30, 2012]

66.3.3.12 Crude Petroleum. See 3.3.82.

66.3.3.13 Cryogenic Fluid. See 3.3.83.

66.3.3.14 Damage-Limiting Construction. See 3.3.87.

66.3.3.15 Distillery. See 3.3.92.

66.3.3.16 Fire Point. See 3.3.124.

66.3.3.17 Flash Point. See 3.3.132.

66.3.3.18* Fugitive Emissions. See 3.3.135.

66.3.3.19* Hazardous Material or Hazardous Chemical. Material presenting dangers beyond the fire problems relating to flash point and boiling point. [30, 2012]

66.3.3.20 Hazardous Materials Storage Locker. See 3.3.148.

66.3.3.21 Hazardous Reaction or Hazardous Chemical Reaction. See 3.3.149.

66.3.3.22 Heat Transfer Fluid (HTF). See 3.3.150.

66.3.3.23 High Hazard Level 2 Contents. Contents that present a deflagration hazard or a hazard from accelerated burning. For the purposes of this chapter, 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. [30, 2012]

66.3.3.24 High Hazard Level 3 Contents. Contents that readily support combustion or that present a physical hazard. For the purposes of this chapter, 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). [30, 2012]

66.3.3.25 Incidental Liquid Use or Storage. See 3.3.158.

66.3.3.26 Liquid.

66.3.3.26.1 Combustible Liquid. See 3.3.165.1.

66.3.3.26.2* Flammable Liquid. See 3.3.165.2.

66.3.3.26.3 Stable Liquid. See 3.3.165.4.

66.3.3.27* Operating Unit (Vessel) or Process Unit (Vessel). See 3.3.186.

66.3.3.28 Operations. See 3.3.187.

66.3.3.29* Process or Processing. See 3.3.205.

66.3.3.30 Protection for Exposures. See 3.3.208.

66.3.3.31 Refinery. See 3.3.216.

66.3.3.32* Safety Can. See 3.3.220.

66.3.3.33 Storage Tank. See 3.3.254.7.

66.3.3.33.1 Aboveground Tank. See 3.3.254.2.

66.3.3.33.1.1 Protected Aboveground Tank. See 3.3.254.2.1.

66.3.3.33.2 Low-Pressure Tank. A storage tank designed to withstand an internal pressure above a gauge pressure of 1.0 psig (6.9 kPa) but not more than a gauge pressure of 15 psi (103 kPa) measured at the top of the tank. [30, 2012]

66.3.3.33.3 Portable Tank. See 3.3.254.4.

66.3.3.33.3.1* Nonmetallic Portable Tank. A portable tank, as herein defined, constructed of plastic, fiber, or a material other than metal. [30, 2012]

66.3.3.33.4 Secondary Containment Tank. See 3.3.254.5.

66.3.3.34 Unit Operation or Unit Process. See 3.3.260.

66.3.3.35 Vapor Pressure. See 3.3.266.

66.3.3.36 Vapor Processing Equipment. Those components of a vapor processing system designed to process vapors or liquids captured during transfer or filling operations. [30, 2012]

66.3.3.37* Vapor Processing System. See 3.3.253.15.

66.3.3.38 Vapor Recovery System. See 3.3.253.16.

66.3.3.39 Vent.

66.3.3.39.1 Emergency Relief Vent. See 3.3.99.

66.3.3.40* Warehouse.

66.3.3.40.1 General-Purpose Warehouse. See 3.3.269.1.

66.3.3.40.2 Liquid Warehouse. See 3.3.269.2.

66.4 Definition and Classification of Liquids.

66.4.1 Definitions Specific to Liquids. For the purposes of this chapter, the terms in this subsection shall have the definitions given. [30:4.2]

66.4.1.1* Boiling Point. See 3.3.28. [30:4.2.1]

66.4.1.2 Combustible Liquid. Any liquid that has a closed-cup flash point at or above 100°F (37.8°C). See 3.3.165.1. Combustible liquids shall be classified in accordance with 66.4.2.2.

66.4.1.3 Flammable Liquid. See 3.3.165.2. Flammable liquids shall be classified in accordance with 66.4.2.1. [30:4.3.1]

66.4.1.4* Flash Point. See 3.3.132. [30:4.2.4]

66.4.1.5 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*. [30:4.2.5]

66.4.1.6* Vapor Pressure. See 3.3.266. [30:4.2.6]

66.4.2* 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 chapter. [30:4.3]

66.4.2.1 Flammable liquids, as defined in 3.3.165.2 and 66.4.1.3, 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)

[30:4.3.1]

66.4.2.2 Combustible liquids, as defined in 3.3.165.1 and 66.4.1.2, 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)

[30:4.3.2]

66.4.3 Determination of Flash Point. The flash point of a liquid shall be determined according to the methods specified in 66.4.3.1 through 66.4.3.4. [30:4.4]

66.4.3.1 Except as specified in 66.4.3.1.1, the flash point of a liquid having a viscosity below 5.5 centiStokes at 104°F (40°C) or 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*. [30:4.4.1]

66.4.3.1.1 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 66.4.3.2. [30:4.4.1.1]

66.4.3.2 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*. [30:4.4.2]

66.4.3.3 As an alternative, ASTM D 3278, *Standard Test Method 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). [30:4.4.3]

66.4.3.4 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. [30:4.4.4]

66.5 Reserved.

66.6 Fire and Explosion Prevention and Risk Control.

66.6.1* Scope. This section shall apply to the hazards associated with storage processing, handling, and use of liquids. This section shall also apply when specifically referenced by another section. [30:6.1]

66.6.2 Reserved.

66.6.3* 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. [30:6.3]

66.6.4 Hazards Analysis.

66.6.4.1 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. [30:6.4.1]

66.6.4.1.1* The extent of fire prevention and control that is provided shall be determined in consultation with the AHJ 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 of NFPA 30
- (4) Analysis of applicable requirements for liquid handling, transfer, and use, as covered in Chapters 17, 18, 19, 28, and 29 of NFPA 30
- (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

[30:6.4.1.1]

66.6.4.1.2* 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 Section 66.6 justifies following the requirements for some other liquid class. [30:6.4.1.2]

66.6.4.2 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

[30:6.4.2]

66.6.5 Control of Ignition Sources.

66.6.5.1 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

[30:6.5.1]

66.6.5.2 Smoking. Smoking shall be permitted only in designated and identified areas. [30:6.5.2]

66.6.5.3* Hot Work.

66.6.5.3.1 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. [30:6.5.3.1]

66.6.5.3.2 The permit shall be issued by a person in authority following inspection of the area to ensure that permit requirements have been implemented and will be followed until the job is completed. [30:6.5.3.2]

66.6.5.4* Static Electricity.

66.6.5.4.1 All equipment such as tanks, machinery, and piping shall be designed and operated to prevent electrostatic ignitions. [30:6.5.4.1]

66.6.5.4.2 All metallic equipment such as tanks, machinery, and piping where the potential exists for an ignitable mixture to be present shall be bonded and grounded. [30:6.5.4.2]

66.6.5.4.3 The bond and ground shall be physically applied or shall be inherently present by the nature of the installation. [30:6.5.4.3]

66.6.5.4.4 Any electrically isolated section of metallic piping or equipment shall be bonded and grounded to prevent hazardous accumulation of static electricity. [30:6.5.4.4]

66.6.5.4.5 All nonmetallic equipment and piping where the potential exists for an ignitable mixture to be present shall be designed and operated to prevent electrostatic ignition. [30:6.5.4.5]

66.6.5.5 Electrical Systems. Design, selection, and installation of electrical wiring and electrical utilization equipment shall meet the requirements of Section 66.7. [30:6.5.5]

66.6.6 Detection and Alarm Systems and Procedures.

66.6.6.1* 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. [30:6.6.1]

66.6.6.2 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

[30:6.6.2]

66.6.7 Fire Protection and Fire Suppression Systems.

66.6.7.1* 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 this chapter. [30:6.7.1]

66.6.7.2 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. [30:6.7.2]

66.6.7.3* Permanent connections between the fire water system and any process system shall be prohibited, to prevent contamination of fire water with process fluids. [30:6.7.3]

66.6.7.4 Where required by this chapter, hydrants, with or without fixed monitor nozzles, shall be provided in accordance with this Code and 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. [30:6.7.4]

66.6.7.5* Where the need is indicated by the hazards of liquid processing, storage, or exposure as determined by 66.6.4, fixed protection shall be provided. [30:6.7.5]

66.6.7.6 Where provided, fire control systems shall be designed, installed, and maintained in accordance with this code and 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 2001, *Standard on Clean Agent Fire Extinguishing Systems*

[30:6.7.6]

66.6.7.7 Where required by this chapter, standpipe and hose systems shall be installed in accordance with Section 13.2 and 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. [30:6.7.7]

66.6.7.8* 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. [30:6.7.8]

66.6.7.9 Where provided, mobile foam apparatus and supplies of foam concentrate shall be appropriate to the specific hazards. [30:6.7.9]

66.6.8 Emergency Planning and Training.

66.6.8.1 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

[30:6.8.1]

66.6.8.2 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. [30:6.8.2]

66.6.8.3 Planning of effective fire control measures shall be coordinated with local emergency response agencies. [30:6.8.3]

66.6.8.4 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. [30:6.8.4]

66.6.8.5 The emergency procedures shall be kept readily available in the operating areas and shall be updated when conditions change, as identified in 66.6.4.2. [30:6.8.5]

66.6.8.5.1 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. [30:6.8.5.1]

66.6.9 Inspection and Maintenance.

66.6.9.1 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 manufacturers recommendations. Water-based fire protection systems shall be inspected, tested, and maintained in accordance with this Code and NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. [30:6.9.1]

66.6.9.2 Maintenance and operating practices shall be established and implemented to control leakage and prevent spillage of flammable and combustible liquids. [30:6.9.2]

66.6.9.3 Combustible waste material and residues in operating areas shall be kept to a minimum, stored in covered metal containers, and disposed of daily. [30:6.9.3]

66.6.9.4 Ground areas around facilities where liquids are stored, handled, or used shall be kept free of weeds, trash, or other unnecessary combustible materials. [30:6.9.4]

66.6.9.5 Aisles established for movement of personnel shall be kept clear of obstructions to permit orderly evacuation and ready access for manual fire-fighting activities. [30:6.9.5]

66.6.10 Management of Security. [30:6.10]

66.6.10.1 Scope. [30:6.10.1]

66.6.10.1.1 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. [30:6.10.1.1]

66.6.10.1.2 These hazards include, but are not limited to, vulnerability to terrorist or other malicious attacks. [30:6.10.1.2]

66.6.10.2 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 of NFPA 30 for more detailed information.*)

[30:6.10.2]

66.6.10.3 Specific Requirements. [30:6.10.3]

66.6.10.3.1 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. [30:6.10.3.1]

66.6.10.3.2 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

[30:6.10.3.2]

66.6.10.3.3 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

[30:6.10.3.3]

66.6.10.3.4 Specific duties of personnel shall be reviewed at the time of initial assignment, as responsibilities or response actions change, and whenever anticipated duties change. [30:6.10.3.4]

66.6.10.3.5 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

[30:6.10.3.5]

66.7 Electrical Systems.

66.7.1 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. [30:7.1]

66.7.2 Reserved.

66.7.3 General Requirements.

66.7.3.1 Electrical utilization equipment and wiring shall not constitute a source of ignition for any ignitable vapor that might be present under normal operation or because of a spill. Compliance with 66.7.3.2 through 66.7.3.7.1 shall be deemed as meeting the requirements of this section. [30:7.3.1]

66.7.3.2 All electrical utilization equipment and wiring shall be of a type specified by and installed in accordance with NFPA 70, *National Electrical Code*. [30:7.3.2]

66.7.3.3* Table 66.7.3.3 shall be used to delineate and classify areas for the purpose of installation of electrical utilization equipment and wiring under normal operating conditions. [30:7.3.3]

Table 66.7.3.3 Electrical Area Classifications

Location	NEC Class I		Extent of Classified Area
	Division	Zone	
Indoor equipment installed in accordance with 66.7.3 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 66.7.3 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
	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

Table 66.7.3.3 *Continued*

Location	NEC Class I		Extent of Classified Area		
	Division	Zone			
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	2	2	Indoor		
			Outdoor		
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	2	2	Outdoor		
			Indoor		
Tank vehicle and tank car ²	1	0	Area inside of the tank		
Loading through open dome			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

Table 66.7.3.3 Continued

Location	NEC Class I		Extent of Classified Area
	Division	Zone	
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 of NFPA 30.		

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

¹The 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.

²When 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. [30: Table 7.3.3]

66.7.3.4 A classified area shall not extend beyond a floor, wall, roof, or other solid partition that has no openings within the classified area. [30:7.3.4]

66.7.3.5 The designation of classes, divisions, and zones shall be as defined in Chapter 5 of *NFPA 70*. [30:7.3.5]

66.7.3.6 The area classifications listed in Table 66.7.3.3 are based on the premise that all applicable requirements of this *Code* have been met. If this is not the case, the AHJ shall have the authority to classify the extent of the area. [30:7.3.6]

66.7.3.7* Where the provisions of 66.7.3.1 through 66.7.3.6 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. [30:7.3.7]

66.7.3.7.1 Ventilation make-up air shall be taken from an uncontaminated source. [30:7.3.7.1]

66.8 Reserved.

66.9 Storage of Liquids in Containers — General Requirements.

66.9.1 Scope.

66.9.1.1 This section 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)

[30:9.1.1]

66.9.1.2 This section shall also apply to limited transfer of liquids incidental thereto. [30:9.1.2]

66.9.1.3 This section 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 66.3.3.10. [30:9.1.3]

66.9.1.4 This section shall not apply to the following:

- (1) Containers, intermediate bulk containers, and portable tanks that are used in operations areas, as covered by Section 66.17
- (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*, 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 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

[30:9.1.4]

66.9.2 Reserved.

66.9.3 General Requirements.

66.9.3.1 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 of *NFPA 30*, regardless of the quantities being stored.

Exception: Where more stringent requirements are set forth in Chapters 10 through 14 of NFPA 30, those requirements shall take precedence. [30:9.3.1]

66.9.3.2 For the purposes of Sections 66.9 through 66.16, unstable liquids shall be treated as Class IA liquids. [30:9.3.2]

66.9.3.3 Means of egress shall meet applicable requirements of *NFPA 101, Life Safety Code*. [30:9.3.3]

66.9.3.3.1 Storage of liquids shall not physically obstruct a means of egress. [30:9.3.3.1]

66.9.3.4 For the purposes of this section and Chapters 10, 12, and 16 of *NFPA 30*, *protected storage* shall mean storage installed after January 1, 1997 that is protected in accordance with Section 66.16. All other storage shall be considered to be unprotected storage unless an alternate means of protection has been approved by the AHJ. [30:9.3.4]

66.9.3.5 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. [30:9.3.5]

66.9.3.6 Class I liquids shall not be permitted to be stored in basements as defined in 3.3.23. [30:9.3.6]

66.9.3.7 Class II and Class IIIA liquids shall be permitted to be stored in basements as defined in 3.3.23, provided the basement is protected in accordance with Section 66.16. [30:9.3.7]

66.9.3.8 Class IIIB liquids shall be permitted to be stored in basements as defined in 3.3.23. [30:9.3.8]

66.9.3.9 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. [30:9.3.9]

66.9.3.9.1 Portable tanks and intermediate bulk containers stored more than one high shall be designed to stack securely, without the use of dunnage. [30:9.3.9.1]

66.9.3.9.2 Materials-handling equipment shall be capable of handling containers, portable tanks, and intermediate bulk containers that are stored at all storage levels. [30:9.3.9.2]

66.9.3.9.3* 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*. [30:9.3.9.3]

66.9.3.10 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. [30:9.3.11]

66.9.3.11 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. [30:9.3.11]

66.9.3.12 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 Section 66.6 justifies following the requirements for some other liquid class. (See 66.6.4.1.2 and A.66.6.4.1.2.)

66.9.4 Acceptable Containers.

66.9.4.1* 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 containers meeting the requirements of and used for petroleum products 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 Kerosine and Diesel Containers for Consumer Use*
 - (c) ANSI/UL 1313, *Standard for Nonmetallic Safety Cans for Petroleum Products*
 - (d) ANSI/UL 30, *Standard for Metal Safety Cans*
 - (e) ANSI/UL 1314, *Standard for Special Purpose Metal Containers*
 - (f) FM Global *Approval Standard for Safety Containers and Filling, Supply, and Disposal Containers* — Class Number 6051 and 6052
- (3) 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*
- (4) Fiber drums that meet the following:
 - (a) Requirements of Items 294 and 296 of the *National Motor Freight Classification* (NMFC), or 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 U.S. Department of Transportation exemption

(5)* 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*

(6) Glass containers up to the capacity limits stated in Table 66.9.4.3 and in accordance with U.S. Department of Transportation Hazardous Materials Regulations in Title 49, Code of Federal Regulations, Parts 100–199

[30:9.4.1]

66.9.4.1.1 For protected storage, rigid nonmetallic intermediate bulk containers, as described in 66.9.4.1(5), shall be subjected to a standard fire test that demonstrates acceptable inside storage fire performance and shall be listed and labeled. [30:9.4.1.1]

66.9.4.1.2 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 66.9.4.1 and 66.9.4.3. [30:9.4.1.2]

66.9.4.2 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. [30:9.4.2]

66.9.4.2.1 The total venting capacity shall be not less than that specified in 22.7.3.2 or 22.7.3.4 of NFPA 30. [30:9.4.2.1]

66.9.4.2.2 At least one pressure-actuated vent having a minimum capacity of 6000 ft³ (170 m³) of free air per hour at an absolute pressure of 14.7 psi (101 kPa) and 60°F (15.6°C) shall be used. It shall be set to open at not less than a gauge pressure of 5 psi (35 kPa). [30:9.4.2.2]

66.9.4.2.3 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. [30:9.4.2.3]

66.9.4.3 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 66.9.4.3.

Exception: As provided for in 66.9.1, 66.9.4.3.1, 66.9.4.3.2, a,d 66.9.4.3.3. [30:9.4.3]

Table 66.9.4.3 Maximum Allowable Size — Containers, Intermediate Bulk Containers (IBCs), and Portable Tanks

Container Type	Flammable Liquids			Combustible Liquids	
	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 66.16.3.6 and is approved for the specific container and protection against static electricity is provided in accordance with 66.6.5.4.

*See 66.9.4.3.1. [30: Table 9.4.3]

66.9.4.3.1 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 66.16.5.2.7. [30:9.4.3.1]

66.9.4.3.2 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. [30:9.4.3.2]

66.9.4.3.3 Leaking or damaged containers up to 60 gal (230 L) capacity shall be permitted to be stored temporarily in accordance with this section and Chapters 10 through 12 of NFPA 30, provided they are enclosed in overpack containers. [30:9.4.3.3]

66.9.4.3.3.1 To be considered protected storage as defined in 66.9.3.4 and in accordance with Section 66.16, an overpack container shall be constructed of the same material as the leaking or damaged container. [30:9.4.3.3.1]

66.9.4.3.3.2 Metal overpack containers shall be considered nonrelieving style containers. [30:9.4.3.3.2]

66.9.5* Flammable Liquids Storage Cabinets.

66.9.5.1 The volume of Class I, Class II, and Class IIIA liquids stored in an individual storage cabinet shall not exceed 120 gal (460 L). [30:9.5.1]

66.9.5.2 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. [30:9.5.2]

66.9.5.3 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 NFPA 251, *Standard Methods of Tests of Fire Resistance of Building and Construction and Materials*, shall be acceptable. All joints and seams shall remain tight and the door shall remain securely closed during the test.
- (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 66.9.5.3(1) shall be acceptable. [30:9.5.3]

66.9.5.4* Storage cabinets shall not be required by this Code to be ventilated for fire protection purposes. [30:9.5.4]

66.9.5.4.1 If not ventilated, storage cabinet vent openings shall be sealed with the bungs supplied with the cabinet or with bungs specified by the cabinet manufacturer. [30:9.5.4.1]

66.9.5.4.2* 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 ignitable 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. [30:9.5.4.2]

66.9.5.5* Storage cabinets shall be marked as follows:

WARNING:
FLAMMABLE
KEEP FIRE AWAY

[30:9.5.5]

66.9.5.5.1 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). [30:9.5.5.1]

66.9.5.5.2 All letters shall be uppercase and in contrasting color to the background. [30:9.5.5.2]

66.9.5.5.3 The marking shall be located on the upper portion of the cabinet's front door(s) or frame. [30:9.5.5.3]

66.9.5.5.4 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. [30:9.5.5.4]

66.9.6 Maximum Allowable Quantities (MAQs) per Control Area.

66.9.6.1 General Occupancy Limits. The MAQs of liquids allowed in each control area shall not exceed the amounts specified in Table 66.9.6.1.

Exception: As modified by 66.9.6.2 and Chapters 10 through 14 of NFPA 30. [30:9.6.1]

66.9.6.2 Special Occupancy Limits.

66.9.6.2.1 For the following occupancies, the MAQs per control area shall not exceed the amounts specified in Table 66.9.6.2.1:

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

[30:9.6.2.1]

Table 66.9.6.1 MAQ of Flammable and Combustible Liquids per Control Area

	Liquid Class(es)	Quantity		Notes
		gal	L	
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 this 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. 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 and designed in accordance with the protection criteria contained in Section 66.16 of this Code. [30: Table 9.6.1]

Table 66.9.6.2.1 MAQs — Special Occupancy Limits

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

[30: Table 9.6.2.1]

66.9.6.2.2 For the occupancies specified in 66.9.6.2.1, 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). [30:9.6.2.2]

66.9.6.2.3 Fuel in the tanks of operating mobile equipment shall be permitted to exceed the quantities specified in Table 66.9.6.1, where the equipment is operated in accordance with this Code. [30:9.6.2.3]

66.9.6.2.4 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 Section 13.3 and NFPA 13. [30:9.6.2.4]

66.9.7 Control Areas.

66.9.7.1 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 66.9.6.1 or Table 66.9.6.2.1 are stored. [30:9.7.1]

66.9.7.2 Control areas shall be separated from each other by fire barriers in accordance with Table 66.9.7.2. [5000:34.2.5.1.1]

Table 66.9.7.2 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			
>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			
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 66.9.6.1, 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. [5000: Table 34.2.5.1.1]

66.9.7.3 Control areas located below grade that are considered basements, as defined in 3.3.23, shall not be utilized for the storage of Class I liquids. [30:9.7.3]

66.9.8 Classification of Occupancies That Exceed the MAQs of Liquids per Control Area.

66.9.8.1* 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. [30:9.8.1]

66.9.8.1.1 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. [30:9.8.1.1]

66.9.8.1.2 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. [30:9.8.1.2]

66.9.8.2* 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*. [30:9.8.2]

66.9.9 Construction Requirements.

66.9.9.1 Storage areas shall be constructed to meet the fire resistance ratings specified in Table 66.9.9.1. Construction assemblies shall comply with the test specifications given in ASTM E 119. [30:9.9.1]

Table 66.9.9.1 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 ft² = 0.09 m².

^aBetween liquid storage areas and any adjacent areas not dedicated to liquid storage.

^bFire 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.

^cFire resistance ratings for liquid warehouses protected in accordance with Section 66.16 are permitted to be reduced to 2 hours.

^dThis shall be a fire wall as defined in NFPA 221, *Standard for Fire Walls and Fire Barrier Walls*.

^eFor 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.

^fFor 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. [30: Table 9.9.1]

^gFor 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.

66.9.9.2 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 fire protection ratings that correspond to the fire resistance rating of the wall as specified in Table 66.9.9.2. [30:9.9.2]

Table 66.9.9.2 Protection Ratings for Fire Doors

Fire Resistance Rating of Wall as Required by Table 66.9.9.1 (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. [30: Table 9.9.2]

66.9.9.2.1 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. [30:9.9.2.1]

66.9.9.2.2 Fire doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*. [30:9.9.2.2]

66.9.9.3 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. [30:9.9.3]

66.9.10 Fire Protection.

66.9.10.1 Protected Storage. Fire protection requirements for protected storage shall meet the requirements of 66.9.10.2 and Section 66.16. [30:9.10.1]

66.9.10.2 Manual Fire Protection.

66.9.10.2.1 Portable fire extinguishers shall be provided in accordance with Section 13.6 and NFPA 10. [30:9.10.2.1]

66.9.10.2.2 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.

Exception: An acceptable alternative is at least one portable fire extinguisher having a capacity of 80:B located within 50 ft (15 m) of such a storage area. [30:9.10.2.2]

66.9.10.2.3 Where provided, hose connections supplied from sprinkler systems shall be installed in accordance with Section 13.3 and NFPA 13. [30:9.10.2.3]

66.9.10.2.4 Where provided, hose connections supplied by a standpipe system shall be installed in accordance with Section 13.2 and NFPA 14. [30:9.10.2.4]

66.9.10.2.5 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.

[30:9.10.2.5]

66.9.10.2.6 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 Section 66.16. [30:9.10.2.6]

66.9.11 Emergency Control Systems. (Reserved)

66.9.12 Electrical Systems.

66.9.12.1 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 66.9.12.2. [30:9.12.1]

66.9.12.2 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 shall apply to Class II and Class III liquids when stored at temperatures above their flash points. [30:9.12.2]

66.9.13* Containment, Drainage, and Spill Control.

66.9.13.1 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. [30:9.13.1]

66.9.13.1.1 Where the drainage system discharges to private or public sewers or waterways, the drainage system shall be equipped with traps and separators. [30:9.13.1.1]

66.9.13.2 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. [30:9.13.2]

66.9.13.3 Containment or drainage to an approved location shall be provided. [30:9.13.3]

66.9.13.3.1 Where a drainage system is used, it shall also have sufficient capacity to carry the expected discharge of water from fire protection systems. [30:9.13.3.1]

66.9.13.4 Where only Class IIIB liquids are stored, spill control, containment, and drainage shall not be required. [30:9.13.4]

66.9.13.5 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 66.16.5.2.11, spill control, containment, and drainage shall not be required. [30:9.13.5]

66.9.13.6 Where storage is protected in accordance with Section 66.16, spill control, containment, and drainage shall also meet the requirements of 66.16.8. [30:9.13.6]

66.9.14 Ventilation. Liquid storage areas where dispensing is conducted shall be provided with ventilation that meets the requirements of 66.18.6. [30:9.14]

66.9.15 Exhausted Enclosures. (Reserved)

66.9.16 Explosion Control.

66.9.16.1* 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 shall not apply to a liquid storage room totally enclosed within a building. [30:9.16.1]

66.9.16.2* 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. [30:9.16.2]

66.9.17 Separation from Incompatible Materials.

66.9.17.1 Except as provided for in 66.9.17.4, 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). [30:9.17.1]

66.9.17.1.1 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 66.9.5

[30:9.17.1.1]

66.9.17.2 Liquids shall be separated from Level 2 and Level 3 aerosols in accordance with Chapter 61 and NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*. [30:9.17.2]

66.9.17.3 Flammable and combustible liquids shall be separated from oxidizers by at least 25 ft (7.6 m). [400:15.2.12.13.1]

66.9.17.4 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. [30:9.17.4]

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

66.9.18.1 Dispensing, handling, and use of liquids shall meet all applicable requirements of Section 66.18. [30:9.18.1]

66.9.18.2 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 ft² (93 m²) in floor area unless the dispensing area is separated from the storage areas in accordance with Table 66.9.9.1 and meets all other requirements of 66.9.9. [30:9.18.2]

66.9.19 Outdoor Storage of Liquids. Storage of liquids outside of buildings shall meet the requirements of Section 66.14 or 66.15, whichever is applicable. [30:9.19]

66.10 Reserved.

66.11 Reserved.

66.12 Reserved.

66.13 Reserved.

66.14 Hazardous Materials Storage Lockers.

66.14.1* Scope. This section 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

[30:14.1]

66.14.2 Reserved.

66.14.3 General Requirements.

66.14.3.1 Lockers that are used as liquid storage rooms shall meet the requirements of Section 66.9. [30:14.3.1]

66.14.3.2 Lockers that are located outside shall meet the requirements of Sections 14.4 through 14.6 of NFPA 30. [30:14.3.2]

66.14.4 Design and Construction of Hazardous Materials Storage Lockers.

66.14.4.1 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 AHJ. [30:14.4.1]

66.14.4.2 Movable prefabricated structures that have been examined, listed, or labeled by an organization acceptable to the AHJ for use as a hazardous materials storage facility shall be acceptable. [30:14.4.2]

66.14.4.3 Lockers shall not exceed 1500 ft² (140 m²) gross floor area. [30:14.4.3]

66.14.4.4 Vertical stacking of lockers shall not be permitted. [30:14.4.4]

66.14.4.5 Where electrical wiring and equipment are required, they shall comply with Section 66.7 and 66.9.12. [30:14.4.5]

66.14.4.6 Where dispensing or filling is permitted inside a locker, operations shall comply with the provisions of Section 66.18. [30:14.4.6]

66.14.4.7 Ventilation shall be provided in accordance with 66.18.6. [30:14.4.7]

66.14.4.8 Lockers shall include a spill containment system to prevent the flow of liquids from the structure under emergency conditions. [30:14.4.8]

66.14.4.8.1 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. [30:14.4.8.1]

66.14.5 Designated Sites for Hazardous Materials Storage Lockers.

66.14.5.1 Lockers shall be located on a designated approved site on the property. [30:14.5.1]

66.14.5.2 The designated site shall be arranged to provide the minimum separation distances specified in Table 66.14.5.2 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. [30:14.5.2]

66.14.5.3 Once the designated site is approved, it shall not be changed without the approval of the AHJ. [30:14.5.3]

66.14.5.4 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 66.14.5.2. [30:14.5.4]

66.14.5.5 Where the approved designated storage site is accessible to the general public, it shall be protected from tampering or trespassing. [30:14.5.5]

Table 66.14.5.2 Designated Sites

Area of Designated Site ^a (ft ²)	Minimum Separation Distance (ft)		
	Between Individual Lockers	From Locker to Property Line That Is or Can Be Built Upon ^b	From Locker to Nearest Side of Public Way 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 ft² = 0.09 m².

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 66.9.15, all distances required by Table 66.14.5.2 are permitted to be waived.

^aSite area limits are intended to differentiate the relative size and thus the number of lockers that are permitted in one designated site.

^bDistances 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.

^cWhen 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).

^dWhen a single locker has a gross single story floor area that will require a site area limit of greater than 1500 ft² (140 m²) or when multiple units exceed the area limit of 1500 ft² (140 m²), the AHJ should be consulted for approval of distances. [30: Table 14.5.2]

66.14.6 Storage Requirements.

66.14.6.1 Containers of liquid in their original shipping packages shall be permitted to be stored either palletized or solid piled. [30:14.6.1]

66.14.6.2 Unpackaged containers shall be permitted to be stored on shelves or directly on the floor of the locker. [30:14.6.2]

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

66.14.6.4 In all cases, the storage arrangement shall provide unrestricted access to and egress from the locker. [30:14.6.4]

66.14.6.5 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. [30:14.6.5]

66.14.6.6 Warning signs for lockers shall be in accordance with applicable local, state, and federal regulations or with NFPA 704. [30:14.6.6]

66.15 Outdoor Storage.

66.15.1 Scope. This section 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

[30:15.1]

66.15.2 Reserved.

66.15.3 General Requirements. Outdoor storage of liquids in containers, intermediate bulk containers, and portable tanks shall comply with Table 66.15.3 and with all applicable requirements of this section. [30:15.3]

66.15.3.1 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. [30:15.3.1]

66.15.3.2 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. [30:15.3.2]

66.15.3.3 The distances specified in Table 66.15.3 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. [30:15.3.3]

66.15.3.4 Where total quantity stored does not exceed 50 percent of the maximum quantity per pile, as specified in Table 66.15.3, 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). [30:15.3.4]

66.15.3.5 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. [30:15.3.5]

66.15.3.5.1 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. [30:15.3.5.1]

66.15.3.6 When accessible to the public, the storage area shall be protected against tampering and trespassing. [30:15.3.6]

66.15.3.7 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. [30:15.3.7]

66.15.3.8 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. [30:15.3.8]

66.15.4 Outdoor Storage Adjacent to a Building.

66.15.4.1 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.

Table 66.15.3 Storage Limitations for Outside Storage

Liquid Class	Containers		Portable Tanks and Metal IBCs		Rigid Plastic and Composite IBCs		Minimum Separation Distance (ft)		
	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.

^aSee 66.15.3.1 regarding mixed-class storage.

^bSee 66.15.3.4 for smaller pile sizes.

^cFor 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.

^dSee 66.15.3.3 regarding protection for exposures. [30: Table 15.3]

- (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.

[30:15.4.1]

66.15.4.2 The provisions of 66.15.4.1(1) through (4) shall be permitted to be waived, subject to the approval of the AHJ, if the building in question is one story, is of fire-resistive or noncombustible construction, and is devoted principally to the storage of liquids. [30:15.4.2]

66.15.4.3 The quantity of liquid stored adjacent to a building that meets the conditions of 66.15.4.1(1) through (4) shall be permitted to exceed that permitted in 66.15.4.1, 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. [30:15.4.3]

66.15.4.4 The quantity of liquid stored shall be permitted to exceed the 1100 gal (4160 L) quantity specified by 66.15.4.1 where a minimum distance equal to that specified by Table 66.15.3 for distance to property line shall be maintained between buildings and the nearest container or portable tank. [30:15.4.4]

66.15.4.5 Where the provisions of 66.15.4.1 cannot be met, a minimum distance equal to that specified by Table 66.15.3 for distance to property line shall be maintained between buildings and the nearest container or portable tank. [30:15.4.5]

66.16 Automatic Fire Protection for Inside Liquid Storage Areas.

66.16.1 Scope.

66.16.1.1* This section 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 66.9.4. [30:16.1.1]

66.16.1.2* This section shall not apply to Class IA flammable liquids or to unstable flammable or combustible liquids. [30:16.1.2]

66.16.1.3 Storage of liquids that is protected in accordance with the applicable requirements of this section shall be considered protected, as defined in 66.16.2.2. All other storage shall be considered unprotected unless an alternate means of protection has been approved by the AHJ. [30:16.1.3]

66.16.2 Definitions Specific to Section 66.16. For the purpose of this section, the following terms shall have the definitions given. [30:16.2]

66.16.2.1 Protected Storage. Flammable and combustible liquids storage that is protected in accordance with this section. [30:16.2.2]

66.16.2.2* 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. [30:16.2.3]

66.16.2.3* 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. [30:16.2.4]

66.16.2.4 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 66.16.2.4. [30:16.2.5]

66.16.2.5 Water-Miscible Liquid. A liquid that mixes in all proportions with water without the use of chemical additives, such as emulsifying agents. [30:16.2.6]

66.16.3 General Requirements.

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

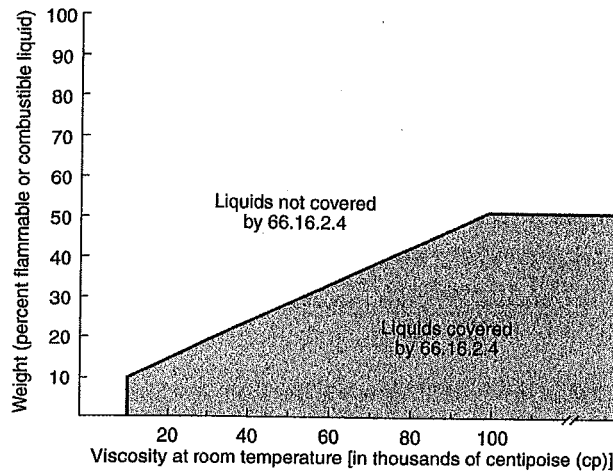


FIGURE 66.16.2.4 Viscous Liquid: Viscosity Versus Weight Percent Flammable or Combustible Component. [30: Figure 16.2.5]

- (1) Requirements of this section 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 66.16.8

[30:16.3.1]

66.16.3.2 Unless otherwise specified in this section, single-row racks shall not be more than 4.5 ft (1.4 m) wide and double-row racks shall not be more than 9 ft (2.8 m) wide. [30:16.3.2]

66.16.3.3 When applying the fire protection criteria of this section, 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 66.16.5. [30:16.3.3]

66.16.3.4 Viscous liquids, as defined in 66.16.2.4, shall be permitted to be protected using either of the following, as applicable:

- (1) Criteria for a Class IIIB liquid in accordance with Figure 66.16.4.1(a) or Figure 66.16.4.1(b)
- (2) Criteria for Group A plastics in accordance with Figure 66.16.4.1(b)

[30:16.3.4]

66.16.3.5 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 section. Such alternative protection systems shall be approved by the AHJ. [30:16.3.5]

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

- (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.

