**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, 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:

\* Any liquid that has a melting point of 100°F (37.8°C) or greater

\* Any liquid that does not meet the criteria for fluidity given in the definition of liquid in Chapter 3 of NFPA 30 and in the provisions of Chapter 4 of NFPA 30

Any cryogenic fluid or liquefied gas, as defined in Chapter 3

\* Any liquid that does not have a flash point, but which is capable of burning under certain conditions

\* Any aerosol product

Any mist, spray, or foam

\* Transportation of ignitible (flammable or combustible) liquids as governed by the U.S. Department of Transportation

\* Storage, handling, and use of fuel oil tanks and containers connected with oil-burning equipment

\* Use and installation of alcohol-based hand rub (ABHR) dispensers (See 60.5.2)

Liquids in the fuel tanks of motor vehicles, aircraft, boats, or portable or stationary engines

Liquids that have no fire point when tested in accordance with ASTM D92, Flash and, Fire Points by Cleveland Open Cup Tester, up to the boiling point of the liquid or up to a temperature at which the liquid shows an obvious physical change

Liquids with a flash point greater than 95°F (35°C) in a water-miscible solution or water-miscible dispersion with a water and noncombustible solids content of more than 80 percent by weight, and which does not sustain combustion when tested in accordance with "Method of Testing for Sustained Combustibility," in accordance with 49 CFR 173, Appendix H, or the UN publication, Recommendations on the Transport of Dangerous Goods

[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.

NFPA 20

NFPA 30A

NFPA 31

NFPA 32

NFPA 33,

NFPA 34

NFPA 35

NFPA 36

NFPA 37

NFPA 45

NFPA 99

NFPA 101

[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 3.3.11.

66.3.3.2 Area

66.3.3.2.1 Fire Area

See 3.3.14.3.

66.3.3.2.2 Inside Liquid Storage Area

See 3.3.14.6.

66.3.3.3 Barrel

See 3.3.21

66.3.3.4 Basement

See 3.3.22.

66.3.3.5 Boiling Point

See 3.3.27.

66.3.3.6\* Boil-Over

See 3.3.28.

66.3.3.7 Building

66.3.3.7.1\* Important Building

See 3.3.29.7.

66.3.3.7.2 Storage Tank Building

See 3.3.29.11.

66.3.3.8 Chemical Plant

See 3.3.47.

66.3.3.9 Closed-Top Diking

See 3.3.54.

66.3.3.10 Container

A vessel of 119 gal (450 L) or less capacity used for transporting or storing liquids, excluding intermediate bulk containers. [30,2021]

66.3.3.10.1 Closed Container

See 3.3.72.3.1.

66.3.3.10.2 Intermediate Bulk Container

See 3.3.72.5.

66.3.3.11 Control Area

For this chapter, a building or portion of a building within which liquids are allowed to be stored, dispensed, and used or handled in quantities that do not exceed the maximum allowable quantity (MAQ). [30,2021]

66.3.3.12 Crude Petroleum

See 3.3.79.

66.3.3.13 Cryogenic Fluid

See 3.3.80.

66.3.3.14 Damage-Limiting Construction

See 3.3.85.

66.3.3.15 Distillery

See 3.3.93.

66.3.3.16 Fire Point

See 3.3.133.

66.3.3.17 Flash Point

See 3.3.140.

66.3.3.18\* Fugitive Emissions

See 3.3.143.

66.3.3.19\* Hazardous Material or Hazardous Chemical

Material presenting dangers beyond the fire problems relating to flash point and boiling point. [30,2021]

66.3.3.20 Hazardous Materials Storage Locker

See 3.3.158.

66.3.3.21 Hazardous Reaction or Hazardous Chemical Reaction

See 3.3.159.

66.3.3.22 Heat Transfer Fluid (HTF)

See 3.3.160.

66.3.3.23 High-Hazard Level 2 Contents

Contents that present a deflagration hazard or a hazard from accelerated burning, which, for this chapter, includes Class I, Class II, or Class IIIA liquids [FP < 200°F (93°C) ] 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. [30,2021]

66.3.3.24 High-Hazard Level 3 Contents

Contents that readily support combustion or that present a physical hazard, which, for this chapter, includes Class I, Class II, or Class IIIA liquids [FP < 200°F (93°C) ] that are used or stored in normally closed containers or in closed systems at gauge pressures of less than 15 psi (103 kPa). [30,2021]

66.3.3.25 Incidental Liquid Use or Storage

See 3.3.169.

66.3.3.26 Liquid

66.3.3.26.1 Combustible Liquid

See 3.3.178.1.

66.3.3.26.2 Flammable Liquid

See 3.3.178.2.

66.3.3.26.3 Stable Liquid

See 3.3.178.6.

66.3.3.27\* Operating Unit (Vessel) or Process Unit (Vessel)

See 3.3.203.

66.3.3.28 Operations

See 3.3.204.

66.3.3.29\* Process or Processing

See 3.3.224.

66.3.3.30 Protection for Exposures

See 3.3.227.

66.3.3.31 Refinery

See 3.3.236.

66.3.3.32\* Safety Can

See 3.3.244.

66.3.3.33 Storage Tank

See 3.3.279.7.

66.3.3.33.1 Aboveground Tank

See 3.3.279.2.

66.3.3.33.1.1 Protected Aboveground Tank

See 3.3.279.2.1.

66.3.3.33.2 Low-Pressure Tank

For the purposes of this chapter, a storage tank designed to withstand an internal pressure above a gauge pressure of 1.0 psi (6.9 kPa) but not more than a gauge pressure of 15 psi (103 kPa) measured at the top of the tank. [30,2021]

66.3.3.33.3 Portable Tank

See 3.3.279.4.

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. [30,2021]

66.3.3.33.4 Secondary Containment Tank

See 3.3.279.5.

66.3.3.34 Unit Operation or Unit Process

See 3.3.289.

66.3.3.35 Vapor Pressure

See 3.3.296.

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. [30,2021]

66.3.3.37\* Vapor Processing System

See 3.3.278.15.

66.3.3.38 Vapor Recovery System

See 3.3.278.16.

66.3.3.39 Vent

66.3.3.39.1 Emergency Relief Vent

See 3.3.101.

66.3.3.40\* Warehouse

66.3.3.40.1 General-Purpose Warehouse

See 3.3.300.1.

66.3.3.40.2 Liquid Warehouse

See 3.3.300.2.

66.4 Classification of Liquids

66.4.1 Classification Scheme

66.4.1.1 Class I Liquids

66.4.1.1.1

A liquid with a closed-cup flash point below 100°F (37.8°C) shall be designated as a Class I liquid (i.e., flammable liquid), as determined by the test procedures and apparatus set forth in 66.4.3 and a Reid vapor pressure that does not exceed an absolute pressure of 40 psi (276 kPa) at 100°F (37.8°C), as determined by ASTM D323, Vapor Pressure of Petroleum Products (Reid Method). [30:4.2.1.1]

66.4.1.1.2

Class I liquids shall be further subclassified in accordance with the following:

Class IA Liquid. A liquid that has a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C).

Class IB Liquid. A liquid that has a flash point below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C).

Class IC Liquid. A liquid that has a flash point at or above 73°F (22.8°C), but below 100°F (37.8°C).

[30:4.2.1.2]

66.4.1.2 Class II Liquids

A liquid with a closed-cup flash point at or above 100°F (37.8°C) but below 140°F (60°C) shall be designated as a Class II liquid (i.e., combustible liquid), as determined by the test procedures and apparatus set forth in 66.4.3. [30:4.2.2]

66.4.1.3 Class III Liquids

66.4.1.3.1

A liquid with a closed-cup flash point at or above 140°F (60°C) shall be designated as a Class III liquid (i.e., combustible liquid), as determined by the test procedures and apparatus set forth in 66.4.3. [30:4.2.3.1]

66.4.1.3.2

Class III liquids shall be further subclassified in accordance with the following:

Class IIIA Liquid. A liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C).

Class IIIB Liquid. A liquid that has a flash point at or above 200°F (93°C).

[30:4.2.3.2]

66.4.2 Determination of Boiling Point (BP)

66.4.2.1

For defining the boiling point, atmospheric pressure shall be considered to be an absolute pressure of 14.7 psi (101.4 kPa). [30:4.3.1]

66.4.2.2

For mixtures that do not have a constant boiling point, the 20 percent evaporated point of a distillation performed in accordance with ASTM D86, Distillation of Petroleum Products at Atmospheric Pressure, shall be considered to be the boiling point. [30:4.3.2]

66.4.3 Determination of Flash Point (FP)

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 D56, Standard Test Method for Rash 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 D56, Standard Test Method for Flash Point by Tag Closed Cup Tester, even if they otherwise meet the viscosity criteria. [30:4.4.1.1]

66.4.3.1.2

Such liquids as stated in 66.4.3.1.1 shall be tested in accordance with 66.4.3.2. [30:4.4.1.2]

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 D93, Standard Test Methods for Flush Point by Pensky-Martens Closed Cup Tester. [30:4.4.2]

66.4.3.3

As an alternative, ASTM D3278, Standard Test Methods for Rash 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 centiStokes at 77°F (25°C). [30:4.4.3]

66.4.3.4

As an alternative, ASTM D3828, 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 D3278 is specifically required. [30:4.4.4]

66.5 Reserved

66.6 Fire and Explosion Prevention and Risk Control

66.6.1\* Scope

This subsection shall apply to the hazards associated with storage processing, handling, and use of ignitible (flammable or combustible) liquids. This subsection 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 subsection shall apply to the management methodology used to identify, evaluate, and control the hazards involved in the processing and handling of ignitible (flammable or 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 ignitible (flammable or combustible) liquids shall be reviewed to ensure that fire and explosion hazards are addressed by fire prevention, fire control, and emergency action plans, except as provided in 66.6.4.1.1. [30:6.4.1]

66.6.4.1.1

The requirement in 66.6.4.1 shall not apply to the following:

Operations where liquids are used solely for on-site consumption as fuels.

Operations where Class II or Class III liquids [FP ≥ 100°F (37.8°C)] are stored in atmospheric tanks or transferred at temperatures below their flash points.

Mercantile occupancies, crude petroleum exploration, drillings, and well servicing operations, and normally unoccupied facilities in remote locations.

[30:6.4.1.1]

66.6.4.1.2 Engineering Evaluation

66.6.4.1.2.1\*

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. [30:6.4.1.2.1]

66.6.4.1.2.2

An engineering evaluation shall include, but not be limited to, the following:

Analysis of the fire and explosion hazards of the operation

Analysis of emergency relief from process vessels, taking into consideration the properties of the materials used and the fire protection and control measures taken

Analysis of applicable facility design requirements in Chapters 17, 18, 19, 28, and 29 of NFPA 30

Analysis of applicable requirements for liquid handling, transfer, and use, as covered in Chapters 17, 18, 19, 28, and 29 of NFPA 30

Analysis of local conditions, such as exposure to and from adjacent properties and exposure to floods, earthquakes, and windstorms

Analysis of the emergency response capabilities of the local emergency services

[30::6.4.1.2.2]

66.6.4.1.3\*

Storage, processing, handling, and use of Class II and Class III liquids [FP ≥ 100°F (37.8°C)] heated at or above their flash point shall follow the requirements for Class I liquids [FP < 100°F (37.8°C)], unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. [30:6.4.1.3]

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:

When changes occur in the materials in process

When changes occur in process equipment

When changes occur in process control

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:

Open flames

Lightning

Hot surfaces

Radiant heat

Smoking

Cutting and welding

Spontaneous ignition

\* Frictional heat or sparks

Static electricity

Electrical sparks

Stray currents

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 Class I liquids [FP < 100°F (37.8°C)] 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 ignitible 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 ignitible 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 shall be provided for prompt notification of fire or other emergency to those identified in the emergency action plan in accordance with Section 66.6.8. [30:6.6.1]

66.6.6.2

Those areas, including buildings, where a potential exists for a Class I liquid [flash point < 100°F (37.8°C)] spill shall be monitored as appropriate. The following methods shall be permitted to be used:

Personnel observation or patrol

Process-monitoring equipment that would indicate a spill or leak could have occurred