[30:16.3.6]

66.16.3.7 To be considered protected by Table 66.16.5.2.9 and Table 66.16.5.2.10, 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. [30:16.3.7]

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

66.16.4.1 Where automatic sprinkler systems or low-expansion foam-water sprinkler systems are used to protect storage of liquids, Figure 66.16.4.1(a), Figure 66.16.4.1(b), or Figure 66.16.4.1(c), whichever is applicable, and the appropriate table in 66.16.5 shall be used to determine protection criteria. [30:16.4.1]

66.16.4.1.1 Figure 66.16.4.1(a) shall be used for miscible and nonmiscible flammable and combustible liquids in metal containers, metal portable tanks, and metal intermediate bulk containers. [30:16.4.1.1]

66.16.4.1.2 Figure 66.16.4.1(b) shall be used for miscible and nonmiscible flammable and combustible liquids in nonmetallic containers and in nonmetallic intermediate bulk containers. [30:16.4.1.2]

66.16.4.1.3 Figure 66.16.4.1(c) shall be used for water-miscible flammable and combustible liquids in nonmetallic containers and in nonmetallic intermediate bulk containers. [30:16.4.1.3]

66.16.4.2 Automatic sprinkler and foam-water fire protection systems shall be wet pipe, deluge, or preaction systems. [30:16.4.2]

66.16.4.2.1 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. [30:16.4.2.1]

66.16.4.2.2 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*. [30:16.4.2.2]

66.16.4.3 Water-based fire protection systems shall be inspected, tested, and maintained in accordance with NFPA 25. [30:16.4.3]

66.16.5 Fire Protection System Design Criteria.

66.16.5.1 General. Subsections 66.16.5.2.1 through 66.16.5.2.12 and their related tables, Table 66.16.5.2.1 through Table 66.16.5.2.12, shall be used to determine the protection criteria and storage arrangement for the applicable liquid class, container type, and storage configuration, as described in 66.16.5.2.1 through 66.16.5.2.12 and subject to the provisions of 66.16.5.1. [30:16.5.1]

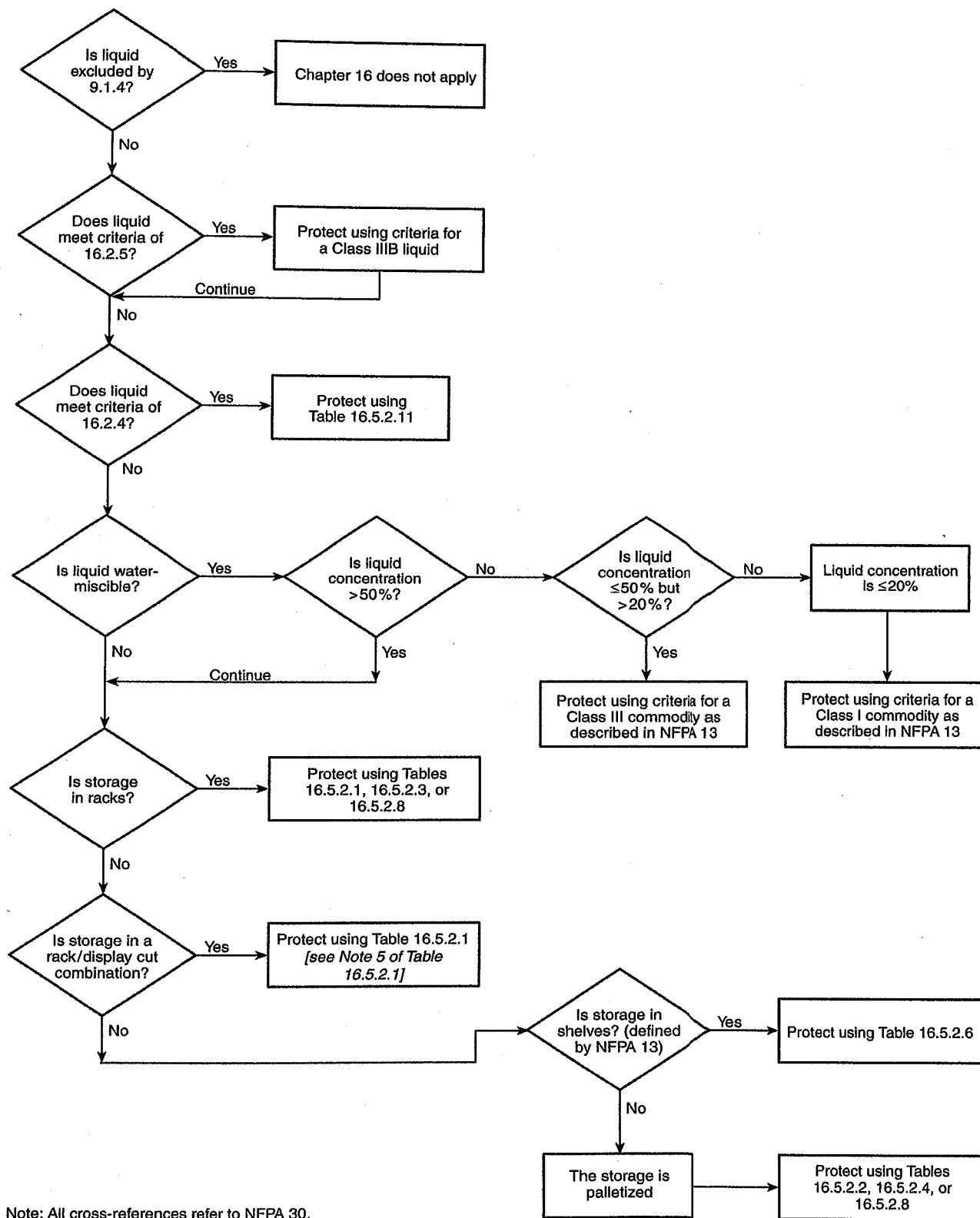
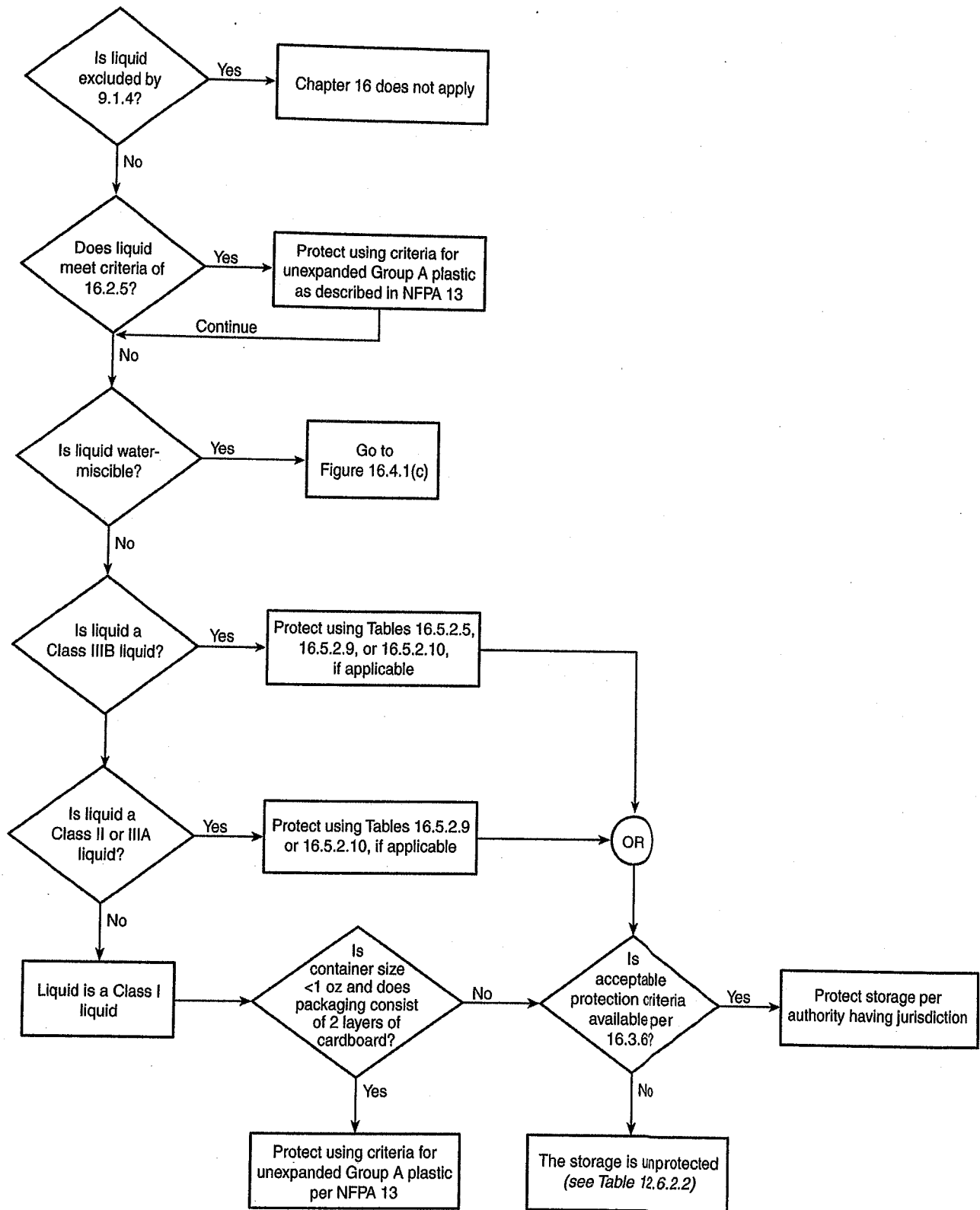
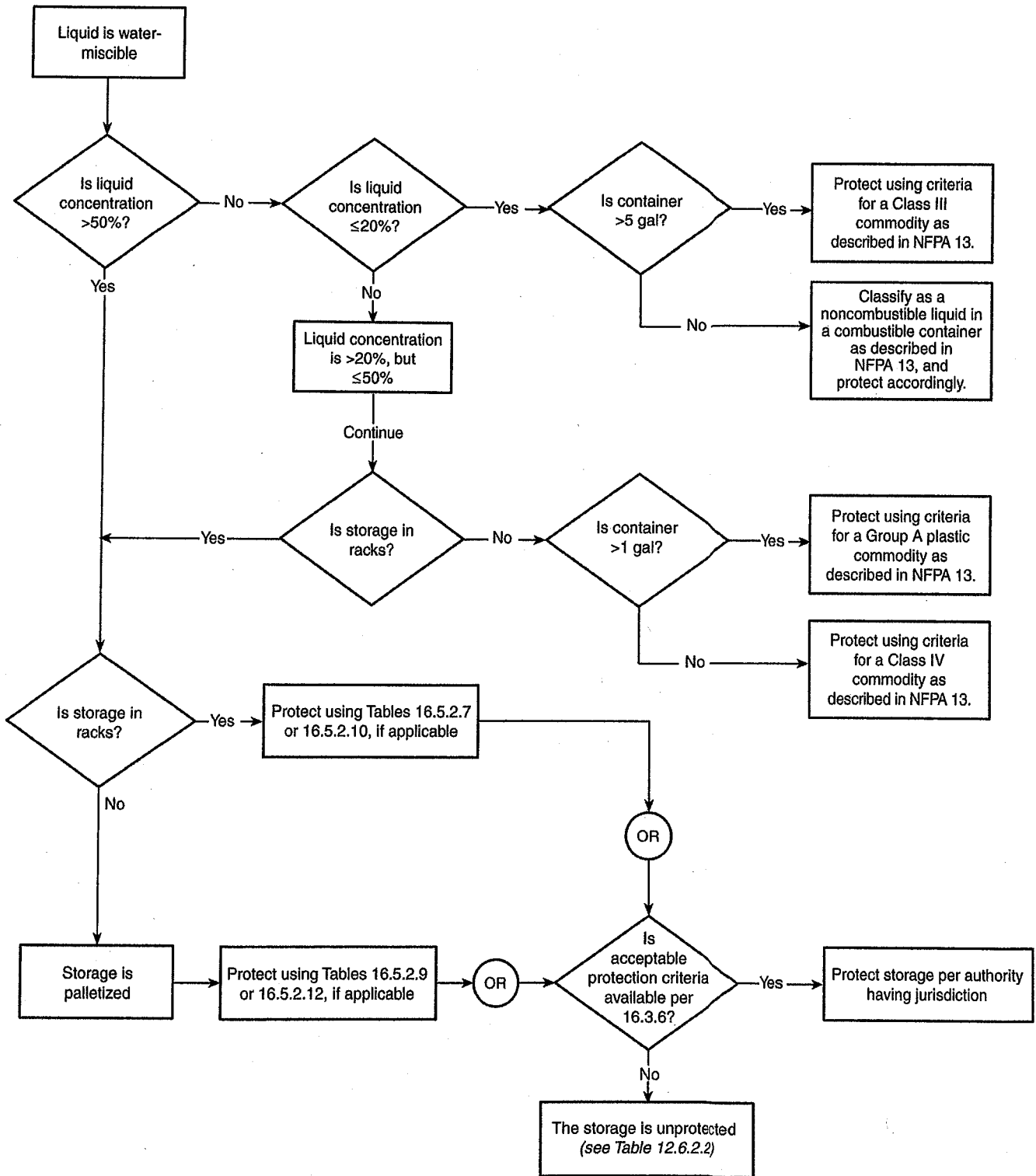


FIGURE 66.16.4.1(a) Fire Protection Criteria Decision Tree for Miscible and Nonmiscible Flammable and Combustible Liquids in Metal Containers. [30: Figure 16.4.1(a)]



Note: All cross-references refer to NFPA 30.

FIGURE 66.16.4.1(b) Fire Protection Criteria Decision Tree for Miscible and Nonmiscible Flammable and Combustible Liquids in Nonmetallic Containers. [30: Figure 16.4.1(b)]



Note: All cross-references refer to NFPA 30.
 For SI units, 1 gal = 3.8 L.

FIGURE 66.16.4.1(c) Fire Protection Criteria Decision Tree for Miscible Flammable and Combustible Liquids in Nonmetallic Containers. [30: Figure 16.4.1(c)]

66.16.5.1.1 Table 66.16.5.2.1 through Table 66.16.5.2.12 shall apply only to stable liquids. [30:16.5.1.1]

66.16.5.1.2 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 section. 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. [30:16.5.1.2]

66.16.5.1.3 In-rack sprinklers shall be installed in accordance with the provisions of Section 13.3 and NFPA 13. In addition, the following modifications shall apply:

- (1) In-rack sprinklers shall be laid out in accordance with 66.16.5.1.10 and 66.16.6, 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 of the 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.

[30:16.5.1.3]

66.16.5.1.4 Ceiling sprinklers shall be installed in accordance with Section 13.3 and NFPA 13 and shall be permitted to have the following maximum head spacing:

- (1) Classes I, II, and IIIA liquids: 100 ft² (9.3 m²) per sprinkler
- (2) Class IIIB liquids: 120 ft² (11.1 m²) per sprinkler

[30:16.5.1.4]

66.16.5.1.4.1 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 ft² (13 m²) coverage, with 12 ft (3.7 m) minimum spacing and a maximum coverage area of 196 ft² (18 m²) coverage. [30:16.5.1.4.1]

66.16.5.1.5 The ceiling heights given in Table 66.16.5.2.1 through Table 66.16.5.2.12 shall be permitted to be increased by a maximum of 10 percent if an equivalent percent increase in ceiling sprinkler design density is provided. [30:16.5.1.5]

66.16.5.1.6 Foam-water sprinkler systems shall be designed and installed in accordance with NFPA 16. [30:16.5.1.6]

66.16.5.1.6.1 Foam-water sprinkler systems shall have at least 15 minutes of foam concentrate, based on the required design flow rate. [30:16.5.1.6.1]

66.16.5.1.6.2* Foam-water sprinkler systems shall provide foam solution at the minimum required concentration with as few as four sprinklers flowing. [30:16.5.1.6.2]

66.16.5.1.7 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. [30:16.5.1.7]

66.16.5.1.8 For the purposes of 66.16.5, a rigid nonmetallic intermediate bulk container is one that meets the maximum allowable capacity criteria of Table 66.9.4.3 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. [30:16.5.1.8]

66.16.5.1.9 For the purposes of 66.16.5, the following shall apply:

- (1) 1 gal = 3.8 L; 1 ft = 0.3 m; 1 ft² = 0.09 m²
- (2) 1 gpm/ft² is equivalent to 40.7 L/min/m² 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

[30:16.5.1.9]

66.16.5.1.10 For the purposes of 66.16.5, the following shall apply to the in-rack sprinkler design layouts specified in Table 66.16.5.2.1 through Table 66.16.5.2.12:

- (1) Layout A shall mean one line of in-rack sprinklers 8 ft (2.4 m) above the floor, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically.
- (2) Layout B 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, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically.
- (3) Layout C shall mean one line of in-rack sprinklers at every storage level above the floor, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically.
- (4) Layout D shall mean one line of in-rack sprinklers at every other storage level, beginning above the first storage level, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically.
- (5) Layout E shall mean one line of in-rack sprinklers in the flue space at every storage level above the floor 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.
- (6) Layout F shall mean one line of in-rack sprinklers in the flue space at every other storage level above the first storage level 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.
- (7) Layout G shall be as shown in Figure 66.16.6.4(a).
- (8) Layout H shall be as shown in Figure 66.16.6.4(d) or Figure 66.16.6.4(e).
- (9) Layout I shall be as shown in Figure 66.16.6.4(b) or Figure 66.16.6.4(c).

[30:16.5.1.10]

66.16.5.1.11 The "Fire Test Ref." number given for each entry in Table 66.16.5.2.1 through Table 66.16.5.2.12 shall be used to identify in Section D.2 of NFPA 30 the information on the fire tests on which the protection criteria for that entry are based. [30:16.5.1.11]

66.16.5.1.12 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. [30:16.5.1.12]

66.16.5.2 Specific Design Criteria.

66.16.5.2.1 Table 66.16.5.2.1 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

[30:16.5.2.1]

66.16.5.2.2 Table 66.16.5.2.2 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

[30:16.5.2.2]

66.16.5.2.3 Table 66.16.5.2.3 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

[30:16.5.2.3]

66.16.5.2.4 Table 66.16.5.2.4 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

[30:16.5.2.4]

66.16.5.2.5 Table 66.16.5.2.5 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

[30:16.5.2.5]

66.16.5.2.6 Table 66.16.5.2.6 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

[30:16.5.2.6]

66.16.5.2.7 Table 66.16.5.2.7 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Single- or double-row rack storage
- (3) Water-miscible liquids with concentration of flammable or combustible component greater than 50 percent by volume
- (4) Plastic containers
- (5) Cartoned or uncartoned
- (6) Minimum 8 ft (2.4 m) aisle width

[30:16.5.2.7]

66.16.5.2.8 Table 66.16.5.2.8 shall apply to the following:

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

[30:16.5.2.8]

66.16.5.2.9 Table 66.16.5.2.9 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Palletized storage
- (3) Class II and Class III nonmiscible and Class II and Class III miscible liquids
- (4) Listed and labeled rigid nonmetallic intermediate bulk containers

[30:16.5.2.9]

66.16.5.2.10 Table 66.16.5.2.10 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Single- or double-row rack storage
- (3) Class II and Class III nonmiscible and Class II and Class III miscible liquids
- (4) Listed and labeled rigid nonmetallic intermediate bulk containers

[30:16.5.2.10]

66.16.5.2.11 Table 66.16.5.2.11 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Palletized or stacked storage
- (3) Unsaturated polyester resins (UPRs) with not more than 50 percent by weight of Class IC, II, or IIIA liquid
- (4) Metal containers; nonrelieving style allowed only up to 6 gal (23 L)

[30:16.5.2.11]

66.16.5.2.12 Table 66.16.5.2.12 shall apply to the following:

- (1) Automatic sprinkler protection
- (2) Palletized or stacked storage
- (3) Miscible liquids with concentration of flammable or combustible components no greater than 80 percent by volume
- (4) Glass or plastic containers

[30:16.5.2.12]

Table 66.16.5.2.1 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				In-Rack Sprinkler Protection				Fire Test Ref. [See Table D.2(a) of NFPA 30]	
			Sprinkler		Design		Sprinkler		Discharge Flow (gpm)	Layout		Notes
			Type	Response	Density (gpm/ft ²)	Area (ft ²)	Type	Response				
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA												
≤1	16	30	K≥11.2	QR (HT)	0.60	2000	K=5.6 or 8.0	QR(OT)	30	A	1, 2	1
	20	30	K≥11.2	SR or QR (HT)	0.60	2000	K=5.6 or 8.0	QR(OT)	30	B	1, 2	2
≤5	25	30	K≥8.0	SR or QR (HT)	0.30	3000	K=5.6 or 8.0	QR(OT)	30	C	1	3
>5 and ≤60	25	30	K≥11.2	SR (HT)	0.40	3000	K=5.6 or 8.0	QR or SR(OT)	30	E	1	5
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB												
≤5	40	50	K≥8.0	SR or QR (HT)	0.30	2000	K=5.6 or 8.0	QR(OT)	30	D	1, 3	4
>5 and ≤60	40	50	K≥8.0	SR (HT)	0.30	3000	K=5.6 or 8.0	QR(OT)	30	D	1, 3	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 or 8.0	QR(OT)	30	D	1, 5	8
>5 and ≤60	25	30	K≥11.2	SR (HT)	0.60	3000	K=5.6 or 8.0	QR(OT)	30	F	1	10
Portable tanks and IBCs	25	30	K≥11.2	SR (HT)	0.60	3000	K=5.6 or 8.0	QR or SR(OT)	30	E	1	12
RELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB												
≤ 5 gal	40	50	K≥8.0	SR or QR (HT)	0.30	2000	K=5.6 or 8.0	QR(OT)	30	D	1	9
>5 and ≤60	40	50	K≥8.0	SR (HT)	0.30	3000	K=5.6 or 8.0	QR(OT)	30	D	1, 3	11
Portable tanks and IBCs	40	50	K≥8.0	SR (HT)	0.30	3000	K=5.6 or 8.0	QR(OT)	30	D	1, 6	13

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft² = 0.09 m², 1 gpm/ft² = 40.7 L/min/m² = 40.7 mm/min.

SR: Standard response sprinkler. QR: Quick response sprinkler. OT: Ordinary temperature. HT: High temperature.

Notes:

- (1) In-rack sprinkler design based on 6 most hydraulically remote sprinklers in each of upper three levels or on 8 most hydraulically remote sprinklers, if only one level.
- (2) Protection for uncartoned or case-cut nonsolid shelf display up to 6.5 ft. (2 m) and storage above in pallets on racking, shelf materials, open wire mesh, or 2 in. × 6 in. (50 mm × 150 mm) wooden slats, spaced a minimum of 2 in. (50 mm) apart.
- (3) For K=8.0 and larger ceiling sprinklers, 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) width.
- (5) For K=8.0 and larger ceiling sprinklers, increase ceiling density to 0.60 over 2000 ft² 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. [30: Table 16.5.2.1]

Table 66.16.5.2.2 Design Criteria for Sprinkler Protection of Palletized and Stacked 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				Notes	Fire Test Ref. [See Table D.2(b) of NFPA 30]
			Sprinkler		Design			
			Type	Response	Density (gpm/ft ²)	Area (ft ²)		
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA								
≤5	4	18	K≥8.0	SR or QR (HT)	0.21	1500	1	1
	5	18	K≥8.0	SR or QR (HT)	0.30	3000	—	2
	6.5	30	K≥11.2	QR (HT)	0.45	3000	—	3
>5 and ≤60	5	18	K≥11.2	SR (HT)	0.40	3000	—	4
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB								
≤5	18	30	K≥8.0	SR or QR (HT)	0.25	3000	—	5
>5 and ≤60	10	20	K≥8.0	SR (HT)	0.25	3000	—	6
	18	30	K≥8.0	SR (HT)	0.35	3000	—	7
RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA								
≤5	12	30	K≥11.2 pendent only	QR (HT)	0.60	3000	2	8
>5 and ≤60	5	30	K≥11.2	SR (HT)	0.40	3000	—	9
	6.5	30	K≥11.2	SR (HT)	0.60	3000	3	10
Portable tanks and IBCs	1-high	30	K≥8.0	SR (HT)	0.30	3000	—	14
	2-high	30	K≥11.2	SR (HT)	0.60	3000	—	15
RELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB								
≤5	18	30	K≥8.0	SR or QR (HT)	0.25	3000	—	11
>5 and ≤60	10	20	K≥8.0	SR (HT)	0.25	3000	—	12
	18	30	K≥8.0	SR (HT)	0.35	3000	—	13
Portable tanks and IBCs	1-high	30	K≥8.0	SR (HT)	0.25	3000	—	16
	2-high	30	K≥11.2	SR (HT)	0.50	3000	—	17

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft² = 0.09 m², 1 gpm/ft² = 40.7 L/min/m² = 40.7 mm/min.

SR: Standard response sprinkler. QR: Quick response sprinkler. HT: High temperature.

Notes:

- (1) Minimum hose stream demand can be reduced to 250 gpm for 2 hours.
- (2) Sprinklers must also be hydraulically calculated to provide a density of 0.80 gpm/ft² over 1000 ft².
- (3) Drums must be placed on open slatted pallet, not nested, to allow pressure relief from drums on lower levels.

[30: Table 16.5.2.2]



Table 66.16.5.2.3 Design Criteria for Foam-Water Sprinkler Protection of Single- or 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				In-Rack Sprinkler Protection				Fire Test Ref. /See Table D.2(c) of NFPA 30j	
			Sprinkler		Design		Sprinkler		Discharge Flow (gpm)	Layout		Notes
			Type	Response	Density (gpm/ft ²)	Area (ft ²)	Type	Response				
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA												
≤5	25	30	K≥8.0	SR or QR (HT)	0.30	2000	K=5.6 or 8.0	QR or SR (OT)	30	C	1, 2, 4	1
>5 and ≤60	25	30	K≥8.0	SR (HT)	0.30	3000	K=5.6 or 8.0	QR or SR (OT)	30	C	1, 3, 4	2
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB												
≤60	40	50	K≥8.0	SR (HT)	0.30	2000	K=5.6 or 8.0	QR or SR (OT)	30	D	1	3
RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA												
≤5	25	30	K≥8.0	SR or QR (HT)	0.30	2000	K=5.6 or 8.0	QR or SR (OT)	30	D	1, 2, 4	4
>5 and ≤60, portable tanks and IBCs	25	30	K≥8.0	SR (HT)	0.30	3000	K=5.6 or 8.0		30	D	1, 3, 4	5
RELIEVING-STYLE CONTAINERS — LIQUID CLASS IIIB												
≤60	40	50	K≥8.0	SR (HT)	0.30	2000	K=5.6 or 8.0	QR or SR (OT)	30	D	1	6

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft² = 0.09 m², 1 gpm/ft² = 40.7 L/min/m² = 40.7 mm/min.
 OR: Quick response sprinkler. SR: Standard response sprinkler. OT: Ordinary temperature. HT: High temperature.

Notes:

- (1) In-rack sprinkler design based on 6 most hydraulically remote sprinklers in each of upper three levels.
- (2) Design area can be reduced to 1500 ft² when using a pre-primed foam-water system installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, and maintained according to NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.
- (3) Design area can be reduced to 2000 ft² when using a pre-primed foam-water system installed in accordance with NFPA 16 and maintained according to NFPA 25.
- (4) In-rack sprinkler hydraulic design can be reduced to three sprinklers operating per level, with three levels operating simultaneously, when using a pre-primed foam-water sprinkler system designed in accordance with NFPA 16 and maintained in accordance with NFPA 25. [30: Table 16.5.2.3]

Table 66.16.5.2.4 Design Criteria for Foam-Water Sprinkler Protection of Palletized and Stacked 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				Notes	Fire Test Ref. [See Table D.2(d) of NFPA 30]
			Sprinkler		Design			
			Type	Response	Density (gpm/ft ²)	Area (ft ²)		
NONRELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA								
≤5, cartoned	11	30	K≥11.2	SR or QR (HT)	0.40	3000	1	1
≤5, uncartoned	12	30	K≥8.0	SR or QR (HT)	0.30	3000	1	2
>5 and ≤60	5 (1-high)	30	K≥8.0	SR (HT)	0.30	3000	1	3
RELIEVING-STYLE CONTAINERS — LIQUID CLASSES IB, IC, II, IIIA								
>5 and ≤60	6.5 (2-high)	30	K≥8.0	SR (HT)	0.30	3000	2, 3	4
	10 (3-high)	33	K≥11.2	SR (HT)	0.45	3000	2, 3	6
	13.75 (4-high)	33	K≥11.2	SR (HT)	0.60	3000	2, 3	7
Portable tanks and IBCs	1- or 2-high	30	K≥8.0	SR (HT)	0.30	3000		5

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft² = 0.09 m², 1 gpm/ft² = 40.7 L/min/m² = 40.7 mm/min.

QR: Quick response sprinkler. SR: Standard response sprinkler. HT: High temperature.

Notes:

(1) Design area can be reduced to 2000 ft² when using a pre-primed foam-water system installed in accordance with NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, and maintained according to NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

(2) Both ¾ in. (20 mm) and 2 in. (50 mm) listed pressure-relieving mechanisms are required on containers greater than 6 gal (23 L) capacity.

(3) Drums placed on open slatted pallet, not nested, to allow pressure relief from drums on lower levels. [30: Table 16.5.2.4]

Table 66.16.5.2.5 Design Criteria for Sprinkler Protection of Single-, Double-, and Multiple-Row Rack Storage of Class IIIB Liquids

Closed-Cup Flash Point (°F)	Container or IBC Capacity (gal)	Packaging	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Minimum Aisle Width (ft)	Rack Width (ft)	Sprinkler Protection		Fire Test Ref. [See Table D.2(e) of NFPA 30]
							Ceiling Sprinkler Type	Design	
≥200	≤5	Plastic containers, cartoned or uncartoned	Unlimited	Unlimited	4	Any	Any	See 66.16.6.1, Fire Protection System Design Scheme "A"	1
≥375	≤275	Flexible plastic liner within a composite continuously wound corrugated paperboard intermediate bulk container (See Special Note 1)	28	30	8	Any	Any	See 66.16.6.3, Fire Protection System Design Scheme "C"	2
≥375	≤6	Flexible plastic liner within a composite corrugated paperboard box	Unlimited	Unlimited	8	Any	Any	See 66.16.6.3, Fire Protection System Design Scheme "C"	2

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 200°F = 93°C, 375°F = 190°C.

Note: Construction of intermediate bulk container to be a minimum of 8 layers of paperboard, with a minimum nominal thickness of 1½ in. (38 mm) at the center of any side panel. [30: Table 16.5.2.5]

Table 66.16.5.2.6 Design Criteria for Sprinkler Protection of Shelf Storage of Liquids in Metal Containers

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection				Special Notes	Fire Test Ref. [See Table D.2(f) of NFPA 30]
			Sprinkler		Design			
			Type	Response	Density (gpm/ft ²)	Area (ft ²)		
≤ 1, nonrelieving style	6	18	K≥8.0	SR or QR (HT)	0.19	1500	1, 2	1

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft² = 0.09 m², 1 gpm/ft² = 40.7 L/min/m² = 40.7 mm/min.
 QR: Quick response sprinkler. SR: Standard response sprinkler. HT: High temperature.

Notes:

(1) Protection limited to mercantile shelving that is 2 ft (600 mm) or less in depth per side, with backing between each side.

(2) Minimum hose stream demand can be reduced to 250 gpm for 2 hours. [30: Table 16.5.2.6]

Table 66.16.5.2.7 Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Water-Miscible Liquids in Glass or Plastic Containers

Container Style and Capacity	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection		Notes	Fire Test Ref. [See Table D.2(g) of NFPA 30]
			Ceiling Sprinkler Protection	In-Rack Sprinklers		
16 oz, cartoned	Unlimited	Unlimited	See 66.16.6.1, Fire Protection System Design Scheme "A"	See 66.16.6.1, Fire Protection System Design Scheme "A"	1, 2	3
≤1 gal, cartoned	Unlimited	Unlimited	See 66.16.6.2, Fire Protection System Design Scheme "B"	See 66.16.6.2, Fire Protection System Design Scheme "B"	1, 2	1
≤60 gal, cartoned or uncartoned	25	30	See 66.16.6.2, Fire Protection System Design Scheme "B"	See 66.16.6.2, Fire Protection System Design Scheme "B"	1, 2	2

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m.

Notes:

(1) Minimum aisle width in all cases is 8 ft (2.4 m).

(2) Maximum rack width in all cases is 9 ft (2.7 m). [30: Table 16.5.2.7]

Table 66.16.5.2.8 Design Criteria for Single-Row Rack, Double-Row Rack, and Palletized Storage of Liquids in Relieving-Style Metal Containers

Container Style and Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection		In-Rack Sprinkler Protection				Notes	Fire Test Ref. [See Table D.2(h) of NFPA 30]
			Sprinkler Type	Design (Number of sprinklers @ Stated Pressure)	Sprinkler Type	Response	End Sprinkler Design Pressure	Layout		
LIQUID CLASSES IB, IC, II, IIIA, IIIB										
RACK STORAGE with MAXIMUM 6 ft RACK WIDTH and MINIMUM 7.5 ft AISLE WIDTH										
≤5, cartoned or uncartoned	14	24	Pendent ESFR K≥14.0	12 @ 50 psi	K=11.2	QR (OT)	10 psi	G	1, 2, 3, 4, 5, 6	1
	14	24	Pendent ESFR K≥25.0	12 @ 25 psi	No in-rack sprinklers required				2, 3, 4, 5, 6	2
LIQUID CLASSES IB, IC, II, IIIA, IIIB										
RACK STORAGE with MAXIMUM 9 ft RACK WIDTH and 8 ft MINIMUM AISLE WIDTH										
≤1, cartoned only	20	30	Pendent ESFR K≥14.0 (OT)	12 @ 75 psi	No in-rack sprinklers required				—	3
≤1, cartoned only	25	30	Pendent ESFR K≥14.0 (OT)	12 @ 50 psi	K=8.0	QR (OT)	15 psi	H	1, 2, 5	4
≤5, cartoned or uncartoned	25	30	Pendent ESFR K≥14.0 (OT)	12 @ 75 psi	K=8.0	QR (OT)	30 psi	I	1, 2, 5	5
LIQUID CLASSES IB, IC, II, IIIA, IIIB PALLETIZED STORAGE with MINIMUM 7.5 ft AISLE WIDTH										
≤1, cartoned only	8	30	Pendent ESFR K≥14.0 (OT)	12 @ 50 psi	—	—	—	—	—	6
≤5, cartoned or uncartoned	12	30	Pendent ESFR K≥14.0 (OT)	12 @ 75 psi	—	—	—	—	—	7

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 psi = 6.9 kPa.

ESFR: Early suppression fast response sprinkler. QR: Quick response sprinkler. OT: Ordinary temperature.

Notes:

(1) The in-rack sprinkler water demand shall be based on the simultaneous operation of the most hydraulically remote sprinklers as follows:

(a) Seven sprinklers where only one level of in-rack sprinklers is installed.

(b) Fourteen sprinklers (seven on each of the two top levels) where more than one level of in-rack sprinklers is installed.

(2) The in-rack sprinkler water demand should be balanced with the ceiling sprinkler water demand at their point of connection.

(3) One-gallon and 1-quart containers are not required to be relieving style.

(4) Provide minimum 3 in. transverse flue at rack uprights.

(5) For Class IIIB liquids, see also Table 66.16.5.2.5.

(6) Racks can have open-mesh wire intermediate shelving on lower levels. [30: Table 16.5.2.8]

Table 66.16.5.2.9 Design Criteria for Sprinkler Protection of Palletized Storage of Class II and Class III Liquids in Listed and Labeled Rigid Nonmetallic IBCs

Maximum Capacity (gal)	Maximum Storage Height	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection				Notes	Fire Test Ref. [See Table D.2(i) of NFPA 30]
			Sprinkler		Design			
			Type	Response	Density (gpm/ft ²)	Area (ft ²)		
793	1-high	30	K≥11.2	SR (HT)	0.45	3000	1, 2, 4	1
793	2-high	30	K≥11.2	SR (HT)	0.60	3000	1, 2, 3, 4	2

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 gpm/ft² = 40.7 L/min/m² = 40.7 mm/min, 1 ft² = 0.9 m².

SR: Standard response sprinkler. HT: High temperature.

Notes:

- (1) Foam-water sprinkler protection shall be permitted to be substituted for water sprinkler protection, provided the same design criteria are used.
- (2) Rigid nonmetallic intermediate bulk containers shall be listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*, or an equivalent test procedure.
- (3) The sprinkler operating gauge pressure shall be a minimum 30 psi (207 kPa).
- (4) See also Section E.1. [30: Table 16.5.2.9]

Table 66.16.5.2.10 Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Class II and Class III Liquids in Listed and Labeled Rigid Nonmetallic IBCs

Maximum Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection		Notes	Fire Test Ref. [See Table D.2(j) of NFPA 30]
			Sprinkler Type	Design		
793	25	30	Standard spray	See 66.16.6.2, Fire Protection System Design Scheme "B"	1, 2, 3, 4	1

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m.

Notes:

- (1) Rigid nonmetallic intermediate bulk containers are listed and labeled in accordance with UL 2368, *Standard for Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids*, or an equivalent test procedure.
- (2) Maximum rack width is 9 ft (2.7 m).
- (3) Minimum aisle width is 8 ft (2.4 m).
- (4) See also Section E.1. [30: Table 16.5.2.10]

Table 66.16.5.2.11 Design Criteria for Sprinkler Protection of Palletized or Stacked Storage of Unsaturated Polyester Resins in Metal Containers

Capacity (gal)	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection				Notes	Fire Test Ref. [See Table D.2(k) of NFPA 30]
			Sprinkler		Design			
			Type	Response	Density (gpm/ft ²)	Area (ft ²)		
>5 and <60	10	33	K≥11.2	SR (HT or OT)	0.45	3000	1, 2, 3	1

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft² = 0.09 m², 1 gpm/ft² = 40.7 L/min/m² = 40.7 mm/min.

SR: Standard response sprinkler. OT: Ordinary temperature. HT: High temperature.

Notes:

- (1) Drums placed on open, slatted pallet, not nested, to allow pressure relief from drums on lower levels.
- (2) Storage areas containing unsaturated polyester resin (UPR) should not be located in the same spill containment area or drainage path of other Class I or Class II liquids, unless protected as required for such other liquids.
- (3) Both ¾ in. (20 mm) and 2 in. (50 mm) listed and labeled pressure-relieving devices are required on containers that exceed 6 gal (23 L) capacity. [30: Table 16.5.2.11]

Table 66.16.5.2.12 Design Criteria for Sprinkler Protection of Palletized or Stacked Storage of Miscible Liquids in Glass or Plastic Containers

Container Style and Capacity	Maximum Storage Height (ft)	Maximum Ceiling Height (ft)	Ceiling Sprinkler Protection				Fire Test Ref. [See Table Annex D.2(1) of NFPA 30]	
			Sprinkler		Design			
			Type	Response	Density (gpm/ft ²)	Area (ft ²)		Notes
≤ 8 oz	5	38	K ≥ 11.2	QR (OT)	0.47	2000	—	S61

For SI units, 1 gal = 3.8 L, 1 ft = 0.3 m, 1 ft² = 0.09 m², 1 gpm/ft² = 40.7 L/min/m² = 40.7 mm/min.
QR: Quick response sprinkler. OT: Ordinary temperature. [30: Table 16.5.2.12]

66.16.6 Fire Protection System Design Schemes.

66.16.6.1 Fire Protection System Design Scheme A.

66.16.6.1.1 Horizontal barriers of plywood having a minimum thickness of $\frac{3}{8}$ in. (10 mm) or of sheet metal of minimum 22 gauge thickness shall be installed in accordance with Figure 66.16.6.1.1(a), Figure 66.16.6.1.1(b), or Figure 66.16.6.1.1(c), whichever is applicable. All liquid storage shall be located beneath a barrier. [See also 66.16.6.1.9 for liquids with flash points equal to or greater than 450°F (230°C).] [30:16.6.1.1]

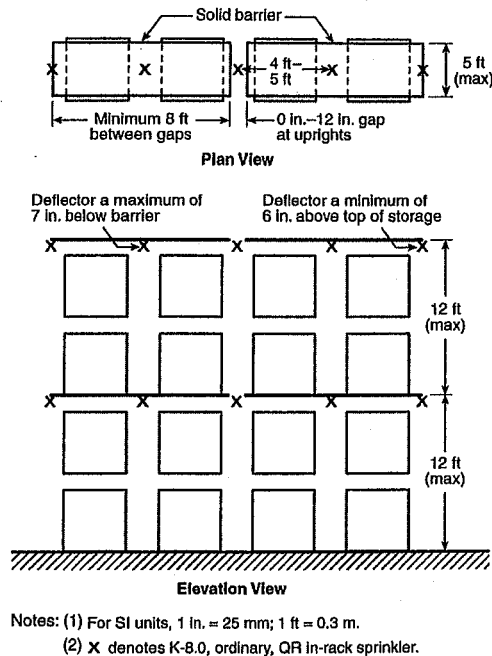


FIGURE 66.16.6.1.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "A." [30: Figure 16.6.1.1(a)]

66.16.6.1.2 In-rack sprinklers shall be installed in accordance with Figure 66.16.6.1.1(a), Figure 66.16.6.1.1(b), or Figure 66.16.6.1.1(c), whichever is applicable. [30:16.6.1.2]

66.16.6.1.3 Vertical barriers shall not be provided between in-rack sprinklers. [30:16.6.1.3]

66.16.6.1.4 In-rack sprinklers shall meet the following requirements:

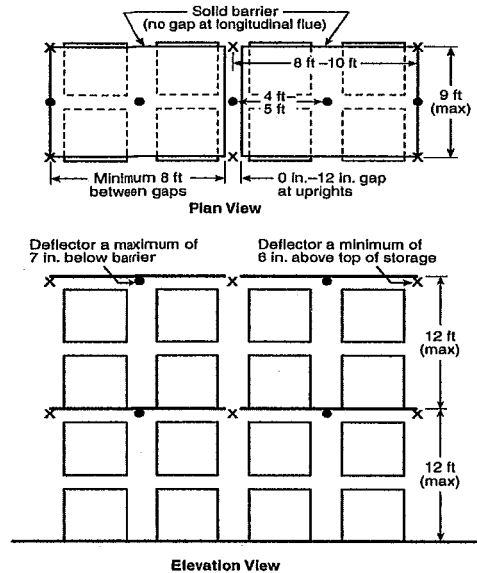


FIGURE 66.16.6.1.1(b) Double-Row Rack Sprinkler Layout for Design Scheme "A." [30: Figure 16.6.1.1(b)]

- (1) In-rack sprinklers shall be nominal K=8.0, ordinary temperature-rated quick-response sprinklers.
- (2) In-rack sprinklers shall be installed below each barrier level.
- (3) In-rack sprinklers shall provide a minimum end operating pressure (gauge pressure) of 50 psi (345 kPa) out of the hydraulically most remote six sprinklers (three on two lines), if one barrier level is provided, or the hydraulically most remote eight sprinklers (four on two lines), if two or more barrier levels are provided.

[30:16.6.1.4]

66.16.6.1.5* Where adjacent rack bays are not dedicated to storage of liquids, the barrier and in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. In addition, barrier and in-rack sprinkler protection shall be provided for any rack across the aisle within 8 ft (2.4 m) of the perimeter of the liquid storage in accordance with 66.16.6.1. [30:16.6.1.5]

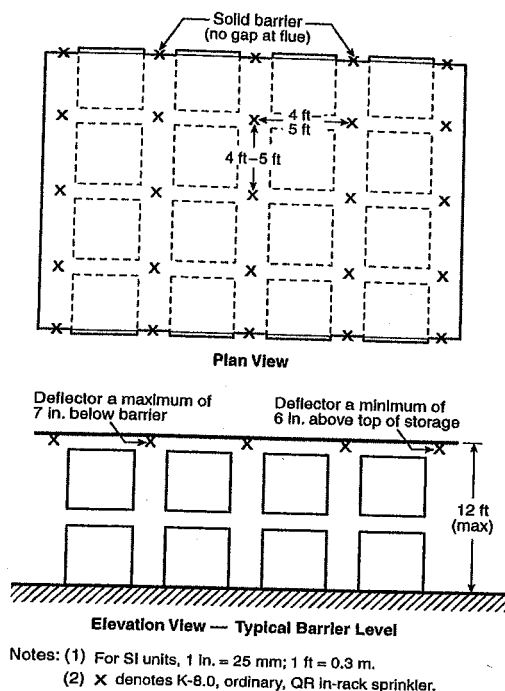


FIGURE 66.16.6.1.1(c) Multiple-Row Rack Sprinkler Layout for Design Scheme "A." [30: Figure 16.6.1.1(c)]

66.16.6.1.6 Ceiling sprinkler demand shall not be included in the hydraulic calculations for in-rack sprinklers. [30:16.6.1.6]

66.16.6.1.7 Water demand at point of supply shall be calculated separately for in-rack and ceiling sprinklers and shall be based on the greater demand. [30:16.6.1.7]

66.16.6.1.8 Ceiling sprinklers shall meet the following requirements:

- (1) Ceiling sprinkler protection shall be designed to protect the surrounding occupancy.
- (2) Any sprinkler type shall be acceptable.
- (3) If standard spray sprinklers are used, they shall be capable of providing not less than 0.20 gpm/ft² over 3000 ft² (8 mm/min over 270 m²).
- (4) If the liquid storage does not extend to the full height of the rack, protection for commodities stored above the top horizontal barrier shall meet the requirements of Section 13.3 and NFPA 13 for the commodities stored, based on the full height of the rack.

[30:16.6.1.8]

66.16.6.1.9 Barriers shall not be required for liquids with closed-cup flash points of 450°F (230°C) or greater. If barriers are omitted, the following shall apply:

- (1) Ceiling sprinkler protection shall provide a minimum density of 0.3 gpm/ft² over the most hydraulically remote 2000 ft² (12 mm/min over 180 m²) using ordinary temperature, standard-response sprinklers with a nominal K-factor equal to or greater than 8.0.

- (2) The ceiling sprinkler water demand and the in-rack water demand shall be balanced at their point of connection.
- (3) The sprinklers located at the rack face shall be staggered vertically.

[30:16.6.1.9]

66.16.6.1.10 A 500 gpm (1900 L/min) hose stream allowance shall be provided. [30:16.6.1.10]

66.16.6.2 Fire Protection System Design Scheme "B."

66.16.6.2.1 Horizontal barriers of plywood having a minimum thickness of 3/8 in. (10 mm) or of sheet metal of minimum 22 gauge thickness shall be installed in accordance with Figure 66.16.6.2.1(a), Figure 66.16.6.2.1(b), or Figure 66.16.6.2.1(c), whichever is applicable. All liquid storage shall be located beneath a barrier. [30:16.6.2.1]

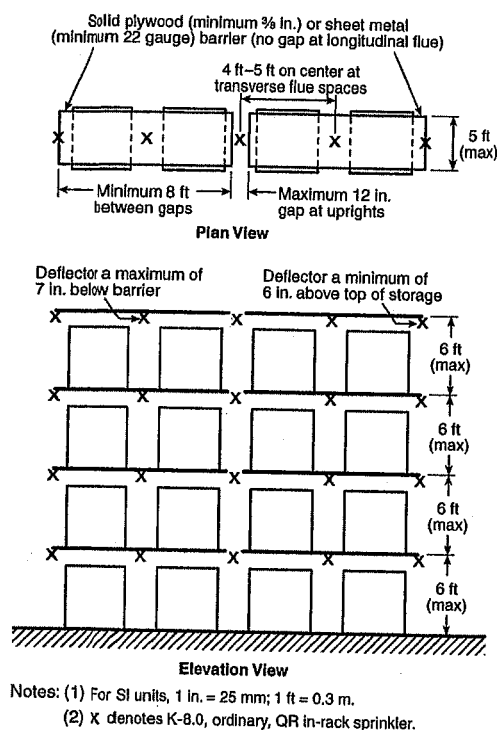


FIGURE 66.16.6.2.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "B" — Sprinklers in Center of Rack. [30: Figure 16.6.2.1(a)]

66.16.6.2.2 In-rack sprinklers shall be installed in accordance with Figure 66.16.6.2.1(a), Figure 66.16.6.2.1(b), or Figure 66.16.6.2.1(c), whichever is applicable. [30:16.6.2.2]

66.16.6.2.3 Vertical barriers shall not be provided between in-rack sprinklers. [30:16.6.2.3]

66.16.6.2.4 In-rack sprinklers shall meet the following requirements:

- (1) In-rack sprinklers shall be nominal K=8.0, ordinary temperature-rated quick-response sprinklers.
- (2) In-rack sprinklers shall be installed below each barrier level.

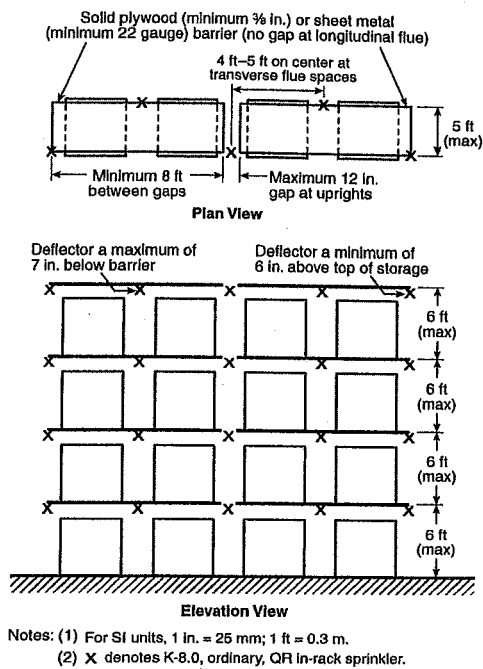


FIGURE 66.16.6.2.1(b) Single-Row Rack Sprinkler Layout for Design Scheme “B” — Sprinklers on Face of Rack. [30: Figure 16.6.2.1(b)]

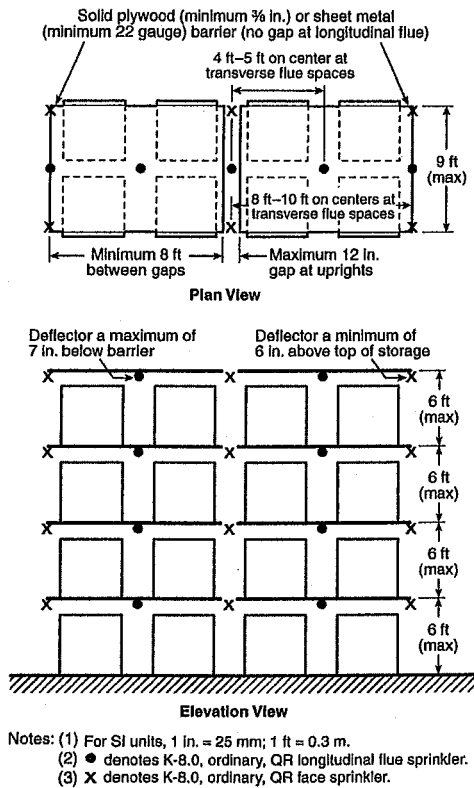


FIGURE 66.16.6.2.1(c) Double-Row Rack Sprinkler Layout for Design Scheme “B.” [30: Figure 16.6.2.1(c)]

- (3) For containers that do not exceed 60 gal (230 L) capacity and where there is only one horizontal barrier, in-rack sprinklers shall provide a minimum end operating pressure (gauge pressure) of 50 psi (345 kPa) out of the hydraulically most remote six sprinklers (three on two lines), if one barrier level is provided, or the hydraulically most remote eight sprinklers (four on two lines), if two or more barrier levels are provided.
- (4) For containers that exceed 60 gal (230 L) capacity, but do not exceed 793 gal (3000 L), in-rack sprinklers shall provide a minimum operating pressure (gauge pressure) of 50 psi (345 kPa) from the hydraulically most remote 12 sprinklers, six each on two lines.

[30:16.6.2.4]

66.16.6.2.5 If there are adjacent rack bays that are not dedicated to storage of liquids, the barrier and in-rack sprinkler protection shall be extended beyond the area devoted to liquid storage as follows:

- (1) For containers that do not exceed 1 gal (3.8 L) capacity, protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. In addition, adjacent racks across the aisles on each side of the liquid storage shall be protected in accordance with Section 13.3 and NFPA 13 for the commodity stored.
- (2) For containers that exceed 1 gal (3.8 L) capacity, but do not exceed 793 gal (3000 L), protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. In addition, protection shall be provided to any rack across the aisle within 8 ft (2.4 m) of the perimeter of the liquid storage in accordance with 66.16.6.2.

[30:16.6.2.5]

66.16.6.2.6 Ceiling sprinklers for containers that do not exceed 1 gal (3.8 L) capacity shall meet the following requirements:

- (1) Ceiling sprinklers shall be designed to protect the surrounding occupancy.
- (2) Ceiling sprinkler water demand shall not be included in the hydraulic calculations for the in-rack sprinkler protection.
- (3) Water demand at the point of supply shall be calculated separately for in-rack and ceiling sprinklers and shall be based on the greater of the two.
- (4) Any sprinkler type shall be acceptable for the ceiling sprinkler protection.
- (5) If standard spray sprinklers are used, they shall be capable of providing not less than 0.20 gpm/ft² over 3000 ft² (8 L/min over 270 m²).
- (6) If the liquid storage does not extend to the full height of the rack, protection for commodities stored above the top horizontal barrier shall meet the requirements of Section 13.3 and NFPA 13 for the commodities stored, based on the full height of the rack.

[30:16.6.2.6]

66.16.6.2.7 Ceiling sprinklers for containers that exceed 1 gal (3.8 L) capacity, but do not exceed 60 gal (230 L), shall meet the following requirements:

- (1) Ceiling sprinkler protection shall provide a minimum density of 0.45 gpm/ft² (18.3 mm/min) over the most hydraulically remote 3000 ft² (270 m²), using high-temperature, standard-response sprinklers of nominal K-factor of 11.2 or greater. Other types of sprinklers shall not be used.
- (2) Ceiling sprinkler water demand and the in-rack sprinkler demand shall be balanced at the point of connection.

[30:16.6.2.7]

66.16.6.2.8 Ceiling sprinklers for containers that exceed 60 gal (230 L) capacity, but do not exceed 793 gal (3000 L), shall meet the following requirements:

- (1) Ceiling sprinklers shall be designed to provide a minimum density of 0.60 gpm/ft² over 3000 ft² (24 mm/min over the most remote 270 m²), using high-temperature-rated, standard-response sprinklers of nominal K-factor of 11.2 or greater. Other types of sprinklers shall not be used.
- (2) Ceiling sprinkler water demand and the in-rack sprinkler demand shall be balanced at the point of connection.

[30:16.6.2.8]

66.16.6.2.9 A 500 gpm (1900 L/min) hose stream allowance shall be provided. [30:16.6.2.9]

66.16.6.3 Fire Protection System Design Scheme "C."

66.16.6.3.1 Horizontal barriers of plywood having a minimum thickness of 3/8 in. (10 mm) or of sheet metal of minimum 22 gauge thickness shall be installed in accordance with Figure 66.16.6.3.1(a), Figure 66.16.6.3.1(b), or Figure 66.16.6.3.1(c), whichever is applicable. All liquid storage shall be located beneath a barrier. [30:16.6.3.1]

66.16.6.3.2 Vertical baffles shall not be installed between in-rack sprinklers. [30:16.6.3.2]

66.16.6.3.3 In-rack sprinklers shall meet the following requirements:

- (1) In-rack sprinklers shall be nominal K=8.0, ordinary temperature-rated, quick-response sprinklers.
- (2) In-rack sprinklers shall be installed below each barrier level.

- (3) In-rack sprinklers shall provide a minimum end operating pressure (gauge pressure) of 14 psi (97 kPa) out of the hydraulically most remote six sprinklers (three on two lines), if one barrier level is provided, or the hydraulically most remote eight sprinklers (four on two lines), if two or more barrier levels are provided.

[30:16.6.3.3]

66.16.6.3.4 If there are adjacent bays of in-rack arrays that are not dedicated to storage of liquids, the barrier and in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to liquid storage. [30:16.6.3.4]

66.16.6.3.5 Ceiling sprinkler demand shall not be included in the hydraulic calculations for in-rack sprinklers. [30:16.6.3.5]

66.16.6.3.6 Water demand at point of supply shall be calculated separately for in-rack and ceiling sprinklers and shall be based on the greater demand. [30:16.6.3.6]

66.16.6.3.7 Ceiling sprinklers shall meet the following requirements:

- (1) Ceiling sprinkler protection shall be designed to protect the surrounding occupancy.
- (2) Any sprinkler type shall be acceptable.
- (3) If standard spray sprinklers are used, they shall be capable of providing not less than 0.20 gpm/ft² over 3000 ft² (8 mm/min over 270 m²).
- (4) If the liquid storage does not extend to the full height of the rack, protection for commodities stored above the top horizontal barrier shall meet the requirements of Section 13.3 and NFPA 13 for the commodities stored, based on the full height of the rack.

[30:16.6.3.7]

66.16.6.3.8 A 500 gpm (1900 L/min) hose stream allowance shall be provided. [30:16.6.3.8]

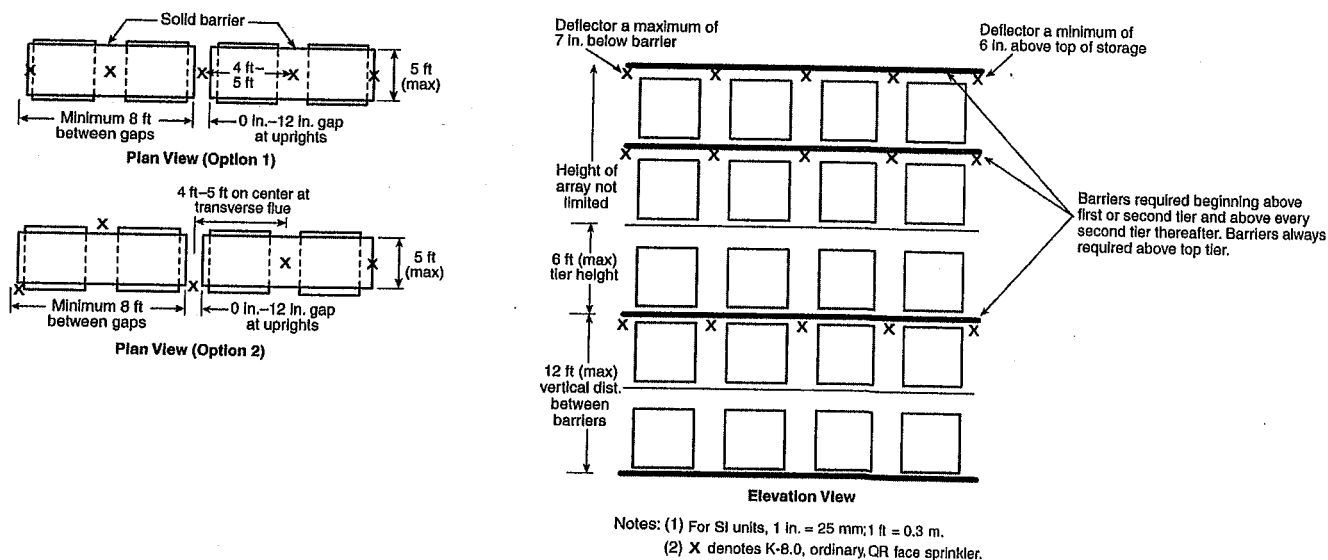
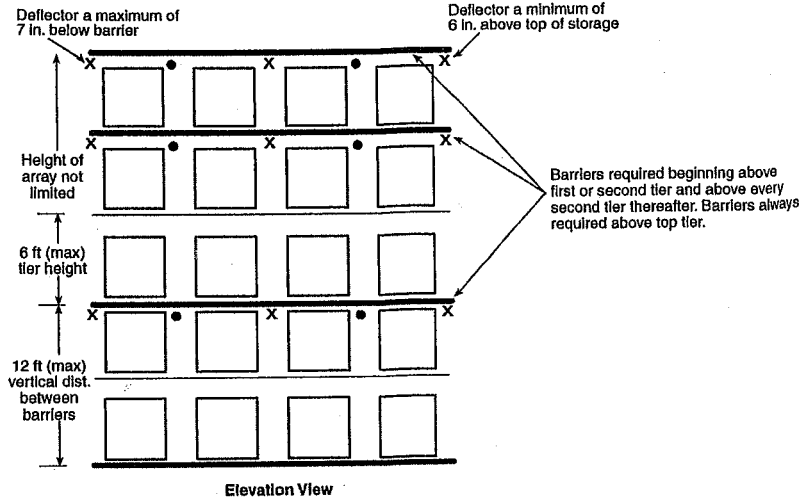
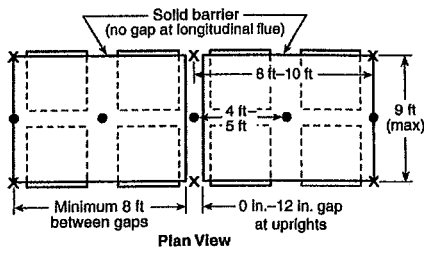
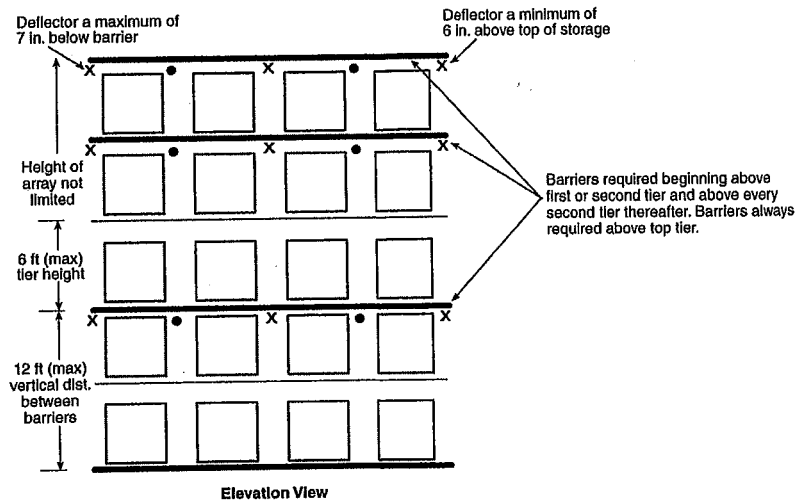
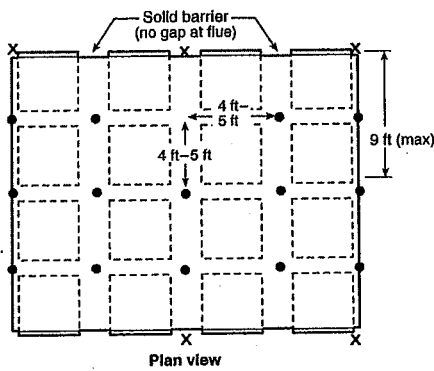


FIGURE 66.16.6.3.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "C." [30: Figure 16.6.3.1(a)]



Notes: (1) For SI units, 1 in. = 25 mm; 1 ft = 0.3 m.
 (2) X denotes K-8.0, ordinary, QR face sprinkler.
 • denotes K-8.0, ordinary, QR flue sprinkler.

FIGURE 66.16.6.3.1(b) Double-Row Rack Sprinkler Layout for Design Scheme "C." [30: Figure 16.6.3.1(b)]



Notes: (1) For SI units, 1 in. = 25 mm; 1 ft = 0.3 m.
 (2) X denotes K-8.0, ordinary, QR face sprinkler.
 • denotes K-8.0, ordinary, QR flue sprinkler.

FIGURE 66.16.6.3.1(c) Multiple-Row Rack Sprinkler Layout for Design Scheme "C." [30: Figure 16.6.3.1(c)]

66.16.6.4 In-Rack Sprinkler Layouts for Table 66.16.5.2.8.

Where indicated in Table 66.16.5.2.8, in-rack sprinklers shall be installed in accordance with Figure 66.16.6.4(a), Figure 66.16.6.4(b), Figure 66.16.6.4(c), Figure 66.16.6.4(d), or Figure 66.16.6.4(e), whichever is applicable. [30:16.6.4]

66.16.7 Water Supply. Water supplies for automatic sprinklers, other water-based protection systems, hose streams, and hydrants shall be capable of supplying the anticipated water flow demand for a minimum of 2 hours. [30:16.7]

66.16.8 Containment, Drainage, and Spill Control.

66.16.8.1 Containment or containment and drainage shall be provided in accordance with Figure 66.16.8.1, when protection systems are installed in accordance with the provisions of this section. [30:16.8.1]

66.16.8.2* Where control of the spread of liquid is required, means to limit the spread of liquid to an area not greater than the design discharge area of the ceiling sprinkler system shall be provided. [30:16.8.2]

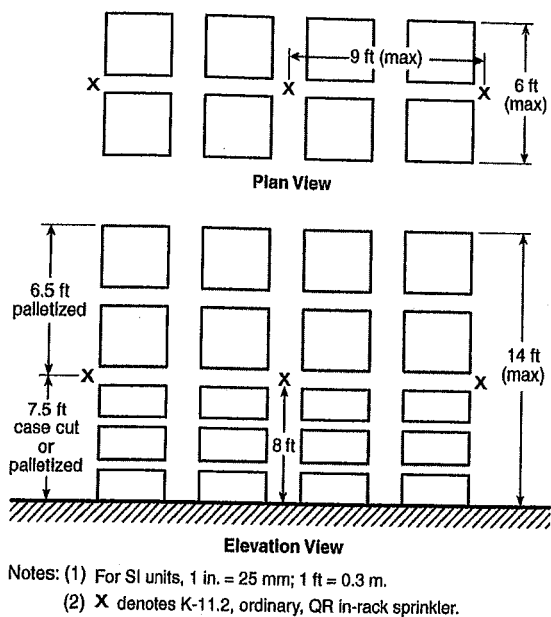


FIGURE 66.16.6.4(a) Double-Row Rack Sprinkler Layout G. [30: Figure 16.6.4(a)]

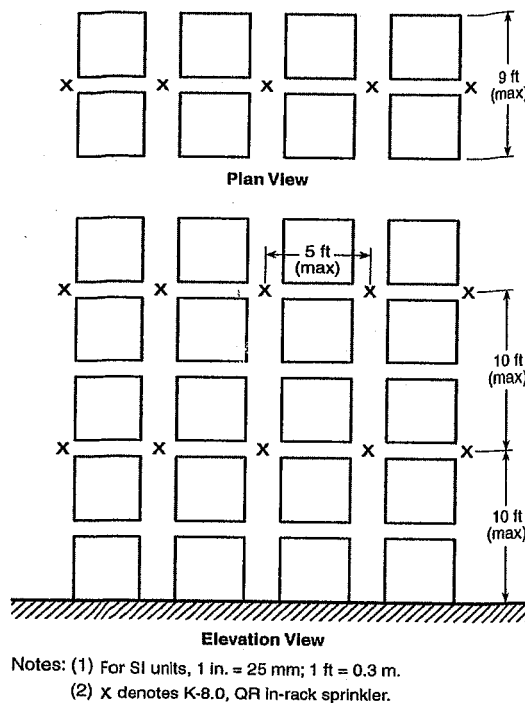


FIGURE 66.16.6.4(c) Double-Row Rack Sprinkler Layout I — Option #2. [30: Figure 16.6.4(c)]

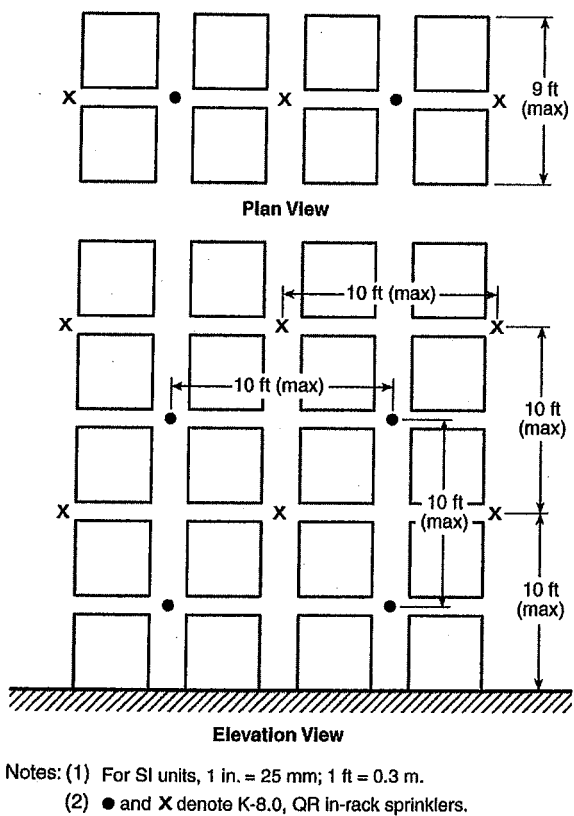


FIGURE 66.16.6.4(b) Double-Row Rack Sprinkler Layout I — Option #1. [30: Figure 16.6.4(b)]

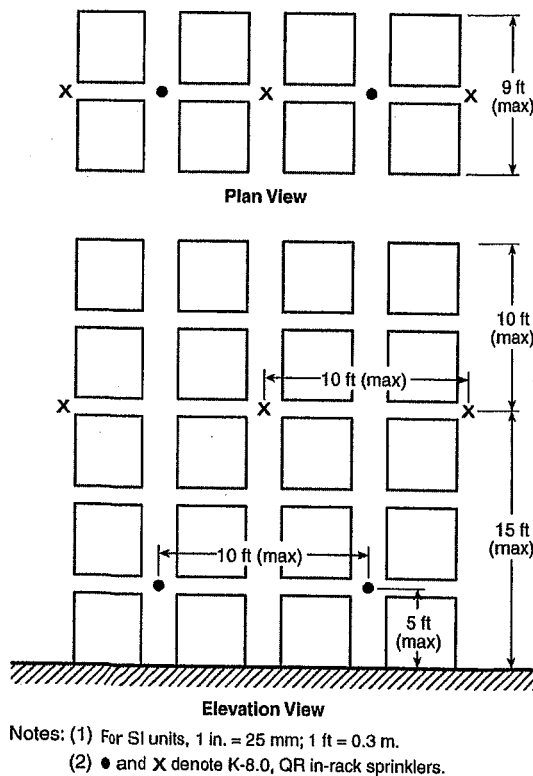


FIGURE 66.16.6.4(d) Double-Row Rack Sprinkler Layout H — Option #1. [30: Figure 16.6.4(d)]

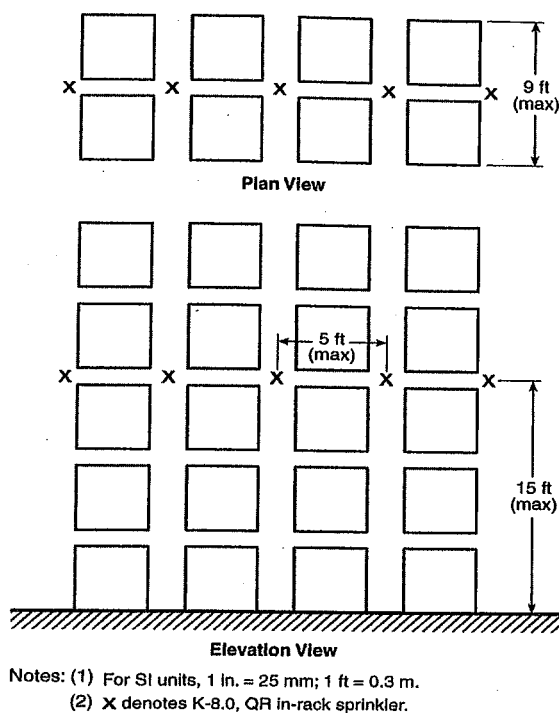


FIGURE 66.16.6.4(e) Double-Row Rack Sprinkler Layout H — Option #2. [30: Figure 16.6.4(e)]

66.16.9 Other Automatic Fire Protection Systems. Alternate fire protection systems, such as automatic water spray systems, automatic water mist systems, high-expansion foam systems, dry chemical extinguishing systems, alternate sprinkler system configurations, or combinations of systems shall be permitted if approved by the AHJ. Such alternate systems shall be designed and installed in accordance with the appropriate NFPA standard and with manufacturer's recommendations for the system(s) selected. [30:16.9]

66.17 Processing Facilities.

66.17.1 Scope.

66.17.1.1* This section shall apply where the processing of liquids is the principal activity, except as covered elsewhere in this Code or in other NFPA standards. (See 66.1.4.) [30:17.1.1]

66.17.1.2 Provisions of this chapter shall not prohibit the use of movable tanks for the dispensing of flammable or combustible liquids into fuel tanks of motorized equipment outside on premises not accessible to the public, where such use has the approval of the AHJ. [30:17.1.2]

66.17.2 Reserved.

66.17.3 General Requirements.

66.17.3.1 Liquid processing operations shall be located and operated so that they do not constitute a significant fire or explosion hazard to life, to property of others, or to important buildings or facilities within the same plant. [30:17.3.1]

66.17.3.2 Specific requirements shall depend on the inherent risk in the operations themselves, including the liquids being processed, operating temperatures and pressures, and the capability to control any liquid or vapor releases or fire incidents that could occur. [30:17.3.2]

66.17.3.3 The interrelationship of the many factors involved shall be based on good engineering and management practices to establish suitable physical and operating requirements. [30:17.3.3]

66.17.3.4 Process facilities shall comply with the applicable requirements for specific operations set forth in Sections 66.18, 66.19, 66.28, or 66.29. [30:17.3.4]

66.17.3.5 Process facilities shall comply with the applicable requirements for procedures and practices for fire and explosion prevention, protection, and control set forth in Section 66.6. [30:17.3.5]

66.17.3.6 Processing and handling 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 Section 66.6 justifies following the requirements for some other liquid class. (See 66.4.1.2 and A.66.6.4.1.2.) [30:17.3.6]

66.17.3.7 When a process heats a liquid to a temperature at or above its flashpoint, the following shall apply:

- (1) The process vessel shall be closed to the room in which it is located and vented to the outside of the building.
- (2) If the vessel needs to be opened to add ingredients, the room ventilation shall meet the requirements of 66.17.11 and the process heating controls will be interlocked with the ventilation such that the process heat will shut down if the ventilation fails or is turned off.
- (3) The process vessel shall be equipped with an excess temperature control set to limit excessive heating of the liquid and the subsequent release of vapors.
- (4) If a heat transfer medium is used to heat the liquid and the heat transfer fluid can heat the liquid to its boiling point on failure of the process and excess temperature heat controls, a redundant excess temperature control shall be provided.