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 ignitible (flammable or combustible) liquid-processing facilities. The application of one or a combination of these systems and methods as well as the use of fire-resistive materials shall be determined in accordance with Sections 66.6.3 and 66.6.4. [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 section, hydrants, with or without fixed monitor nozzles, shall be provided in accordance with this Code and NFPA 24. 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 ignitible (flammable or combustible) 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 required by this section, standpipe and hose systems shall be installed in accordance with Section 13.2 and NFPA 14 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]

66.6.7.7\*

Where required by this section, 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]

66.6.7.8

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:

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

Procedures and schedules for conducting drills of these procedures

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

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

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

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. [30:6.9.1]

66.6.9.2

Maintenance and operating practices shall be established and implemented to prevent and control leakage and spillage of ignitible (flammable or 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

66.6.10.1 Scope

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, storage, and handling of ignitible (flammable or 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:

Identification and evaluation of security risks

Evaluation of the security performance of the facility

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

66.6.10.3.1

Operations involving ignitible (flammable or combustible) liquids shall be reviewed to ensure that security vulnerabilities identified during the security vulnerability assessment (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:

Assessing overall facility

Evaluating vulnerabilities

Assessing threats/consequences

Assessing physical factors/attractiveness

Identifying mitigation factors

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:

Procedures to be followed such as initiating alarms, notifying appropriate agencies, evacuating personnel, and controlling and extinguishing the fire

Procedures and schedules for conducting drills of these procedures

Appointment and training of personnel to carry out assigned duties

Maintenance of fire protection and response equipment

Procedures for shutting down or isolating equipment to reduce the release of liquid

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:

For an initial review of all new relevant facilities and assets

When substantial changes to the threat or process occur

After a significant security incident

For periodic revalidation of the SVA

[30:6.10.3.5]

66.7 Electrical Systems

66.7.1 Scope

This section shall apply to areas where Class I liquids [FP < 100°F (37.8°C)] are stored, handled, or used and to areas where Class II or Class III liquids [FP ≥ 100°F (37.8°C)] are stored, handled, or used 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 ignitible 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. [30:7.3.2]

66.7.3.3\*

Table 66.7.3.3 shall be used to delineate and classify areas for 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\*

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

With no fixed outer roof

1

1

Area above the floating roof and within the shell

Tank vault — interior

1

1

Entire interior volume, if Class I liquids [FP < 100°F (37.8°C)] are stored within

Underground tank fill opening

1

1

Any pit, box, or space below grade level, if any part is within a Division 1 or 2 or Zone 1 or 2 classified location

2

2

Up to 18 in. above grade level within a horizontal radius of 10 ft from a loose fill connection and within a horizontal radius of 5 ft from a tight fill connection

Vent — discharging upward

1

0

Area inside of vent piping or opening

1

1

Within 3 ft of open end of vent, extending in all directions

2

2

Area between 3 ft and 5 ft of open end of vent, extending in all directions

Drum and container filling — outdoors or indoors

1

0

Area inside the drum or container

1

1

Within 3 ft of vent and fill openings, extending in all directions

2

2

Area between 3 ft and 5 ft from vent or fill opening, extending in all directions; also, up to 18 in. above floor or grade level within a horizontal radius of 10 ft from vent or fill opening

Pumps, bleeders, withdrawal fittings

Indoor

2

2

Within 5 ft of any edge of such devices, extending in all directions; also, up to 3 ft above floor or grade level within 25 ft horizontally from any edge of such devices

Outdoor

2

2

Within 3 ft of any edge of such devices, extending in all directions; also, up to 18 in. above grade level within 10 ft horizontally from any edge of such devices

Pits and sumps

Without mechanical ventilation

1

1

Entire area within a pit or sump if any part is within a Division 1 or 2 or Zone 1 or 2 classified location

With adequate mechanical ventilation

2

2

Entire area within a pit or sump if any part is within a Division 1 or 2 or Zone 1 or 2 classified location

Containing valves, fittings, or piping, and not within a Division 1 or 2 or Zone 1 or 2 classified location

2

2

Entire pit or sump

Drainage ditches, separators, impounding basins

Outdoor

2

2

Area up to 18 in. above ditch, separator, or basin; also, area up to 18 in. above grade within 15 ft horizontally from any edge

Indoor

Same as pits and sumps

Tank vehicle and tank car†

Loading through open dome

1

0

Area inside of the tank

1

1

Within 3 ft of edge of dome, extending in all directions

2

2

Area between 3 ft and 15 ft from edge of dome, extending in all directions

Loading through bottom connections with atmospheric venting

1

0

Area inside of the tank

1

1

Within 3 ft of point of venting to atmosphere, extending in all directions

2

2

Area between 3 ft and 15 ft from point of venting to atmosphere, extending in all directions; also, up to 18 in. above grade within a horizontal radius of 10 ft from point of loading connection

Loading through closed dome with atmospheric venting

1

1

Within 3 ft of open end of vent, extending in all directions

2

2

Area between 3 ft and 15 ft from open end of vent, extending in all directions; also, within 3 ft of edge of dome, extending in all directions

Loading through closed dome with vapor control

2

2

Within 3 ft of point of connection of both fill and vapor lines, extending in all directions

Bottom loading with vapor control or any bottom unloading

2

2

Within 3 ft of point of connections, extending in all directions; also, up to 18 in. above grade within a horizontal radius of 10 ft from point of connections

Storage and repair garage for tank vehicles

1

1

All pits or spaces below floor level

2

2

Area up to 18 in. above floor or grade level for entire storage or repair garage

Garages for other than tank vehicles

Ordinary

If there is any opening to these rooms within the extent of an outdoor classified location, the entire room shall be classified the same as the area classification at the point of the opening

Outdoor drum storage

Ordinary

Inside rooms or storage lockers used for the storage of Class I liquids [FP < 100°F (37.8°C)]

2

2

Entire room or locker

Indoor warehousing where there is no Class I liquid [FP < 100°F (37.8°C)] 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.

\*The release of Class I liquids [FP < 100°F (37.8°C)] 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.

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

Area classification shall be used to assure that fixed electrical utilization equipment, electrical fixtures, and wiring are installed within Class I, Division 1; Zone 1; Class I, Division 2; or Zone 2 designated areas, as defined by Article 500 of NFPA 70. [30:7.4]

66.9 Storage of Ignitible (Flammable or Combustible) Liquids in Containers — General Requirements

66.9.1 Scope

66.9.1.1

This section shall apply to the storage of ignitible (flammable or combustible) liquids in:

Drums or other containers that do not exceed 119 gal (450 L) individual capacity

Portable tanks that do not exceed 660 gal (2500 L) individual capacity

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 ignitible (flammable or combustible) 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:

Containers, intermediate bulk containers, and portable tanks that are used in operations areas, as covered by Section 66.17

Liquids in the fuel tanks of motor vehicles, aircraft, boats, or portable or stationary engines

Beverages, medicines, foodstuffs, cosmetics, and other products that do not contain more than 20 percent by volume of water-miscible ignitible (flammable or combustible) liquids, with the remainder of the product consisting of components that do not burn

Liquids that have no fire point when tested in accordance with ASTM D92, Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester, up to the boiling point of the liquid or up to a temperature at which the liquid shows an obvious physical change

Liquids with a flash point greater than 95°F (35°C) in a water-miscible solution or water-miscible dispersion with a water and noncombustible solids content of more than 80 percent by weight, and which does not sustain combustion when tested in accordance with "Method of Testing for Sustained Combustibility," in accordance with 49 CFR 173, Appendix H, or the UN publication, Recommendations on the Transport of Dangerous Goods

Distilled spirits and wines in wooden barrels or casks

[30:9.1.4]

66.9.2 General Requirements

66.9.2.1

The general requirements of this section shall be applicable to the storage of ignitible (flammable or combustible) 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]

66.9.2.2

For the purposes of Sections 66.9 through 66.16, unstable liquids shall be treated as Class IA liquids [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)]. [30:9.3.2]

66.9.2.3

Means of egress shall meet applicable requirements of NFPA 101. [30:9.3.3]

66.9.2.4

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. [30:9.3.4]

66.9.2.5

Class I liquids [FP < 100°F (37.8°C)] shall not be permitted to be stored in basements as defined in 3.3.22. [30:9.3.5]

66.9.2.6

Class II and Class IIIA liquids [100°F (37.8°C) ≤ FP < 200°F (93°C)] shall be permitted to be stored in basements as defined in 3.3.22, provided the basement is protected in accordance with Section 66.16. [30:9.3.6]

66.9.2.7

Class IIIB liquids [FP ≥ 200°F (93°C)] shall be permitted to be stored in basements as defined in 3.3.22. [30:9.3.7]

66.9.2.8

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. [30:9.3.8]

66.9.2.8.1

Portable tanks and intermediate bulk containers stored more than one high shall be designed to stack securely, without the use of dunnage. [30:9.3.8.1]

66.9.2.8.2

Materials-handling equipment shall be capable of handling containers, portable tanks, and intermediate bulk containers that are stored at all storage levels. [30:9.3.8.2]

66.9.2.8.3\*

Power-operated industrial trucks used to move Class I liquids [FP < 100°F (37.8°C)] shall be selected, operated, and maintained in accordance with NFPA 505. [30:9.3.8.3]

66.9.2.9

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. [30:9.3.9]

66.9.2.10

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. [30:9.3.10]

66.9.2.11

Storage, handling, and use of Class II and Class III liquids [FP ≥ 100°F (37.8°C)] heated at or above their FP shall follow the requirements for Class I liquids [FP < 100°F (37.8°C)], unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. (See 66.6.4.1.3 and A.66.6.4.1.3.)[30:9.3.11]

66.9.3 Acceptable Containers

66.9.3.1\*

Only the following approved containers, intermediate bulk containers, and portable tanks shall be used for Class I, Class II, and Class IIIA liquids [FP < 200°F (93°C)]:

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 49 CFR 100-199, or by Part 6 of the UN Recommendations on the Transport of Dangerous Goods

Plastic or metal consumer-use containers meeting the requirements of, and used within the scope of, ASTM F852, Standard Specification for Portable Gasoline, Kerosene and Diesel Containers for Consumer Use

ASTM F852, Standard Specification for Portable Gasoline Containers for Consumer Use

ASTM F976, Standard Specification for Portable Kerosene and Diesel Containers for Consumer Use

Nonmetallic or metallic commercial/industrial safety cans meeting the requirements of, and used within the scope of, one or more of the following specifications:

UL 30, Metal Safety Cans

UL 1313, Nonmetallic Safety Cans for Petroleum Products

FM Global Approval Standard for Safety Containers and Filling, Supply, and Disposal Containers — Class Number 6051 and 6052

Plastic containers that meet requirements set by, and contain products authorized by, the following:

The U.S. Department of Transportation Hazardous Materials Regulations in 49 CFR 100-199, or by Part 6 of the UN publication Recommendations on the Transport of Dangerous Goods

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 49 CFR 100-199, or by Part 6 of the UN publication Recommendations on the Transport of Dangerous Goods

Fiber drums that meet the following:

Requirements of Items 294 and 296 of the National Motor Freight Classification (NMFC), or of Rule 51 of the Uniform Freight Classification (UFC), for Types 2A, 3A, 3B-H, 3B-L, or 4A

Requirements of, and containing liquid products authorized by, either the U.S. Department of Transportation Hazardous Materials Regulations in 49 CFR Chapter I, or by the U.S. Department of Transportation exemption

\* Rigid nonmetallic intermediate bulk containers that meet requirements set by and contain products authorized by the following:

The U.S. Department of Transportation Hazardous Materials Regulations in 49 CFR 100-199, or by Part 6 of the UN publication, Recommendations on the Transport of Dangerous Goods, for Classes 31H1, 31H2, and 31HZ1

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 49 CFR 100-199, or by Part 6 of the UN publication Recommendations on the Transport of Dangerous Goods

Glass containers up to the capacity limits stated in Table 66.9.3.3 and in accordance with U.S. Department of Transportation Hazardous Materials Regulations in 49 CFR 100-199

Other nonmetallic intermediate bulk containers that comply with 66.9.3.1.1

[30:9.4.1]

66.9.3.1.1

For protected storage, nonmetallic intermediate bulk containers shall comply with Table 66.9.3.3 and shall be listed and labeled in accordance with UL 2368, Fire Exposure Testing of Intermediate Bulk Containers or Flammable and Combustible Liquids; FM 6020, Approval Standard for Composite Intermediate Bulk Containers; or an equivalent test procedure. [30:9.4.1.1]

66.9.3.1.2

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 66.9.3.1 and 66.9.3.3. [30:9.4.1.2]

66.9.3.2

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]

66.9.3.2.1

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]

66.9.3.2.2

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. The vent shall be set to open at not less than a gauge pressure of 5 psi (35 kPa). [30:9.4.2.2]

66.9.3.2.3

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]

66.9.3.3

The maximum allowable size of a container, intermediate bulk container, or metal portable tank for Class I, Class II, and Class IIIA liquids [FP < 200°F (93°C)] shall not exceed that specified in Table 66.9.3.3.