[30:17.3.7]

66.17.4 Location of Process Vessels and Equipment.

66.17.4.1 Liquid-processing vessels and equipment shall be located in accordance with the requirements of this section. [30:17.4.1]

66.17.4.2 Processing vessels and buildings containing such processing vessels shall be located so that a fire involving the vessels does not constitute an exposure hazard to other occupancies. [30:17.4.2]

66.17.4.3 The minimum distance of a processing vessel to a property line that is or can be built upon, including the opposite side of a public way; to the nearest side of a public way; or to the nearest important building on the same property shall be one of the following:

- (1) In accordance with Table 66.17.4.3
- (2) Determined by an engineering evaluation of the process, followed by application of sound fire protection and process engineering principles

[30:17.4.3]

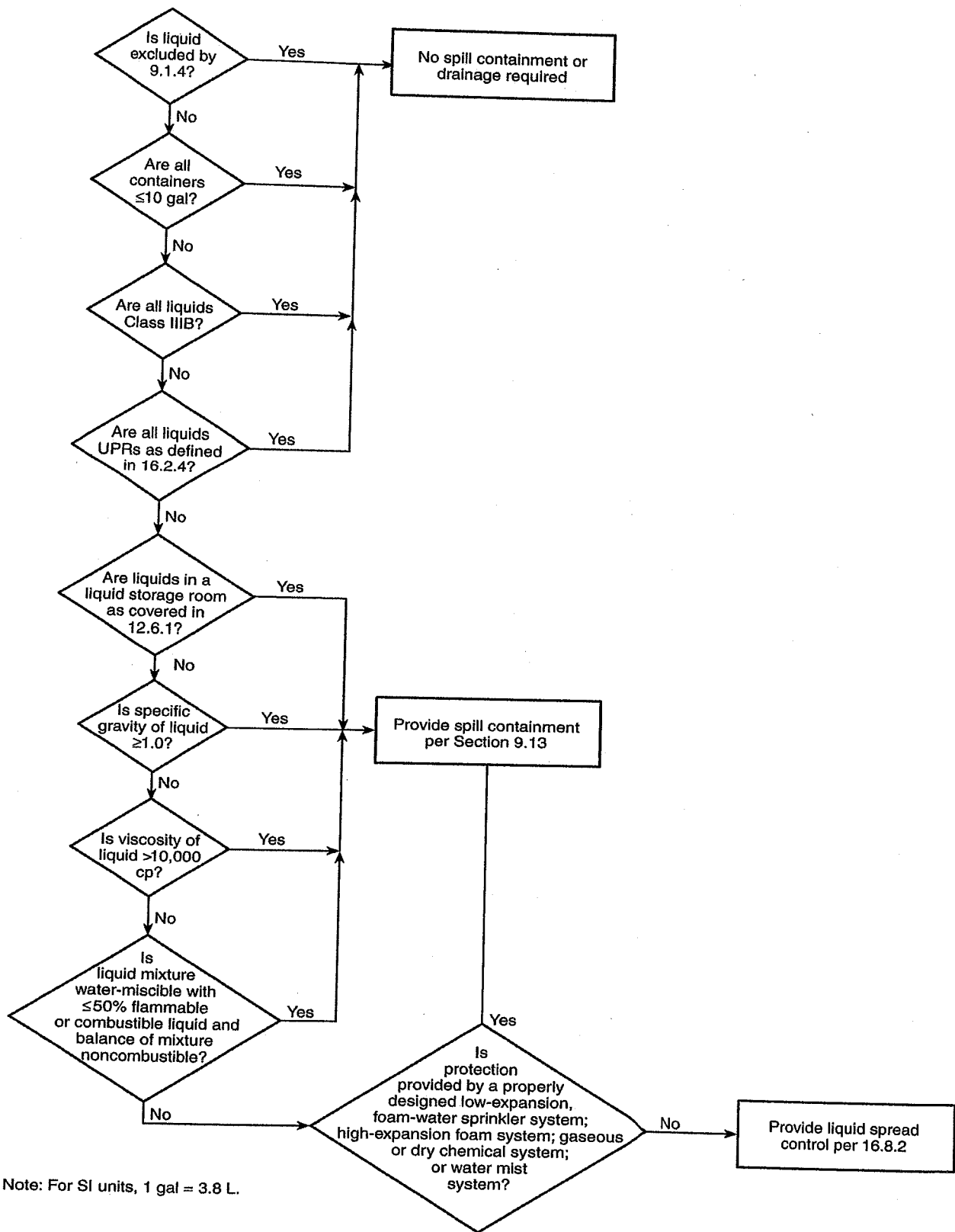


FIGURE 66.16.8.1 Spill Containment and Liquid Spread Control for Protected Storage. [30: Figure 16.8.1]

Table 66.17.4.3 Location of Process Vessels with Respect to Property Lines, Public Ways, and the Nearest Important Building on the Same Property — Protection for Exposures Is Provided

Vessel Maximum Operating Liquid Capacity (gal)	Minimum Distance (ft)							
	From Property Line that Is or Can Be Built upon, Including Opposite Side of Public Way				From Nearest Side of Any Public Way or from Nearest Important Building on Same Property that Is Not an Integral Part of the Process			
	Stable Liquid Emergency Relief*		Unstable Liquid Emergency Relief*		Stable Liquid Emergency Relief*		Unstable Liquid Emergency Relief*	
	Not Over 2.5 psi	Over 2.5 psi	Not Over 2.5 psi	Over 2.5 psi	Not Over 2.5 psi	Over 2.5 psi	Not Over 2.5 psi	Over 2.5 psi
275 or less	5	10	15	20	5	10	15	20
276 to 750	10	15	25	40	5	10	15	20
751 to 12,000	15	25	40	60	5	10	15	20
12,001 to 30,000	20	30	50	80	5	10	15	20
30,001 to 50,000	30	45	75	120	10	15	25	40
50,001 to 100,000	50	75	125	200	15	25	40	60
Over 100,000	80	120	200	300	25	40	65	100

For SI units, 1 gal = 3.8 L; 1 ft = 0.3 m; 1 psi = a gauge pressure of 6.9 kPa.

Note: Double all of above distances where protection for exposures is not provided.

*Gauge pressure. [30: Table 17.4.3]

66.17.4.4 Where process vessels are located in a building and the exterior wall facing the exposure (line of adjoining property that is or can be built upon or nearest important building on the same property) is greater than 25 ft (7.6 m) from the exposure and is a blank wall having a fire resistance rating of not less than 2 hours, any greater distances required by Table 66.17.4.3 shall be permitted to be waived. If the exterior wall is a blank wall having a fire resistance rating of not less than 4 hours, all distances required by Table 66.17.4.3 shall be permitted to be waived. [30:17.4.4]

66.17.4.5 All the distances given in Table 66.17.4.3 shall be doubled where protection for exposures is not provided. [30:17.4.5]

66.17.4.6* Liquid-processing equipment, such as pumps, heaters, filters, and exchangers, shall not be located closer than 25 ft (7.6 m) to property lines where the adjoining property is or can be built upon or to the nearest important building on the same property that is not an integral part of the process. This spacing requirement shall be permitted to be waived where exposures are protected in accordance with 66.17.4.3. [30:17.4.6]

66.17.4.7 Processing equipment in which unstable liquids are handled shall be separated from unrelated plant facilities by either of the following:

- (1) 25 ft (7.6 m) clear spacing
- (2) A wall having a fire resistance rating of not less than 2 hours and explosion resistance consistent with the expected hazard

[30:17.4.7]

66.17.5 Accessibility. Each process unit or building containing liquid-processing equipment shall be accessible from at least one side for fire fighting and fire control. [30:17.5]

66.17.6 Construction Requirements.

66.17.6.1 Process buildings or structures used for liquid operations shall be constructed consistent with the operations being conducted and with the classes of liquids handled. They shall be constructed to minimum Type II (000) construction, as defined in *NFPA 5000*, and shall be constructed in accordance with Table 66.17.6.1. [30:17.6.1]

66.17.6.2 Construction types shall be as defined in *NFPA 5000*. [30:17.6.2]

66.17.6.3 Where protection for exposures is not provided, the applicable distances given in Table 66.17.6.1 shall be doubled. [30:17.6.3]

66.17.6.4 For buildings or structures that are not provided with approved automatic sprinkler protection, the separation distances otherwise required by Table 66.17.6.1 shall be determined by an engineering evaluation of the process, but shall not be less than the separation distances required by Table 66.17.4.3. [30:17.6.4]

66.17.6.5 Buildings or structures used solely for blending, mixing, or dispensing of Class IIIB liquids at temperatures below their flash points shall be permitted to be constructed of combustible construction, subject to the approval of the AHJ. [30:17.6.5]

66.17.6.6 Buildings or structures used for processing or handling of liquids where the quantities of liquids do not exceed 360 gal (1360 L) of Class I and Class II liquids and 720 gal (2725 L) of Class IIIA liquids shall be permitted to be constructed of combustible construction, subject to the approval of the AHJ. [30:17.6.6]



Table 66.17.6.1 Minimum Separation Distances for Buildings or Structures Used for Liquid Handling and Operations

Liquid Class	Minimum Type of Construction*	Minimum Separation Distance (ft)	
		To Street, Alley, or Public Way	To Adjacent Property Line that Is or Can Be Built Upon
Class I liquids; unstable liquids of any class; liquids of any class heated above their flash points†	II (222)	5	10
	II (111)	5	25
	II (000)	10	50
Class II	II (111)	5	10
	II (000)	5	25
Class III	II (000)	5	10

For SI units, 1 ft = 0.3 m.

Note: Distances apply to properties that have protection for exposures, as defined in this code. If there are exposures for which protection does not exist, the distances should be doubled, in accordance with 66.17.6.3.

*Construction types are defined in NFPA 220, *Standard on Types of Building Construction*. [30: Table 17.6.1]

†For stable liquids of any class heated above their flash points, see 66.6.4.1.2 and A.66.6.4.1.2.

66.17.6.7 Buildings or structures used for processing or handling of liquids protected with automatic sprinklers or equivalent fire protection systems shall be permitted to be constructed of combustible construction, subject to the approval of the AHJ. [30:17.6.7]

66.17.6.8* Load-bearing building supports and load-bearing supports of vessels and equipment capable of releasing quantities of liquids that could result in a fire capable of causing substantial property damage shall be protected by one or more of the following:

- (1) Drainage to a safe location to prevent liquids from accumulating under vessels or equipment or around load-bearing supports
- (2) Fire-resistive construction
- (3) Fire-resistant protective coatings or systems
- (4) Water spray systems designed and installed in accordance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
- (5) Other alternate means acceptable to the AHJ

[30:17.6.8]

66.17.6.9 Class I liquids shall not be handled or used in basements. [30:17.6.9]

66.17.6.9.1 Where Class I liquids are handled or used above grade within buildings with basements or closed pits into which flammable vapors can travel, such belowgrade areas shall be provided with mechanical ventilation designed to prevent the accumulation of flammable vapors. [30:17.6.9.1]

66.17.6.9.2 Means shall be provided to prevent liquid spills from running into basements. [30:17.6.9.2]

66.17.6.10* Smoke and heat venting shall be permitted to be used where it assists access for fire fighting. [30:17.6.10]

66.17.6.11* Areas shall have exit facilities arranged to prevent occupants from being trapped in the event of fire. [30:17.6.11]

66.17.6.11.1 Exits shall not be exposed by the drainage facilities described in 66.17.10. [30:17.6.11.1]

66.17.6.12 Aisles shall be maintained for unobstructed movement of personnel and fire protection equipment. [30:17.6.12]

66.17.6.13 Indoor areas where Class IA or unstable liquids are in use shall be designed to direct flame, combustion gases, and pressures resulting from a deflagration away from important buildings or occupied areas through the use of damage-limiting construction in accordance with NFPA 68, *Standard on Explosion Protection by Deflagration Venting*. [30:17.6.13]

66.17.6.13.1 The damage-limiting construction design shall be in accordance with recognized standards and shall be acceptable to the AHJ. (See A.66.9.16.1.) [30:17.6.13.1]

66.17.6.13.2 Where unstable liquids are in use, an approved engineered construction method that is designed to limit damage from an explosion (deflagration or detonation, depending on the characteristics of the liquid) shall be used. [30:17.6.13.2]

66.17.7 Reserved.

66.17.8 Reserved.

66.17.9 Electrical Systems. Electrical wiring and electrical utilization equipment shall comply with Section 66.7. [30:17.9]

66.17.10 Containment, Drainage, and Spill Control.

66.17.10.1* Emergency drainage systems shall be provided to direct liquid leakage and fire protection water to a safe location. [30:17.10.1]

66.17.10.2 Emergency drainage systems, if connected to public sewers or discharged into public waterways, shall be equipped with traps or separators. [30:17.10.2]

66.17.10.3 A facility shall be designed and operated to prevent the discharge of liquids to public waterways, public sewers, or adjoining property. [30:17.10.3]

66.17.11 Ventilation.

66.17.11.1 Enclosed processing areas handling or using Class I liquids, or Class II or Class III liquids heated to temperatures at or above their flash points, shall be ventilated at a rate sufficient to maintain the concentration of vapors within the area at or below 25 percent of the lower flammable limit (LFL). Compliance with 66.17.11.2 through 66.17.11.10 shall be deemed as meeting the requirements of this section. [30:17.11.1]

66.17.11.2* Ventilation requirements shall be confirmed by one of the following:

- (1) Calculations based on the anticipated fugitive emissions (see Annex F of NFPA 30 for calculation method).
- (2) Sampling of the actual vapor concentration under normal operating conditions. Sampling shall be conducted at a 5 ft (1.5 m) radius from each potential vapor source extending to or toward the bottom and the top of the enclosed processing area. The vapor concentration used to determine the required ventilation rate shall be the highest measured concentration during the sampling procedure.

[30:17.11.2]

66.17.11.3 A ventilation rate of not less than 1 ft³/min/ft² (0.3 m³/min/m²) of solid floor area shall be considered as meeting the requirements of 66.17.11.1. [30:17.11.3]

66.17.11.4 Ventilation shall be accomplished by mechanical or natural means. [30:17.11.4]

66.17.11.5 Exhaust ventilation discharge shall be to a safe location outside the building. [30:17.11.5]

66.17.11.6 Recirculation of the exhaust air shall be permitted only when it is monitored continuously using a fail-safe system that is designed to automatically sound an alarm, stop recirculation, and provide full exhaust to the outside in the event that vapor-air mixtures in concentrations over one-fourth of the lower flammable limit are detected. [30:17.11.6]

66.17.11.7* Provision shall be made for introduction of make-up air in such a manner as to avoid short-circuiting the ventilation. [30:17.11.7]

66.17.11.8 Ventilation shall be arranged to include all floor areas or pits where flammable vapors can collect. [30:17.11.8]

66.17.11.9 Local or spot ventilation to control special fire or health hazards, if provided, shall be permitted to be utilized for up to 75 percent of the required ventilation. [30:17.11.9]

66.17.11.10 Where equipment such as dispensing stations, open centrifuges, plate and frame filters, and open vacuum filters is used in a building, the equipment and ventilation of the building shall be designed to limit flammable vapor-air mixtures under normal operating conditions to the interior of equipment and to not more than 5 ft (1.5 m) from equipment that exposes Class I liquids to the air. [30:17.11.10]

66.17.12 Reserved.

66.17.13 Reserved.

66.17.14* Process Equipment and Vessels. Equipment shall be designed and arranged to prevent the unintentional escape of liquids and vapors and to minimize the quantity escaping in the event of accidental release. [30:17.14]

66.17.15 Management of Operations Hazards.

66.17.15.1 This section shall apply to the management methodology used to identify, evaluate, and control the hazards involved in 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. [30:17.15.1]

66.17.15.2 Operations involving flammable and combustible liquids shall be reviewed to ensure that fire and explosion hazards resulting from loss of containment of liquids are provided with corresponding fire prevention 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.

[30:17.15.2]

66.17.15.3 The extent of fire prevention and control that is provided shall be determined 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 66.17.3 through 66.17.4
- (4) Analysis of applicable requirements in Sections 66.18, 66.19, 66.28, and 66.29 for liquid handling, transfer, and use
- (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

[30:17.15.3]

66.17.15.4 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, which shall be reviewed at the time of initial assignment, as responsibilities or response actions change, and whenever anticipated duties change
- (4) Procedures for maintenance of the following:
 - (a) Fire protection equipment and systems
 - (b) Drainage and containment systems
 - (c) Ventilation equipment and systems
- (5) Procedures for shutting down or isolating equipment to reduce, control, or stop the release of liquid or vapors, including assigning personnel responsible for maintaining critical plant functions or shutdown of plant processes and safe startup following isolation or shutdown
- (6) Alternate measures for the safety of occupants

[30:17.15.4]

66.17.15.5 The fire hazards management review conducted in accordance with 66.17.15.2 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

[30:17.15.5]

66.18 Dispensing, Handling, Transfer, and Use of Liquids.

66.18.1 Scope. This section applies where liquids are handled, dispensed, transferred, or used, including in process areas. [30:18.1]

66.18.2 Reserved.

66.18.3 General Requirements. Processing and handling 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 Section 66.6 justifies following the requirements for some other liquid class. (See 66.4.1.2 and A.66.6.4.1.2.) [30:18.3]

66.18.4 Dispensing, Handling, Transfer, and Use.

66.18.4.1 Class I liquids shall be kept in closed tanks or containers when not actually in use. Class II and Class III liquids shall be kept in closed tanks or containers when not actually in use when the ambient or process temperature is at or above their flash points. [30:18.4.1]

66.18.4.2 Where liquids are used or handled, provisions shall be made to promptly and safely mitigate and dispose of leakage or spills. [30:18.4.2]

66.18.4.3 Class I liquids shall not be used outside closed systems where there are open flames or other ignition sources within the classified areas set forth in Section 66.7. [30:18.4.3]

66.18.4.4 Transfer of liquids among vessels, containers, tanks, and piping systems by means of air or inert gas pressure shall be permitted only under all of the following conditions:

- (1) The vessels, containers, tanks, and piping systems shall be designed for such pressurized transfer and shall be capable of withstanding the anticipated operating pressure.
- (2) Safety and operating controls, including pressure-relief devices, shall be provided to prevent overpressure of any part of the system.
- (3) Only inert gas shall be used to transfer Class I liquids. Only inert gas shall be used to transfer Class II and Class III liquids that are heated above their flash points.

[30:18.4.4]

66.18.4.5 Positive displacement pumps shall be provided with pressure relief that discharges back to the tank, pump suction, or other suitable location or shall be provided with interlocks to prevent overpressure. [30:18.4.5]

66.18.4.6 Piping, valves, and fittings shall meet the requirements of Section 66.27. [30:18.4.6]

66.18.4.7 Listed flexible connectors shall be permitted to be used where vibration exists. Approved hose shall be permitted to be used at transfer stations. [30:18.4.7]

66.18.4.8* The staging of liquids in containers, intermediate bulk containers, and portable tanks shall be limited to the following:

- (1) Containers, intermediate bulk containers, and portable tanks that are in use
- (2) Containers, intermediate bulk containers, and portable tanks that were filled during a single shift
- (3) Containers, intermediate bulk containers, and portable tanks needed to supply the process for one continuous 24-hour period
- (4) Containers, intermediate bulk containers, and portable tanks that are stored in accordance with Section 66.9

[30:18.4.8]

66.18.4.9 Class I, Class II, or Class IIIA liquids used in a process and staged in the process area shall not be filled in the process area.

Exception No. 1: Intermediate bulk containers and portable tanks that meet the requirements of Section 66.9.

Exception No. 2: Intermediate products that are manufactured in the process area. [30:18.4.9]

66.18.5 Incidental Operations.

66.18.5.1* This section shall apply to areas where the use, handling, and storage of liquids is only a limited activity to the established occupancy classification. [30:18.5.1]

66.18.5.2 Class I liquids or Class II and Class III liquids that are heated up to or above their flash points shall be drawn from or transferred into vessels, containers, or portable tanks as follows:

- (1) From original shipping containers with a capacity of 5.3 gal (20 L) or less
- (2) From safety cans
- (3) Through a closed piping system
- (4) From portable tanks or containers by means of a device that has antisiphoning protection and that draws through an opening in the top of the tank or container
- (5) By gravity through a listed self-closing valve or self-closing faucet

[30:18.5.2]

66.18.5.2.1 If hose is used in the transfer operation, it shall be equipped with a self-closing valve without a hold-open latch in addition to the outlet valve. Only listed or approved hose shall be used. [30:18.5.2.1]

66.18.5.2.2 Means shall be provided to minimize generation of static electricity. Such means shall meet the requirements of 66.6.5.4. [30:18.5.2.2]

66.18.5.2.3 Where pumps are used for liquid transfer, means shall be provided to deactivate liquid transfer in the event of a liquid spill or fire. [30:18.5.2.3]

66.18.5.3 Storage of liquids other than those governed by 66.18.5.4 and 66.18.5.5 shall comply with Section 66.9. [30:18.5.3]

66.18.5.4 The quantity of liquid located outside of identified storage areas, such as storage cabinets, other inside liquid storage areas, general-purpose warehouses, or other specific processing areas that are cut off from the general plant area by at least a 2-hour fire separation, shall meet the requirements of 66.18.5.4.1. [30:18.5.4]

66.18.5.4.1 The maximum quantity of liquids permitted for incidental operations in a single fire area shall not exceed the greater of the following:

- (1)* The amount required to supply incidental operations for one continuous 24-hour period
- (2) The aggregate sum of the following:
 - (a) 25 gal (95 L) of Class IA liquids in containers
 - (b) 120 gal (454 L) of Class IB, Class IC, Class II, or Class III liquids in containers
 - (c) 1585 gal (6000 L) of any combination of the following:
 - i. Class IB, IC, II, or IIIA liquids in metal portable tanks or metal intermediate bulk containers, each not exceeding 793 gal (3000 L)
 - ii. Class II or Class IIIA liquids in nonmetallic intermediate bulk containers, each not exceeding 793 gal (3000 L)
 - (d) 20 portable tanks or intermediate bulk containers each not exceeding 793 gal (3000 L) of Class IIIB liquids

[30:18.5.4.1]

66.18.5.5 Where quantities of liquids in excess of the limits in 66.18.5.4.1 are necessary, storage shall be in tanks that meet all applicable requirements of Section 66.17, Sections 66.21 through 66.25, and Section 66.27. [30:18.5.5]

66.18.5.6 Areas in which liquids are transferred from one tank or container to another container shall be provided with the following:

- (1) Separation from other operations where potential ignition sources are present by distance or by fire-resistant construction
- (2) Drainage or other means to control spills
- (3) Natural or mechanical ventilation that meets the requirements of 66.17.11

[30:18.5.6]

66.18.6 Ventilation for Dispensing Areas. Liquid storage areas where dispensing is conducted shall be provided with either a gravity system or a continuous mechanical exhaust ventilation system. Mechanical ventilation shall be used if Class I liquids are dispensed within the room. [30:18.6]

66.18.6.1 Exhaust air shall be taken from a point near a wall on one side of the room and within 12 in. (300 mm) of the floor, with one or more make-up inlets located on the opposite side of the room within 12 in. (300 mm) of the floor. [30:18.6.1]

66.18.6.2 The location of both the exhaust and inlet air openings shall be arranged to provide air movement across all portions of the floor to prevent accumulation of flammable vapors. [30:18.6.2]

66.18.6.3* Exhaust ventilation discharge shall be to a safe location outside the building. [30:18.6.3]

66.18.6.3.1 Recirculation of the exhaust air shall be permitted only when it is monitored continuously using a fail-safe system that is designed to automatically sound an alarm, stop recirculation, and provide full exhaust to the outside in the event that vapor-air mixtures in concentrations over one-fourth of the lower flammable limit are detected. [30:18.6.3.1]

66.18.6.4 If ducts are used, they shall not be used for any other purpose and shall comply with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*. [30:18.6.4]

66.18.6.4.1 If make-up air to a mechanical system is taken from within the building, the opening shall be equipped with a fire door or damper, as required in NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*. [30:18.6.4.1]

66.18.6.4.2 For gravity systems, the make-up air shall be supplied from outside the building. [30:18.6.4.2]

66.18.6.5 Mechanical ventilation systems shall provide at least 1 cfm of exhaust air for each square foot of floor area (0.3 m³/min/m²), but not less than 150 cfm (4 m³/min). [30:18.6.5]

66.18.6.5.1 The mechanical ventilation system for dispensing areas shall be equipped with an airflow switch or other equally reliable method that is interlocked to sound an audible alarm upon failure of the ventilation system. [30:18.6.5.1]

66.19 Specific Operations.

66.19.1 Scope. This section shall apply to the handling and use of flammable and combustible liquids in specific operations as herein described. [30:19.1]

66.19.2 Reserved.

66.19.3 Reserved.

66.19.4 Recirculating Heat Transfer Systems.

66.19.4.1 Scope.

66.19.4.1.1 This section shall apply only to recirculating heat transfer systems that use a heat transfer fluid that is heated up to or above its flash point under normal operation. [30:19.4.1.1]

66.19.4.1.2 This section shall not apply to process streams used as a means of heat transfer or to any heat transfer system of 60 gal (230 L) capacity or less. [30:19.4.1.2]

66.19.4.2* General Requirements. A heater or vaporizer for heat transfer fluid that is located inside a building shall meet all applicable requirements of Section 66.17. [30:19.4.2]

66.19.4.3* System Design.

66.19.4.3.1* Drainage shall be provided at strategic low points in the heat transfer system. Drains shall be piped to a safe location that is capable of accommodating the total capacity of the system or the capacity of that part of the system that is isolated. [30:19.4.3.1]

66.19.4.3.2* Where the heat transfer system expansion tank is located above floor level and has a capacity of more than 250 gal (950 L), it shall be provided with a low-point drain line that can allow the expansion tank to drain to a drain tank on a lower level. The drain line valve shall be operable from a safe location. [30:19.4.3.2]

66.19.4.3.3 A heat transfer fluid system shall not be used to provide direct building heat. [30:19.4.3.3]

66.19.4.3.4 All pressure-relief device outlets shall be piped to a safe location. [30:19.4.3.4]

66.19.4.4* Fuel Burner Controls and Interlocks. Oil- or gas-fired heaters or vaporizers shall be designed and installed in accordance with the applicable requirements of NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, or NFPA 85, *Boiler and Combustion Systems Hazards Code*, whichever is applicable. Wood dust suspension-fired heaters or vaporizers shall be designed and installed in accordance with the applicable requirements of NFPA 85. [30:19.4.4]

66.19.4.5 Piping.

66.19.4.5.1* Piping shall meet all applicable requirements of Section 66.27. [30:19.4.5.1]

66.19.4.5.2 All pipe connections shall be welded. [30:19.4.5.2]

66.19.4.5.2.1 Welded, threaded connections shall be permitted to be used for piping 2 in. (50 mm) and smaller. [30:19.4.5.2.1]

66.19.4.5.2.2 Mechanical joints shall be permitted to be used at pump, valve, and equipment connections. [30:19.4.5.2.2]

66.19.4.5.3 New piping that is to be insulated with permanent insulation and existing piping that has been disturbed and is to be reinsulated with permanent insulation shall be covered with a closed-cell, nonabsorbent insulation material. [30:19.4.5.3]

66.19.4.5.3.1 Where all pipe joints are welded and where there are no other points in the system subject to leakage, such as at valves or pumps, other types of insulation shall be permitted. [30:19.4.5.3.1]

66.19.4.5.3.2 Where dams are formed around possible leak-producing areas, using metal "donut" flanges that are welded to the pipe or using a "donut" segment of nonabsorbent insulation sealed to the pipe to prevent migration of leakage into adjacent insulation, the piping from dam to dam shall be considered to be a closed system and other types of insulation shall be permitted. The area subject to leakage where the dam has been constructed shall be insulated with nonabsorbent insulation or a nonabsorbent insulation system. [30:19.4.5.3.2]

66.19.4.5.3.3 Where removable, reusable insulated covers are required for access, the covers shall be fabricated of flexible or rigid insulation that is encapsulated in a manner to provide a nonabsorbent insulation system to prevent absorption of leakage into the insulation. [30:19.4.5.3.3]

66.19.4.6 Fire Protection.

66.19.4.6.1* Automatic sprinkler protection meeting the requirements of Section 13.3 and NFPA 13, *Standard for the Installation of Sprinkler Systems* for Extra Hazard (Group I) Occupancies shall be provided for building areas containing a heat transfer system heater or vaporizer. [30:19.4.6.1]

66.19.4.6.2 An alternate fire protection system shall be permitted to be used, if approved by the AHJ. Such alternate system shall be designed and installed in accordance with the appropriate NFPA standard and with manufacturer's recommendations for the system selected. [30:19.4.6.2]

66.19.4.7 Operation.

66.19.4.7.1* Operations involving heat transfer fluid systems and equipment shall be reviewed to ensure that the fire and explosion hazards resulting from loss of containment of the fluid or failure of the system are provided with corresponding fire prevention and emergency action plans. [30:19.4.7.1]

66.19.4.7.2 Operators of heat transfer systems shall be trained in the hazards of improper operation of the system and leakage and shall be trained to recognize upset conditions that can lead to dangerous situations. [30:19.4.7.2]

66.19.4.7.3 Safety interlocks shall be inspected, calibrated, and tested annually or at other intervals established in accordance with other applicable standards to determine that they are in proper operating condition. [30:19.4.7.3]

66.19.5 Vapor Recovery and Vapor Processing Systems.

66.19.5.1 Scope.

66.19.5.1.1 This section shall apply to vapor recovery and vapor processing systems where the vapor source operates at pressures from vacuum up to and including a gauge pressure of 1.0 psi (6.9 kPa), or where there is a potential for vapor mixtures in the flammable range. [30:19.5.1.1]

66.19.5.1.2 This section shall not apply to the following:

- (1) Marine systems that comply with U.S. Department of Transportation Regulations in Title 33, Code of Federal Regulations, Parts 154, 155, and 156, and U.S. Coast Guard Regulations in Title 46, Code of Federal Regulations, Parts 30, 32, 35, and 39
- (2) Marine and automotive service station systems that comply with Chapter 30 and NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*

[30:19.5.1.2]

66.19.5.2 Overpressure Protection and Vacuum Protection. Tanks and equipment shall have independent venting for overpressure or vacuum conditions that could occur from malfunction of the vapor recovery or vapor processing system.

Exception: For tanks, venting shall comply with 66.21.4.3. [30:19.5.2]

66.19.5.3 Vent Location.

66.19.5.3.1 Vents on vapor processing systems shall be not less than 12 ft (3.7 m) from adjacent ground level, with outlets located and directed so that ignitable vapors will disperse to a concentration below the lower flammable limit before reaching any location that contains an ignition source. [30:19.5.3.1]

66.19.5.3.2 Vent outlets shall be located so that vapors will not be trapped by eaves or other obstructions and shall be at least 5 ft (1.5 m) from building openings and at least 15 ft (4.5 m) from powered ventilation air intake devices. [30:19.5.3.2]

66.19.5.3.3 Vapor processing equipment and their vents shall be located in accordance with 66.17.3. [30:19.5.3.3]

66.19.5.4 Vapor Collection Systems.

66.19.5.4.1 Vapor collection piping shall be designed to prevent trapping liquid. [30:19.5.4.1]

66.19.5.4.2 Vapor recovery and vapor processing systems that are not designed to handle liquid shall be provided with a means to eliminate any liquid that carries over to or condenses in the vapor collection system. [30:19.5.4.2]

66.19.5.5 Liquid Level Monitoring.

66.19.5.5.1* A liquid knock-out vessel used in the vapor collection system shall have means to verify the liquid level and a high liquid level sensor that activates an alarm. [30:19.5.5.1]

66.19.5.5.2 For unattended facilities, the high liquid level sensor shall initiate shutdown of liquid transfer into the vessel and shutdown of vapor recovery or vapor processing systems. [30:19.5.5.2]

66.19.5.6 Overfill Protection.

66.19.5.6.1 Storage tanks served by vapor processing or vapor recovery systems shall be equipped with overfill protection in accordance with 66.21.7.1. [30:19.5.6.1]

66.19.5.6.2 Overfill protection of tank vehicles shall be in accordance with applicable provisions of 66.28.11.1. [30:19.5.6.2]

66.19.5.7 Sources of Ignition.

66.19.5.7.1 Vapor Release. Tank or equipment openings provided for purposes of vapor recovery shall be protected against possible vapor release in accordance with 66.23.13.7 and 66.28.11.1.8.1. [30:19.5.7.1]

66.19.5.7.2* Electrical Area Classification. Electrical area classification shall be in accordance with Section 66.7. [30:19.5.7.2]

66.19.5.7.3* Static Electricity. Vapor collection and vapor processing equipment shall be protected against static electricity in accordance with 66.6.5.4. [30:19.5.7.3]

66.19.5.7.4* Spontaneous Ignition. Equipment shall be designed or written procedures established and implemented to prevent ignition where the potential exists for spontaneous ignition. [30:19.5.7.4]

66.19.5.7.5* Friction Heat or Sparks from Mechanical Equipment. Mechanical equipment used to move vapors that are in the flammable range shall be designed to prevent sparks

or other ignition sources under both normal and equipment malfunction conditions. [30:19.5.7.5]

66.19.5.7.6* Flame Propagation. Where there is reasonable potential for ignition of a vapor mixture in the flammable range, means shall be provided to stop the propagation of flame through the vapor collection system. The means chosen shall prevent flame propagation under the conditions with which they will be used. [30:19.5.7.6]

66.19.5.7.7 Explosion Protection. Where used, explosion protection systems shall comply with NFPA 69. [30:19.5.7.7]

66.19.5.8 Emergency Shutdown Systems. Emergency shutdown systems shall be designed to fail to a safe position in the event of loss of normal system power (i.e., air or electric) or equipment malfunction. [30:19.5.8]

66.19.6 Solvent Distillation Units.

66.19.6.1 Scope.

66.19.6.1.1 This section shall apply to solvent distillation units having distillation chambers or still pots that do not exceed 60 gal (227 L) nominal capacity and are used to recycle Class I, Class II, or Class IIIA liquids. [30:19.6.1.1]

66.19.6.1.2 This section shall not apply to research, testing, or experimental processes; to distillation processes carried out in petroleum refineries, chemical plants, or distilleries; or to distillation equipment used in dry cleaning operations. [30:19.6.1.2]

66.19.6.2 Equipment. Solvent distillation units shall be approved or shall be listed in accordance with ANSI/UL 2208, *Standard for Solvent Distillation Units*. [30:19.6.2]

66.19.6.3 Solvents. Solvent distillation units shall only be used to distill liquids for which they have been investigated and that are listed on the unit's marking or contained within the manufacturers' literature. [30:19.6.3]

66.19.6.3.1 Unstable or reactive liquids or materials shall not be processed unless they have been specifically listed on the system's markings or contained within the manufacturer's literature. [30:19.6.3.1]

66.19.6.4 Location.

66.19.6.4.1 Solvent distillation units shall be located and operated in locations in accordance with their approval or listing. [30:19.6.4.1]

66.19.6.4.2 Solvent distillation units shall not be used in basements. [30:19.6.4.2]

66.19.6.4.3 Solvent distillation units shall be located away from potential sources of ignition, as indicated on the unit's marking. [30:19.6.4.3]

66.19.6.5 Liquid Storage. Distilled liquids and liquids awaiting distillation shall be stored in accordance with this *Code*. [30:19.6.5]

66.20 Reserved.

66.21 Storage of Liquids in Tanks — Requirements for All Storage Tanks.

66.21.1 Scope. This section shall apply to the following:

- (1) The storage of flammable and combustible liquids, as defined in 3.3.165.1 and 3.3.165.2 and Section 66.4, in fixed tanks that exceed 60 gal (230 L) capacity

- (2) The storage of flammable and combustible liquids in portable tanks that exceed 660 gal (2500 L) capacity
- (3) The storage of flammable and combustible liquids in intermediate bulk containers that exceed 793 gal (3000 L) capacity
- (4) The design, installation, testing, operation, and maintenance of such tanks, portable tanks, and bulk containers

[30:21.1]

66.21.2 Definitions Specific to Section 66.21. For the purpose of this section, the terms in this section shall have the definitions given. [30:21.2]

66.21.2.1 Compartmented Tank. A tank that is divided into two or more compartments intended to contain the same or different liquids. [30:21.2.1]

66.21.3 General Requirements.

66.21.3.1 Storage 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 Section 66.6 and 66.21.6 justifies following the requirements for some other liquid class. [30:21.3.1]

66.21.3.2 Tanks shall be permitted to be of any shape, size, or type consistent with recognized engineering standards. Metal tanks shall be welded, riveted, and caulked, or bolted or constructed using a combination of these methods. [30:21.3.2]

66.21.3.3 Tanks designed and intended for aboveground use shall not be used as underground tanks. [30:21.3.3]

66.21.3.4 Tanks designed and intended for underground use shall not be used as aboveground tanks. [30:21.3.4]

66.21.3.5 Tanks shall be designed and built in accordance with recognized engineering standards for the material of construction being used. [30:21.3.5]

66.21.4 Design and Construction of Storage Tanks.

66.21.4.1 Materials of Construction. Tanks shall be of steel or other approved noncombustible material and shall meet the applicable requirements of 66.21.4.1.1 through 66.21.4.1.5. [30:21.4.1]

66.21.4.1.1 The materials of construction for tanks and their appurtenances shall be compatible with the liquid to be stored. In case of doubt about the properties of the liquid to be stored, the supplier, producer of the liquid, or other competent authority shall be consulted. [30:21.4.1.1]

66.21.4.1.2 Tanks shall be permitted to be constructed of combustible materials when approved. Tanks constructed of combustible materials shall be limited to any of the following:

- (1) Underground installation
- (2) Use where required by the properties of the liquid stored
- (3) Aboveground storage of Class IIIB liquids in areas not exposed to a spill or leak of Class I or Class II liquid
- (4) Storage of Class IIIB liquids inside a building protected by an approved automatic fire-extinguishing system

[30:21.4.1.2]

66.21.4.1.3 Unlined concrete tanks shall be permitted to be used for storing liquids that have a gravity of 40° API or heavier. Concrete tanks with special linings shall be permitted to be used for other liquids, provided they are designed and constructed in accordance with recognized engineering standards. [30:21.4.1.3]

66.21.4.1.4 Tanks shall be permitted to have combustible or noncombustible linings. The selection, specification, and type of lining material and its required thickness shall be based on the properties of the liquid to be stored. When there is a change in the characteristics of the liquid to be stored, the compatibility of the lining and the liquid shall be verified. [30:21.4.1.4]

66.21.4.1.5 An engineering evaluation shall be made if the specific gravity of the liquid to be stored exceeds that of water or if the tank is designed to contain liquids at a liquid temperature below 0°F (-18°C). [30:21.4.1.5]

66.21.4.2 Design Standards for Storage Tanks.

66.21.4.2.1 Design Standards for Atmospheric Tanks.

66.21.4.2.1.1* Atmospheric tanks shall be designed and constructed in accordance with recognized engineering standards. Atmospheric tanks that meet any of the following standards shall be deemed as meeting the requirements of 66.21.4.2.1:

- (1) API Specification 12B, *Bolted Tanks for Storage of Production Liquids*
- (2) API Specification 12D, *Field Welded Tanks for Storage of Production Liquids*
- (3) API Specification 12F, *Shop Welded Tanks for Storage of Production Liquids*
- (4) API Standard 650, *Welded Steel Tanks for Oil Storage*
- (5) UL 58, *Standard for Steel Underground Tanks for Flammable and Combustible Liquids*
- (6) ANSI/UL 80, *Standard for Steel Tanks for Oil Burner Fuel*
- (7) ANSI/UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*
- (8) UL 1316, *Standard for Glass-Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures*
- (9) ANSI/UL 1746, *Standard for External Corrosion Protection Systems for Steel Underground Storage Tanks*
- (10) UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*
- (11) ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*

[30:21.4.2.1.1]

66.21.4.2.1.2 Except as provided for in 66.21.4.2.1.3 and 66.21.4.2.1.4, atmospheric tanks designed and constructed in accordance with Appendix F of API Standard 650, *Welded Steel Tanks for Oil Storage*, shall be permitted to operate at pressures from atmospheric to a gauge pressure of 1.0 psi (6.9 kPa). All other tanks shall be limited to operation from atmospheric to a gauge pressure of 0.5 psi (3.5 kPa). [30:21.4.2.1.2]

66.21.4.2.1.3 Atmospheric tanks that are not designed and constructed in accordance with Appendix F of API Standard 650, *Welded Steel Tanks for Oil Storage*, shall be permitted to operate at pressures from atmospheric to a gauge pressure of 1.0 psi (6.9 kPa) only if an engineering analysis is performed to determine that the tank can withstand the elevated pressure. [30:21.4.2.1.3]

66.21.4.2.1.4 Horizontal cylindrical and rectangular tanks built according to any of the standards specified in 66.21.4.2.1.1 shall be permitted to operate at pressures from atmospheric to a gauge pressure of 1.0 psi (6.9 kPa) and shall be limited to a gauge pressure of 2.5 psi (17 kPa) under emergency venting conditions. [30:21.4.2.1.4]

66.21.4.2.1.5 Low-pressure tanks and pressure vessels shall be permitted to be used as atmospheric tanks. [30:21.4.2.1.5]

66.21.4.2.1.6 Atmospheric tanks shall not be used to store a liquid at a temperature at or above its boiling point. [30:21.4.2.1.6]

66.21.4.2.2 Design Standards for Low-Pressure Tanks.

66.21.4.2.2.1 Low-pressure tanks shall be designed and constructed in accordance with recognized engineering standards. Low-pressure tanks that meet either of the following standards shall be deemed as meeting the requirements of 66.21.4.2.2:

- (1) API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*
- (2) ASME Code for Unfired Pressure Vessels, Section VIII, Division 1

[30:21.4.2.2.1]

66.21.4.2.2.2 Low-pressure tanks shall not be operated above their design pressures. [30:21.4.2.2.2]

66.21.4.2.2.3 Pressure vessels shall be permitted to be used as low-pressure tanks. [30:21.4.2.2.3]

66.21.4.2.3 Design Standards for Pressure Vessels.

66.21.4.2.3.1 Tanks with storage pressures above a gauge pressure of 15 psi (100 kPa) shall be designed and constructed in accordance with recognized engineering standards. Pressure vessels that meet any of the following standards shall be deemed as meeting the requirements of 66.21.4.2.3:

- (1) Fired pressure vessels shall be designed and constructed in accordance with Section I (Power Boilers), or Section VIII, Division 1 or Division 2 (Pressure Vessels), as applicable, of the ASME *Boiler and Pressure Vessel Code*.
- (2) Unfired pressure vessels shall be designed and constructed in accordance with Section VIII, Division 1 or Division 2, of the ASME *Boiler and Pressure Vessel Code*. [30:21.4.2.3.1]

66.21.4.2.3.2* Pressure vessels that do not meet the requirements of 66.21.4.2.3.1(1) or 66.21.4.2.3.1(2) shall be permitted to be used, provided they are approved by the AHJ. [30:21.4.2.3.2]

66.21.4.2.3.3 Pressure vessels shall not be operated above their design pressures. The normal operating pressure of the vessel shall not exceed the design pressure of the vessel. [30:21.4.2.3.3]

66.21.4.3 Normal Venting for Storage Tanks.

66.21.4.3.1 Storage tanks shall be vented to prevent the development of vacuum or pressure that can distort the tank or exceed the rated design pressure of the tank when the tank is filled or emptied or because of atmospheric temperature changes. Normal vents shall be located above the maximum normal liquid level. [30:21.4.3.1]

66.21.4.3.2* Normal venting shall be provided for primary tanks and each primary compartment of a compartmented tank. [30:21.4.3.2]

66.21.4.3.3 Normal vents shall be sized in accordance with either API Standard 2000, *Venting Atmospheric and Low-Pressure Storage Tanks*, or another approved standard. Alternatively, the normal vent shall be at least as large as the largest filling or withdrawal connection, but in no case shall it be less than 1.25 in. (32 mm) nominal inside diameter. [30:21.4.3.3]

66.21.4.3.4 Atmospheric storage tanks shall be vented to prevent the development of vacuum or pressure above the 1.0 psi (6.9 kPa) maximum operating pressure. [30:21.4.3.4]

66.21.4.3.5 Low-pressure tanks and pressure vessels shall be vented to prevent the development of pressure or vacuum that exceeds the rated design pressure of the tank or vessel. Means shall also be provided to prevent overpressure from any pump discharging into the tank or vessel when the pump discharge pressure can exceed the design pressure of the tank or vessel. [30:21.4.3.5]

66.21.4.3.6 If any tank or pressure vessel has more than one fill or withdrawal connection and simultaneous filling or withdrawal can be made, the vent size shall be based on the maximum anticipated simultaneous flow. [30:21.4.3.6]

66.21.4.3.7 For tanks equipped with vents that permit pressures to exceed a gauge pressure of 2.5 psi (17 kPa) and for low-pressure tanks and for pressure vessels, the outlet of all vents and vent drains shall be arranged to discharge in a manner that prevents localized overheating of or flame impingement on any part of the tank, if vapors from the vents are ignited. [30:21.4.3.7]

66.21.4.3.8 Tanks and pressure vessels that store Class IA liquids shall be equipped with venting devices that are closed, except when venting under pressure or vacuum conditions. [30:21.4.3.8]

66.21.4.3.9 Tanks and pressure vessels that store Class IB and Class IC liquids shall be equipped with venting devices or with listed flame arresters. When used, vent devices shall be closed, except when venting under pressure or vacuum conditions. [30:21.4.3.9]

66.21.4.3.10 Tanks of 3000 barrels (bbl) [126,000 gal or (475 m³)] capacity or less that store crude petroleum in crude-producing areas and outside aboveground atmospheric tanks of less than 1000 gal (3785 L) capacity that contain other than Class IA liquids shall be permitted to have open vents. [30:21.4.3.10]

66.21.4.3.11* Flame arresters or venting devices required in 66.21.4.3.8 and 66.21.4.3.9 shall be permitted to be omitted on tanks that store Class IB or Class IC liquids where conditions are such that their use can, in case of obstruction, result in damage to the tank. [30:21.4.3.11]

66.21.4.3.12 Piping for normal vents shall be designed in accordance with Section 66.27. [30:21.4.3.12]

66.21.4.4* Tank Fill Pipes. Fill pipes that enter the top of a tank shall terminate within 6 in. (150 mm) of the bottom of the tank. Fill pipes shall be installed or arranged so that vibration is minimized.

Exception No. 1: Fill pipes in tanks whose vapor space under the expected range of operating conditions is not in the flammable range or is inerted need not meet this requirement.

Exception No. 2: Fill pipes in tanks handling liquids with minimal potential for accumulation of static charge need not meet this requirement, provided that the fill line is designed and the system is operated to avoid mist generation and to provide residence time downstream of filters or screens to allow dissipation of the generated static charge. [30:21.4.4]

66.21.4.5* Corrosion Protection.

66.21.4.5.1 Corrosion protection shall meet the requirements of 66.21.4.5.2 or 66.21.4.5.3, whichever is applicable. [30:21.4.5.1]

66.21.4.5.2 Internal Corrosion Protection for Metal Storage Tanks. Where tanks are not designed in accordance with standards of the American Petroleum Institute, the American Society of Mechanical Engineers, or Underwriters Laboratories Inc., or if corrosion is anticipated beyond that provided for in the design formulas or standards used, additional metal thickness or approved protective coatings or linings shall be provided to compensate for the corrosion loss expected during the design life of the tank. [30:21.4.5.2]

66.21.4.5.3 Internal Corrosion Protection for Nonmetallic Tanks. Where tanks are not designed in accordance with standards of the American Petroleum Institute, the American Society of Mechanical Engineers, ASTM International, or Underwriters Laboratories Inc., or if degradation is anticipated beyond that provided for in the design formulas or standards used, degradation shall be compensated for by providing additional tank material thickness or by application of protective coatings or linings, as determined by an engineering analysis. [30:21.4.5.3]

66.21.5 Testing Requirements for Tanks.

66.21.5.1 General. All tanks, whether shop-built or field-erected, shall be tested before they are placed in service in accordance with the requirements of the code under which they were built. [30:21.5.1]

66.21.5.1.1 An approved listing mark on a tank shall be considered to be evidence of compliance with 66.21.5.1. Tanks not so marked shall be tested before they are placed in service in accordance with the applicable requirements for testing in the codes listed in 66.21.4.2.1.1, 66.21.4.2.2.1, or 66.21.4.2.3.1 or in accordance with recognized engineering standards. Upon satisfactory completion of testing, a permanent record of the test results shall be maintained by the owner. [30:21.5.1.1]

66.21.5.1.2 Where the vertical length of the fill and vent pipes is such that, when filled with liquid, the static head imposed on the bottom of the tank exceeds a gauge pressure of 10 psi (70 kPa), the tank and its related piping shall be tested hydrostatically to a pressure equal to the static head thus imposed by using recognized engineering standards. [30:21.5.1.2]

66.21.5.1.3 Before the tank is initially placed in service, all leaks or deformations shall be corrected in an approved manner. Mechanical caulking shall not be permitted for correcting leaks in welded tanks except for pinhole leaks in the roof. [30:21.5.1.3]

66.21.5.1.4 Tanks to be operated at pressures below their design pressure shall be tested by the applicable provisions of 66.21.5.1.1 or 66.21.5.1.2 based upon the pressure developed under full emergency venting of the tank. [30:21.5.1.4]

66.21.5.2* Tightness Testing. In addition to the tests called for in 66.21.5.1, all tanks and connections shall be tested for tightness after installation and before being placed in service in accordance with 66.21.5.2.2 and 66.21.5.2.3, as applicable. Except for underground tanks, this test shall be made at operating pressure with air, inert gas, or water. [30:21.5.2]

66.21.5.2.1 Testing required by 66.21.5.2 shall not be required for a primary tank or an interstitial space that continues to maintain a factory-applied vacuum in accordance with the manufacturer's instructions. Such components shall be considered to be tight until such time that the vacuum is broken. Final tightness testing of an interstitial space shall not be required if the factory-applied vacuum is maintained until one of the following conditions is met:

- (1) For aboveground tanks, the tank is set on the site at the location where it is intended to be installed.
- (2) For underground tanks, backfill has been completed to the top of the tank.

[30:21.5.2.1]

66.21.5.2.2 Air pressure shall not be used to test tanks that contain flammable or combustible liquids or vapors. (See 66.27.7 for testing pressure piping.) [30:21.5.2.2]

66.21.5.2.3 For field-erected tanks, the tests required by 66.21.5.1.1 or 66.21.5.1.2 shall be permitted to be considered the test for tank tightness. [30:21.5.2.3]

66.21.5.3* Periodic Testing. Each tank shall be tested when required by the manufacturer's instructions and applicable standards to ensure the integrity of the tank. [30:21.5.3]

66.21.6 Fire Prevention and Control.

66.21.6.1 General Requirements.

66.21.6.1.1 This section shall apply to the commonly recognized management techniques and fire control methods used to prevent or minimize the loss from fire or explosion in tank storage facilities. The wide range in size, design, and location of tank storage facilities shall preclude the inclusion of detailed fire prevention and control methods applicable to all such facilities. [30:21.6.1.1]

66.21.6.1.2 Tank storage facilities shall establish and implement fire prevention and control methods for life safety, for minimizing property loss, and for reducing fire exposure to adjoining facilities resulting from fire and explosion. Compliance with 66.21.6.2 through 66.21.6.6 shall be deemed as meeting the requirements of 66.21.6.1. [30:21.6.1.2]

66.21.6.2 Control of Ignition Sources. In order to prevent the ignition of flammable vapors in tank storage facilities, ignition sources shall be controlled in accordance with Section 66.6. [30:21.6.2]

66.21.6.3 Management of Fire Hazards. The extent of fire and explosion prevention and control procedures and measures provided for tank storage facilities shall be determined by an engineering evaluation of the installation and operation, followed by the application of recognized fire and explosion protection and process engineering principles. The evaluation shall include, but not be limited to, the following:

- (1) Analysis of fire and explosion hazards of the facility
- (2) Analysis of local conditions, such as exposure to and from adjacent properties, flood potential, or earthquake potential
- (3) Fire department or mutual aid response

[30:21.6.3]

66.21.6.4 Fire Control. Tank storage facilities for flammable and combustible liquids shall be reviewed to ensure that fire and explosion hazards resulting from loss of containment of liquids are provided with corresponding fire prevention and emergency action plans. (See also 66.6.3.) [30:21.6.4]

66.21.6.5 Emergency Planning and Training.

66.21.6.5.1* An emergency plan, consistent with the available equipment, resources, and personnel, shall be established and implemented to respond to fires and explosions, and other emergencies. This plan shall address the following:

- (1) Procedures to be used in case of fire, explosion, or accidental release of liquid or vapor including, but not limited to, sounding the alarm, notifying the fire department, evacuating personnel, controlling and mitigating the explosion, and controlling and extinguishing the fire
- (2) Appointing and training of personnel to carry out emergency response duties
- (3) Maintenance of fire protection, spill control and containment, and other emergency response equipment
- (4) Conducting emergency response drills
- (5) Shutdown or isolation of equipment to control unintentional releases
- (6) Alternative measures for the safety of personnel while any fire protection or other emergency response equipment is shut down or inoperative

[30:21.6.5.1]

66.21.6.5.2 Personnel responsible for the use and operation of fire protection equipment shall be trained in the use of and be able to demonstrate knowledge of the use or operation of that equipment. Refresher training shall be conducted at least annually. [30:21.6.5.2]

66.21.6.5.3 Planning of effective fire control measures shall be coordinated with local emergency response agencies and shall include, but not be limited to, the identification of all tanks by location, contents, size, and hazard identification as required in 66.21.7.2.1. [30:21.6.5.3]

66.21.6.5.4 Procedures shall be established to provide for safe shutdown of tank storage facilities under emergency conditions and for safe return to service. These procedures shall provide requirements for periodic training of personnel and inspection and testing of associated alarms, interlocks, and controls. [30:21.6.5.4]

66.21.6.5.5 Emergency procedures shall be kept available in an operating area. The procedures shall be reviewed and updated whenever conditions change. [30:21.6.5.5]

66.21.6.5.6 Where tank storage facilities are unattended, a summary of the emergency plan shall be posted or located in a strategic location that is accessible to emergency responders. [30:21.6.5.6]

66.21.6.6 Inspection and Maintenance of Fire Protection and Emergency Response Equipment.

66.21.6.6.1* All fire protection and emergency response equipment shall be maintained, inspected, and tested in accordance with regulatory requirements, standard practices, and equipment manufacturers' recommendations. [30:21.6.6.1]

66.21.6.6.2 Maintenance and operating procedures and practices at tank storage facilities shall be established and implemented to control leakage and prevent spillage and release of liquids. [30:21.6.6.2]

66.21.6.6.3 Ground areas around tank storage facilities shall be kept free of weeds, trash, or other unnecessary combustible materials. [30:21.6.6.3]

66.21.6.6.4 Accessways established for movement of personnel shall be maintained clear of obstructions to permit evacuation and access for manual fire fighting and emergency response in accordance with regulatory requirements and the emergency plan. [30:21.6.6.4]

66.21.6.6.5 Combustible waste material and residues in operating areas shall be kept to a minimum, stored in covered metal containers, and disposed of daily. [30:21.6.6.5]

66.21.6.6.6 Personnel responsible for the inspection and maintenance of fire protection and emergency response equipment shall be trained and shall be able to demonstrate knowledge of the inspection and maintenance of that equipment. Refresher training shall be conducted as needed to maintain proficiency. [30:21.6.6.6]

66.21.7 Operation of Storage Tanks.

66.21.7.1* Prevention of Overfilling of Storage Tanks. Facilities with aboveground tanks larger than 1320 gal (5000 L) storing Class I or Class II liquids shall establish procedures or shall provide equipment, or both, to prevent overfilling of tanks. [30:21.7.1]

66.21.7.1.1 Facilities with aboveground tanks that receive and transfer Class I liquids from mainline pipelines or marine vessels shall establish and follow formal written procedures to prevent overfilling of tanks utilizing one of the following methods of protection:

- (1) Tanks shall be gauged at intervals in accordance with established procedures by personnel continuously on the premises during product receipt. Acknowledged communication shall be maintained with the supplier so flow can be shut down or diverted in accordance with established procedures.
- (2) Tanks shall be equipped with a high-level detection device that is either independent of any gauging equipment or incorporates a gauging and alarm system that provides electronic self-checking to indicate when the gauging and alarm system has failed. Alarms shall be located where personnel who are on duty throughout product transfer can arrange for flow stoppage or diversion in accordance with established procedures.
- (3) Tanks shall be equipped with an independent high-level detection system that will automatically shut down or divert flow in accordance with established procedures.

[30:21.7.1.1]

66.21.7.1.2 Alternatives to instrumentation described in 66.21.7.1.1(2) and 66.21.7.1.1(3) shall be allowed where approved as affording equivalent protection. [30:21.7.1.2]

66.21.7.1.3 Instrumentation systems covered in 66.21.7.1.1(2) and 66.21.7.1.1(3) shall be wired fail-safe, such that valid alarm conditions or system failures create an alarm condition that will notify personnel or automatically shut down or divert flow. [30:21.7.1.3]

66.21.7.1.3.1 Written instrumentation performance procedures shall be established to define valid alarm conditions and system failures in accordance with API 2350, *Overfill Protection for Storage Tanks in Petroleum Facilities*. [30:21.7.1.3.1]

66.21.7.1.3.2 System failure shall include but not be limited to the following:

- (1) Loss of main electrical power
- (2) Electrical break, short circuit, or ground fault in the level detection system circuit or the alarm and signal circuit
- (3) Failure or malfunction of the level detection system control equipment or signaling devices

[30:21.7.1.3.2]

66.21.7.1.4 Formal written procedures required by 66.21.7.1.1 shall include the following:

- (1) Instructions covering methods to check for lineup and receipt of initial delivery to tank designated to receive shipment.
- (2) Provision for training and monitoring the performance of operating personnel by supervisors.
- (3) Schedules and procedures for inspection and testing of gauging equipment and high-level instrumentation and related systems. Inspection and testing intervals shall be approved but shall not exceed 1 year.

[30:21.7.1.4]

66.21.7.1.5 An underground tank shall be equipped with overfill prevention equipment that will operate as follows either alert the transfer operator when the tank is no more than 90 percent full by triggering an audible and visual high-level alarm or automatically shut off the flow of liquid into the tank when the tank is no more than 95 percent full. [30:21.7.1.5]

66.21.7.1.5.1 Other methods of overfill protection shall be permitted as approved by the authority having jurisdiction. [30:21.7.1.5.1]

66.21.7.1.6 Shop-fabricated aboveground atmospheric storage tanks, constructed to the recognized standards of 66.21.4.2.1.1, shall meet the requirements of 66.21.7.1.6.1 through 66.21.7.1.6.4 whenever the vertical length from the tank bottom to the top of the fill, normal vent, or emergency vent exceeds 12 ft (3.7 m). [30:21.7.1.6]

66.21.7.1.6.1 An approved means shall be provided to notify the tank filling operator of the pending completion of the tank fill operation at the fill connection. [30:21.7.1.6.1]

66.21.7.1.6.2 An approved means shall be provided to stop delivery of liquid to the tank prior to the complete filling of the tank. [30:21.7.1.6.2]

66.21.7.1.6.3 In no case shall these provisions restrict or interfere with the functioning of the normal vent or emergency vent. [30:21.7.1.6.3]

66.21.7.1.6.4 The manufacturer of the tank shall be consulted to determine if reinforcement of the tank is required. If reinforcement is deemed necessary, it shall be done. [30:21.7.1.6.4]

66.21.7.2 Identification and Security.

66.21.7.2.1 Identification for Emergency Responders. A sign or marking that meets the requirements of NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, or another approved system, shall be applied to storage tanks containing liquids. The marking shall be located where it can be seen, such as on the side of the tank, the shoulder of an accessway or walkway to the tank or tanks, or on the piping outside of the diked area. If more than one tank is involved, the markings shall be so located that each tank can be identified. [30:21.7.2.1]

66.21.7.2.2 Security for Unsupervised Storage Tanks. Unsupervised, isolated aboveground storage tanks shall be secured and shall be marked to identify the fire hazards of the tank and the tank's contents to the general public. Where necessary to protect the tank from tampering or trespassing, the area where the tank is located shall be secured. [30:21.7.2.2]

66.21.7.3 Storage Tanks in Areas Subject to Flooding.

66.21.7.3.1 Water Loading.

66.21.7.3.1.1 The filling of a tank to be protected by water loading shall be started as soon as floodwaters are predicted to reach a dangerous flood stage. [30:21.7.3.1.1]



66.21.7.3.1.2 Where independently fueled water pumps are relied on, sufficient fuel shall be available at all times to permit continuing operations until all tanks are filled. [30:21.7.3.1.2]

66.21.7.3.1.3 Tank valves shall be locked in a closed position when water loading has been completed. [30:21.7.3.1.3]

66.21.7.3.2 Operating Instructions. Operating instructions or procedures to be followed in a flood emergency shall be established and implemented by personnel identified in 66.21.7.3.3. [30:21.7.3.2]

66.21.7.3.3 Personnel Training. Personnel responsible for activating and performing flood emergency procedures shall be trained in their implementation and shall be informed of the location and operation of valves and other controls and equipment necessary to effect the intent of these procedures. Personnel shall also be trained in the procedures required to place the facility back into service following a flood emergency. [30:21.7.3.3]

66.21.7.4 Removal from Service of Storage Tanks.

66.21.7.4.1* Closure of Aboveground Storage Tanks. Aboveground tanks taken out of service or abandoned shall be emptied of liquid, rendered vapor-free, and safeguarded against trespassing in accordance with NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, or in accordance with the requirements of the AHJ. [30:21.7.4.1]

66.21.7.4.2 Reuse of Aboveground Storage Tanks. Aboveground tanks shall be permitted to be reused for flammable or combustible liquids service provided they comply with applicable sections of this *Code* and are approved. [30:21.7.4.2]

66.21.7.4.3 Removal from Service of Underground Storage Tanks.

66.21.7.4.3.1 General. Underground tanks taken out of service or abandoned shall be emptied of liquid, rendered vapor-free, and safeguarded against trespassing in accordance with this section and in accordance with NFPA 326 or in accordance with the requirements of the AHJ. The procedures outlined in this section shall be followed when taking underground tanks temporarily out of service, closing them in place permanently, or removing them. (*See Annex C of NFPA 30 for additional information.*) [30:21.7.4.3.1]

66.21.7.4.3.2 Temporary Closure. Underground tanks shall be rendered temporarily out of service only when it is planned that they will be returned to active service, closed in place permanently, or removed within an approved period not exceeding 1 year. The following requirements shall be met:

- (1) Corrosion protection and release detection systems shall be maintained in operation.
- (2) The vent line shall be left open and functioning.
- (3) The tank shall be secured against tampering.
- (4) All other lines shall be capped or plugged.

[30:21.7.4.3.2]

66.21.7.4.3.2.1 Tanks remaining temporarily out of service for more than 1 year shall be permanently closed in place or removed in accordance with 66.21.7.4.3.3 or 66.21.7.4.3.4, as applicable. [30:21.7.4.3.2.1]

66.21.7.4.3.3 Permanent Closure in Place. Underground tanks shall be permitted to be permanently closed in place if approved by the AHJ. All of the following requirements shall be met:

- (1) All applicable AHJs shall be notified.
- (2)* A safe workplace shall be maintained throughout the prescribed activities.
- (3) All flammable and combustible liquids and residues shall be removed from the tank, appurtenances, and piping and shall be disposed of in accordance with regulatory requirements and industry practices, using a written procedure.
- (4) The tank, appurtenances, and piping shall be made safe by either purging them of flammable vapors or inerting the potential explosive atmosphere. Confirmation that the atmosphere in the tank is safe shall be by testing of the atmosphere using a combustible gas indicator if purging, or an oxygen meter if inerting, at intervals in accordance with written procedures.
- (5) Access to the tank shall be made by careful excavation to the top of the tank.
- (6) All exposed piping, gauging and tank fixtures, and other appurtenances, except the vent, shall be disconnected and removed.
- (7) The tank shall be completely filled with an inert solid material.
- (8) The tank vent and remaining underground piping shall be capped or removed.
- (9) The tank excavation shall be backfilled.

[30:21.7.4.3.3]

66.21.7.4.3.4 Removal and Disposal. Underground tanks and piping shall be removed in accordance with the following requirements:

- (1) The steps described in 66.21.7.4.3.3(1) through 66.21.7.4.3.3(5) shall be followed.
- (2) All exposed piping, gauging and tank fixtures, and other appurtenances, including the vent, shall be disconnected and removed.
- (3) All openings shall be plugged, leaving a ¼ in. (6 mm) opening to avoid buildup of pressure in the tank.
- (4) The tank shall be removed from the excavated site and shall be secured against movement.
- (5) Any corrosion holes shall be plugged.
- (6) The tank shall be labeled with its former contents, present vapor state, vapor-freeing method, and a warning against reuse.
- (7) The tank shall be removed from the site as authorized by the AHJ, preferably the same day.

[30:21.7.4.3.4]

66.21.7.4.3.5 Temporary Storage of Removed Tanks. If it is necessary to temporarily store an underground tank that has been removed, it shall be placed in a secure area where public access is restricted. A ¼ in. (6 mm) opening shall be maintained to avoid buildup of pressure in the tank. [30:21.7.4.3.5]

66.21.7.4.3.6 Disposal of Tanks. Disposal of underground tanks shall meet the following requirements:

- (1) Before a tank is cut up for scrap or landfill, the atmosphere in the tank shall be tested in accordance with 66.21.7.4.3.3(4) to ensure that it is safe.
- (2) The tank shall be made unfit for further use by cutting holes in the tank heads and shell.

[30:21.7.4.3.6]

66.21.7.4.3.7 Documentation. All necessary documentation shall be prepared and maintained in accordance with all federal, state, and local rules and regulations. [30:21.7.4.3.7]

66.21.7.4.3.8 Reuse of Underground Storage Tanks. Underground tanks shall be permitted to be reused for underground storage of flammable or combustible liquids provided they comply with applicable sections of this *Code* and are approved. [30:21.7.4.3.8]

66.21.7.5* Leak Detection and Inventory Records for Underground Storage Tanks. Accurate inventory records or a leak detection program shall be maintained on all Class I liquid storage tanks for indication of leakage from the tanks or associated piping. [30:21.7.5]

66.21.8 Inspection and Maintenance of Storage Tanks and Storage Tank Appurtenances.

66.21.8.1* Each storage tank constructed of steel shall be inspected and maintained in accordance with API Standard 653, *Tank Inspection, Repair, Alteration, and Reconstruction*, or STI SP001, *Standard for the Inspection of Aboveground Storage Tanks*, whichever is applicable. [30:21.8.1]

66.21.8.2 Each storage tank constructed of other materials shall be inspected and maintained in accordance with the manufacturer's instructions and applicable standards to ensure compliance with the requirements of this *Code*. [30:21.8.2]

66.21.8.3 Testing of storage tanks shall meet the requirements of 66.21.5. [30:21.8.3]

66.21.8.4 Each storage tank shall be maintained liquidtight. Each storage tank that is leaking shall be emptied of liquid or repaired in a manner acceptable to the AHJ. [30:21.8.4]

66.21.8.5 Each storage tank that has been structurally damaged, repaired, reconstructed, relocated, jacked, or damaged by impact, flood, or other trauma, or is suspected of leaking shall be inspected and tested in accordance with 66.21.5 or in a manner acceptable to the AHJ. [30:21.8.5]

66.21.8.6* Storage tanks and their appurtenances, including normal vents, emergency vents, overfill prevention devices, and related devices, shall be inspected and maintained to ensure that they function as intended in accordance with written procedures. [30:21.8.6]

66.21.8.7 Openings for gauging on storage tanks storing Class I liquids shall be provided with a vaportight cap or cover. Such covers shall be closed when not gauging. [30:21.8.7]

66.21.8.8* Facilities with aboveground storage tanks shall establish and implement a procedure to check for and remove water from the bottom of storage tanks that contain nonmiscible liquids. [30:21.8.8]

66.21.9 Change of Stored Liquid. Storage tanks that undergo any change of stored liquid shall be re-evaluated for compliance with Sections 66.21 through 66.25, as applicable. [30:21.9]

66.22 Storage of Liquids in Tanks — Aboveground Storage Tanks.

66.22.1 Scope. This chapter shall apply to the following:

- (1) The storage of flammable and combustible liquids, as defined in 3.3.165.1 and 3.3.165.2 and Section 66.4, in fixed tanks that exceed 60 gal (230 L) capacity
- (2) The storage of flammable and combustible liquids in portable tanks that exceed 660 gal (2500 L) capacity
- (3) The storage of flammable and combustible liquids in intermediate bulk containers that exceed 793 gal (3000 L)

- (4) The design, installation, testing, operation, and maintenance of such tanks, portable tanks, and bulk containers

[30:22.1]

66.22.2 Definitions Specific to Section 66.22. For the purpose of this section, the terms in this section shall have the definition given. [30:22.2]

66.22.2.1 Fire-Resistant Tank. An atmospheric aboveground storage tank with thermal insulation that has been evaluated for resistance to physical damage and for limiting the heat transferred to the primary tank when exposed to a hydrocarbon fuel fire and is listed in accordance with UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*, or an equivalent test procedure. [30:22.2.1]

66.22.2.2 Floating Roof Tank. An aboveground storage tank that incorporates one of the following designs:

- (1) A closed-top pontoon or double-deck metal floating roof in an open-top tank constructed in accordance with API Standard 650, *Welded Steel Tanks for Oil Storage*
- (2) A fixed metal roof with ventilation at the top and roof eaves constructed in accordance with API Standard 650 and containing a closed-top pontoon or double-deck metal floating roof meeting the requirements of API Standard 650
- (3) A fixed metal roof with ventilation at the top and roof eaves constructed in accordance with API Standard 650 and containing a metal floating cover supported by liquidtight metal floating devices that provide buoyancy to prevent the liquid surface from being exposed when half of the flotation is lost

[30:22.2.2]

66.22.2.2.1 For the purposes of this section, an aboveground storage tank with an internal metal floating pan, roof, or cover that does not meet 66.22.2.2 or one that uses plastic foam (except for seals) for flotation, even if encapsulated in metal or fiberglass, shall meet the requirements for a fixed roof tank. [30:22.2.2.1]

66.22.2.3 Protected Aboveground Tank. An atmospheric aboveground storage tank with integral secondary containment and thermal insulation that has been evaluated for resistance to physical damage and for limiting the heat transferred to the primary tank when exposed to a hydrocarbon pool fire and is listed in accordance with ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*, or an equivalent test procedure. [30:22.2.3]

66.22.3 General Requirements. Storage 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 Section 66.6 justifies following the requirements for some other liquid class. [30:22.3]

66.22.4* Location of Aboveground Storage Tanks.