Exception: As provided for in 66.9.1, 66.9.3.3.1, 66.9.3.3.3, and 66.9.3.3.4. [30:9.4.3]

Table 66.9.3.3 Maximum Allowable Size — Containers, Intermediate Bulk Containers (IBCs), and Portable Tanks

Container Type

Class IA#

Class IB#

Class IC#

Class II#

Class IIIA#

Glass 1 pt (0.5 L) 1 qt (1 L) 1.3 gal (5 L) 1.3 gal (5 L) 5.3 gal (20 L)

Metal (other than drums) or approved plastic

1.3 gal (5 L) 5.3 gal (20 L) 5.3 gal (20 L) 5.3 gal (20 L) 5.3 gal (20 L)

Safety cans 2.6 gal (10 L) 5.3 gal (20 L) 5.3 gal (20 L) 5.3 gal (20 L) 5.3 gal (20 L)

Metal drum (e.g., UN 1A1/1A2) 119 gal (450 L) 119 gal (450 L) 119 gal (450 L) 119 gal (450 L) 119 gal (450 L)

Approved metal portable tanks and IBCs

793 gal (3000 L) 793 gal (3000 L) 793 gal (3000 L) 793 gal (3000 L) 793 gal (3000 L)

Rigid plastic IBCs (UN 31H1 or 31H2) and composite IBCs with rigid inner receptacle (UN31HZ1)†

NP NP NP 793 gal (3000 L) 793 gal (3000 L)

Composite IBCs with flexible inner receptacle (UN31HZ2) DOT/UN-approved flexible IBCs, and NMFC/ISTA-compliant IBCs†

NP NP NP 331 gal (1300 L) 331 gal (1300 L)

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.

\*See 66.9.3.3.1.

†See 66.9.3.3.2

#See 66.4.1 for details on the classification scheme.

[30: Table 9.4.3]

66.9.3.3.1

Class IB and Class IC [FP < 100°F (37.8°C) and BP ≥ 100°F (37.8°C)] 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]

66.9.3.3.2

Nonmetallic intermediate bulk containers, as permitted by Table 66.9.3.3, shall be listed and labeled in accordance with UL 2368, Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids; FM 6020, Approval Standard for Composite Intermediate Bulk Containers; or an equivalent test procedure. [30:9.4.3.2]

66.9.3.3.3

Class IA and Class IB [FP < 73°F (22.8°C)] 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. [30:9.4.3.3]

66.9.3.3.4

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. [30:9.4.3.4]

66.9.3.3.4.1

To be considered protected storage as defined in 9.2.1 of NFPA 30 and in accordance with Section 66.16, an overpack container shall be constructed of the same material as the leaking or damaged container. [30:9.4.3.4.1]

66.9.3.3.4.2

Metal overpack containers shall be considered nonrelieving style containers. [30:9.4.3.4.2]

66.9.4\* Liquid Storage Cabinets

66.9.4.1

The volume of Class I, Class II, and Class IIIA [FP < 200°F (93°C)] liquids stored in an individual storage cabinet shall not exceed 120 gal (460 L). [30:9.5.1]

66.9.4.2

The total aggregate volume of Class I, Class II, and Class IIIA liquids [FP < 200°F (93°C)] in a group of storage cabinets shall not exceed the maximum allowable quantity of liquids per control area based on the occupancy where the cabinets are located. [30:9.5.2]

66.9.4.3

Storage cabinets that meet at least one of the following sets of requirements shall be acceptable for storage of ignitible (flammable or combustible) liquids:

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 timetemperature curve specified in ASTM E119, Fire Tests of Building Construction and Materials, shall be acceptable. All joints and seams shall remain tight and the door shall remain securely closed during the test.

Metal storage cabinets constructed in the following manner shall be acceptable:

The bottom, top, door, and sides of the cabinet shall be at least No. 18 gauge sheet steel and shall be double-walled, with 11/2 in. (38 mm) air space.

Joints shall be riveted, welded, or made tight by some equally effective means.

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.

New cabinets shall have self-closing doors.

Wooden cabinets constructed in the following manner shall be acceptable:

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.

All joints shall be rabbetted and shall be fastened in two directions with wood screws.

Where more than one door is used, there shall be a rabbetted overlap of not less than 1 in. (25 mm).

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.

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.

New cabinets shall have self-closing doors.

Listed storage cabinets that have been constructed and tested in accordance with UL 1275, Flammable Liquid Storage Cabinets; FM 6050, Approval Standard for Storage Cabinets for Ignitable (Flammable Liquids); or equivalent shall be acceptable.

[30:9.5.3]

66.9.4.4\*

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

66.9.4.4.1

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

66.9.4.4.2\*

If a storage cabinet is ventilated for any reason, the vent openings shall be ducted directly to a safe location outdoors or to a treatment device designed to control volatile organic compounds (VOCs) and ignitible vapors in such a manner that will not compromise the specified performance of the cabinet and in a manner that is acceptable to the AHJ. [30:9.5.4.2]

66.9.4.5\*

Storage cabinets shall include the following marking:

FLAMMABLE

KEEP FIRE AWAY

[30:9.5.5]

66.9.4.5.1

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]

66.9.4.5.2

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

66.9.4.5.3

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

66.9.4.5.4

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]

66.9.5 Maximum Allowable Quantities (MAQs) Per Control Area

66.9.5.1 General Occupancy Limits

The maximum allowable quantities (MAQs) of ignitible (flammable or combustible) liquids allowed in each control area shall not exceed the amounts specified in Table 66.9.5.1. [30:9.6.1]

Exception: As modified by 66.9.5.2 of this Code and Chapters 10 through 14 of NFPA 30. [30:9.6.1]

Table 66.9.5.1 MAQ of Ignitible (Flammable or Combustible) Liquids per Control Area

Liquid Class(es)#

Quantity

gal

L

Notes

IA

30

115

1,2

IB and IC

120

460

1,2

IA, IB, IC combined

120

460

1,2,3

II

120

460

1,2

IIIA

330

1,265

1,2

IIIB

13,200

50,600

1,2,4

#See 66.4.1 for details on the classification scheme.

Notes:

Quantities are permitted to be increased 100 percent where stored in approved liquid 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.

Quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system installed in accordance with NFPA13. Where Note 1 also applies, the increase for both notes is permitted to be applied accumulatively.

Containing not more than the maximum allowable quantity per control area of Class IA, Class IB, or Class IC [FP < 100°F (37.8°C)] liquids, individually.

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]

66.9.5.2 Special Occupancy Limits

66.9.5.2.1

For the following occupancies, the MAQs per control area shall not exceed the amounts specified in Table 66.9.5.2.1:

Assembly

Ambulatory health care

Business

Day care

Detention and correctional

Educational

Health care

Residential

[30:9.6.2.1]

Table 66.9.5.2.1 MAQs — Special Occupancy Limits

Liquid Class (es)# Quantity

gal

L

I and II

10

38

IIIA

60

227

IIIB

120

454

#See 66.4.1 for details on the classification scheme.

[30: Table 9.6.2.1]

66.9.5.2.2

For the occupancies specified in 66.9.5.2.1, storage in excess of 10 gal (38 L) of Class I and Class II liquids [FP < 140°F (60°C)] combined or in excess of 60 gal (227 L) of Class IIIA liquids [140°F (60°C) ≤ FP < 200°F (93°C)] shall be permitted where stored in ignitible (flammable or combustible) liquid storage cabinets and where the total aggregate quantity does not exceed 180 gal (680 L). [30:9.6.2.2]

66.9.5.2.3

Fuel in the tanks of operating mobile equipment shall be permitted to exceed the quantities specified in Table 66.9.5.1, where the equipment is operated in accordance with this Code. [30:9.6.2.3]

66.9.5.2.4

For ambulatory health care, day care, educational, and health care occupancies, the MAQ for Class IIIB liquids [FP ≥ 200°F (93°C)] 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]

66.9.6 Control Areas

66.9.6.1

For the purpose of this Code, a control area shall be a space within a building where quantities of ignitible (flammable or combustible) liquids that do not exceed the maximum quantities allowed by Table 66.9.5.1 or Table 66.9.5.2.1 are stored. [30:9.7.1]

66.9.6.2

Control areas shall be separated from each other by fire barriers in accordance with Table 60.4.2.2.1. [400:5.2.2.1]

66.9.6.3

Control areas located below grade that are considered basements, as defined in 3.3.22, shall not be utilized for the storage of Class I liquids [FP < 100°F (37.8°C)]. [30:9.7.3]

66.9.7 Classification of Occupancies That Exceed the Maximum Allowable Quantities of Ignitible (Flammable or Combustible) Liquids Per Control Area

66.9.7.1\* 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]

66.9.7.1.1 Protection Level 2

Buildings and portions thereof storing quantities of ignitible (flammable or combustible) 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]

66.9.7.1.2 Protection Level 3

Buildings and portions thereof storing quantities of ignitible (flammable or combustible) 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]

66.9.7.2\* Requirements for Specific Occupancies

Ignitible (flammable or combustible) 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. [30:9.8.2]

66.9.8 Construction Requirements

66.9.8.1

Fire resistance ratings for ignitible (flammable or combustible) liquid storage areas shall comply with Table 66.9.8.1. [30:9.9.1]

Table 66.9.8.1 Fire Resistance Ratings for Ignitible (Flammable or Combustible) Liquid Storage Areas

Fire Resistance Rating (hr)

Type of Storage Area

Interior Walls, Ceilings, Intermediate Floorsa

Roofs

Exterior Walls

Liquid storage room

Floor area ≤ 150 ft2

1

NR

NR

Floor area >150 ft2, but ≤ 500 ft2

2

NR

NR

Liquid warehouse

4b

NR

4c

For SI units, 1 ft2 = 0.09 m2.

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

bA 4-hour firewall, in accordance with NFPA 221 is required except as follows:

Where storage of liquids in a liquid warehouse is limited to Class IIIB liquids [FP ≥ 200°F (93°C)] that are not heated above their FP, 2-hour fire resistance rated assemblies are permitted.

Where a liquid warehouse is protected in accordance with Section 66.16, 2-hour fire resistance rated assemblies are permitted.

Where a liquid warehouse is protected in accordance with Section 66.16, accessory use areas, such as offices and restrooms, having a combined area is less than 10 percent of the area of the liquid warehouse do not require a fire resistance rating for the interior walls and ceilings.

cThe fire resistance rating for 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 is permitted to be 2 hours. Walls located 50 ft (15 m) or more from an important building or line of adjoining property that can be built upon do not require a fire resistance rating

[30: Table 9.9.1]

66.9.8.2

Acceptable methods for determining fire resistance shall be in accordance with this Code and the building code. [30:9.9.2]

66.9.8.3

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 66.9.8.3. [30:9.9.3]

Table 66.9.8.3 Protection Ratings for Fire Doors

Fire Resistance Rating of Wall as Required by Table 66.9.8.1 (hr)

Fire Protection Rating of Door (hr)

1

3/4

2

11/2

4

3\*

\*One fire door required on each side of interior openings for attached liquid warehouses. [30: Table 9.9.3]

66.9.8.3.1

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. [30:9.9.3.1]

66.9.8.3.2

Fire doors shall be installed in accordance with NFPA 80. [30:9.9.3.2]

66.9.8.4

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. [30:9.9.4]

66.9.9 Fire Protection

66.9.9.1 Protected Storage

Fire protection requirements for protected storage shall meet the requirements of 66.9.9.2 and Section 66.16. [30:9.10.1]

66.9.9.2 Manual Fire Protection

66.9.9.2.1

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

66.9.9.2.2

Portable fire extinguishers shall meet the following requirements:

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.

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

[30:9.10.2.2]

66.9.9.2.3

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]

66.9.9.2.4

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]

66.9.9.2.5

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

Hose connections shall be provided in protected general-purpose warehouses and in protected liquid warehouses.

Where preconnected hose is provided, it shall be either 11/2 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]

66.9.9.2.6

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]

66.9.10 Elmergency Control Systems. (Reserved)

66.9.11 Electrical Systems

66.9.11.1

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 66.9.11.2. [30:9.12.1]

66.9.11.2

For liquid storage rooms that are totally enclosed within the building, electrical wiring and utilization equipment for Class I liquid [FP < 100°F (37.8°C)] storage shall be Class I, Division 2 (Zone 2), and electrical wiring and utilization equipment in liquid storage rooms used for the storage of Class II and Class III liquids [FP ≥ 100°F (37.8°C)] shall be suitable for ordinary purpose.

Exception: Class I, Division 2 (Zone 2) requirements apply to Class II and Class III liquids [FP ≥ 100°F (37.8°C)] when stored at temperatures above their FP. [30:9.12.2]

66.9.12\* Containment, Drainage, and Spill Control

66.9.12.1

Storage areas shall be designed and operated to prevent the discharge of ignitible (flammable or combustible) liquids to public waterways, public sewers, or adjoining property, unless such discharge has been specifically approved. [30:9.13.1]

66.9.12.1.1

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]

66.9.12.2

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]

66.9.12.3

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

66.9.12.3.1

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]

66.9.12.4

Where only Class IIIB liquids [FP ≥ 200°F (93°C)] are stored, spill control, containment, and drainage shall not be required. [30:9.13.4]

66.9.12.5

Where only unsaturated polyester resins (UPRs) containing not more than 50 percent by weight of Class IC, Class II, or Class IIIA liquid [73°F (22.8°C) ≤ FP < 200°F (93°C)] 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]

66.9.12.6

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]

66.9.13 Ventilation

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

66.9.14 Exhausted Enclosures. (Reserved)

66.9.15 Explosion Control

66.9.15.1\*

Where Class IA liquids [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)] 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. An approved engineered damage limiting construction design shall also be permitted.

Exception: This does not apply to a liquid storage room totally enclosed within a building. [30:9.16.1]

66.9.15.2\*

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]

66.9.16 Separation From Incompatible Materials

66.9.16.1

Except as provided for in 66.9.16.3, ignitible (flammable or combustible) 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 1/2 gal (1.89 L). [30:9.17.1]

66.9.16.1.1

Separation shall be accomplished by one of the following methods:

Segregating incompatible materials storage by a distance of not less than 20 ft (6.1 m)

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

Storing liquid materials in Class I liquids [FP < 100°F (37.8°C)] storage cabinets in accordance with 66.9.4

[30:9.17.1.1]

66.9.16.2

Ignitible (flammable or combustible) liquids shall be separated from Level 2 and Level 3 aerosols in accordance with Chapter 61 and NFPA 30B. [30:9.17.2]

66.9.16.3

Liquids shall be separated from oxidizers by at least 25 ft (7.6 m). [30:9.17.3]

66.9.16.4

Materials that are water-reactive, as described in NFPA 704 shall not be stored in the same control area with ignitible (flammable or combustible) liquids. [30:9.17.4]

66.9.17 Dispensing, Handling, and Use of Ignitible (Flammable or Combustible) Liquids in Storage Areas

66.9.17.1

Dispensing, handling, and use of ignitible (flammable or combustible) liquids shall meet all applicable requirements of Section 66.18. [30:9.18.1]

66.9.17.2

Dispensing of Class I liquids [FP < 100°F (37.8°C)] or Class II and Class III liquids [FP ≥ 100°F (37.8°C)] at temperatures at or above their FP 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 66.9.8.1 and meets all other requirements of 66.9.8. [30:9.18.2]

66.9.18 Outdoor Storage of Ignitible (Flammable or Combustible) Liquids

Storage of ignitible (flammable or combustible) 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 ignitible (flammable or combustible) 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:

Containers that do not exceed 119 gal (450 L) individual capacity

Portable tanks that do not exceed 660 gal (2500 L) individual capacity

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 Chapters 9 and 12 of NFPA 30, 66.14.4 and 66.14.6. [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 electrical utilization equipment are required, they shall comply with Section 66.7 and 66.9.11. [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 ignitible (flammable or combustible) liquids from the locker 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]

Table 66.14.5.2 Designated Sites

Area of Designated Sitea (ft2)

Minimum Separation Distance (ft)

Between Individual Lockers

From Locker to Property Line That Is or Can Be Built Uponb

From Locker to Nearest Side of Public Way or to Important Buildings on Same Propertyb,c

≤100

5

10

5

>100 and ≤500

5

20

10

>500 and ≤1500d

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]

66.14.5.3

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]

66.14.6 Storage Requirements

66.14.6.1

Containers of ignitible (flammable or combustible) liquid in their original shipping packages shall be permitted to be stored either palletized or solid piled within the locker. [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 [FP < 140°F (60°C)] 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 ignitible (flammable or combustible) liquids outdoors in the following:

Drums or other containers that do not exceed 119 gal (450 L) individual capacity

Portable tanks that do not exceed 660 gal (2500 L) individual capacity

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 ignitible (flammable or combustible) 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]

Table 66.15.3 Storage Limitations for Outside Storage

Containers

Portable Tanks and

Metal IBCs

Rigid Plastic and

Composite IBCs

Minimum Separation Distance (ft)

Liquid Class#

Maximum Quantity per Pile

(gal)a,b,c

Maximum Storage Height

(ft)

Maximum Quantity per Pile

(gal)

Maximum Storage Height

(ft)

Maximum Quantity per Pile

(gal)a,c

Maximum Storage Height

(ft)

Between Piles or Rack Sections

To Property Line That Is or Can Be Built Uponb,d

To Street, Alley, or Public Wayb

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.

#See 66.4.1 for details on the classification scheme.

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]

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 ignitible (flammable or combustible) 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 ignitible (flammable or combustible) 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:

The adjacent building wall has an exterior fire resistance rating of 2 hours.

The adjacent building wall has no openings at grade or above grade that are within 10 ft (3 m) horizontally of the storage.

The adjacent building wall has no openings directly above the storage.

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 ignitible (flammable or combustible) liquids. [30:15.4.2]

66.15.4.3

The quantity of ignitible (flammable or combustible) 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 ignitible (flammable or combustible) 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 ignitible (flammable or combustible) liquids in containers, intermediate bulk containers, and portable tanks as specified in 66.9.3. [30:16.1.1]

66.16.1.2 \*

This section shall not apply to Class IA liquids [FP < 73°F 22.8°C) and BP < 100°F (37.8°C)] or to unstable liquids. [30:16.1.2]

66.16.1.3

Storage of ignitible (flammable or combustible) liquids that is protected in accordance with the applicable requirements of this section shall be considered protected, as defined in 66.16.2.1. 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 terms in this section shall have the definitions given. [30:16.2]

66.16.2.1\* Protected

For the purposes of 66.16, this term shall apply to the storage of containers that meet the appropriate provisions of 66.16 or alternate provisions that have been approved by the AHJ (see 66.16.3.5 and 66.16.9). [30:16.2.2]

66.16.2.2\* Unprotected

For the purposes of this section, this term shall apply to the storage of containers that do not meet the criteria to be considered protected, as defined in 66.16.2.1. [30:16.2.3]

66.16.2.3\* Relieving-Style Container

A metal container, a metal intermediate bulk container, or a metal portable tank that is equipped with at least one pressure-relieving mechanism at its top that is designed, sized, and arranged to relieve the internal pressure generated due to exposure to fire so that violent rupture is prevented. [30:16.2.4]

66.16.2.4\* Unsaturated Polyester Resin (UPR)

A resin that contains up to 50 percent by weight of Class IC, Class II, or Class III [FP > 73°F (22.8°C)] liquid, but no Class IA or Class IB [FP < 73°F (22.8°C)] liquid. [30:16.2.5]

66.16.2.5 Viscous Liquid

A liquid that gels, thickens, or solidifies when heated or whose viscosity at room temperature versus weight percent content of Class I, Class II, or Class III liquid (any FP or BP) is in the shaded portion of Figure 66.16.2.5. [30:16.2.6]

FIGURE 66.16.2.5 Viscous Liquid: Viscosity Versus Weight Percent Flammable or Combustible (Ignitible) Component. [30: Figure 16.2.6]

66.16.2.6 Water-Miscible Liquid

A liquid that mixes in all proportions with water without the use of chemical additives, such as emulsifying agents.[30:16.2.7]

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:

Requirements of this section for the most severe storage fire hazard present

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:

Extend 20 ft (6 m) beyond its perimeter, but not less than the required minimum sprinkler design area

Be provided with means to prevent the flow of burning ignitible (flammable or combustible) liquid under emergency conditions into adjacent hazard areas

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) in depth and double-row racks shall not be more than 9 ft (2.8 m) in depth. [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 66.16.2.5, shall be permitted to be protected using one of the following:

For metal containers, the criteria for Class IIIB liquids [FP ≥ 200°F (93°C)], as determined by Figure 66.16.4.1(a)

For nonmetallic containers, the criteria for Class IIIB liquids, [FP ≥ 200°F (93°C)], as determined by Figure 66.16.4.1(b)

For nonmetallic containers, the criteria for cartoned unexpanded Group A plastics in accordance with NFPA 13, as indicated in 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:

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.

The pressure-relieving mechanism shall not be painted, and cap seals, if used, shall be made of thermoplastic material.

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 listed and labeled in accordance with UL 2368, Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids; FM 6020, Approval Standard for Composite Intermediate Bulk Containers, or an equivalent test procedure. [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 ignitible (flammable or combustible) 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]

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

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

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

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

66.16.4.1.1

Figure 66.16.4.1(a) shall be used for miscible and nonmiscible ignitible (flammable or 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 ignitible (flammable or 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 ignitible (flammable or 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. [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]

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]

66.16.5.1.1.1

The protection criteria in Table 66.16.5.2.1 through Table 66.16.5.2.12 shall only be used with ceilings having a pitch of 2 in 12 or less. [30:16.5.1.1.1]

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 ignitible (flammable or combustible) 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:

In-rack sprinklers shall be laid out in accordance with 66.16.5.1.10 and 66.16.6, as applicable.

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.

A vertical clear space of at least 6 in. (150 mm) shall be maintained between the sprinkler deflector and the top tier of storage.

Sprinkler discharge shall not be obstructed by horizontal rack structural members.

Where in-rack sprinklers are installed below horizontal barriers, the deflector shall be located a maximum of 7 in. (180 mm) below the barrier.

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:

Class I, Class II, and Class IIIA liquids [FP < 200°F (93°C)]: 100 ft2 (9.3 m2) per sprinkler

Class IIIB liquids [FP ≥ 200°F (93°C)]: 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, excluding Table 66.16.5.2.8, shall be permitted to be increased by a maximum of 10 percent if an equivalent percent increase in ceiling sprinkler design density is provided. [30:16.5.1.5]

66.16.5.1.6

Foam-water sprinkler systems shall be 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 flowrate. [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 3/4 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 66.9.3.3 and has been listed and labeled in accordance with UL 2368, 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 gal = 3.8 L; 1 ft = 0.3 m; 1 ft2 = 0.09 m2

1 gpm/ft2 is equivalent to 40.7 L/min/m2 or 40.7 mm/min

A gauge pressure of 1 psi is equivalent to a gauge pressure of 6.9 kPa

SR = standard response sprinkler; QR = quick response sprinkler; ESFR = early suppression fast response sprinkler; OT = ordinary temperature; HT = high temperature

Where an ordinary-temperature sprinkler is indicated, an intermediate-temperature sprinkler shall be used where ambient conditions require.

[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:

Layout 1, as referenced in Table 66.16.5.2.1, shall mean one line of in-rack sprinklers 8 ft (2.4 m) above the floor in the longitudinal flue space, with sprinklers spaced not more than 10 ft (3 m) on center.

Layout 2, as referenced in Table 66.16.5.2.1, shall mean one line of in-rack sprinklers 6 ft (1.8 m) above the floor and one line of in-rack sprinklers 12 ft (3.6 m) above the floor in the longitudinal flue space, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically.

Layout 3, as referenced in Table 66.16.5.2.1 and Table 66.16.5.2.3, shall mean one line of in-rack sprinklers in the longitudinal flue space at every storage level above the floor except above the top tier, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically, where more than one level of in-rack sprinklers is installed.