66.22.4.1 Location with Respect to Property Lines, Public Ways, and Important Buildings.

66.22.4.1.1 Tanks storing Class I, Class II, or Class IIIA stable liquids whose internal pressure is not permitted to exceed a gauge pressure of 2.5 psi (17 kPa) shall be located in accordance with Table 66.22.4.1.1(a) and Table 66.22.4.1.1(b). Where tank spacing is based on a weak roof-to-shell seam design, the user shall present evidence certifying such construction to the AHJ upon request. [30:22.4.1.1]

Table 66.22.4.1.1(a) Location of Aboveground Storage Tanks Storing Stable Liquids — Internal Pressure Not to Exceed a Gauge Pressure of 2.5 psi (17 kPa)

Type of Tank	Protection	Minimum Distance (ft)	
		From Property Line That Is or Can Be Built Upon, Including the Opposite Side of a Public Way ^a	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property ^a
Floating roof	Protection for exposures ^b	$\frac{1}{2} \times$ diameter of tank	$\frac{1}{6} \times$ diameter of tank
	None	Diameter of tank but need not exceed 175 ft	$\frac{1}{6} \times$ diameter of tank
Vertical with weak roof-to-shell seam	Approved foam or inerting system ^c on tanks not exceeding 150 ft in diameter ^d	$\frac{1}{2} \times$ diameter of tank	$\frac{1}{6} \times$ diameter of tank
	Protection for exposures ^b	Diameter of tank	$\frac{1}{3} \times$ diameter of tank
	None	$2 \times$ diameter of tank but need not exceed 350 ft	$\frac{1}{3} \times$ diameter of tank
Horizontal and vertical tanks with emergency relief venting to limit pressures to 2.5 psi (gauge pressure of 17 kPa)	Approved inerting system ^b on the tank or approved foam system on vertical tanks	$\frac{1}{2} \times$ value in Table 66.22.4.1.1(b)	$\frac{1}{2} \times$ value in Table 66.22.4.1.1(b)
	Protection for exposures ^b	Value in Table 66.22.4.1.1(b)	Value in Table 66.22.4.1.1(b)
	None	$2 \times$ value in Table 66.22.4.1.1(b)	Value in Table 66.22.4.1.1(b)
Protected aboveground tank	None	$\frac{1}{2} \times$ value in Table 66.22.4.1.1(b)	$\frac{1}{2} \times$ value in Table 66.22.4.1.1(b)

For SI units, 1 ft = 0.3 m.

^aThe minimum distance cannot be less than 5 ft (1.5 m).

^bSee definition 3.3.46 of NFPA 30, Protection for Exposures.

^cSee NFPA 69, *Standard on Explosion Prevention Systems*.

^dFor tanks over 150 ft (45 m) in diameter, use "Protection for Exposures" or "None," as applicable. [30: Table 22.4.1.1(a)]

Table 66.22.4.1.1(b) Reference Table for Use with Tables 66.22.4.1.1(a), 66.22.4.1.3, and 66.22.4.1.5

Tank Capacity (gal)	Minimum Distance (ft)	
	From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
275 or less	5	5
276 to 750	10	5
751 to 12,000	15	5
12,001 to 30,000	20	5
30,001 to 50,000	30	10
50,001 to 100,000	50	15
100,001 to 500,000	80	25
500,001 to 1,000,000	100	35
1,000,001 to 2,000,000	135	45
2,000,001 to 3,000,000	165	55
3,000,001 or more	175	60

For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L. [30: Table 22.4.1.1(b)]

66.22.4.1.2 Vertical tanks with weak roof-to-shell seams (*see* 66.22.7.2) that store Class IIIA liquids shall be permitted to be located at one-half the distances specified in Table 66.22.4.1.1(a), provided the tanks are not within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid. [30:22.4.1.2]

66.22.4.1.3 Tanks storing Class I, Class II, or Class IIIA stable liquids and operating at pressures that exceed a gauge pressure of 2.5 psi (17 kPa), or are equipped with emergency venting that will permit pressures to exceed a gauge pressure of 2.5 psi (17 kPa), shall be located in accordance with Table 66.22.4.1.3 and Table 66.22.4.1.1(b). [30:22.4.1.3]

66.22.4.1.4 Tanks storing liquids with boil-over characteristics shall be located in accordance with Table 66.22.4.1.4. Liquids with boil-over characteristics shall not be stored in fixed roof tanks larger than 150 ft (45 m) in diameter, unless an approved inerting system is provided on the tank. [30:22.4.1.4]

66.22.4.1.5 Tanks storing unstable liquids shall be located in accordance with Table 66.22.4.1.5 and Table 66.22.4.1.1(b). [30:22.4.1.5]

66.22.4.1.6 Tanks storing Class IIIB stable liquids shall be located in accordance with Table 66.22.4.1.6.

Exception: If located within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid, the tank storing Class IIIB liquid shall be located in accordance with 66.22.4.1.1.

[30:22.4.1.6]

66.22.4.1.7 Where two tank properties of diverse ownership have a common boundary, the AHJ shall be permitted, with the written consent of the owners of the two properties, to substitute the distances provided in 66.22.4.2 for the minimum distances set forth in 66.22.4.1.1. [30:22.4.1.7]

Table 66.22.4.1.3 Location of Aboveground Storage Tanks Storing Stable Liquids — Internal Pressure Permitted to Exceed a Gauge Pressure of 2.5 psi (17 kPa)

Type of Tank	Protection	Minimum Distance (ft)	
		From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
Any type	Protection for exposures*	$1\frac{1}{2} \times$ value in Table 66.22.4.1.1(b) but not less than 25 ft	$1\frac{1}{2} \times$ value in Table 66.22.4.1.1(b) but not less than 25 ft
	None	$3 \times$ value in Table 66.22.4.1.1(b) but not less than 50 ft	$1\frac{1}{2} \times$ value in Table 66.22.4.1.1(b) but not less than 25 ft

For SI units, 1 ft = 0.3 m.

*See definition 3.3.46 of NFPA 30, Protection for Exposures. [30: Table 22.4.1.3]

Table 66.22.4.1.4 Location of Aboveground Storage Tanks Storing Boil-Over Liquids

Type of Tank	Protection	Minimum Distance (ft)	
		From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way ^a	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property ^a
Floating roof	Protection for exposures ^b	$\frac{1}{2} \times$ diameter of tank	$\frac{1}{6} \times$ diameter of tank
	None	Diameter of tank	$\frac{1}{6} \times$ diameter of tank
Fixed roof	Approved foam or inerting system ^c	Diameter of tank	$\frac{1}{3} \times$ diameter of tank
	Protection for exposures ^b	$2 \times$ diameter of tank	$\frac{2}{3} \times$ diameter of tank
	None	$4 \times$ diameter of tank but need not exceed 350 ft	$\frac{2}{3} \times$ diameter of tank

For SI units, 1 ft = 0.3 m.

^aThe minimum distance cannot be less than 5 ft.

^bSee definition 3.3.46 of NFPA 30, Protection for Exposures.

^cSee NFPA 69, *Standard on Explosion Prevention Systems*. [30: Table 22.4.1.4]



Table 66.22.4.1.5 Location of Aboveground Storage Tanks Storing Unstable Liquids

Type of Tank	Protection	Minimum Distance (ft)	
		From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property ^a
Horizontal and vertical tanks with emergency relief venting to permit pressure not in excess of a gauge pressure of 2.5 psi (17 kPa)	Tank protected with any one of the following: approved water spray, approved inerting, ^a approved insulation and refrigeration, approved barricade	Value in Table 66.22.4.1.1(b) but not less than 25 ft	Not less than 25 ft
	Protection for exposures ^b	2½ × value in Table 66.22.4.1.1(b) but not less than 50 ft	Not less than 50 ft
	None	5 × value in Table 66.22.4.1.1(b) but not less than 100 ft	Not less than 100 ft
Horizontal and vertical tanks with emergency relief venting to permit pressure over a gauge pressure of 2.5 psi (17 kPa)	Tank protected with any one of the following: approved water spray, approved inerting, ^a approved insulation and refrigeration, approved barricade	2 × value in Table 66.22.4.1.1(b) but not less than 50 ft	Not less than 50 ft
	Protection for exposures ^b	4 × value in Table 66.22.4.1.1(b) but not less than 100 ft	Not less than 100 ft
	None	8 × value in Table 66.22.4.1.1(b) but not less than 150 ft	Not less than 150 ft

For SI units, 1 ft = 0.3 m.

^aSee NFPA 69, *Standard on Explosion Prevention Systems*.

^bSee definition 3.3.46 of NFPA 30, *Protection for Exposures*. [30: Table 22.4.1.5]

Table 66.22.4.1.6 Location of Aboveground Storage Tanks Storing Class IIIB Liquids

Tank Capacity (gal)	Minimum Distance (ft)	
	From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
12,000 or less	5	5
12,001 to 30,000	10	5
30,001 to 50,000	10	10
50,001 to 100,000	15	10
100,001 or more	15	15

For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L. [30: Table 22.4.1.6]

66.22.4.1.8 Where end failure of a horizontal pressure tank or vessel can expose property, the tank or vessel shall be placed with its longitudinal axis parallel to the nearest important exposure. [30:22.4.1.8]

66.22.4.2 Shell-to-Shell Spacing of Adjacent Aboveground Storage Tanks.

66.22.4.2.1* Tanks storing Class I, Class II, or Class IIIA stable liquids shall be separated by the distances given in Table 66.22.4.2.1. [30:22.4.2.1]

66.22.4.2.1.1 Tanks that store crude petroleum, have individual capacities not exceeding 3000 bbl (126,000 gal or 480 m³), and are located at production facilities in isolated locations shall not be required to be separated by more than 3 ft (0.9 m). [30:22.4.2.1.1]

66.22.4.2.1.2 Tanks used only for storing Class IIIB liquids shall not be required to be separated by more than 3 ft (0.9 m) provided they are not within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid. If located within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid, the tank storing Class IIIB liquid shall be spaced in accordance with the requirements for Class IIIA liquids in Table 66.22.4.2.1. [30:22.4.2.1.2]

Table 66.22.4.2.1 Minimum Shell-to-Shell Spacing of Aboveground Storage Tanks

Tank Diameter	Floating Roof Tanks	Fixed or Horizontal Tanks	
		Class I or II Liquids	Class IIIA Liquids
All tanks not over 150 ft (45 m) in diameter	$\frac{1}{6}$ × sum of adjacent tank diameters but not less than 3 ft (0.9 m)	$\frac{1}{6}$ × sum of adjacent tank diameters but not less than 3 ft (0.9 m)	$\frac{1}{6}$ × sum of adjacent tank diameters but not less than 3 ft (0.9 m)
Tanks larger than 150 ft (45 m) in diameter:			
If remote impounding is provided in accordance with 66.22.11.1	$\frac{1}{6}$ × sum of adjacent tank diameters	$\frac{1}{4}$ × sum of adjacent tank diameters	$\frac{1}{6}$ × sum of adjacent tank diameters
If open diking is provided in accordance with 66.22.11.2	$\frac{1}{4}$ × sum of adjacent tank diameters	$\frac{1}{3}$ × sum of adjacent tank diameters	$\frac{1}{4}$ × sum of adjacent tank diameters

Note: The "sum of adjacent tank diameters" means the sum of the diameters of each pair of tanks that are adjacent to each other. See also A.66.22.4.2.1. [30: Table 22.4.2.1]

66.22.4.2.2 A tank storing unstable liquid shall be separated from any other tank containing either an unstable liquid or a Class I, II, or III liquid by a distance not less than one-half the sum of their diameters. [30:22.4.2.2]

66.22.4.2.3 Where tanks are in a diked area containing Class I or Class II liquids or in the drainage path of Class I or Class II liquids and are compacted in three or more rows or in an irregular pattern, greater spacing or other means shall be permitted to be required by the AHJ to make tanks in the interior of the pattern accessible for fire-fighting purposes. [30:22.4.2.3]

66.22.4.2.4 The minimum horizontal separation between an LP-Gas container and a Class I, Class II, or Class IIIA liquid storage tank shall be 20 ft (6 m). [30:22.4.2.4]

66.22.4.2.4.1 Means shall be provided to prevent Class I, Class II, or Class IIIA liquids from accumulating under adjacent LP-Gas containers by means of dikes, diversion curbs, or grading. [30:22.4.2.4.1]

66.22.4.2.4.2 Where flammable or combustible liquid storage tanks are within a diked area, the LP-Gas containers shall be outside the diked area and at least 3 ft (0.9 m) away from the centerline of the wall of the diked area. [30:22.4.2.4.2]

66.22.4.2.5 If a tank storing a Class I, Class II, or Class IIIA liquid operates at pressures exceeding a gauge pressure of 2.5 psi (17 kPa) or is equipped with emergency relief venting that will permit pressures to exceed a gauge pressure of 2.5 psi (17 kPa), it shall be separated from an LP-Gas container by the appropriate distance given in Table 66.22.4.2.1. [30:22.4.2.5]

66.22.4.2.6 The requirements of 66.22.4.2.4 shall not apply where LP-Gas containers of 125 gal (475 L) or less capacity are installed adjacent to fuel oil supply tanks of 660 gal (2500 L) or less capacity. [30:22.4.2.6]

66.22.5 Installation of Aboveground Storage Tanks.

66.22.5.1 Tank Supports.

66.22.5.1.1 Tank supports shall be designed and constructed in accordance with recognized engineering standards. [30:22.5.1.1]

66.22.5.1.2 Tanks shall be supported in a manner that prevents excessive concentration of loads on the supported portion of the shell. [30:22.5.1.2]

66.22.5.1.3 In areas subject to earthquakes, tank supports and connections shall be designed to resist damage as a result of such shocks. [30:22.5.1.3]

66.22.5.2 Foundations for and Anchoring of Aboveground Storage Tanks.

66.22.5.2.1* Tanks shall rest on the ground or on foundations made of concrete, masonry, piling, or steel. [30:22.5.2.1]

66.22.5.2.2 Tank foundations shall be designed to minimize the possibility of uneven settling of the tank and to minimize corrosion in any part of the tank resting on the foundation. [30:22.5.2.2]

66.22.5.2.3 Where tanks storing Class I, Class II, or Class IIIA liquids are supported above their foundations, tank supports shall be of concrete, masonry, or protected steel.

Exception: Single wood timber supports (not cribbing), laid horizontally, shall be permitted to be used for outside aboveground tanks if not more than 12 in. (300 mm) high at their lowest point.

[30:22.5.2.3]

66.22.5.2.4* Steel support structures or exposed piling for tanks storing Class I, Class II, or Class IIIA liquids shall be protected by materials having a fire resistance rating of not less than 2 hours.

Exception No. 1: Steel saddles do not need to be protected if less than 12 in. (300 mm) high at their lowest point.

Exception No. 2: At the discretion of the AHJ, water spray protection in accordance with NFPA 15, Standard for Water Spray Fixed Systems for Fire Protection, or NFPA 13, is permitted to be used. [30:22.5.2.4]

66.22.5.2.5 Where a tank is located in an area subject to flooding, provisions shall be taken to prevent tanks, either full or empty, from floating during a rise in water level up to the established maximum flood stage. (See 66.21.7.3.) [30:22.5.2.5]

66.22.6 Vent Piping for Aboveground Tanks. Piping for normal and emergency relief venting shall be constructed in accordance with Section 66.27. [30:22.6]



66.22.7 Emergency Relief Venting for Fire Exposure for Aboveground Storage Tanks.

66.22.7.1 General.

66.22.7.1.1 Every aboveground storage tank shall have emergency relief venting in the form of construction or a device or devices that will relieve excessive internal pressure caused by an exposure fire. [30:22.7.1.1]

66.22.7.1.1.1 This requirement shall apply to each compartment of a compartmented tank, the interstitial space (annulus) of a secondary containment-type tank, and the enclosed space of tanks of closed-top dike construction. [30:22.7.1.1.1]

66.22.7.1.1.2 This requirement shall also apply to spaces or enclosed volumes, such as those intended for insulation, membranes, or weather shields, that are capable of containing liquid because of a leak from the primary vessel. The insulation, membrane, or weather shield shall not interfere with emergency venting. [30:22.7.1.1.2]

66.22.7.1.1.3 Tanks storing Class IIIB liquids that are larger than 12,000 gal (45,400 L) capacity and are not within the diked area or the drainage path of tanks storing Class I or Class II liquids shall not be required to meet the requirements of 66.22.7.1.1. [30:22.7.1.1.3]

66.22.7.1.2 For vertical tanks, the emergency relief venting construction referred to in 66.22.7.1.1 shall be permitted to be a floating roof, a lifter roof, a weak roof-to-shell seam, or another approved pressure-relieving construction. [30:22.7.1.2]

66.22.7.1.3 If unstable liquids are stored, the effects of heat or gas resulting from polymerization, decomposition, condensation, or self-reactivity shall be taken into account. [30:22.7.1.3]

66.22.7.1.4 If two-phase flow is anticipated during emergency venting, an engineering evaluation shall be conducted in order to size the pressure-relieving devices. [30:22.7.1.4]

66.22.7.2 Weak Roof-to-Shell Seam Construction. If used, a weak roof-to-shell seam shall be constructed to fail preferential to any other seam and shall be designed in accordance with API Standard 650, *Welded Steel Tanks for Oil Storage*, or ANSI/UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*. [30:22.7.2]

66.22.7.3 Pressure-Relieving Devices.

66.22.7.3.1* Where entire dependence for emergency relief venting is placed upon pressure-relieving devices, the total venting capacity of both normal and emergency vents shall be sufficient to prevent rupture of the shell or bottom of a vertical tank or of the shell or heads of a horizontal tank. [30:22.7.3.1]

66.22.7.3.2 Emergency relief vent devices shall be vaportight and shall be permitted to be any one of the following:

- (1) Self-closing manway cover
- (2) Manway cover provided with long bolts that permit the cover to lift under internal pressure
- (3) Additional or larger relief valve or valves

[30:22.7.3.2.1]

66.22.7.3.3 The outlets of all vents and vent drains on tanks equipped with emergency relief venting that permits pressures to exceed a gauge pressure of 2.5 psi (17.2 kPa) shall be arranged to discharge so that localized overheating or flame impingement on any part of the tank will not occur if vapors from the vents are ignited. [30:22.7.3.9]

66.22.7.3.4 Each commercial tank venting device shall have the following information either stamped or cast into the metal body of the device or included on a metal nameplate permanently affixed to it.

- (1) Start-to-open pressure
- (2) Pressure at which the valve reaches the full open position
- (3) Flow capacity at the pressure indicated by 66.22.7.3.4(2)

[30:22.7.3.10]

66.22.7.4* Extension of Emergency Vent Piping. Piping to or from approved emergency vent devices for atmospheric and low-pressure tanks shall be sized to provide emergency vent flows that limit the back pressure to less than the maximum pressure permitted by the design of the tank. Piping to or from approved emergency vent devices for pressure vessels shall be sized in accordance with the ASME *Boiler and Pressure Vessel Code*. [30:22.7.4]

66.22.8 Fire Control.

66.22.8.1* A fire-extinguishing system in accordance with an applicable NFPA standard shall be provided or shall be available for vertical atmospheric fixed-roof storage tanks larger than 50,000 gal (190 m³) capacity, storing Class I liquids, if located in a congested area where there is an unusual exposure hazard to the tank from adjacent property or to adjacent property from the tank. [30:22.8.1]

66.22.8.2 Fixed-roof tanks storing Class II or Class III liquids at temperatures below their flash points and floating-roof tanks storing any liquid shall not require protection when installed in accordance with this section. [30:22.8.2]

66.22.9 Additional Requirements for Fire-Resistant Aboveground Storage Tanks.

66.22.9.1 Fire-resistant tanks shall be tested and listed in accordance with UL 2080, *Standard for Fire Resistant Tanks for Flammable and Combustible Liquids*. [30:22.9.1]

66.22.10 Additional Requirements for Protected Aboveground Storage Tanks.

66.22.10.1 Protected aboveground tanks shall be tested and listed in accordance with ANSI/UL 2085, *Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids*. [30:22.10.1]

66.22.11* Control of Spills from Aboveground Storage Tanks. Every tank that contains a Class I, Class II, or Class IIIA liquid shall be provided with means to prevent an accidental release of liquid from endangering important facilities and adjoining property or from reaching waterways. Such means shall meet the requirements of 66.22.11.1, 66.22.11.2, 66.22.11.3, or 66.22.11.4, whichever is applicable. [30:22.11]

66.22.11.1 Remote Impounding. Where control of spills is provided by drainage to a remote impounding area so that spilled liquid does not collect around tanks, the requirements of 66.22.11.1.1 through 66.22.11.1.4 shall apply. [30:22.11.1]

66.22.11.1.1 The drainage route shall have a slope of not less than 1 percent away from the tank for at least 50 ft (15 m) toward the impounding area. [30:22.11.1.1]

66.22.11.1.2 The impounding area shall have a capacity not less than that of the largest tank that drains into it.

Exception: Where compliance with 66.22.11.1.2 is not possible because there is not enough open area around the tanks, "partial" remote impounding for a percentage of the required capacity is permitted. The remainder of the volume required for spill control can be provided by open diking meeting the requirements of 66.22.11.2

[30:22.11.1.2]

66.22.11.1.3 The drainage route shall be located so that, if the liquid in the drainage system is ignited, the fire will not seriously expose tanks or adjoining property. [30:22.11.1.3]

66.22.11.1.4 The impounding area shall be located so that, when filled to capacity, the liquid will not be closer than 50 ft (15 m) from any property line that is or can be built upon or from any tank.

Exception: Where partial remote impounding as provided for in 66.22.11.1.2 is used, the liquid in the partial remote impounding area shall meet the requirements of 66.22.11.1.4. Tank spacing shall be determined based on the diked tank provisions of Table 66.22.4.2.1. [30:22.11.1.4]

66.22.11.2 Impounding Around Tanks by Open Diking.

Where control of spills is provided by means of impounding by open diking around the tanks, such systems shall meet the requirements of 66.22.11.2.1 through 66.22.11.2.8. [30:22.11.2]

66.22.11.2.1 A slope of not less than 1 percent away from the tank shall be provided for at least 50 ft (15 m) or to the dike base, whichever is less. [30:22.11.2.1]

66.22.11.2.2* The volumetric capacity of the diked area shall not be less than the greatest amount of liquid that can be released from the largest tank within the diked area, assuming a full tank. [30:22.11.2.2]

66.22.11.2.2.1 To allow for volume occupied by tanks, the capacity of the diked area enclosing more than one tank shall be calculated after deducting the volume of the tanks, other than the largest tank, below the height of the dike. [30:22.11.2.2.1]

66.22.11.2.3 To permit access, the outside base of the dike at ground level shall be no closer than 10 ft (3 m) to any property line that is or can be built upon. [30:22.11.2.3]

66.22.11.2.4 Walls of the diked area shall be of earth, steel, concrete, or solid masonry designed to be liquidtight and to withstand a full hydrostatic head. [30:22.11.2.4]

66.22.11.2.4.1* Earthen walls 3 ft (0.9 m) or more in height shall have a flat section at the top not less than 2 ft (0.6 m) wide and shall have a slope that is consistent with the angle of repose of the material of which the wall is constructed. [30:22.11.2.4.1]

66.22.11.2.5 Where the average interior height of the walls of the diked area exceeds 6 ft (1.8 m), provisions shall be made for normal access; necessary emergency access to tanks, valves, and other equipment; and egress from the diked enclosure. The following requirements shall apply:

- (1) Where the average height of a dike containing Class I liquids is over 12 ft (3.6 m) high, measured from interior grade, or where the distance between any tank and the top inside edge of the dike wall is less than the height of the dike wall, provisions shall be made for operation of valves and for access to tank roof(s) without entering below the top of the dike. These provisions shall be permitted to be met through the use of remote-operated valves, elevated walkways, or other arrangements.

- (2) Piping passing through dike walls shall be designed to withstand imposed stresses as a result of settlement or fire exposure.
- (3) The distance between the shell of any tank and the toe of the interior of the dike wall shall be not less than 5 ft (1.5 m).

[30:22.11.2.5]

66.22.11.2.6 Each diked area containing two or more tanks shall be subdivided, preferably by drainage channels or at least by intermediate dikes, in order to prevent minor spills from a tank from endangering adjacent tanks within the diked area. [30:22.11.2.6]

66.22.11.2.6.1 The drainage channels or intermediate dikes shall be located between tanks so as to take full advantage of the space with due regard for the individual tank capacities. [30:22.11.2.6.1]

66.22.11.2.6.2 Intermediate dikes shall be not less than 18 in. (450 mm) in height. [30:22.11.2.6.2]

66.22.11.2.6.3 Subdivision shall be provided according to the requirements of 66.22.11.2.6.3.1, 66.22.11.2.6.3.2, 66.22.11.2.6.3.3, 66.22.11.2.6.3.4, or 66.22.11.2.6.3.5, whichever is applicable. [30:22.11.2.6.3]

66.22.11.2.6.3.1 Where stable liquids are stored in vertical cone roof tanks of weak roof-to-shell seam design or in floating roof tanks, one subdivision shall be provided for each tank greater than 10,000 bbl (420,000 gal or 1590 m³) capacity. In addition, one subdivision shall be provided for each group of tanks [with no individual tank exceeding 10,000 bbl (420,000 gal or 1590 m³) capacity] having an aggregate capacity not greater than 15,000 bbl (630,000 gal or 2385 m³). [30:22.11.2.6.3.1]

66.22.11.2.6.3.2 Where crude petroleum is stored in producing areas in any type of tank, one subdivision shall be provided for each tank greater than 10,000 bbl (420,000 gal or 1590 m³) capacity. In addition, one subdivision shall be provided for each group of tanks [with no individual tank exceeding 10,000 bbl (420,000 gal or 1590 m³) capacity] having an aggregate capacity not greater than 15,000 bbl (630,000 gal or 2385 m³). [30:22.11.2.6.3.2]

66.22.11.2.6.3.3 Where stable liquids are stored in tanks not covered in 66.22.11.2.6.3.1, one subdivision shall be provided for each tank greater than 2380 bbl (100,000 gal or 380 m³) capacity. In addition, one subdivision shall be provided for each group of tanks [with no individual tank exceeding 2380 bbl (100,000 gal or 380 m³) capacity] having an aggregate capacity not greater than 3750 bbl (150,000 gal or 570 m³). [30:22.11.2.6.3.3]

66.22.11.2.6.3.4* Where unstable liquids are stored in any type of tank, one subdivision shall be provided for each tank.

Exception: Tanks that store unstable liquids and that are installed with drainage meeting the requirements of NFPA 15 need not meet this requirement. [30:22.11.2.6.3.4]

66.22.11.2.6.3.5 Whenever two or more tanks storing Class I liquids, any one of which is over 150 ft (45 m) in diameter, are located in a common diked area, intermediate dikes shall be provided between adjacent tanks to hold at least 10 percent of the capacity of the tank so enclosed, not including the volume displaced by the tank. [30:22.11.2.6.3.5]

66.22.11.2.7 Where provision is made for draining water from diked areas, such drains shall be controlled to prevent liquids from entering natural water courses, public sewers, or public drains. [30:22.11.2.7]

66.22.11.2.7.1 Control of drainage shall be accessible under fire conditions from outside the dike. [30:22.11.2.7.1]

66.22.11.2.8 Storage of combustible materials, empty drums, full drums, or barrels shall not be permitted within the diked area. [30:22.11.2.8]

66.22.11.3 Impounding Around Tanks by Closed-Top Diking. Where control of spills is provided by means of impounding by closed-top diking around the tanks, such systems shall meet all of the requirements of 66.22.11.4 or shall meet the requirements of 66.22.11.3.1 through 66.22.11.3.4. [30:22.11.3]

66.22.11.3.1* The volumetric capacity of the diked area shall not be less than the greatest amount of liquid that can be released from the largest tank within the diked area, assuming a full tank. [30:22.11.3.1]

66.22.11.3.2 To allow for volume occupied by tanks, the capacity of the diked area enclosing more than one tank shall be calculated after deducting the volume of the tanks, other than the largest tank, below the height of the dike. [30:22.11.3.2]

66.22.11.3.3 To permit access, the outside base of the dike at ground level shall be no closer than 10 ft (3 m) to any property line that is or can be built upon. [30:22.11.3.3]

66.22.11.3.4 Walls of the diked area shall be of steel, concrete, or solid masonry designed to be liquidtight and to withstand a full hydrostatic head. [30:22.11.3.4]

66.22.11.3.5 Where provision is made for draining water from diked areas, such drains shall be controlled to prevent liquids from entering natural water courses, public sewers, or public drains. [30:22.11.3.5]

66.22.11.3.5.1 Control of drainage shall be accessible under fire conditions from outside the dike. [30:22.11.3.5.1]

66.22.11.3.6 Storage of combustible materials, empty drums, full drums, or barrels shall not be permitted within the diked area. [30:22.11.3.6]

66.22.11.3.7 The capacity of the primary tank shall not exceed the capacities given in Table 66.22.11.4.1. [30:22.11.3.7]

66.22.11.3.8 All piping connections to the tank shall be made above the normal maximum liquid level. [30:22.11.3.8]

66.22.11.3.9 The tank shall be capable of resisting the damage from the impact of a motor vehicle, or collision barriers shall be provided. [30:22.11.3.9]

66.22.11.3.10 Where the means of secondary containment is enclosed, it shall be provided with emergency venting in accordance with 66.22.7. [30:22.11.3.10]

66.22.11.3.11 Means shall be provided to establish the integrity of the secondary containment, in accordance with Section 66.21. [30:22.11.3.11]

66.22.11.3.12 Where the normal vent or the emergency vent device or both discharge outside the enclosure created by the closed-top diking, the tank within the enclosure shall comply with 66.22.11.4.4 and 66.22.11.4.5. [30:22.11.3.12]

66.22.11.3.13 Where the fill connection for the tank within the enclosure created by the closed-top diking is not located within the enclosure, the tank shall meet the requirements of 66.22.11.4.4 and 66.22.11.4.5. [30:22.11.3.13]

66.22.11.4 Secondary Containment-Type Aboveground Storage Tanks. Where a secondary containment-type tank is used to provide spill control, the tank shall meet all of the requirements of 66.22.11.4.1 through 66.22.11.4.10. [30:22.11.4]

66.22.11.4.1 The capacity of the listed primary tank shall not exceed the capacities given in Table 66.22.11.4.1. [30:22.11.4.1]

Table 66.22.11.4.1 Maximum Capacities for Secondary Containment-Type Aboveground Storage Tanks

Liquid Classification	Capacity	
	gal	L
I	12,000	45,400
II and IIIA	20,000	75,700

[30: Table 22.11.4.1]

66.22.11.4.2 All piping connections to the tank shall be made above the maximum liquid level. [30:22.11.4.2]

66.22.11.4.3 Means shall be provided to prevent the release of liquid from the tank by siphon flow. [30:22.11.4.3]

66.22.11.4.4 Means shall be provided for determining the level of liquid in the tank. This means shall be accessible to the delivery operator. [30:22.11.4.4]

66.22.11.4.5 Means shall be provided to prevent overfilling by sounding an alarm when the liquid level in the tank reaches 90 percent of capacity and by automatically stopping delivery of liquid to the tank when the liquid level in the tank reaches 95 percent of capacity. [30:22.11.4.5]

66.22.11.4.5.1 In no case shall these provisions restrict or interfere with the functioning of the normal vent or the emergency vent. [30:22.11.4.5.1]

66.22.11.4.6 Spacing between adjacent tanks shall be not less than 3 ft (0.9 m). [30:22.11.4.6]

66.22.11.4.7 The tank shall be capable of resisting the damage from the impact of a motor vehicle, or collision barriers shall be provided. [30:22.11.4.7]

66.22.11.4.8 Where the means of secondary containment is enclosed, it shall be provided with emergency venting in accordance with 66.22.7. [30:22.11.4.8]

66.22.11.4.9 Means shall be provided to establish the integrity of the secondary containment, in accordance with Section 66.21. [30:22.11.4.9]

66.22.11.4.10 The secondary containment shall be designed to withstand the hydrostatic head resulting from a leak from the primary tank of the maximum amount of liquid that can be stored in the primary tank. [30:22.11.4.10]

66.22.12 Equipment, Piping, and Fire Protection Systems in Remote Impoundment Areas and Diked Areas.

66.22.12.1* Location of Piping. Only piping for product, utility, or fire protection purposes directly connected to a tank or tanks within a single diked area shall be routed through a diked area, a remote impoundment area, a spillway draining to a remote impoundment area, or above a storage tank drainage area where the piping can be exposed to a fire.

Exception: Piping for other product lines and from adjacent tanks is permitted to be routed through such areas if engineering designs are provided to incorporate features to prevent the piping from creating an exposure hazard. [30:22.12.1]

66.22.12.2 Drainage.

66.22.12.2.1 Drainage shall be provided to prevent accumulation of any liquid under the piping by providing a slope of not less than 1 percent away from the piping for at least 50 ft (15 m). [30:22.12.2.1]

66.22.12.2.2 Corrosion-resistant piping and piping that is protected against corrosion shall be permitted to be buried where such drainage is not provided. [30:22.12.2.2]

66.22.12.3* Location of Equipment. If located in a remote impoundment area, a diked area, or a spillway draining to a remote impoundment area, process equipment, pumps, instrumentation, and electrical utilization equipment shall be located or protected so that a fire involving such equipment does not constitute an exposure hazard to the tank or tanks in the same area for a period of time consistent with emergency response capabilities. [30:22.12.3]

66.22.12.4 Fire Protection Systems. Hose connections, controls, and control valves for application of fire protection foam or water to tanks shall be located outside remote impoundment areas, diked areas, or spillways draining to a remote impoundment area. [30:22.12.4]

66.22.12.5 Combustible Materials. Structures such as stairways, walkways, instrumentation shelters, and supports for piping and equipment that are located in a remote impoundment area, diked area, or spillway draining to a remote impoundment area shall be constructed of noncombustible materials. [30:22.12.5]

66.22.13 Tank Openings Other Than Vents.

66.22.13.1 Each connection to an aboveground tank through which liquid can normally flow shall be provided with an internal or an external valve located as close as practical to the shell of the tank. [30:22.13.1]

66.22.13.2 Each connection below the liquid level through which liquid does not normally flow shall be provided with a liquidtight closure such as a valve, plug, or blind, or a combination of these. [30:22.13.2]

66.22.13.3 Openings for gauging on tanks storing Class I liquids shall be provided with a vaportight cap or cover. [30:22.13.3]

66.22.13.4 Filling and emptying connections for Class I, Class II, and Class IIIA liquids that are connected and disconnected shall be located outside of buildings at a location free from any source of ignition. [30:22.13.4]

66.22.13.4.1 Such connections shall be located not less than 5 ft (1.5 m) away from any building opening. [30:22.13.4.1]

66.22.13.4.2 Such connections for any liquid shall be closed and liquidtight when not in use and shall be properly identified. [30:22.13.4.2]

66.22.14 Aboveground Storage Tanks Located in Areas Subject to Flooding.

66.22.14.1 Vertical tanks shall be located so that the tops of the tanks extend above the maximum flood stage by at least 30 percent of their allowable storage capacity. [30:22.14.1]

66.22.14.2 Horizontal tanks that are located where more than 70 percent of the tank's storage capacity will be submerged at the established flood stage shall be secured by one of the following methods:

- (1) Anchored to resist movement
- (2) Attached to a foundation of steel and concrete or of concrete having sufficient weight to provide load for the tank when filled with liquid and submerged by flood water to the established flood stage
- (3) Secured from floating by other means

[30:22.14.2]

66.22.14.3 Tank vents or other openings that are not liquidtight shall extend above the maximum flood stage water level. [30:22.14.3]

66.22.14.4 A dependable water supply shall be used for filling an empty or partially filled tank.

Exception: Where filling the tank with water is impractical or hazardous because of the contents of the tank, the tank should be protected by other means against movement or collapse. [30:22.14.4]

66.22.14.5 Spherical or spheroid tanks shall be protected by any of the methods specified in 66.22.14. [30:22.14.5]

66.22.15 Collision Protection for Aboveground Storage Tanks. Where a tank is exposed to vehicular impact, protection shall be provided to prevent damage to the tank. [30:22.15]

66.22.16 Installation Instructions for Aboveground Storage Tanks. Factory-built aboveground tanks shall be provided with instructions for testing the tanks and for installation of the normal and emergency vents. [30:22.16]

66.22.17 Inspection and Maintenance of Aboveground Storage Tanks.

66.22.17.1 Inspection and maintenance of aboveground tanks shall meet the requirements of 66.21.8. [30:22.17.1]

66.22.17.2 Each aboveground steel tank shall be inspected and maintained in accordance with API 653, *Tank Inspection, Repair, Alteration, and Reconstruction*, or STI SP001, *Standard for Inspection of Aboveground Storage Tanks*, whichever is applicable. [30:22.17.2]

66.22.17.3 Each tank constructed of materials other than steel shall be inspected and maintained in accordance with manufacturers' instructions and applicable standards. [30:22.17.3]

66.22.17.4* Pontoons in external floating roof tanks shall be inspected, at intervals not exceeding 5 years, by visual and atmospheric testing methods to ensure that the pontoon covers are mechanically secured to the floating roof deck and to ensure the pontoons do not contain liquids or vapors resulting from leaks or corrosion holes in the pontoons. If liquids, or flammable vapor concentrations at or above 25 percent of the LFL are found, the liquids or vapors shall be safely removed and the source of the leak shall be repaired. The finding of vapors at levels below 25 percent of the LFL shall result either in the implementation of monitoring of the tank pontoons at least annually to assure that vapors in the flammable range are not achieved before corrective action is taken or removal of the tank from service. Rim vents, if any, shall also be inspected to ensure that they are not frozen open. [30:22.17.4]

66.23 Storage of Liquids in Tanks — Underground Tanks.

66.23.1 Scope. This section shall apply to the following:

- (1) The storage of flammable and combustible liquids, as defined in 3.3.165.1 and 3.3.165.2, in fixed underground tanks
- (2) The installation and operation of underground tanks

[30:23.1]

66.23.2 Definitions Specific to Chapter 23. (Reserved)

66.23.3 General Requirements.

66.23.3.1 Class II and Class III Liquids at Elevated Temperatures. Storage 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 Section 66.6 justifies following the requirements for some other liquid class. [30:23.3.1]

66.23.3.2 Installation. All underground tanks shall be installed in accordance with the manufacturer's instructions. [30:23.3.2]

66.23.3.3 Excavation. Excavation for underground tanks shall not undermine foundations of existing structures. [30:23.3.3]

66.23.3.4* Care in Handling of Tank. The tank shall not be damaged during delivery, unloading, and placement into the tank excavation. [30:23.3.4]

66.23.3.5* External Corrosion Protection for Underground Storage Tank. Underground tanks and their piping shall be protected by either of the following:

- (1) A properly engineered, installed, and maintained cathodic protection system in accordance with recognized engineering standards of design
- (2) Approved or listed corrosion-resistant materials or systems

[30:23.3.5]

66.23.3.5.1* Selection of the type of protection to be employed shall be based upon the corrosion history of the area and the judgment of a qualified engineer. [30:23.3.5.1]

66.23.3.5.2* The AHJ shall be permitted to waive the requirements for corrosion protection where an engineering evaluation demonstrates that such protection is not necessary. [30:23.3.5.2]

66.23.4 Location of Underground Storage Tanks.

66.23.4.1 Underground tanks or tanks under buildings shall be located with respect to existing building foundations and supports so that the loads carried by the foundation are not transmitted to the tank. [30:23.4.1]

66.23.4.2 The distance from any part of a tank storing Class I liquids to the nearest wall of any basement or pit shall be not less than 1 ft (0.3 m) and to any property line that is or can be built upon shall not be less than 3 ft (0.9 m). [30:23.4.2]

66.23.4.3 The distance from any part of a tank storing Class II or Class III liquids to the nearest wall of any basement, pit, or property line shall be not less than 1 ft (0.3 m). [30:23.4.3]

66.23.5 Reserved.

66.23.6 Normal Venting for Underground Storage Tanks.

66.23.6.1* Tank venting systems shall be provided with sufficient capacity to prevent blowback of vapor or liquid at the fill opening while the tank is being filled. [30:23.6.1]

66.23.6.2 Vent piping shall be sized in accordance with Table 66.23.6.2, but shall not be less than 1.25 in. (32 mm) nominal inside diameter. [30:23.6.2]

Table 66.23.6.2 Nominal Vent Line Diameter in Inches

Maximum Flow (gpm)	Pipe Length*		
	50 ft	100 ft	200 ft
100	1.25	1.25	1.25
200	1.25	1.25	1.25
300	1.25	1.25	1.5
400	1.25	1.5	2
500	1.5	1.5	2
600	1.5	2	2
700	2	2	2
800	2	2	3
900	2	2	3
1000	2	2	3

For SI units, 1 in. = 25 mm; 1 ft = 0.3 m; 1 gal = 3.8 L.

* Assumes stated length of piping, plus 7 ells. [30: Table 23.6.2]

66.23.6.3 Where tank venting devices are installed in vent lines, their flow capacities shall be determined in accordance with 66.22.7.3.4. [30:23.6.3]

66.23.6.4 Piping for normal venting shall be designed in accordance with Section 66.27. [30:23.6.4]

66.23.7 Reserved.

66.23.8 Reserved.

66.23.9 Reserved.

66.23.10 Reserved.

66.23.11 Reserved.

66.23.12 Reserved.

66.23.13 Tank Openings Other than Vents.

66.23.13.1 Connections for all tank openings shall be liquidtight and vaportight. [30:23.13.1]

66.23.13.2 Openings for manual gauging, if independent of the fill pipe, shall be provided with a liquidtight and vaportight cap or cover. Covers shall be kept closed when not gauging. [30:23.13.2]

66.23.13.2.1 If inside a building, each such opening shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other approved device. [30:23.13.2.1]

66.23.13.3 Fill and discharge lines shall enter tanks only through the top. [30:23.13.3]

66.23.13.4 Fill lines shall be sloped toward the tank. [30:23.13.4]

66.23.13.5 Underground tanks for Class I liquids having a capacity of more than 1000 gal (3800 L) shall be equipped with a tight fill device for connecting the fill hose to the tank. [30:23.13.5]

66.23.13.6 Filling, emptying, and vapor recovery connections for Class I, Class II, or Class IIIA liquids that are connected and disconnected shall be located outside of buildings at a location free from any source of ignition and not less than 5 ft (1.5 m) from any building opening or air intake. [30:23.13.6]

66.23.13.6.1 Such connections shall be closed and liquidtight and vaportight when not in use. [30:23.13.6.1]

66.23.13.6.2 Such connections shall be identified. [30:23.13.6.2]

66.23.13.7 Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connection, or other approved device, unless the opening is pipe-connected to a vapor processing system. [30:23.13.7]

66.23.13.7.1 Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. [30:23.13.7.1]

66.23.13.7.2 All connections shall be vaportight. [30:23.13.7.2]

66.23.14 Underground Storage Tanks Located in Areas Subject to Flooding.

66.23.14.1* Tanks shall be anchored or shall be secured by approved means to resist movement when subjected to hydrostatic forces associated with high groundwater or floodwater. [30:23.14.1]

66.23.14.1.1 The design of the anchoring or securing method shall be based on the buoyancy of an empty tank that is fully submerged. [30:23.14.1.1]

66.23.14.1.2 Tank vents and other openings that are not liquidtight shall be extended above maximum flood stage water level. [30:23.14.1.2]

66.23.14.1.3 Each tank shall be so constructed and installed that it will safely resist external pressures if submerged. [30:23.14.1.3]

66.23.15 Reserved.

66.23.16 Installation Instructions for Underground Storage Tanks. Factory-built underground tanks shall be provided with instructions for testing and for installation of the normal vents. [30:23.16]

66.23.17 Inspection and Maintenance of Underground Storage Tanks.

66.23.17.1 Inspection and maintenance for underground tanks shall meet the requirements of 66.21.8. [30:23.17.1]

66.23.17.2 Overfill protection devices or systems shall be inspected and tested annually to ensure proper operation. [30:23.17.2]

66.24 Storage Tank Buildings.

66.24.1* Scope.

66.24.1.1 This section shall apply to installations of tanks storing Class I, Class II, and Class IIIA liquids in storage tank buildings. [30:24.1.1]

66.24.1.2 This section shall also apply to installations of aboveground storage tanks storing Class II, Class IIIA, or Class IIIB liquids in storage tank buildings where the liquids are heated at or above their flash points. In such cases, the liquids shall be regulated as Class I liquids unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. [30:24.1.2]

66.24.1.3 This section shall not apply to the following:

- (1) Tanks covered by Sections 66.17, 66.18, and 66.19.

- (2) A tank that has 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. Such tanks shall comply with the provisions of this *Code*.

[30:24.1.3]

66.24.2 Definitions Specific to Chapter 24. (Reserved)

66.24.3 Reserved.

66.24.4 Location of Storage Tank Buildings.

66.24.4.1 Tanks and associated equipment within the storage tank building shall be so located that a fire in the area shall not constitute an exposure hazard to adjoining buildings or tanks for a period of time consistent with the response and suppression capabilities of the fire-fighting operations available to the location. Compliance with 66.24.4.2 through 66.24.4.8 shall be deemed as meeting the requirements of 66.24.4.1. [30:24.4.1]

66.24.4.2 The minimum distance from exposed property lines and buildings for tank installations within structures having walls with a fire resistance rating of less than 2 hours shall be in accordance with Table 66.24.4.2. [30:24.4.2]

66.24.4.3 The capacity of any individual tank shall not exceed 100,000 gal (380 m³) without the approval of the AHJ. [30:24.4.3]

66.24.4.4 Where protection for exposures is not provided, the distances given in Table 66.24.4.2 shall be doubled. The distances shall not be required to exceed 300 ft (90 m). [30:24.4.4]

66.24.4.5 Where a storage tank building has an exterior wall facing an exposure, the distances in Table 66.24.4.2 shall be permitted to be modified as follows:

- (1) Where the wall is a blank wall having a fire resistance rating of not less than 2 hours, separation distance between the storage tank building and its exposure shall not be required to be greater than 25 ft (7.6 m).
- (2) Where a blank wall having a fire resistance rating of not less than 4 hours is provided, the distance requirements of Table 66.24.4.2 shall not apply.
- (3)* Where Class IA liquids or unstable liquids are stored, the exposing wall shall have explosion resistance in accordance with recognized engineering standards, and deflagration venting designed in accordance with NFPA 68 shall be provided in the nonexposing walls and roof.

[30:24.4.5]

66.24.4.6 Other equipment associated with tanks, such as pumps, heaters, filters, and exchangers, shall not be located closer than 25 ft (7.6 m) to property lines where the adjoining property is or can be built upon or to the nearest important building on the same property that is not an integral part of the storage tank building. This spacing requirement shall not apply where exposures are protected as outlined in 66.24.4.2. [30:24.4.6]

66.24.4.7 Tanks in which unstable liquids are stored shall be separated from potential fire exposures by a clear space of at least 25 ft (7.6 m) or by a wall having a fire resistance rating of not less than 2 hours. [30:24.4.7]

66.24.4.8 Each storage tank building and each tank within the building shall be accessible from at least two sides for fire fighting and fire control. [30:24.4.8]

Table 66.24.4.2 Location of Storage Tank Buildings with Respect to Property Lines, Public Ways, and the Nearest Important Building on the Same Property

Largest Tank — Operating Liquid Capacity (gal)	Minimum Distance from Property Line that Is or Can Be Built Upon, Including Opposite Side of Public Way (ft)				Minimum Distance from Nearest Side of Any Public Way or from Nearest Important Building on Same Property (ft)			
	Stable Liquid Emergency Relief		Unstable Liquid Emergency Relief		Stable Liquid Emergency Relief		Unstable Liquid Emergency Relief	
	Not over 2.5 psi	Over 2.5 psi	Not over 2.5 psi	Over 2.5 psi	Not over 2.5 psi	Over 2.5 psi	Not over 2.5 psi	Over 2.5 psi
Up to 12,000	15	25	40	60	5	10	15	20
12,001 to 30,000	20	30	50	80	5	10	15	20
30,001 to 50,000	30	45	75	120	10	15	25	40
50,001 to 100,000	50	75	125	200	15	25	40	60

For SI units, 1 gal = 3.8 L; 1 ft = 0.3 m; 1 psi = 6.9 kPa. [30: Table 66.24.4.2]

66.24.4.9 Class I liquids and Class II or Class IIIA liquids heated above their flash points shall not be stored in basements. [30:24.4.9]

66.24.5 Construction of Storage Tank Buildings.

66.24.5.1 Storage tank buildings shall be constructed so as to maintain structural integrity for 2 hours under fire exposure conditions and to provide access and egress for unobstructed movement of all personnel and fire protection equipment. Compliance with 66.24.5.2 through 66.24.5.7 shall be deemed as meeting the requirements of 66.24.5.1. [30:24.5.1]

66.24.5.2* Buildings or structures shall be of at least 2-hour fire resistance rating. [30:24.5.2]

66.24.5.2.1 Noncombustible or combustible construction shall be permitted when protected by automatic sprinklers or equivalent protection subject to the approval of the AHJ. [30:24.5.2.1]

66.24.5.3 Where Class I liquids are stored above grade within buildings with basements or other belowgrade areas into which flammable vapors can travel, such belowgrade areas shall be provided with mechanical ventilation designed to prevent the accumulation of flammable vapors. Enclosed storage tank pits shall not be considered basements. [30:24.5.3]

66.24.5.4* Storage tank buildings where Class IA liquids are stored shall be designed to direct flame, combustion gases, and pressure resulting from an deflagration away from important buildings or occupied areas through the use of damage-limiting construction. The damage-limiting construction design shall be designed in accordance with NFPA 68 and shall be acceptable to the AHJ. [30:24.5.4]

66.24.5.5 Storage tank buildings where unstable liquids are stored shall be designed using an approved engineered construction method that is intended to limit damage from an explosion (deflagration or detonation, depending on the liquid). [30:24.5.5]

66.24.5.6* Access aisles of at least 3 ft (0.9 m) shall be maintained for movement of fire-fighting personnel and fire protection equipment. [30:24.5.6]

66.24.5.7 A clear space of at least 3 ft (0.9 m) shall be maintained between the top of each tank and the building structure for buildings protected in accordance with 66.24.6.2.3. For buildings without fixed fire suppression systems, sufficient clear space shall

be provided to allow for the application of hose streams to the top of the tank(s) for cooling purposes. [30:24.5.7]

66.24.6 Fire Protection for Storage Tank Buildings.

66.24.6.1 Manual Fire Control Equipment for Storage Tank Buildings.

66.24.6.1.1* Listed portable fire extinguishers shall be provided for facilities in such quantities, sizes, and types as could be needed for special storage hazards as determined in accordance with 66.21.6.1.2. [30:24.6.1.1]

66.24.6.1.2* Where the need is indicated in accordance with 66.21.6.3, water shall be utilized through standpipe and hose systems, or through hose connections from sprinkler systems using combination spray and straight stream nozzles to permit effective fire control. [30:24.6.1.2]

66.24.6.1.3 Where the need is indicated in accordance with 66.21.6.3, mobile foam apparatus shall be provided. [30:24.6.1.3]

66.24.6.2 Fixed Fire Control Equipment for Tank Buildings.

66.24.6.2.1 A reliable water supply or other suitable fire control agent shall be available in pressure and quantity to meet the fire demands indicated by special storage hazards or exposure as determined by 66.21.6.3. [30:24.6.2.1]

66.24.6.2.2* Hydrants, with or without fixed monitor nozzles, shall be provided in accordance with accepted practice. The number and placement shall depend on the hazard of the storage, or exposure, as determined by 66.21.6.3. [30:24.6.2.2]

66.24.6.2.3* Where the need is indicated by the hazards of storage or exposure as determined by 66.21.6.3, fixed protection shall be required utilizing approved foam, foam-water sprinkler systems, sprinkler systems, water spray systems, deluge systems, gaseous extinguishing systems, dry chemical extinguishing systems, fire-resistive materials, or a combination of these. [30:24.6.2.3]

66.24.6.2.3.1 When foam or foam-water fire protection systems are provided, discharge densities shall be determined based on the listing criteria for selected foam discharge devices, the foam concentrate, and the specific flammable or combustible liquids to be protected. [30:24.6.2.3.1]

66.24.6.2.4 If provided, fire control systems shall be designed, installed, and maintained in accordance with the following NFPA standards:

- (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 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*

[30:24.6.2.4]

66.24.7 Reserved.

66.24.8 Electrical Systems for Storage Tank Buildings.

66.24.8.1 Installation of electrical utilization equipment and wiring shall meet the requirements of Section 66.7. [30:24.8.1]

66.24.8.2 Section 66.7 shall be used to determine the extent of classified locations for the purpose of installation of electrical equipment. [30:24.8.2]

66.24.8.2.1 In establishing the extent of a classified location, it shall not extend beyond a floor, wall, roof, or other solid partition that has no openings within the classified area. [30:24.8.2.1]

66.24.9 Containment, Drainage, and Spill Control from Storage Tank Buildings.

66.24.9.1 Drainage systems shall be designed to minimize fire exposure to other tanks and adjacent properties or waterways. Compliance with 66.24.9.2 through 66.24.9.6 shall be deemed as meeting the requirements of 66.24.9.1. [30:24.9.1]

66.24.9.2 The facility shall be designed and operated to prevent the discharge of flammable or combustible liquids to public waterways, public sewers, or adjoining property under normal operating conditions. [30:24.9.2]

66.24.9.3 Except for drains, solid floors shall be liquidtight and walls shall be liquidtight where they join the floor and for at least 4 in. (100 mm) above the floor. [30:24.9.3]

66.24.9.4 Openings to adjacent rooms or buildings shall be provided with noncombustible, liquidtight raised sills or ramps at least 4 in. (100 mm) in height or shall be otherwise designed to prevent the flow of liquids to the adjoining areas. [30:24.9.4]

66.24.9.4.1 An open-grated trench across the width of the opening inside of the room that drains to a safe location shall be permitted to be used as an alternative to a sill or ramp. [30:24.9.4.1]

66.24.9.5 Means shall be provided to prevent liquid spills from running into basements. [30:24.9.5]

66.24.9.6* The containment shall have a capacity not less than that of the largest tank that can drain into it. [30:24.9.6]

66.24.9.7 Emergency drainage systems shall be provided to direct flammable or combustible liquid leakage and fire-protection water to a safe location. [30:24.9.7]

66.24.9.8 Curbs, scuppers, or special drainage systems shall be permitted to be used. [30:24.9.8]

66.24.9.9 Emergency drainage systems, if connected to public sewers or discharged into public waterways, shall be equipped with traps or separators. [30:24.9.9]

66.24.10 Ventilation for Storage Tank Buildings.

66.24.10.1 Storage tank buildings storing Class I liquids or Class II or Class III liquids at temperatures at or above their flash points shall be ventilated at a rate sufficient to maintain the concentration of vapors within the building at or below 25 percent of the lower flammable limit. Compliance with 66.24.10.2 through 66.24.10.7 shall be deemed as meeting the requirements of 66.24.10.1. [30:24.10.1]

66.24.10.2* Ventilation shall be designed based on one of the following:

- (1) Calculations based on the anticipated fugitive emissions (*See Annex E of NFPA 30 for calculation methods.*)
- (2) Sampling of the actual vapor concentration under normal operating conditions
- (3) Ventilation at a rate of not less than 1 cfm of exhaust air for each square foot of solid floor area (0.3 m³/min/m²)

[30:24.10.2]

66.24.10.2.1 If vapor concentrations are confirmed by sampling, the sampling shall be conducted at a distance of a 5 ft (1.5 m) radius from each potential vapor source extending to or toward the bottom and the top of the enclosed storage area. The vapor concentration used to determine the required ventilation rate shall be the highest measured concentration during the sampling procedure. [30:24.10.2.1]

66.24.10.3 Ventilation shall be accomplished by natural or mechanical ventilation, with discharge or exhaust to a safe location outside the building. [30:24.10.3]

66.24.10.3.1 Recirculation of exhaust air shall be permitted only when it is monitored continuously using a fail-safe system that is designed to automatically sound an alarm, stop recirculation, and provide full exhaust to the outside in the event that vapor-air mixtures having concentrations over 25 percent of the lower flammable limit are detected. [30:24.10.3.1]

66.24.10.4* Provision shall be made for introduction of make-up air in such a manner as to avoid short-circuiting the ventilation. [30:24.10.4]

66.24.10.5 Ventilation shall be arranged to include all floor areas or pits where flammable vapors can collect. [30:24.10.5]

66.24.10.6 Where natural ventilation is inadequate, mechanical ventilation shall be provided and shall be kept in operation while flammable liquids are being handled. [30:24.10.6]

66.24.10.6.1 Local or spot ventilation, if provided, shall be permitted to be used for up to 75 percent of the required ventilation. [30:24.10.6.1]

66.24.10.7 Storage tank buildings with the interior grade more than 12 in. (300 mm) below the average exterior grade shall be provided with one of the following:

- (1) Continuous mechanical ventilation in accordance with 66.24.10.2(3)
- (2) A vapor detection system set to sound a warning alarm at a constantly attended location at 25 percent of the lower flammable limit, and to start the mechanical ventilation system

[30:24.10.7]

66.24.11 Reserved.

66.24.12 Reserved.

66.24.13 Vents for Tanks Inside Storage Tank Buildings.

66.24.13.1 Vents for tanks inside tank buildings shall be designed to ensure that vapors are not released inside the building. Compliance with 66.24.13.2 through 66.24.13.6 shall be deemed as meeting the requirements of 66.24.13.1. [30:24.13.1]

66.24.13.2 Vents for tanks inside tank buildings shall be as required in 66.21.4.3 and 66.22.7. [30:24.13.2]

66.24.13.3 Emergency venting by the use of a weak roof-to-shell seam shall not be permitted. [30:24.13.3]

66.24.13.4 Automatic sprinkler systems designed in accordance with the requirements of Section 13.3 and NFPA 13 shall be accepted by the AHJ as equivalent to water spray systems for purposes of calculating the required airflow rates for emergency vents in 22.7.3.5 of NFPA 30, provided the density and coverage requirements of NFPA 15 are met. [30:24.13.4]

66.24.13.5 Vents shall terminate outside the building in accordance with 66.27.8.1. [30:24.13.5]

66.24.13.6 Piping for normal and emergency relief venting shall meet the requirements of Section 66.27. [30:24.13.6]

66.24.14 Tank Openings Other than Vents for Tanks Inside Storage Tank Buildings.

66.24.14.1 Tank openings other than vents for tanks inside tank buildings shall be designed to ensure that flammable liquids or vapors are not released inside the building. Compliance with 66.24.14.2 through 66.24.14.9 shall be deemed as meeting the requirements of 66.24.14.1. [30:24.14.1]

66.24.14.2 All tank openings that are located at or below the maximum liquid level shall be liquidtight. Those that are located above the maximum liquid level shall be normally closed and shall be mechanically secured to prevent release of vapors. [30:24.14.2]

66.24.14.3 Each liquid transfer connection on any tank storing Class I or Class II liquids inside buildings shall be provided with one of the following:

- (1) A normally closed, remotely activated valve
- (2) An automatic-closing, heat-activated valve
- (3) Another approved device

[30:24.14.3]

66.24.14.4 Connections used for emergency disposal or to provide for quick cutoff of flow in the event of fire in the vicinity of the tank shall not be required to meet the requirement of 66.24.14.3. [30:24.14.4]

66.24.14.5 Each connection through which liquid can gravity flow from a tank inside a building shall be provided with an internal or an external valve located as close as practical to the shell of the tank. This valve shall be considered to be in compliance with 66.24.14.3. If a separate valve is used, both valves shall be located adjacent to each other. [30:24.14.5]

66.24.14.6* Openings for manual gauging of Class I or Class II liquids, if independent of the fill pipe, shall be provided with a vaportight cap or cover that shall be kept closed when not in use. [30:24.14.6]

66.24.14.6.1 Each such opening for any liquid shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other approved device. [30:24.14.6.1]

66.24.14.7 The inlet of the fill pipe and the outlet of a vapor recovery line for which connections to tank vehicles and tank cars are made and broken shall be as follows:

- (1) Located outside of buildings at a location free from any source of ignition
- (2) Located not less than 5 ft (1.5 m) away from any building opening
- (3) Closed tight and protected against tampering when not in use
- (4) Identified

[30:24.14.7]

66.24.14.8* Tanks storing Class I, Class II, or Class IIIA liquids inside buildings shall be equipped with a device, or other means shall be provided, to prevent overflow into the building. [30:24.14.8]

66.24.14.9 Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connection or other approved device, unless the opening is pipe-connected to a vapor processing system. [30:24.14.9]

66.24.14.9.1 Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. [30:24.14.9.1]

66.24.14.9.2 All connections shall be vaportight. [30:24.14.9.2]

66.24.15 Detection and Alarm Systems for Storage Tank Buildings.

66.24.15.1 An approved means shall be provided to promptly notify those within the plant and the available public or mutual aid fire department of any fire or other emergency. [30:24.15.1]

66.24.15.2 Those areas, including buildings, where the potential exists for a flammable liquid spill shall be monitored as appropriate. Such methods shall include both of the following:

- (1) Personnel observation or patrol
- (2) Monitoring equipment that indicates a spill or leak has occurred in an unattended area

[30:24.15.2]

66.24.16 Inspection and Maintenance for Storage Tank Buildings.

66.24.16.1 Combustible waste material and residues in operating areas shall be kept to a minimum, stored in covered metal containers, and disposed of daily. [30:24.16.1]

66.24.16.2 Storage of combustible materials and empty or full drums or barrels shall not be permitted within the storage tank building. [30:24.16.2]

66.25 Storage Tank Vaults.

66.25.1 Scope. This section shall apply to the design, construction, and installation of vaults for aboveground tanks. [30:25.1]

66.25.2 Definitions Specific to Section 66.25. (Reserved)

66.25.3 General Requirements.

66.25.3.1* Storage Tank Selection and Arrangement.

66.25.3.1.1 Aboveground tanks shall be permitted to be installed in vaults that meet the requirements of this section. [30:25.3.1.1]

66.25.3.1.2 Vaults shall be constructed and listed in accordance with UL 2245, *Standard for Below-Grade Vaults for Flammable Liquid Storage Tanks*. [30:25.3.1.2]

66.25.3.1.3 Except as modified by the provisions of this section, vaults shall meet all other applicable provisions of this *Code*. [30:25.3.1.3]

66.25.3.1.4 Tanks installed in storage tank vaults shall be listed for aboveground use. [30:25.3.1.4]

66.25.3.1.5 Each tank shall be in its own vault and shall be completely enclosed by the vault. [30:25.3.1.5]

66.25.3.1.6 Sufficient clearance between the tank and the vault shall be provided to allow for visual inspection and maintenance of the tank and its appurtenances. [30:25.3.1.6]

66.25.3.1.7 Backfill shall not be permitted around the tank. [30:25.3.1.7]

66.25.3.1.8 Dispensing devices shall be permitted to be installed on the tops of vaults. Dispensing devices used for motor fuels shall be installed in accordance with NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*. [30:25.3.1.8]

66.25.3.1.9 At each entry point into the vault, a warning sign indicating the need for procedures for safe entry into confined spaces shall be posted. Each entry point shall be secured against unauthorized entry and vandalism. [30:25.3.1.9]

66.25.3.2 Storage Tank Appurtenances.

66.25.3.2.1 An approved means of overfill protection shall be provided for the tanks in the vaults. The use of ball float valves shall be prohibited. [30:25.3.2.1]

66.25.3.2.2 Fill connections for vaults installed inside buildings shall comply with 66.22.13.4. [30:25.3.2.2]

66.25.3.3 Vault Arrangement.

66.25.3.3.1 Vaults shall be permitted to be either above or below grade. [30:25.3.3.1]

66.25.4 Location of Storage Tank Vaults. In lieu of the separation distance requirements given in 66.22.4, separation distances between the vault and any of the following shall be permitted to be reduced to 0 ft (0 m), as measured from the outer perimeter of the vault wall:

- (1) Any property line that is or can be built upon
- (2) The near and far sides of a public way
- (3) The nearest important building on the same property

[30:25.4]

66.25.5 Construction and Installation of Storage Tank Vaults.

66.25.5.1 Construction Requirements. Vaults shall be designed and constructed in accordance with 66.25.5.1.1 through 66.25.5.1.4. [30:25.5.1]

66.25.5.1.1 The top of an abovegrade vault that contains a tank storing Class I liquid or Class II liquid stored at a temperature above its flash point shall be constructed of noncombustible material and shall be designed to be weaker than the walls of the vault to ensure that the thrust of any explosion occurring inside the vault is directed upward before destructive internal pressure develops within the vault. [30:25.5.1.1]

66.25.5.1.2 The top of an at-grade or belowgrade vault that contains a tank storing Class I liquid or Class II liquid stored at a temperature above its flash point shall be designed to relieve or contain the force of any explosion occurring inside the vault. [30:25.5.1.2]

66.25.5.1.3 Adjacent vaults shall be permitted to share a common wall. [30:25.5.1.3]

66.25.5.1.4 Where required, the vault shall be wind and earthquake resistant, in accordance with recognized engineering standards. [30:25.5.1.4]

66.25.5.2 Installation Requirements. Storage tank vaults shall be installed in accordance with the requirements of 66.25.5.2.1 and 66.25.5.2.2. [30:25.5.2]

66.25.5.2.1 Each vault and its tank shall be anchored to resist uplifting by groundwater or flooding, including when the tank is empty. [30:25.5.2.1]

66.25.5.2.2 Vaults that are not resistant to damage from the impact of a motor vehicle shall be protected by collision barriers. [30:25.5.2.2]

66.25.6 Reserved.

66.25.7 Reserved.

66.25.8 Reserved.

66.25.9 Containment, Drainage, and Spill Control for Storage Tank Vaults.

66.25.9.1 Means shall be provided to recover liquid from the vault. [30:25.9.1]

66.25.9.2 If a pump is used to meet this requirement, the pump shall not be permanently installed in the vault. [30:25.9.2]

66.25.9.3 Electric-powered portable pumps shall be approved for use in Class I, Division 1 locations, as defined in *NFPA 70*. [30:25.9.3]

66.25.10 Ventilation Systems for Storage Tank Vaults.

66.25.10.1 Vaults that contain tanks storing Class I liquids shall be ventilated at a rate of not less than 1 cfm/ft² of floor area (0.3 m³/min/m²), but not less than 150 cfm (4 m³/min). [30:25.10.1]

66.25.10.2 Such ventilation shall operate continuously or shall be designed to operate upon activation of a vapor and liquid detection system. [30:25.10.2]

66.25.10.3 Failure of the exhaust airflow shall automatically shut down the dispensing system. [30:25.10.3]

66.25.10.4 The exhaust system shall be designed to provide air movement across all parts of the vault floor. [30:25.10.4]

66.25.10.5 Supply and exhaust ducts shall extend to within 3 in. (75 mm), but not more than 12 in. (300 mm) of the floor. [30:25.10.5]

66.25.10.6 The exhaust system shall be installed in accordance with the provisions of NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*. [30:25.10.6]

66.25.11 Reserved.

66.25.12 Reserved.

66.25.13 Vents for Tanks Inside Storage Tank Vaults.

66.25.13.1 Vent pipes that are provided for normal tank venting shall terminate outside the vault and at least 12 ft (3.6 m) above ground level and shall meet the requirements of 66.27.8.1. [30:25.13.1]

66.25.13.2 Emergency vents shall be vaportight and shall be permitted to discharge inside the vault. Long-bolt manhole covers shall not be permitted for this purpose. [30:25.13.2]

66.25.14 Reserved.

66.25.15 Detection and Alarm Systems for Storage Tank Vaults.

66.25.15.1 Each vault shall be provided with an approved vapor and liquid detection system that is equipped with on-site audible and visual warning devices with battery backup. [30:25.15.1]

66.25.15.2 The vapor detection system shall sound an alarm when the system detects vapors that reach or exceed 25 percent of the lower flammable limit of the liquid stored. [30:25.15.2]

66.25.15.3 Vapor detectors shall be located no higher than 12 in. (300 mm) above the lowest point in the vault. [30:25.15.3]

66.25.15.4 The liquid detection system shall sound an alarm upon detection of any liquid, including water. [30:25.15.4]

66.25.15.5 Liquid detectors shall be located in accordance with the manufacturer's instructions. [30:25.15.5]

66.25.15.6 Activation of either the vapor detection system or the liquid detection system shall cause a signal to be sounded at an approved, constantly attended location within the facility serving the tanks or at an approved location. [30:25.15.6]

66.25.16 Inspection and Maintenance of Storage Tank Vaults and Equipment. Vaults and their required equipment shall be maintained in accordance with the requirements of this section. [30:25.16]

66.26 Reserved.

66.27 Piping Systems.

66.27.1 Scope.

66.27.1.1 This section shall apply to the design, installation, testing, operation, and maintenance of piping systems for flammable and combustible liquids or vapors. Such piping systems shall include but not be limited to pipe, tubing, flanges, bolting, gaskets, valves, fittings, flexible connectors, the pressure-containing parts of other components including but not limited to expansion joints and strainers, and devices that serve such purposes as mixing, separating, snubbing, distributing, metering, control of flow, or secondary containment. [30:27.1.1]

66.27.1.2 This section shall not apply to any of the following:

- (1) Tubing or casing on any oil or gas wells and any piping connected directly thereto
- (2) Motor vehicles, aircraft, boats, or piping that are integral to a stationary engine assembly
- (3) Piping within the scope of any applicable boiler and pressure vessel code

[30:27.1.2]

66.27.2 Definitions Specific to Section 66.27. For the purpose of this section, terms in this section shall have the definitions given. [30:27.2]

66.27.2.1 Corrosion Protection. A means to lessen or prevent the deterioration of the piping system from exposure to its contents or its environment. [30:27.2.1]

66.27.2.2 Flexible Connector. A connection joint in a piping system that allows differential movement of the piping system and limits system stress and mechanical damage. [30:27.2.2]

66.27.2.3 Leak. An unintended release of liquid or vapor from the piping system due to failure of the piping system. [30:27.2.3]

66.27.2.4 Secondary Containment. Containment that is external to and separate from the primary piping system. [30:27.2.4]

66.27.3 General Requirements.

66.27.3.1 Performance Standards. The design, fabrication, assembly, test, and inspection of piping systems shall be suitable for the working pressures and structural stresses to be encountered by the piping system. Compliance with applicable sections of ASME B31, *Code for Pressure Piping*, and the provisions of this section shall be considered *prima facie* evidence of compliance with the foregoing provisions. [30:27.3.1]

66.27.3.2 Tightness of Piping. Piping systems shall be maintained liquidtight. A piping system that has leaks that constitute a hazard shall be repaired in a manner acceptable to the AHJ, or it shall be emptied of liquid, vapor freed, and no longer used. [30:27.3.2]

66.27.4 Materials of Construction for Piping Systems.

66.27.4.1 Materials Specifications. Pipe, valves, faucets, couplings, flexible connectors, fittings, and other pressure-containing parts shall meet the material specifications and pressure and temperature limitations of ASME B31, *Code for Pressure Piping*, except as provided for in 66.27.4.2, 66.27.4.3, and 66.27.4.4. [30:27.4.1]

66.27.4.2 Ductile Iron. Ductile (nodular) iron shall meet the specifications of ASTM A 395, *Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*. [30:27.4.2]

66.27.4.3 Materials of Construction for Valves. Valves at storage tanks, as required by 66.22.13 and 66.24.14, and their connections to the tank shall be of steel or ductile iron, except as provided for in 66.27.4.3.1, 66.27.4.3.2, or 66.27.4.4. [30:27.4.3]

66.27.4.3.1 Valves at storage tanks shall be permitted to be other than steel or ductile iron where the chemical characteristics of the liquid stored are not compatible with steel or where the valves are installed internally to the tank. [30:27.4.3.1]

66.27.4.3.2* Valves installed externally to the tank shall be permitted to be other than steel or ductile iron if the material of construction has a ductility and melting point comparable to steel or ductile iron and is capable of withstanding the stresses and temperatures involved in fire exposure or the valves are otherwise protected from fire exposures, such as by materials having a fire resistance rating of not less than 2 hours. [30:27.4.3.2]

66.27.4.3.3 Cast iron, brass, copper, aluminum, malleable iron, and similar materials shall be permitted to be used on tanks described in 66.22.4.2.1.1 or on tanks storing Class IIIB liquids where the tanks are located outdoors and not within a diked area or drainage path of a tank storing a Class I, Class II, or Class IIIA liquid. [30:27.4.3.3]

66.27.4.4 Low Melting Point Materials. Low melting point materials such as aluminum, copper, and brass; materials that soften on fire exposure such as plastics; or nonductile materials such as cast iron shall be permitted to be used underground within the pressure and temperature limitations of ASME B31, *Code for Pressure Piping*. [30:27.4.4]

66.27.4.4.1 Such materials shall be permitted to be used outdoors above ground or inside buildings, provided they meet one of the following conditions:

- (1) They are resistant to damage by fire.
- (2) They are located so that any leakage resulting from failure will not expose persons, important buildings, or structures.
- (3) They are located where leakage can be controlled by operation of one or more accessible, remotely located valves.