Layout 4, as referenced in Table 66.16.5.2.1 and Table 66.16.5.2.3, shall mean one line of in-rack sprinklers in the longitudinal flue space at every other storage level, except above the top tier, beginning above the first storage level, with sprinklers spaced not more than 10 ft (3 m) on center. Sprinklers shall be staggered vertically where more than one level of in-rack sprinklers is installed.

Layout 5, as referenced in Table 66.16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every storage level above the floor except above the top tier and face sprinklers at the first storage level at each rack upright. In-rack sprinklers shall be spaced not more than 9 ft (2.7 m) on center and shall be staggered vertically, where more than one level of in-rack sprinklers is installed.

Layout 6, as referenced in Table 66.16.5.2.1, shall mean one line of in-rack sprinklers in the longitudinal flue space at every other storage level above the first storage level except the top tier and face sprinklers at the first storage level at each rack upright. In-rack sprinklers shall be spaced not more than 10 ft (3 m) on center and shall be staggered vertically, where more than one level of inrack sprinklers is installed.

[30:16.5.1.10]

66.16.5.1.11

For each entry in Table 66.16.5.2.1 through Table 66.16.5.2.12 the "Fire Test Ref." number shall be used to identify the information in Section D.2 of NFPA 30 about 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 section. [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:

Automatic sprinkler protection

Single- or double-row rack storage

All liquid classes except Class LA liquids [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)]

Metal containers, metal portable tanks, metal intermediate bulk containers

Relieving- or nonrelieving-style containers

[30:16.5.2.1]

Table 66.16.5.2.1 Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Ignitible (Flammable or Combustible) 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

Notes

Fire Test Ref. [See NFPA 30:Table D.2(a)]

Sprinkler

Design

Sprinkler

Discharge Flow (gpm)

Layout (See 66.16.5.1.10)

Type

Response

Density (gpm/ft2)

Area (ft2)

Type Response

NONRELIEVING-STYLE CONTAINERS — CLASS IB, CLASS IC, CLASS II, CLASS IIIA LIQUIDS# [FP < 200°F (93°C) AND BP ≥ 100°F (37.8°C)]

≤1

16

30

K ≥ 11.2

QR (HT)

0.6

2000

K ≥ 5.6

QR (OT)

30

1

1, 2, 7

1

20

30

K ≥ 11.2

SR or QR (HT)

0.6

2000

K ≥ 5.6

QR (OT)

30

2

1, 2, 7

2

≤5

25

30

K ≥ 8.0

SR or QR (HT)

0.3

3000

K ≥ 5.6

QR (OT)

30

3

1, 7

3

>5 and ≤60

25

30

K ≥ 11.2

SR (HT)

0.4

3000

K ≥ 5.6

QR or SR (OT)

30

5

1, 7

5

NONRELIEVING-STYLE CONTAINERS — CLASS IIIB LIQUID# [FP ≥ 200°F (93°C)]

≤5

40

50

K ≥ 8.0

SR or QR (HT)

0.3

2000

K ≥ 5.6

QR(OT)

30

4

1, 3, 7

4

>5 and ≤60

40

50

K ≥ 8.0

SR (HT)

0.3

3000

K ≥ 5.6

QR(OT)

30

4

1, 3, 7

6

RELIEVING-STYLE CONTAINERS — CLASS IB, CLASS IC, CLASS II, CLASS IIIA LIQUIDS# [FP < 200°F (93°C) AND BP ≥ 100°F (37.8°C)]

≤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)

0.3

3000

K ≥ 5.6

QR (OT)

30

4, 7

1, 5

8

>5 and ≤60

25

30

K ≥ 11.2

SR (HT)

0.6

3000

K ≥ 5.6

QR (OT)

30

6, 7

1

10

Portable tanks and IBCs

25

50

K ≥ 11.2

SR (HT)

0.6

3000

K ≥ 5.6

QR or SR (OT)

30

5, 7

1

12

RELIEVING-STYLE CONTAINERS — CLASS IIIB LIQUID# [FP ≥ 200°F (93°C)]

≤5 gal

40

50

K ≥ 8.0

SR or QR (HT)

0.3

2000

K ≥ 5.6

QR(OT)

30

4, 7

1

9

>5 and ≤60

40

50

K ≥ 8.0

SR (HT)

0.3

3000

K ≥ 5.6

QR (OT)

30

4, 7

1, 3

11

Portable tanks and IBCs

40

50

K ≥ 8.0

SR (HT)

0.3

3000

K ≥ 5.6

QR (OT)

30

4, 7

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.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

#See 66.4.1 for details on classification scheme.

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

Where one level of in-rack sprinklers is installed, the design shall include the eight most hydraulically remote sprinklers

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

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

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

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

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

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.

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

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

[30:Table 16.5.2.1]

66.16.5.2.2

Table 66.16.5.2.2 shall apply to the following:

Automatic sprinkler protection

Palletized or stacked storage

All liquid classes except Class IA liquids [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)]

Metal containers, metal portable tanks, metal intermediate bulk containers

Relieving- or nonrelieving-style containers

[30:16.5.2.2]

Table 66.16.5.2.2 Design Criteria for Sprinkler Protection of Palletized and Stacked Storage of Ignitible (Flammable or Combustible) 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/ft2)

Area (ft2)

NONRELIEVING-STYLE CONTAINERS — CLASS IB, CLASS IC, CLASS II, CLASS IIIA LIQUIDS# [FP < 200°F (93°C) AND BP ≥ 100°F (37.8°C)]

≤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 — CLASS IIIB LIQUID# [FP ≥ 200°F (93°C)]

≤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 — CLASS IB, CLASS IC, CLASS II, CLASS IIIA LIQUIDS# [FP < 200°F (93°C) AND BP ≥ 100°F (37.8°C)]

≤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

1-high

30

K≥8.0

SR (HT)

0.30

3000

—

14

and IBCs

2-high

30

K≥11.2

SR (HT)

0.60

3000

—

15

RELIEVING-STYLE CONTAINERS — CLASS IIIB LIQUID# [FP ≥ 200°F (93°C)]

≤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

20

K≥8.0

SR (HT)

0.35

3000

—

13

Portable tanks

1-high

30

K≥8.0

SR (HT)

0.25

3000

—

16

and IBCs

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.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

#See 66.4.1 for details on classification scheme.

Notes:

Minimum hose stream demand can be reduced to 250 gpm for 2 hours.

Sprinklers must also be hydraulically calculated to provide a density of 0.80 gpm/ft2 over 1000 ft2.

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]

66.16.5.2.3

Table 66.16.5.2.3 shall apply to the following:

Foam water sprinkler protection

Single- or double-row rack storage

All liquid classes except Class IA liquids [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)]

Metal containers, metal portable tanks, metal intermediate bulk containers

Relieving- or nonrelieving-style containers

[30:16.5.2.3]

Table 66.16.5.2.3 Design Criteria for Foam-Water Sprinkler Protection of Single- or Double-Row Rack Storage of Ignitible (Flammable or Combustible) 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

Notes

Fire Test Ref. [See NFPA 30:Table D.2(c)]

Sprinkler

Design

Sprinkler

Discharge Flow (gpm)

Layout (See 66.16.5.1.10)

Type

Response

Density (gpm/ft2)

Area (ft2)

Type Response

NONRELIEVING-STYLE CONTAINERS — CLASS IB, CLASS IC, CLASS II, CLASS IIIA LIQUIDS# [FP < 200°F (93°C) AND BP ≥ 100°F (37.8°C)]

≤5

25

30

K≥8.0

SR or QR (HT)

0.30

2000

K≥5.6

QR or SR (OT)

30

3

1, 2, 4, 5

1

>5 and ≤60

25

30

K≥8.0

SR (HT)

0.30

3000

K≥5.6

QR or SR (OT)

30

3

1, 3, 4, 5

2

NONRELIEVING-STYLE CONTAINERS — CLASS IIIB LIQUID# [FP ≥ 200°F (93°C)]

≤60

40

50

K≥8.0

SR (HT)

0.30

2000

K≥5.6

QR or SR (OT)

30

4

1, 5

3

RELIEVING-STYLE CONTAINERS — CLASS IB, CLASS IC, CLASS II, CLASS IIIA LIQUIDS# [FP < 200°F (93°C) AND BP ≥ 100°F (37.8°C)]

≤5

25

30

K≥8.0

SR or QR (HT)

0.30

2000

K≥5.6

QR or SR (OT)

30

4

1, 2, 4, 5

4

>5 and ≤60,

portable tanks and IBCs

25

30

K≥8.0

SR (HT)

0.30

3000

K≥5.6

30

4

1, 3, 4, 5

5

RELIEVING-STYLE CONTAINERS — CLASS IIIB LIQUID#[FP ≥ 200°F (93°C)]

≤60

40

50

K≥8.0

SR (HT)

0.30

2000

K ≥5.6

QR or SR (OT)

30

4

1,5

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.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

#See 66.4.1 for details on classification scheme.

Notes:

In-rack sprinkler design based on the six most hydraulically remote sprinklers in each of the up per three levels.

Design area can be reduced to 1500 ft2 when using a preprimed foam-water system installed in accordance with NFPA 16 and maintained according to NFPA 25.

Design area can be reduced to 2000 ft2 when using a preprimed foam-water system installed in accordance with NFPA 16 and maintained according to NFPA 25.

In-rack sprinkler hydraulic design can be reduced to three sprinklers operating per level, with three levels operating simultaneously, when using a preprimed foam-water sprinkler system designed in accordance with NFPA 16 and maintained in accordance with NFPA 25.

The minimum in-rack sprinkler discharge pressure shall n o t be less than a gauge pressure of 10 psi.

[30:Table 16.5.2.3]

66.16.5.2.4

Table 66.16.5.2.4 shall apply to the following:

Foam water sprinkler protection

Palletized or stacked storage

All liquid classes except Class IA liquids [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)]

Metal containers, metal portable tanks, metal intermediate bulk containers

Relieving- or nonrelieving-style containers

[30:16.5.2.4]

Table 66.16.5.2.4 Design Criteria for Sprinkler Protection of Palletized and Stacked Storage of Ignitible (Flammable or Combustible) 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/ft2)

Area (ft2)

NONRELIEVING-STYLE CONTAINERS — CLASS IB, CLASS IC, CLASS II, CLASS IIIA LIQUIDS# [FP < 200°F (93°C) AND BP ≥ 100°F (37.8°C)]

≤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 — CLASS IB, CLASS IC, CLASS II, CLASS IIIA LIQUIDS# [FP < 200°F (93°C) AND BP ≥ 100°F (37.8°C)]

>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.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

#See 66.4.1 for details on classification scheme.

Notes:

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.

Both 3/4 in. (20 mm) and 2 in. (50 mm) listed pressure-relieving mechanisms are required on containers greater than 6 gal (23 L) capacity.

Drums placed on open slatted pallet, not nested, to allow pressure relief from drums on lower levels.

[30: Table 16.5.2.4]

66.16.5.2.5

Table 66.16.5.2.5 shall apply to the following:

Automatic sprinkler protection

Single-, double-, or multiple-row rack storage

Class IIIB liquids [FP ≥ 200°F (93°C)]

Nonmetallic containers or intermediate bulk containers

Cartoned or uncartoned

[30:16.5.2.5]

Table 66.16.5.2.5 Design Criteria for Sprinkler Protection of Single-, Double-, and Multiple-Row Rack Storage of Class IIIB Liquids [FP ≥ 200°F (93°C)] in Nonmetallic Containers

Closed-Cup

FP

(°F)

Container or lBC Capacity

(gal)

Packaging

Maximum Storage Height

(ft)

Maximum Ceiling Height

(ft)

Minimum Aisle Width

(ft)

Rack Depth

(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 11/2 in. (38 mm) at the center of any side panel.

[30: Table 16.5.2.5]

66.16.5.2.6

Table 66.16.5.2.6 shall apply to the following:

Automatic sprinkler protection

Shelf storage

All liquid classes except Class IA liquids [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)]

Metal containers

Nonrelieving-style containers

[30:16.5.2.6]

Table 66.16.5.2.6 Design Criteria for Sprinkler Protection of Shelf Storage of Ignitible (Flammable or Combustible) 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/ft2)

Area (ft2)

≤1, nonrelieving style

6

18

K≥5.6

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.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

Notes:

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

Minimum hose stream demand can be reduced to 250 gpm for 2 hours.