[30:27.4.4.1]

66.27.4.4.2 The piping materials chosen shall be compatible with the liquids being handled. [30:27.4.4.2]

66.27.4.4.3 Piping systems of these materials shall be designed and built in accordance with recognized standards of design for the particular materials chosen or with approved equivalent standards or shall be listed. [30:27.4.4.3]

66.27.4.5 Lining Materials. Piping, valves, and fittings shall be permitted to have combustible or noncombustible linings. [30:27.4.5]

66.27.4.6 Nonmetallic Piping.

66.27.4.6.1 Piping systems of nonmetallic materials, including piping systems incorporating secondary containment, shall be designed and built in accordance with recognized standards of design or approved equivalents and shall be installed in accordance with 66.27.4.4. [30:27.4.6.1]

66.27.4.6.2 Nonmetallic piping shall be built and used within the scope of their approvals or within the scope of UL 971, *Standard for Nonmetallic Underground Piping for Flammable Liquids*. [30:27.4.6.2]

66.27.4.6.3 Nonmetallic piping systems and components shall be installed in accordance with manufacturer's instructions. [30:27.4.6.3]

66.27.5 Pipe Joints.

66.27.5.1 Tightness of Pipe Joints.

66.27.5.1.1 Joints shall be made liquidtight and shall be welded, flanged, threaded, or mechanically attached. [30:27.5.1.1]

66.27.5.1.2* Joints shall be designed and installed so that the mechanical strength of the joint will not be impaired if exposed to a fire. [30:27.5.1.2]

66.27.5.1.3 Threaded joints shall be made with a suitable thread sealant or lubricant. [30:27.5.1.3]

66.27.5.1.4 Joints in piping systems handling Class I liquids shall be welded when located in concealed spaces within buildings. [30:27.5.1.4]

66.27.5.2 Flexible Connectors. Listed flexible connectors shall be permitted to be used where installed in accordance with 66.27.5.3. [30:27.5.2]

66.27.5.3 Friction Joints.

66.27.5.3.1 Pipe joints dependent upon the friction characteristics of combustible materials for mechanical continuity or liquidtightness of piping shall only be used outside of buildings above ground, except as provided for in 66.27.5.3.3, or below ground. [30:27.5.3.1]

66.27.5.3.2 Where such joints are used aboveground, either the piping shall be secured to prevent disengagement at the fitting or the piping system shall be so designed that any spill or leak resulting from disengagement will not expose persons, important buildings, or structures and can be controlled by remote valves. [30:27.5.3.2]

66.27.5.3.3 Pipe joints dependent on the friction characteristics of their components shall be permitted to be used inside buildings provided both of the following are met:

- (1) They are located where leakage can be controlled by operation of an accessible, remotely located valve that is outside the fire risk area.
- (2) The mechanical strength and liquidtightness of the joint is not dependent on the resiliency of a combustible material or component.

[30:27.5.3.3]

66.27.6 Installation of Piping Systems.

66.27.6.1 General Requirements. Piping systems shall be supported and protected against physical damage, including damage from stresses arising from settlement, vibration, expansion, or contraction. The installation of nonmetallic piping shall be in accordance with the manufacturer's instructions. [30:27.6.1]

66.27.6.2* Load-Bearing Supports. Load-bearing piping supports that are located in areas with a high fire exposure risk shall be protected by one or more of the following:

- (1) Drainage to a safe location to prevent liquid from accumulating under pipeways
- (2) Fire-resistive construction
- (3) Fire-resistant protective coatings or systems
- (4) Water spray systems designed and installed in accordance with NFPA 15
- (5) Other alternate means acceptable to the AHJ

[30:27.6.2]

66.27.6.3 Pipe Penetrations. Piping that passes through or pierces a dike wall or the wall of a structure shall be designed to prevent damaging stresses and leakage due to settlement or fire exposure. [30:27.6.3]

66.27.6.4* Corrosion Protection. Aboveground piping systems that are subject to external corrosion shall be suitably protected. Underground piping systems shall be protected against corrosion in accordance with 66.23.3.5. [30:27.6.4]

66.27.6.5 Installation of Underground Piping. Underground piping shall be installed in accordance with 27.6.5 of NFPA 30.

66.27.6.6 Valves.

66.27.6.6.1 Piping systems shall contain valves to operate the system properly and to isolate the equipment in the event of an emergency. [30:27.6.6.1]

66.27.6.6.2 Piping systems in connection with pumps shall contain valves to properly control the flow of liquid both in normal operation and in the event of an emergency. [30:27.6.6.2]

66.27.6.6.3 Each connection to a piping system by which equipment such as tank cars, tank vehicles, or marine vessels discharges liquids into storage tanks shall be provided with a check valve for automatic protection against backflow if the piping arrangement is such that backflow from the system is possible. (See also 66.22.13.1.) [30:27.6.6.3]

66.27.6.7 Common Loading and Unloading Piping. If loading and unloading is done through a common pipe system, a check valve shall not be required. However, an isolation valve shall be provided. This valve shall be located so that it is accessible or shall be remotely operable. [30:27.6.7]

66.27.7 Testing of Piping Systems.

66.27.7.1 Initial Testing. Unless tested in accordance with the applicable sections of ASME B31, *Code for Pressure Piping*, all piping shall be tested before being covered, enclosed, or placed in use. [30:27.7.1]

66.27.7.1.1 Testing shall be done hydrostatically to 150 percent of the maximum anticipated pressure of the system or pneumatically to 110 percent of the maximum anticipated pressure of the system, and the test pressure shall be maintained while a complete visual inspection of all joints and connections is conducted. [30:27.7.1.1]

66.27.7.1.2 In no case shall the test pressure be less than a gauge pressure of 5 psi (35 kPa) measured at the highest point of the system, and in no case shall the test pressure be maintained for less than 10 minutes. [30:27.7.1.2]

66.27.7.2 Initial Testing of Secondary Containment Piping. The interstitial space of secondary containment-type piping shall be tested hydrostatically or with air pressure at a gauge pressure of 5 psi (35 kPa) or shall be tested in accordance with its listing or with the manufacturer's instructions. [30:27.7.2]

66.27.7.2.1 The pressure source shall be disconnected from the interstitial space to ensure that the test is being conducted on a closed system. [30:27.7.2.1]

66.27.7.2.2 The pressure shall be maintained for a minimum of 1 hour. [30:27.7.2.2]

66.27.7.3 Testing During Maintenance. Existing piping shall be tested in accordance with this subsection if the piping is leaking. [30:27.7.3]

66.27.7.3.1 Piping that could contain a Class I, Class II, or Class IIIA liquid or vapor shall not be tested using air. [30:27.7.3.1]

66.27.8 Vent Piping. Vent piping shall be designed, constructed, and installed in accordance with this section. [30:27.8]

66.27.8.1 Vent Piping for Aboveground Storage Tanks.

66.27.8.1.1 Where the outlets of vent pipes for tanks storing Class I liquids are adjacent to buildings or public ways, they shall be located so that vapors are released at a safe point outside of buildings and not less than 12 ft (3.6 m) above the adjacent ground level. [30:27.8.1.1]

66.27.8.1.2 Vapors shall be discharged upward or horizontally away from adjacent walls. [30:27.8.1.2]

66.27.8.1.3 Vent outlets shall be located so that vapors will not be trapped by eaves or other obstructions and shall be at least 5 ft (1.5 m) from building openings and at least 15 ft (4.5 m) from powered ventilation air intake devices. [30:27.8.1.3]

66.27.8.1.4 Manifolding of vent piping shall be prohibited except where required for special purposes such as vapor recovery, vapor conservation, or air pollution control. [30:27.8.1.4]

66.27.8.1.4.1 Where vent piping is manifolded, pipe sizes shall be capable of discharging, within the pressure limitations of the system, the vapors they are required to handle when all manifolded tanks are subject to the same fire exposure. [30:27.8.1.4.1]

66.27.8.1.5 Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II or Class III liquids unless positive means are provided to prevent the following:

- (1) Vapors of Class I liquids from entering tanks storing Class II or Class III liquids
- (2) Contamination
- (3) Possible change in classification of the less volatile liquid

[30:27.8.1.5]

66.27.8.1.6* Extension of Emergency Vent Piping. Piping to or from approved emergency vent devices for atmospheric and low-pressure tanks shall be sized to provide emergency vent flows that limit the back pressure to less than the maximum pressure permitted by the design of the tank. Piping to or from approved emergency vent devices for pressure vessels shall be sized in accordance with the ASME *Boiler and Pressure Vessel Code*. [30:27.8.1.6]

66.27.8.2 Vent Piping for Underground Tanks.

66.27.8.2.1* Vent pipes from underground tanks storing Class I liquids shall be located so that the discharge point is outside of buildings, higher than the fill pipe opening, and not less than 12 ft (3.6 m) above the adjacent ground level. [30:27.8.2.1]

66.27.8.2.2 Vent pipe outlets shall be located and directed so that vapors will not accumulate or travel to an unsafe location, enter building openings, or be trapped under eaves and shall be at least 5 ft (1.5 m) from building openings and at least 15 ft (4.5 m) from powered ventilation air intake devices. [30:27.8.2.2]

66.27.8.2.3 Vent pipes shall not be obstructed by devices provided for vapor recovery or other purposes unless the tank and associated piping and equipment are otherwise protected to limit back-pressure development to less than the maximum working pressure of the tank and equipment by the provision of pressure-vacuum vents, rupture discs, or other tank-venting devices installed in the tank vent lines. [30:27.8.2.3]

66.27.8.2.4 Vent outlets and devices shall be protected to minimize the possibility of blockage from weather, dirt, or insect nests. [30:27.8.2.4]

66.27.8.2.5 Vent piping shall be sized in accordance with Table 66.23.6.2. [30:27.8.2.5]

66.27.8.2.6 Vent pipes from tanks storing Class II or Class IIIA liquids shall terminate outside of the building and higher than the fill pipe opening. [30:27.8.2.6]

66.27.8.2.7 Vent outlets shall be above normal snow level. [30:27.8.2.7]

66.27.8.2.8 Vent pipes shall be permitted to be fitted with return bends, coarse screens, or other devices to minimize ingress of foreign material. [30:27.8.2.8]

66.27.8.2.9 Vent pipes and vapor return piping shall be installed without sags or traps in which liquid can collect. [30:27.8.2.9]

66.27.8.2.10 Condensate tanks, if utilized, shall be installed and maintained so that blocking of the vapor return piping by liquid is prevented. [30:27.8.2.10]

66.27.8.2.11 Vent pipes and condensate tanks shall be located so that they will not be subjected to physical damage. The tank end of the vent pipe shall enter the tank through the top. [30:27.8.2.11]

66.27.8.2.12 Where tank vent piping is manifolded, pipe sizes shall be such as to discharge, within the pressure limitations of the system, the vapors they could be required to handle when manifolded tanks are filled simultaneously. [30:27.8.2.12]

66.27.8.2.12.1 Float-type check valves installed in tank openings connected to manifolded vent piping to prevent product contamination shall be permitted to be used, provided that the tank pressure will not exceed that permitted by 23.5.3.2 of NFPA 30 when the valves close. [30:27.8.2.12.1]

66.27.8.2.13 Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II or Class III liquids unless positive means are provided to prevent the following:

- (1) Vapors of Class I liquids from entering tanks storing Class II or Class III liquids
- (2) Contamination
- (3) Possible change in classification of the less volatile liquid

[30:27.8.2.13]

66.27.9 Bonding and Grounding. Piping systems shall be bonded and grounded in accordance with 66.6.5.4. [30:27.9]

66.27.10* Identification and Marking of Piping Systems. Each loading and unloading riser shall be marked to identify the product for which it is to be used. [30:27.10]

66.27.11 Special Requirements for Marine Piping Systems.

66.27.11.1 Where piping is from a floating structure or pier, an approved flexible connector shall be permitted between the fixed shore piping and the piping on the floating structure or pier and between separate sections of the floating structure to accommodate changes in water level. [30:27.11.1]

66.27.11.2 The interior of the flexible connectors shall be compatible with the liquid handled. [30:27.11.2]

66.27.11.3 The exterior of the flexible connectors shall be resistant to or shielded from salt water and fresh water, ultraviolet radiation, physical damage, and damage by fire. [30:27.11.3]

66.27.11.4 The flexible connectors shall be suitable for the intended pressures and shall be tested in accordance with 66.27.7. [30:27.11.4]

66.27.12 Removal from Service of Piping Systems. Piping systems taken out of service or abandoned shall be temporarily or permanently closed in accordance with 66.27.12. [30:27.12]

66.27.12.1 Temporary Closure. (Reserved)

66.27.12.2 Permanent Closure in Place. (Reserved)

66.27.12.3 Permanent Removal. (Reserved)

66.28 Bulk Loading and Unloading Facilities for Tank Cars and Tank Vehicles.

66.28.1 Scope. This section shall apply to operations involving the loading or unloading of tank cars and tank vehicles. [30:28.1]

66.28.2 Reserved.

66.28.3 General Requirements.

66.28.3.1 Bonding and Grounding and Stray Currents.

66.28.3.1.1 Bonding for the control of static electricity shall not be required where the following conditions exist:

- (1) Where tank cars and tank vehicles are loaded exclusively with products that do not have static-accumulating properties, such as asphalts (including cutback asphalts), most crude oils, residual oils, and water-soluble liquids
- (2) Where no Class I liquids are handled at the loading facility and where the tank cars and tank vehicles loaded are used exclusively for Class II and Class III liquids at temperatures below their flash points
- (3) Where tank cars and tank vehicles are loaded or unloaded through closed connections

[30:28.3.1.1]

66.28.3.1.2* Loading and unloading facilities that are used to load liquids into tank vehicles through open domes shall be provided with a means for electrically bonding to protect against static electricity hazards. [30:28.3.1.2]

66.28.3.1.2.1 Such means shall consist of a metallic bond wire that is permanently electrically connected to the fill pipe assembly or to some part of the rack structure that is in electrical contact with the fill pipe assembly. [30:28.3.1.2.1]

66.28.3.1.2.2 The free end of this wire shall be provided with a clamp or an equivalent device for convenient attachment to some metallic part that is in electrical contact with the cargo tank of the tank vehicle. [30:28.3.1.2.2]

66.28.3.1.2.3 All parts of the fill pipe assembly, including, but not limited to, the drop tube, rack structure and piping, shall form a continuous electrically conductive path that is directed to ground through the rack assembly or by conductive wiring. [30:28.3.1.2.3]

66.28.3.1.3 Loading and unloading facilities that are used to transfer liquids into and from tank cars through open domes shall be protected against stray currents by permanently bonding the fill pipe to at least one rail and to the facility structure, if of metal. [30:28.3.1.3]

66.28.3.1.3.1 Multiple pipelines that enter the area shall be permanently bonded together. [30:28.3.1.3.1]

66.28.3.1.3.2 In areas where excessive stray currents are known to exist, all pipelines entering the area shall be provided with insulating sections to electrically isolate them from the facility piping.

Exception: These precautions need not be required where only Class II or Class III liquids, at temperatures below their flash points, are handled and where there is no probability that tank cars will contain vapors from previous cargoes of Class I liquids. [30:28.3.1.3.2]

66.28.4 Location of Loading and Unloading Facilities.

66.28.4.1 Tank vehicle and tank car loading and unloading facilities shall be separated from aboveground tanks, warehouses, other plant buildings, or the nearest line of adjoining property that can be built upon by a distance of at least 25 ft (7.6 m) for Class I liquids and for Class II and Class III liquids handled at temperatures at or above their flash points and at least 15 ft (4.6 m) for Class II and Class III liquids handled at temperatures below their flash points, measured from the nearest fill spout or transfer connection. [30:28.4.1]

66.28.4.2* These distances shall be permitted to be reduced if there is suitable protection for exposures. [30:28.4.2]

66.28.4.3 Buildings for pumps or shelters for personnel shall be permitted to be a part of the facility. [30:28.4.3]

66.28.5 Roofed Structures. A loading or unloading facility that has 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 shall be treated as an outdoor facility. [30:28.5]

66.28.6 Reserved.

66.28.7 Reserved.

66.28.8 Reserved.

66.28.9* Containment, Drainage, and Spill Control. Loading and unloading facilities shall be provided with drainage systems or other means to contain spills. [30:28.9]

66.28.10 Equipment.

66.28.10.1 Equipment such as piping, pumps, and meters used for the transfer of Class I liquids between storage tanks and the fill stem of the loading facility shall not be used for the transfer of Class II or Class III liquids unless one of the following conditions exists:

- (1) Only water-miscible liquid mixtures are handled, and the class of the mixture is determined by the concentration of liquid in water.
- (2) The equipment is cleaned between transfers.

[30:28.10.1]

66.28.10.2 Remote pumps located in underground tanks shall have a listed leak detection device installed on the pump discharge side that will indicate if the piping system is not essentially liquidtight. [30:28.10.2]

66.28.10.2.1 This device shall be checked and tested at least annually according to the manufacturer's specifications to ensure proper installation and operation. [30:28.10.2.1]

66.28.11 Operating Requirements.

66.28.11.1 Loading and Unloading of Tank Vehicles.

66.28.11.1.1 Liquids shall be loaded only into cargo tanks whose material of construction is compatible with the chemical characteristics of the liquid. The liquid being loaded shall also be chemically compatible with the liquid hauled on the previous load unless the cargo tank has been cleaned. [30:28.11.1.1]

66.28.11.1.2 Before loading tank vehicles through open domes, a bonding connection shall be made to the vehicle or tank before dome covers are raised and shall remain in place until filling is completed and all dome covers have been closed and secured, unless one of the conditions of 66.28.3.1 exists. [30:28.11.1.2]

66.28.11.1.3 When transferring Class I liquids, or Class II or Class III liquids at temperatures at or above their flash points, engines of tank vehicles or motors of auxiliary or portable pumps shall be shut down during the making and breaking of hose connections. [30:28.11.1.3]

66.28.11.1.4 If loading or unloading is done without requiring the use of the motor of the tank vehicle, the motor shall be shut down throughout any transfer operations involving Class I liquids. [30:28.11.1.4]

66.28.11.1.5* Filling through open domes into tank vehicles that contain vapor-air mixtures within the flammable range or where the liquid being filled can form such a mixture shall be by means of a downspout that extends to within 6 in. (150 mm) of the bottom of the tank unless the liquid is not an accumulator of static electric charges. [30:28.11.1.5]

66.28.11.1.6 When top loading a tank vehicle with Class I or Class II liquids without a vapor control system, valves used for the final control of flow shall be of the self-closing type and shall be manually held open except where automatic means are provided for shutting off the flow when the vehicle is full. [30:28.11.1.6]

66.28.11.1.6.1 Automatic shutoff systems shall be provided with a manual shutoff valve located at a safe distance from the loading nozzle to stop the flow if the automatic system fails. [30:28.11.1.6.1]

66.28.11.1.6.2 When top loading a tank vehicle with vapor control, flow control shall be in accordance with 66.28.11.1.8 and 66.28.11.1.9. [30:28.11.1.6.2]

66.28.11.1.7 When bottom loading a tank vehicle, a positive means shall be provided for loading a predetermined quantity of liquid, together with a secondary automatic shutoff control to prevent overfill. [30:28.11.1.7]

66.28.11.1.7.1 The connecting components between the loading rack and the tank vehicle that are required to operate the secondary control shall be functionally compatible. [30:28.11.1.7.1]

66.28.11.1.7.2 The connection between the liquid loading hose or pipe and the tank vehicle piping shall be by means of a dry disconnect coupling. [30:28.11.1.7.2]

66.28.11.1.8 When bottom loading a tank vehicle that is equipped for vapor control, but when vapor control is not used, the tank shall be vented to the atmosphere, at a height not lower than the top of the cargo tank of the vehicle, to prevent pressurization of the tank. [30:28.11.1.8]

66.28.11.1.8.1 Connections to the facility's vapor control system shall be designed to prevent the escape of vapor to the atmosphere when the system is not connected to a tank vehicle. [30:28.11.1.8.1]

66.28.11.1.9 When bottom loading is used, reduced flow rates (until the fill opening is submerged), splash deflectors, or other devices shall be used to prevent splashing and to minimize turbulence. [30:28.11.1.9]

66.28.11.1.10 Metal or conductive objects, such as gauge tapes, sample containers, and thermometers, shall not be lowered into or suspended in a compartment while the compartment is being filled or immediately after cessation of pumping, in order to permit the relaxation of charge. [30:28.11.1.10]

66.28.11.1.11 Hose materials used for transfer shall be compatible with the liquids being handled. [30:28.11.1.11]

66.28.11.2 Loading and Unloading of Tank Cars.

66.28.11.2.1 Liquids shall be loaded only into tank cars whose material of construction is compatible with the chemical characteristics of the liquid. The liquid being loaded shall also be chemically compatible with the liquid hauled on the previous load unless the tank car has been cleaned. [30:28.11.2.1]

66.28.11.2.2* Filling through open domes into tank cars that contain vapor-air mixtures within the flammable range, or where the liquid being filled can form such a mixture, shall be by means of a downspout that extends to within 6 in. (150 mm) of the bottom of the tank unless the liquid is not an accumulator of static electric charges. [30:28.11.2.2]

66.28.11.2.3 When bottom loading is used, reduced flow rates (until the fill opening is submerged), splash deflectors, or other devices shall be used to prevent splashing and to minimize turbulence. [30:28.11.2.3]

66.28.11.2.4 Metal or conductive objects, such as gauge tapes, sample containers, and thermometers, shall not be lowered into or suspended in a compartment while the compartment is being filled or immediately after cessation of pumping, in order to permit the relaxation of charge. [30:28.11.2.4]

66.28.11.2.5 Hose materials used for transfer shall be compatible with the liquids being handled. [30:28.11.2.5]

66.28.11.3* Switch Loading. To prevent hazards due to a change in flash point of liquids, any tank car or tank vehicle that has previously contained a Class I liquid shall not be loaded with a Class II or Class III liquid unless proper precautions are taken. [30:28.11.3]

66.29 Wharves.

66.29.1 Scope.

66.29.1.1 This section shall apply to all wharves, as defined in 3.3.271, whose primary purpose is the bulk transfer of liquids. [30:29.1.1]

66.29.1.2 This section shall not apply to the following:

- (1) Marine service stations, as covered in Chapter 30 and NFPA 30A
- (2) Marinas and boatyards, as covered in Chapter 28 and NFPA 303
- (3) Wharves that handle liquefied petroleum gas, as covered in Chapter 69 and NFPA 58, *Liquefied Petroleum Gas Code*, or liquefied natural gas, as covered in NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*

[30:29.1.2]

66.29.2 Reserved.

66.29.3 General Requirements.

66.29.3.1 General-purpose wharves that handle bulk transfer of liquids and other commodities shall meet the requirements of Section 28.2 and NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*. [30:29.3.1]

66.29.3.2 Incidental handling of packaged cargo of liquids and loading or unloading of general cargo, such as ships' stores, during transfer of liquids shall be conducted only when approved by the wharf supervisor and the senior officer of the vessel. [30:29.3.2]

66.29.3.3 Wharves at which liquid cargoes are to be transferred in bulk to or from tank vessels shall be at least 100 ft (30 m) from any bridge over a navigable waterway or from any entrance to or superstructure of a vehicular or railroad tunnel under a waterway. [30:29.3.3]

66.29.3.4 The termination of the loading or unloading fixed piping shall be at least 200 ft (60 m) from any bridge or from any entrance to or superstructure of a tunnel. [30:29.3.4]

66.29.3.5 The substructure and deck of the wharf shall be designed for the use intended. [30:29.3.5]

66.29.3.6 The deck of the wharf shall be permitted to be of any material that will afford the desired combination of flexibility, resistance to shock, durability, strength, and fire resistance. [30:29.3.6]

66.29.3.7 Heavy timber construction shall be permitted. [30:29.3.7]

66.29.3.8 Tanks used exclusively for ballast water or Class II or Class III liquids stored at temperatures below their flash points shall be permitted to be installed on a wharf designed to support the weight of the tank and its contents. [30:29.3.8]

66.29.3.9 Loading pumps capable of building up pressures that exceed the safe working pressure of cargo hose or loading arms shall be provided with bypasses, relief valves, or other arrangements to protect the loading facilities against excessive pressure. [30:29.3.9]

66.29.3.9.1 Relief devices shall be tested at least annually to determine that they function satisfactorily at their set pressure. [30:29.3.9.1]

66.29.3.10 All pressure hose and couplings shall be inspected at intervals recommended by the manufacturer for the service in which they are used. [30:29.3.10]

66.29.3.10.1 With the hose extended, the hose and couplings shall be tested using the in-service maximum operating pressure. [30:29.3.10.1]

66.29.3.10.2 Any hose showing material deterioration, signs of leakage, or weakness in its carcass or at the couplings shall be withdrawn from service and repaired or discarded. [30:29.3.10.2]

66.29.3.10.3 The hose materials used for transfer shall be compatible with the liquids being handled. [30:29.3.10.3]

66.29.3.11 Piping, valves, and fittings shall meet applicable requirements of Section 66.27 and shall also meet the following requirements:

- (1) Flexibility of piping shall be assured by layout and arrangement of piping supports so that motion of the wharf structure resulting from wave action, currents, tides, or the mooring of vessels will not subject the piping to excessive strain.
- (2) Pipe joints that depend on the friction characteristics of combustible materials or on the grooving of pipe ends for mechanical continuity of piping shall not be permitted.
- (3) Swivel joints shall be permitted to be used in piping to which hose are connected and for articulated swivel-joint transfer systems, provided the design is such that the mechanical strength of the joint will not be impaired if the packing materials should fail, for example, by exposure to fire.
- (4) Each line conveying Class I or Class II liquids leading to a wharf shall be provided with a readily accessible block valve located on shore near the approach to the wharf and outside of any diked area. Where more than one line is involved, the valves shall be identified as to their specific lines and grouped in one location.
- (5) Means shall be provided for easy access to any cargo line valves that are located below the wharf deck.

[30:29.3.11]

66.29.3.12 Pipelines on wharves that handle Class I or Class II liquids, or Class III liquids at temperatures at or above their flash points, shall be bonded and grounded. [30:29.3.12]

66.29.3.12.1 Insulating flanges or joints shall be installed for protection against stray currents. [30:29.3.12.1]

66.29.3.12.2 Bonding and grounding connections on all pipelines shall be located on the wharf side of insulating flanges, if used, and shall be accessible for inspection. [30:29.3.12.2]

66.29.3.12.3 Bonding between the wharf and the vessel shall not be required. [30:29.3.12.3]

66.29.3.13 Hose or articulated swivel-joint pipe connections used for cargo transfer shall be capable of accommodating the combined effects of change in draft and change in tide. Hose shall be supported to avoid kinking and damage from chafing. [30:29.3.13]

66.29.3.14 Mooring lines shall be kept adjusted to prevent surge of the vessel from placing stress on the cargo transfer system. [30:29.3.14]

66.29.3.15 Material shall not be placed on wharves in such a manner as to obstruct access to fire-fighting equipment or important pipeline control valves. [30:29.3.15]

66.29.3.16 Where the wharf is accessible to vehicle traffic, an unobstructed roadway to the shore end of the wharf shall be maintained for access of fire-fighting apparatus. [30:29.3.16]

66.29.3.17 Loading or unloading shall not commence until the wharf supervisor and the person in charge of the tank vessel agree that the tank vessel is properly moored and all connections are properly made. [30:29.3.17]

66.29.3.18 Mechanical work shall not be performed on the wharf during cargo transfer, except under special authorization based on a review of the area involved, methods to be employed, and precautions necessary. [30:29.3.18]

66.29.3.19 Sources of ignition shall be controlled during transfer of liquids. [30:29.3.19]

66.29.3.20 Vehicular traffic and mechanical work including, but not limited to, welding, grinding, and other hot work, shall not be performed during cargo transfer except as authorized by the wharf supervisor and the senior officer on the vessel. [30:29.3.20]

66.29.3.21 Smoking shall be prohibited at all times on the wharf during cargo transfer operations. [30:29.3.21]

66.29.3.22 For marine terminals handling flammable liquids and combustible liquids at temperatures at or above their flash points, Figure 66.29.3.22 shall be used to determine the extent of classified areas for the purpose of installation of electrical equipment. [30:29.3.22]

66.29.3.23 Where a flammable atmosphere can exist in the vessel cargo compartment, cargo transfer systems shall be designed to limit the velocity of the incoming liquid stream to 3 ft (0.9 m) per second until the compartment inlet opening is sufficiently submerged to prevent splashing. [30:29.3.23]

66.29.3.24 Filters, pumps, wire screens, and other devices that can produce static electric charges through turbulence shall be so located to allow a minimum of 30 seconds of relaxation time prior to discharging cargo into the compartment. [30:29.3.24]

66.29.3.25* Spill collection shall be provided around manifold areas to prevent spread of liquids to other areas of the wharf or under the wharf. [30:29.3.25]

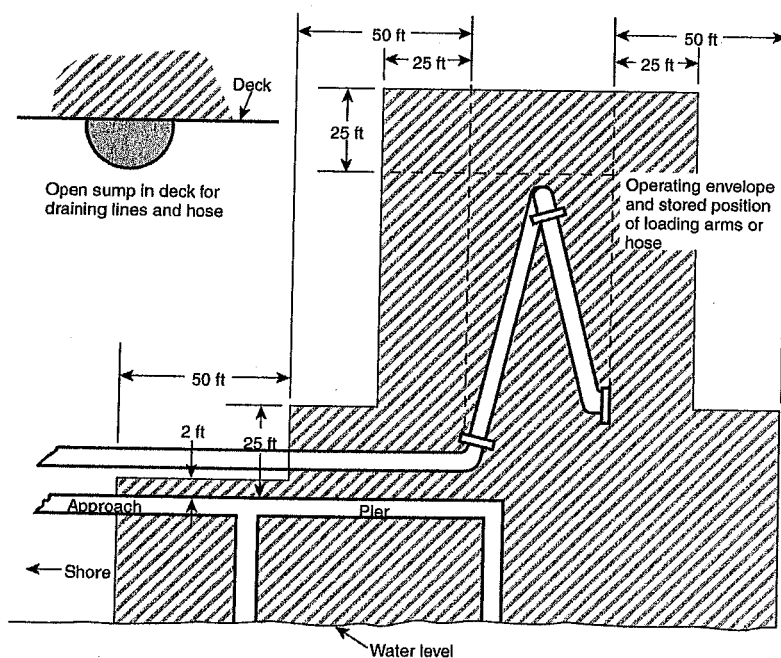
66.29.3.26 Vapor seals shall be provided on all drain lines leaving the wharf. [30:29.3.26]

66.29.3.27 Where required, wharves shall have a system to isolate and shut down the loading operation in the event of failure of a hose, loading arm, or manifold valve. This system shall meet all of the following requirements:

- (1) If the protective system closes a valve on a gravity-fed or pipeline-fed loading system, it shall be designed to ensure the line is not subjected to damage from pressure surges.
- (2) Emergency shutdown systems shall be permitted to be automatically or manually activated.

[30:29.3.27]

66.29.3.27.1 Manually activated device(s) shall be identified and accessible during an emergency. [30:29.3.27.1]



Key:

- Division 1
- Division 2
- Nonclassified

Notes:

- (1) For SI units, 1 in. = 25 mm; 1 ft = 0.3 m.
- (2) The "source of vapor" is the operating envelope and stored position of the outboard flange connection of the loading arm (or hose).
- (3) The berth area adjacent to tanker and barge cargo tanks is to be Division 2 to the following extent:
 - (a) 25 ft (7.6 m) horizontally in all directions on the pier side from the portion of the hull containing cargo tanks.
 - (b) From the water level to 25 ft (7.6 m) above the cargo tanks at their highest position.
- (4) Additional locations can be classified as required by the presence of other sources of flammable liquids on the berth, or by Coast Guard or other regulations.

FIGURE 66.29.3.22 Area Classification for a Marine Terminal Handling Flammable Liquids. [30: Figure 29.3.22]

66.29.3.28* Fire protection and emergency response equipment for wharves shall be related to the products being handled, emergency response capability, size, location, frequency of use, and adjacent exposures. [30:29.3.28]

66.29.3.28.1 Where a fire water main is provided, the main shall be permitted to be wet or dry. In all cases, isolation valves and fire department connections shall be provided at the wharf-to-shore connection. [30:29.3.28.1]

66.29.3.28.2 Where a fire water main is provided, hydrants and monitors shall also be provided so that effective fire water streams can be applied to any berth or loading manifold from two directions. [30:29.3.28.2]

66.29.3.28.3 Fire water pumps, fire hose, fire water mains, foam systems, and other fire suppression equipment shall be maintained and tested in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. [30:29.3.28.3]

66.29.3.28.4 Where no fire water main is provided, at least two 150 lb (68 kg) dry chemical extinguishers shall be provided. The extinguishers shall be located within 50 ft (15 m) of pump or manifold areas and shall be easily reached along emergency access paths. [30:29.3.28.4]

Chapter 67 Flammable Solids

67.1 General.

67.1.1 The storage, use, and handling of flammable solids shall comply with the requirements of Chapter 60.

67.1.2 The storage, use, and handling of flammable solids in amounts exceeding the maximum allowable quantity permitted in control areas as set forth in Chapter 60 shall also comply with the requirements of NFPA 400, *Hazardous Materials Code*.

Chapter 68 Highly Toxic and Toxic Solids and Liquids

68.1 General.

68.1.1 The storage, use, and handling of highly toxic and toxic solids and liquids shall comply with Chapter 60.

68.1.2 The storage, use, and handling of highly toxic and toxic solids and liquids in amounts exceeding the maximum allowable quantity permitted in control areas as set forth in Chapter 60 shall also comply with the requirements of NFPA 400, *Hazardous Materials Code*.

Chapter 69 Liquefied Petroleum Gases and Liquefied Natural Gases

69.1 General Provisions.

69.1.1* Application.

69.1.1.1 The storage, use, and handling of liquefied petroleum gases (LP-Gas) shall comply with the requirements of this chapter; NFPA 58, *Liquefied Petroleum Gas Code*; and Sections 60.1 through 60.4 of this Code.

69.1.1.2 Where the provisions of Chapter 69 or NFPA 58 conflict with the provisions of Chapter 60, the provisions of this chapter and NFPA 58 shall apply.

69.1.1.3 Stationary Installations. Plans for stationary installations utilizing storage containers of over 2000 gal (7.6 m³) individual water capacity, or with aggregate water capacity exceeding 4000 gal (15.1 m³), and all rooftop installations of ASME containers shall be submitted to the AHJ by the person or company that either installs or contracts to have the containers installed, before the installation is started. [See also 6.19.11.1(F) of NFPA 58.] [58:4.3.1]

69.1.2 Permits. Permits, where required, shall comply with Section 1.12.

69.2 LP-Gas Equipment and Appliances.

69.2.1 Containers.

69.2.1.1 General.

69.2.1.1.1* Containers shall be designed, fabricated, tested, and marked (or stamped) in accordance with the regulations of the U.S. Department of Transportation (DOT); the ASME *Boiler and Pressure Vessel Code*, Section VIII, "Rules for the Construction of Unfired Pressure Vessels"; or the API-ASME *Code for Unfired Pressure Vessels for Petroleum Liquids and Gases*, except for UG-125 through UG-136. [58:5.2.1.1]

69.2.1.1.1.1 Used containers constructed to specifications of the Association of American Railroads shall not be installed. [58:5.2.1.1(A)]

69.2.1.1.1.2 Adherence to applicable ASME Code case interpretations and addenda that have been adopted and published by ASME 180 calendar days prior to the effective date of NFPA 58 shall be considered as compliant with the ASME Code. [58:5.2.1.1(B)]

69.2.1.1.1.3 Where containers fabricated to earlier editions of regulations, rules, or codes listed in 69.2.1.1.1, and of the Interstate Commerce Commission (ICC) *Rules for Construction of Unfired Pressure Vessels*, prior to April 1, 1967, are used, the requirements of Section 1.4 of NFPA 58 shall apply. [58:5.2.1.1(C)]

69.2.1.1.2 Containers that have been involved in a fire and show no distortion shall be requalified for continued service before being used or reinstalled. [58:5.2.1.2]

69.2.1.1.2.1 Cylinders shall be requalified by a manufacturer of that type of cylinder or by a repair facility approved by DOT. [58:5.2.1.2(A)]

69.2.1.1.2.2 ASME or API-ASME containers shall be retested using the hydrostatic test procedure applicable at the time of the original fabrication. [58:5.2.1.2(B)]

69.2.1.1.2.3 All container appurtenances shall be replaced. [58:5.2.1.2(C)]

69.2.1.1.2.4 DOT 4E specification (aluminum) cylinders and composite cylinders involved in a fire shall be permanently removed from service. [58:5.2.1.2(D)]

69.2.1.1.3 ASME paragraph U-68 or U-69 containers shall be permitted to be continued in use, installed, reinstalled, or placed back into service. Installation of containers shall be in accordance with all provisions listed in NFPA 58. (See Section 5.2, Table 5.2.4.2 and Table 5.7.2.5(A), and Annex D of NFPA 58.) [58:5.2.1.3]