The minimum aisle width shall not be less than 5 ft (1.5 m)

[30: Table 16.5.2.6]

66.16.5.2.7

Table 66.16.5.2.7 shall apply to the following:

Automatic sprinkler protection

Single- or double-row rack storage

Water-miscible ignitible (flammable or combustible) liquids with concentration greater than 50 percent by volume

Glass or plastic containers

Cartoned or uncartoned

[30:16.5.2.7]

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

Container Style and Capacity

Maximum

Storage Height

(ft)

Maximum

Ceiling

Height

(ft)

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:

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

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

66.16.5.2.8

Table 66.16.5.2.8 shall apply to the following:

Automatic sprinkler protection

Single- or double-row rack storage or palletized storage

All liquid classes except Class IA liquids [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)]

Relieving-style containers

[30:16.5.2.8]

Table 66.16.5.2.8 Design Criteria for Sprinkler Protection of Single-Row Rack, Double-Row Rack, and Palletized Storage of Ignitible (Flammable or Combustible) 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 NFPA 30:Table D.2(h)]

Sprinkler Type

Design (Number of Sprinklers @ Stated Pressure)

Sprinkler

Minimum Discharge Flow

Layout (See 66.16.5.1.10 & 66.16.6.4)

Type

Response

CLASS IB, CLASS IC, CLASS II, CLASS IIIA, CLASS IIIB LIQUIDS#[FP< 200°F (93°C) AND BP≥ 100°F (37.8°C)] RACK STORAGE with MAXIMUM 6 ft RACK DEPTH and MINIMUM 7.5 ft AISLE WIDTH

≤5, cartoned or uncartoned

14

24

Pendent ESFR K≥14.0 (OT)

12 @ 50 psi

K = 11.2

QR (OT) QR (OT)

36 gpm

7

1, 2, 3, 4, 5, 6, 7

1

14

24

Pendent ESFR K≥25.0 (OT)

12 @ 25 psi

No in-rack sprinklers required

2, 3, 4, 5, 6

2

CLASS IB, CLASS IC, CLASS II, CLASS IIIA, CLASS IIIB LIQUIDS# [FP< 200°F (93°C) AND BP≥ 100°F (37.8°C)] RACK STORAGE with MAXIMUM 9 ft RACK DEPTH 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)

31 gpm

8

1, 2, 5, 7

4

≤5, cartoned or uncartoned

25

30

Pendent ESFR K≥14.0 (OT)

12 @ 75 psi

K = 8.0

QR (OT)

44 gpm

9

1, 2, 5, 7

5

CLASS IB, CLASS IC, CLASS II, CLASS IIIA, CLASS IIIB LIQUIDS# [FP< 200°F (93°C) AND BP≥ 100°F (37.8°C)] 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.

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

#See 66.4.1 for details on classification scheme.

Notes:

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

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

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

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

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

Provide minimum 3 in. transverse flue at rack uprights.

For Class IIIB liquids [FP ≥ 200°F (93°C)], see also Table 66.16.5.2.5.

Racks can have open-mesh wire intermediate shelving on lower levels.

The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi.

[30:Table 16.5.2.8]

66.16.5.2.9

Table 66.16.5.2.9 shall apply to the following:

Automatic sprinkler protection

Palletized storage

Class IIIB liquids [FP ≥ 200°F (93°C)]

Listed and labeled rigid nonmetallic intermediate bulk containers

[30:16.5.2.9]

Table 66.16.5.2.9 Design Criteria for Sprinkler Protection of Palletized Storage of Class II and Class III Liquids [FP ≥ 100°F (37.8°C)] 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/ft2)

Area (ft2)

793

1-high

30

K≥11.2

SR (HT)

0.45

3000

1, 2

1

793

2-high

30

K≥11.2

SR (HT)

0.60

3000

1, 2, 3

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 = 0.09 m2.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

Note: See also 66.16.5.2.9.1 through 66.16.5.2.9.3.

[30: Table 16.5.2.9]

66.16.5.2.9.1

Foam-water sprinkler protection shall be permitted to be substituted for water sprinkler protection, provided the same design criteria are used. [30:16.5.2.9.1]

66.16.5.2.9.2

Rigid nonmetallic intermediate bulk containers shall be listed and labeled in accordance with UL 2368, Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids; FM Class 6020, Approval Standard for Intermediate Bulk Containers; or an equivalent test procedure. [30:16.5.2.9.2]

66.16.5.2.9.3

The sprinkler operating gauge pressure shall be a minimum 30 psi (207 kPa). [30:16.5.2.9.3]

66.16.5.2.10

Table 66.16.5.2.10 shall apply to the following:

Automatic sprinkler protection

Single- or double-row rack storage

Class II and III nonmiscible and Class II and III miscible liquids [FP ≥ 100°F (37.8°C)]

Listed and labeled rigid nonmetallic intermediate bulk containers

[30:16.5.2.10]

Table 66.16.5.2.10 Design Criteria for Sprinkler Protection of Single- and Double-Row Rack Storage of Class II and III Liquids [FP ≥ 100°F (37.8°C)] 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

1

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

Notes:

Rigid nonmetallic intermediate bulk containers are listed and labeled in accordance with UL 2368, Fire Exposure Testing of Intermediate Bulk Containers for Flammable and Combustible Liquids, or an equivalent test procedure.

Maximum rack depth is 9 ft (2.7 m).

Minimum aisle width is 8 ft (2.4 m).

30: Table 16.5.2.10]

66.16.5.2.11

Table 66.16.5.2.11 shall apply to the following:

Automatic sprinkler protection

Palletized or stacked storage

Unsaturated polyester resins (UPRs) with not more than 50 percent by weight of Class IC, Class II, or Class IIIA liquid [73°F (22.8°C) ≤ FP < 200°F (93°C)]

Metal containers

Relieving-style metal containers; nonrelieving-style allowed only up to 6 gal (23 L)

[30:16.5.2.11]

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/ft2)

Area (ft2)

>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.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). See also 66.16.5.1.9(5).

Notes:

Drums placed on open, slatted pallet, not nested, to allow pressure relief from drums on lower levels.

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 [FP < 140°F (60°C)].

Both 3/4 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]

66.16.5.2.12

Table 66.16.5.2.12 shall apply to the following:

Automatic sprinkler protection

Palletized or stacked storage

Miscible liquids with concentration of ignitible (flammable or combustible) no greater than 80 percent by volume

Glass or plastic containers

[30:16.5.2.12]

Table 66.16.5.2.12 Design Criteria for Sprinkler Protection of Palletized or Stacked Storage of Miscible Ignitible (Flammable or Combustible) 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(l) of NFPA 30]

Sprinkler

Design

Type

Response

Density (gpm/ft2)

Area (ft2)

≤ 8 oz

5

38

K ≥ 11.2

QR (OT)

0.47

2000

—

P60 and P61

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.

For definitions of abbreviations used in the Response column, see 66.16.5.1.9(4). (See also 66.16.5.1.9(5).) [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 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 ignitible (flammable or combustible) liquid storage shall be located beneath a barrier. All ignitible (flammable or combustible) 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)]

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

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

66.16.6.1.2

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:

In-rack sprinklers shall be ordinary temperature-rated quick-response sprinklers and shall have a nominal K-factor equal to or greater than 8.0. Intermediate-temperature sprinklers shall be used where ambient conditions require.

In-rack sprinklers shall be installed below each barrier level.

In-rack sprinklers shall provide a minimum operating flow of 57 gpm (220 L/min) out of each of the hydraulically most remote six sprinklers (six on one line or three on two lines) if one barrier level is provided, or out of each of the hydraulically most remote eight sprinklers (eight on one line or four on two lines on the same level), if two or more barrier levels are provided. The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi (0.69 bar).

[30:16.6.1.4]

66.16.6.1.5\*

Where adjacent rack bays are not dedicated to storage of ignitible (flammable or combustible) liquids, the barrier and in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to ignitible (flammable or combustible) 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 ignitible (flammable or combustible) liquid storage in accordance with 66.16.6.1. [30:16.6.1.5]

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:

Ceiling sprinkler protection shall be designed to protect the surrounding occupancy.

Any sprinkler type shall be acceptable.

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).

If the ignitible (flammable or combustible) 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:

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. Sprinklers shall have a nominal K-factor equal to or greater than 8.0. Intermediate-temperature sprinklers shall be used where ambient conditions require.

The ceiling sprinkler water demand and the in-rack water demand shall be balanced at their point of connection.

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 ignitible (flammable or combustible) 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)]

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)]

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:

In-rack sprinklers shall be ordinary temperature-rated quick-response sprinklers and shall have a nominal K-factor equal to or greater than 8.0. Intermediate-temperature sprinklers shall be used where ambient conditions require.

In-rack sprinklers shall be installed below each barrier level.

For containers that do not exceed 60 gal (230 L) capacity, in-rack sprinklers shall provide a minimum discharge flow of 57 gpm (220 L/min) out of each of the hydraulically most remote six sprinklers (six on one line or three on two lines) if one barrier level is provided, or out of each of the hydraulically most remote eight sprinklers (eight on one line or four on two lines on the same level), if two or more barrier levels are provided. The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi (0.69 bar).

For containers that exceed 60 gal (230 L) capacity, but do not exceed 793 gal (3000 L), in-rack sprinklers shall provide a minimum discharge flow of 57 gpm (220 L/ min) out of each of the hydraulically most remote 12 sprinklers (12 on one line or six on two lines on the same level). The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi (0.69 bar).

[30:16.6.2.4]

66.16.6.2.5

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

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 ignitible (flammable or combustible) liquid storage. In addition, adjacent racks across the aisles on each side of the ignitible (flammable or combustible) liquid storage shall be protected in accordance with Section 13.3 and NFPA 13 for the commodity stored.

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 ignitible (flammable or combustible) liquid storage. In addition, protection shall be provided for any rack across the aisle within 8 ft (2.4 m) of the perimeter of the ignitible (flammable or combustible) 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:

Ceiling sprinklers shall be designed to protect the surrounding occupancy.

Ceiling sprinkler water demand shall not be included in the hydraulic calculations for the in-rack sprinkler protection.

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.

Any sprinkler type shall be acceptable for the ceiling sprinkler protection.

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).

If the ignitible (flammable or combustible) 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:

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.

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:

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.

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 ignitible (flammable or combustible) liquid storage shall be located beneath a barrier. [30:16.6.3.1]

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

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

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

66.16.6.3.2

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:

In-rack sprinklers shall be ordinary temperature-rated, quick-response sprinklers. Sprinklers shall have a nominal K-factor equal to or greater than 8.0. An intermediate-temperature sprinkler shall be used where ambient conditions require.

In-rack sprinklers shall be installed below each barrier level.

In-rack sprinklers shall provide a minimum discharge flow of 30 gpm (110 L/min) out of each of the hydraulically most remote six sprinklers (six on one line or three on two lines), if one barrier level is provided, or out of each of the hydraulically most remote eight sprinklers (eight on one line or four on two lines on the same level), if two or more barrier levels are provided. The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 10 psi (0.69 bar).

[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 ignitible (flammable or combustible) liquids, the barrier and in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to ignitible (flammable or combustible) 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:

Ceiling sprinkler protection shall be designed to protect the surrounding occupancy.

Any sprinkler type shall be acceptable.

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).

If the ignitible (flammable or combustible) 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]

66.16.6.4 Fire Protection System Design Scheme "D."

66.16.6.4.1

In-rack sprinklers shall meet the following requirements:

In-rack sprinklers shall be installed in accordance with Figure 66.16.6.4.1(a) or Figure 66.16.6.4.1(b), whichever is applicable.

In-rack sprinklers shall be ordinary-temperature-rated, quick-response sprinklers.

In-rack sprinklers shall have a K-factor of 8.0 (115).

In-rack sprinklers shall provide a minimum discharge flow of 30 gpm (113 L/min) out of the hydraulically most remote:

Eight sprinklers on one level if one level of in-racks (8 total)

Seven sprinklers on two levels if two or more levels of in-racks (14 total)

[30:16.6.4.1]

FIGURE 66.16.6.4.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "D." [30:16.6.4.1(a)]

FIGURE 66.16.6.4.1(b) Double-Row Rack Sprinkler Layout for Design Scheme "D." [30:16.6.4.1(b)]

66.16.6.4.2

If there are adjacent bays of in-rack arrays that are not dedicated to ignitible (flammable or combustible) storage of liquids, in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to ignitible (flammable or combustible) liquid storage. [30:16.6.4.2]

66.16.6.4.3

Ceiling sprinklers shall be designed to provide a minimum density of 0.3 gpm/ft2 (12.2 mm/min) over the most remote 2000 ft2 (185 m2) using ordinary-temperature-rated, standard-response spray sprinklers, having a nominal K-factor of 8.0 or 11.2. [30:16.6.4.3]

66.16.6.4.4

The ceiling and in-rack sprinkler water demands shall be balanced at the point of connection to the water supply. [30:16.6.4.4]

66.16.6.4.5

A 500 gpm (1890L/min) hose stream allowance shall be provided. [30:16.6.4.5]

66.16.6.4.6

A 1-hour duration shall be provided for the fire protection water demand. [30:16.6.4.6]

66.16.6.5 Fire Protection System Design Scheme "E."

66.16.6.5.1

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 66.16.6.4.1 (a) or Figure 66.16.6.4.1 (b), whichever is applicable. [30:16.6.5.1]

66.16.6.5.2

All ignitible (flammable or combustible) liquid storage shall be located beneath a barrier. [30:16.6.5.2]

66.16.6.5.3

Vertical baffles shall not be installed between in-rack sprinklers. [30:16.6.5.3]

66.16.6.5.4

In-rack sprinklers shall meet the following requirements:

In-rack sprinklers shall be intermediate temperature-rated, pendent sprinklers with a nominal K-factor of 25.2, RTI of 50 (m/sec)1/2 or less, and be listed as extended coverage control mode density/area storage sprinklers.

In-rack sprinklers shall be installed below each barrier level.

The minimum in-rack sprinkler discharge pressure shall not be less than a gauge pressure of 30 psi.

Where one level of in-rack sprinklers is installed, the design shall include the four most hydraulically remote sprinklers (i.e., four on one line).

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

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

Foam-water sprinkler protection shall be permitted to be substituted for water sprinkler protection, provided the same design criteria is used.

[30:16.6.5.4]

66.16.6.5.5

If there are adjacent bays of in-rack arrays that are not dedicated to storage of ignitible (flammable or combustible) liquids, the barrier and in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to ignitible (flammable or combustible) liquid storage. [30:16.6.5.5]

66.16.6.5.6

Ceiling sprinkler demand shall not be included in the hydraulic calculations for in-rack sprinklers where standard-response sprinklers are used for ceiling-level protection. [30:16.6.5.6]

66.16.6.5.7 Water Demand

66.16.6.5.7.1

Water demand at point of supply shall be calculated separately for in-rack and ceiling sprinklers. [30:16.6.5.7.1]

66.16.6.5.7.2

Water demand shall be based on the greater demand between in-rack and ceiling sprinklers. [30:16.6.5.7.2]

66.16.6.5.8

Ceiling sprinklers shall meet the following requirements:

Ceiling sprinkler protection shall be designed to protect the surrounding occupancy.

Any sprinkler type shall be acceptable.

\*If standard spray sprinklers are used, they shall be capable of providing not less than 0.30 gpm/ft2 over 3000 ft2 (8 mm/min over 270 m2) when supplied with water.

If the ignitible (flammable or combustible) 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 NFPA 13 for the commodities stored, based on the full height of the rack.

[30:16.6.5.8]

66.16.6.5.9

A 500 gpm (1900 L/min) hose stream allowance shall be provided. [30:16.6.5.9]

66.16.6.6 Fire Protection System Design Scheme "F."

66.16.6.6.1

In-rack sprinklers shall meet the following requirements:

In-rack sprinklers shall be ordinary temperature-rated, quick-response sprinklers.

In-rack sprinklers shall have a K-factor of 8.0 (115) or 11.2 (160).

In-rack sprinklers shall be installed on 20 ft (6 m) vertical increments in accordance with Figure 66.16.6.6.1(a) and Figure 66.16.6.6.1(b) with the in-rack pattern shown in Figure 66.16.6.6.1 (b) repeated from rack face to rack face for multiple-row racks.

In-rack sprinklers shall provide a minimum discharge flow of 30 gpm (110 L/min) out of the hydraulically most remote sprinkler as follows:

Six in-rack sprinklers on one level if one level of in-racks (6 total)

Six in-rack sprinklers on two levels if two levels of in-racks (12 total)

Six in-rack sprinklers on three levels if three or more levels of in-racks (18 total)

[30:16.6.6.1]

FIGURE 66.16.6.6.1(a) Single-Row Rack Sprinkler Layout for Design Scheme "F." [30:16.6.6.1(a)]

FIGURE 66.16.6.6.1(b) Double-Row Rack Sprinkler Layout for Design Scheme "F." (Multiple row racks shall extend the same sprinkler pattern through the rack.) [30:16.6.6.1(b)]

66.16.6.6.2

If there are adjacent bays of rack storage that are not dedicated to ignitible (flammable or combustible) liquid storage, the in-rack sprinkler protection shall be extended at least 8 ft (2.4 m) beyond the area devoted to ignitible (flammable or combustible) liquid storage. [30:16.6.6.2]

66.16.6.6.3

The ceiling and in-rack sprinkler demands shall be balanced at the point of connection to the water supply. [30:16.6.6.3]

66.16.6.6.4

A 500 gpm (1890L/min) hose stream allowance shall be provided. [30:16.6.6.4]

66.16.6.6.5

A 1-hour duration shall be provided for the fire protection water demand. [30:16.6.6.5]

66.16.6.7 In-Rack Sprinkler Layouts for Table 66.16.5.2.8

Where indicated in Table 66.16.5.2.8 of this Code and Table 16.5.2.16 of NFPA 30, in-rack sprinklers shall be installed as follows:

Where Layout 7 is required, in-rack sprinklers shall be installed in accordance with Figure 66.16.6.7(a),

Where Layout 8 is required, in-rack sprinklers shall be installed in accordance with Figure 66.16.6.7(b) or Figure 66.16.6.7(c).

Where Layout 9 is required, in-rack sprinklers shall be installed in accordance with Figure 66.16.6.7(d), or Figure 66.16.6.7(e), whichever is applicable.

[30:16.6.7]

FIGURE 66.16.6.7(a) Double-Row Rack Sprinkler Layout 7. [30: Figure 16.6.7(a)]

FIGURE 66.16.6.7(b) Double-Row Rack Sprinkler Layout 8 — Option #1. [30: Figure 16.6.7(b)]

FIGURE 66.16.6.7(c) Double-Row Rack Sprinkler Layout 8 — Option #2. [30: Figure 16.6.7(c)]

FIGURE 66.16.6.7(d) Double-Row Rack Sprinkler Layout 9 — Option #1. [30: Figure 16.6.7(d)]

FIGURE 66.16.6.7(e) Double-Row Rack Sprinkler Layout 9 — Option #2. [30: Figure 16.6.7(e)]

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]

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

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 ignitible (flammable or combustible) 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 section shall not prohibit the use of movable tanks for the dispensing of ignitible (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

Ignitible (flammable or combustible) 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 ignitible (flammable or combustible) liquids being processed, operating temperatures and pressures, and the capability to control any ignitible (flammable or combustible) 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 [FP ≥ 100°F (37.8°C)] heated at or above their flash point shall follow the requirements for Class I liquids [FP < 100°F (37.8°C)], unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. (See 66.6.4.1.3 and A.66.6.4.1.3.) [30:17.3.6]

66.17.3.7

When a process heats an ignitible (flammable or combustible) liquid to a temperature at or above its flashpoint, the following shall apply:

The process vessel shall be closed to the room in which it is located and vented to the outside of the building.

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.

The process vessel shall be equipped with an excess temperature control set to limit excessive heating of the ignitible (flammable or combustible) liquid and the subsequent release of vapors.

If a heat transfer medium is used to heat the ignitible (flammable or combustible) liquid and the heat transfer fluid can heat the ignitible (flammable or combustible) 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

Ignitible (flammable or combustible) liquidprocessing 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 determined by one of the following:

In accordance with Table 66.17.4.3

In accordance with an engineering evaluation of the process, followed by application of sound fire protection and process engineering principles

[30:17.4.3]

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

25

50

100

5

25

50

100

276 to 750

10

25

50

100

5

25

50

100

751 to 12,000

15

25

50

100

5

25

50

100

12,001 to 30,000

20

30

50

100

5

25

50

100

30,001 to 50,000

30

45

75

120

10

25

50

100

50,001 to 100,000

50

75

125

200

15

25

50

100

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]

66.17.4.3.1

Processing vessels used solely to process stable Class IIIB liquids [FP ≥ 200°F (93°C)] shall be located in accordance with Table 66.22.4.1.6. [30:17.4.3.1]

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\*

Ignitible (flammable or combustible) 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:

25 ft (7.6 m) clear spacing

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 ignitible (flammable or combustible) 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 ignitible (flammable or combustible) 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]

Table 66.17.6.1 Minimum Separation Distances for Buildings or Structures Used for Ignitible (Flammable or Combustible) Liquid Handling and Operations

Minimum Separation Distance (ft)

Liquid Class

Minimum Type of Construction\*

To Street, Alley, or Public Way

To Adjacent Property Line that Is or Can Be Built Upon

Class I liquids [FP < 100°F (37.8°C)]; 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 liquids

[100°F (37.8°C)

≤ FP < 140°F (60°C)]

II (111)

5

10

II (000)

5

25

Class III

[FP ≥ 140°F (60°C)]

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. [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.

66.17.6.2

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 [FP ≥ 200°F (93°C)] 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 ignitible (flammable or combustible) liquids where the quantities of ignitible (flammable or combustible) liquids do not exceed 360 gal (1360 L) of Class I and Class II liquids [FP < 140°F (60°C)] and 720 gal (2725 L) of Class IIIA liquids [140°F (60°C) ≤ FP < 200°F (93°C)] shall be permitted to be constructed of combustible construction, subject to the approval of the AHJ. [30:17.6.6]

66.17.6.7

Buildings or structures used for processing or handling of ignitible (flammable or combustible) 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 ignitible (flammable or combustible) liquids that could result in a fire capable of causing substantial property damage shall be protected by one or more of the following:

Drainage to a safe location to prevent ignitible (flammable or combustible) liquids from accumulating under vessels or equipment or around load-bearing supports

Fire-resistive construction

Fire-resistant protective coatings or systems

Water spray systems designed and installed in accordance with NFPA 15

Other alternate means acceptable to the AHJ

[30:17.6.8]

66.17.6.9

Class I liquids [FP < 100°F (37.8°C)] shall not be handled or used in basements. [30:17.6.9]

66.17.6.9.1

Where Class I liquids [FP < 100°F (37.8°C)] 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 ignitible (flammable or combustible) 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 liquids [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)], unstable liquids, or other liquids intentionally heated to or above their BP 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. [30:17.6.13]

66.17.6.13.1

The damage-limiting construction design shall be both of the following: (See A.66.9.15.1.) [30:17.6.13.1]

In accordance with recognized standards

Acceptable to the AHJ

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 (i.e., 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\*

A facility shall be designed and operated to prevent the discharge of ignitible (flammable or combustible) liquids to public waterways, public sewers, or adjoining property. [30:17.10.1]

66.17.10.2

Emergency drainage systems shall be provided to direct ignitible (flammable or combustible) liquid leakage and fire protection water to a safe location. [30:17.10.2]

66.17.10.3

Emergency drainage systems, if connected to public sewers or discharged into public waterways, shall be equipped with traps or separators. [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 in accordance with NFPA 30.

66.17.11.2

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

66.17.11.3

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

66.17.11.4

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]

66.17.11.5\*

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

66.17.11.6

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

66.17.11.7

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]

66.17.11.8

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 [FP < 100°F (37.8°C)] 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 ignitible (flammable or combustible) 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 ignitible (flammable or 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 ignitible (flammable or combustible) liquids shall be reviewed to ensure that fire and explosion hazards resulting from loss of containment of ignitible (flammable or combustible) liquids are provided with corresponding fire prevention and emergency action plans. [30:17.15.2]

66.17.15.2.1

Operations where ignitible (flammable or combustible) liquids are used solely for on-site consumption as fuels shall not be required to comply with 66.17.15.2. [30:17.15.2.1]

66.17.15.2.2

Operations where Class II or Class III liquids [FP ≥ 100°F (37.8°C)] are stored in atmospheric tanks or transferred at temperatures below their flash points shall not be required to comply with 66.17.15.2. [30:17.15.2.2]

66.17.15.2.3

Mercantile occupancies, crude petroleum exploration, drillings, and well servicing operations, and normally unoccupied facilities in remote locations shall not be required to comply with 66.17.15.2. [30:17.15.2.3]

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:

Analysis of the fire and explosion hazards of the operation

Analysis of emergency relief from process vessels, taking into consideration the properties of the materials used and the fire-protection and control measures taken

Analysis of applicable facility design requirements in 66.17.3 through 66.17.4

Analysis of applicable requirements in Sections 66.18, 66.19, 66.28, and 66.29 for liquid handling, transfer, and use

Analysis of local conditions, such as exposure to and from adjacent properties and exposure to floods, earthquakes, and windstorms

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:

Procedures to be followed in case of fire or release of ignitible (flammable or combustible) liquids or vapors, such as sounding the alarm, notifying the fire department, evacuating personnel, and controlling and extinguishing the fire

Procedures and schedules for conducting drills of these procedures

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

Procedures for maintenance of the following:

Fire protection equipment and systems

Drainage and containment systems

Ventilation equipment and systems

Procedures for shutting down or isolating equipment to reduce, control, or stop the release of ignitible (flammable or combustible) liquid or vapors, including assigning personnel responsible for maintaining critical plant functions or shutdown of plant processes and safe startup following isolation or shutdown

Alternative 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:

When changes occur in the materials in process

When changes occur in process equipment

When changes occur in process control

When changes occur in operating procedures or assignments

[30:17.15.5]

66.18 Dispensing, Handling, Transfer, and Use of Ignitible (Flammable or Combustible) Liquids

66.18.1 Scope

This section applies where ignitible (flammable or combustible) 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 [FP ≥ 100°F (37.8°C)] heated at or above their FP shall follow the requirements for Class I liquids [FP < 100°F (37.8°C)], unless an engineering evaluation conducted in accordance with Section 66.6 justifies following the requirements for some other liquid class. (See 66.6.4.1.3 and A.66.6.4.1.3.) [30:18.3]

66.18.4 Dispensing, Handling, Transfer, and Use

66.18.4.1

Class I liquids [FP < 100°F (37.8°C)] shall be kept in closed tanks or containers when not actually in use. Class II and Class III liquids [FP ≥ 100°F (37.8°C)] shall be kept in closed tanks or containers when not actually in use when the ambient or process temperature is at or above their FP. [30:18.4.1]

66.18.4.2

Where ignitible (flammable or combustible) 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 [FP < 100°F (37.8°C)] 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 ignitible (flammable or combustible) 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:

The vessels, containers, tanks, and piping systems shall be designed for such pressurized transfer and shall be capable of withstanding the anticipated operating pressure.

Safety and operating controls, including pressure-relief devices, shall be provided to prevent overpressure of any part of the system.

Only inert gas shall be used to transfer Class I liquids [FP < 100°F (37.8°C)]. Only inert gas shall be used to transfer Class II and Class III liquids [FP ≥ 100°F (37.8°C)] that are heated above their FP.

[30:18.4.4]

66.18.4.4.1

Dispensing of Class I liquids [FP < 100°F (37.8°C)] from a container by means of air shall be permitted under the following conditions:

The pressure shall be generated by means of a listed hand-operated device.

Pressure shall not exceed a gauge pressure of 6 psi (41 kPa) and pressure relief shall be provided.

The container shall not exceed 119 gal (450 L) and shall be capable of withstanding the maximum pressure generated by the device.

The device shall be bonded and grounded or shall be demonstrated as not being capable of generating a static charge under any operating condition.

The device shall be constructed of material compatible with the ignitible (flammable or combustible) liquid dispensed.

[30:18.4.4.1]

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

Approved hose shall be permitted to be used at transfer stations. [30:18.4.7]

66.18.4.8\*

The staging of ignitible (flammable or combustible) liquids in containers, intermediate bulk containers, and portable tanks shall be limited to the following:

Containers, intermediate bulk containers, and portable tanks that are in use

Containers, intermediate bulk containers, and portable tanks that were filled during a single shift

Containers, intermediate bulk containers, and portable tanks needed to supply the process for one continuous 24-hour period

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 [FP < 200°F (93°C)] used in a process and staged in the process area shall not be filled in the process area. [30:18.4.9]

66.18.4.9.1

Intermediate bulk containers and portable tanks that meet the requirements of Section 66.9 shall be permitted to be filled in the process area. [30:18.4.9.1]

66.18.4.9.2

Intermediate products that are manufactured in the process area shall be permitted to be filled in the process area. [30:18.4.9.2]

66.18.5 Incidental Operations

66.18.5.1\*

This section shall apply to areas where the use, handling, and storage of ignitible (flammable or combustible) liquids is only a limited activity to the established occupancy classification. [30:18.5.1]

66.18.5.2

Class I liquids [FP < 100°F (37.8°C)] or Class II and Class III liquids [FP ≥ 100°F (37.8°C)] that are heated up to or above their FP shall be drawn from or transferred into vessels, containers, or portable tanks as follows:

From original shipping containers with a capacity of 5.3 gal (20 L) or less

From safety cans

Through a closed piping system

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

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 ignitible (flammable or combustible) liquid transfer, means shall be provided to deactivate liquid transfer in the event of an ignitible (flammable or combustible) liquid spill or fire. [30:18.5.2.3]

66.18.5.3

Storage of ignitible (flammable or combustible) 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 maximum allowable quantities (MAQs) of ignitible (flammable or combustible) liquids in containers in use in incidental operations in a control area shall not exceed the greater of the following:

\* The amount required to supply incidental operations for one continuous 24-hour period, provided the hazard analysis required in Section 66.6 accounts for these quantities

The aggregate sum of the quantities provided in Table 66.18.5.4

Table 66.18.5.4 MAQ of Liquids Per Control Area for Incidental Operations

Liquid Class(es)#

Open Use

Use — Closed Containers

gal

L

gal

L

IA 10 38 30 115

IB and IC 30 115 120 460

II 30 115 120 460

IIIA 80 300 330 1,265

IIIB 3,300 12,650 13,200 50,600

#See 66.4.1 for details on the classification scheme.

Notes:

Quantities are permitted to be increased 100 percent where stored in approved Class I liquids [FP < 100°F (37.8°C)] storage cabinets or in safety cans. Where note (2) also applies, the increase for both notes is permitted to be applied accumulatively.

Quantities are permitted to be increased 100 percent in buildings equipped throughout with an approved 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.

[30:18.5.4]

66.18.5.4.1

Where the quantities of ignitible (flammable or combustible) liquids in incidental operations are governed by 66.18.5.4(2), the aggregate quantity of liquids in storage and in use shall not exceed the maximum allowable quantity per control area in Section 66.9. [30:18.5.4.1]

66.18.5.4.2

Control areas shall be in accordance with Section 66.9. [30:18.5.4.2]

66.18.5.5

Where quantities of ignitible (flammable or combustible) 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 ignitible (flammable or combustible) liquids are transferred from one tank or container to another container shall be provided with the following:

Separation from other operations where potential ignition sources are present by distance or by fire-resistant construction

Drainage or other means to control spills

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 Ventilation Type

66.18.6.1.1

Areas where dispensing is conducted shall be provided with either a gravity system or a continuous mechanical exhaust ventilation system. [30:18.6.1.1]

66.18.6.1.2

Mechanical ventilation shall be used if Class I liquids [FP < 100°F (37.8°C)] are dispensed within the room. [30:18.6.1.2]

66.18.6.2

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. [30:18.6.2]

66.18.6.3

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. [30:18.6.3]

66.18.6.4\*

Exhaust ventilation discharge shall be to a safe location outside the building. [30:18.6.4]

66.18.6.4.1

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. [30:18.6.4.1]

66.18.6.5

If ducts are used, they shall not be used for any other purpose and shall comply with NFPA 91. [30:18.6.5]

66.18.6.5.1

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. [30:18.6.5.1]

66.18.6.5.2

For gravity systems, the make-up air shall be supplied from outside the building. [30:18.6.5.2]

66.18.6.6

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). [30:18.6.6]

66.18.6.6.1

The mechanical ventilation system for dispensing areas shall be designed to provide an alarm notification upon loss of airflow. [30:18.6.6.1]

66.18.6.6.2

Dispensing operations shall be stopped upon loss or failure of the ventilation. [30:18.6.6.2]

66.18.6.7

Mechanical ventilation systems shall be in accordance with NFPA 30.

66.19 Specific Operations

66.19.1 Scope

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

66.19.2 Definitions Specific to Section 66.19

66.19.2.1\* Cooking Oil

Where used in this section, cooking oil shall be classified as a Class IIIB liquid [FP ≥ 200°F (93°C)]. This definition shall apply to both fresh, or new, cooking oil and waste, or used, cooking oil. [30:19.2.1]

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 or NFPA 85 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 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:

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

Marine and automotive service station systems that comply with Chapter 30 and NFPA 30A

[30:19.5.1.2]

66.19.5.2 Overpressure Protection and Vacuum Protection

66.19.5.2.1

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. [30:19.5.2.1]

66.19.5.2.2

Venting of tanks shall comply with 66.21.4.3. [30:19.5.2.2]

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 ignitible 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 ignitible (flammable or combustible) liquid. [30:19.5.4.1]

66.19.5.4.2

Vapor recovery and vapor processing systems that are not designed to handle ignitible (flammable or combustible) liquid shall be provided with a means to eliminate any ignitible (flammable or combustible) 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 ignitible (flammable or combustible) 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 ignitible (flammable or combustible) 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 21.7.1 of NFPA 30. [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 66.28.11.1.8.1 and 23.13.7 of NFPA 30. [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 [FP < 200°F (93°C)]. [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 UL 2208, 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]

66.19.7 Cooking Oil Storage Tank Systems in Commercial Kitchens

66.19.7.1 Scope

66.19.7.1.1

This section shall apply to storage tank systems for cooking oil, as defined in 66.19.2.1, located in commercial kitchens where tank capacities are greater than 60 gal (227 L). [30:19.7.1.1]

66.19.7.1.2

This section shall apply to both fresh and waste cooking oil storage tank systems. [30:19.7.1.2]

66.19.7.1.3\*

Where there are conflicts between the requirements of this section and requirements of other sections of this Code, the requirements of this section shall take precedence. [30:19.7.1.3]

66.19.7.2 Design and Construction of Cooking Oil Storage Tanks

66.19.7.2.1 Materials of Construction

Tanks shall be of metallic or nonmetallic construction. [30:19.7.2.1]

66.19.7.2.1.1

Tanks and their appurtenances shall be constructed of materials compatible with cooking oil. [30:19.7.2.1.1]

66.19.7.2.1.2\*

For tanks storing waste cooking oil, the tanks and their appurtenances shall be constructed of materials compatible with cooking oil at a minimum temperature of 140°F (60°C) continuous and 235°F (113°C) intermittent. [30:19.7.2.1.2]

66.19.7.2.2 Design Standards

66.19.7.2.2.1\*

Metallic cooking oil storage tanks shall be listed in accordance with UL 142, Steel Aboveground Tanks for Flammable and Combustible Liquids, or UL 80, Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids. [30:19.7.2.2.1]

66.19.7.2.2.2

Nonmetallic cooking oil storage tanks shall be listed in accordance with UL 2152, Outline of Investigation for Special Purpose Nonmetallic Containers and Tanks for Specific Combustible or Noncombustible Liquids, and shall not exceed 200 gal (757 L) per tank. [30:19.7.2.2.2]

66.19.7.2.3 Normal Venting

66.19.7.2.3.1

The normal vent(s) shall be located above the maximum normal liquid level. [30:19.7.2.3.1]

66.19.7.2.3.2

The normal vent shall be at least as large as the largest filling or withdrawal connection. [30:19.7.2.3.2]

66.19.7.2.3.3

Where used, normal vents, including vent piping, that are smaller than 1.25 in. (32 mm) nominal inside diameter shall be tested to verify that internal tank pressures will remain below a gauge pressure of 0.5 psi (3.5 kPa) under maximum expected flow rates for tank filling and withdrawal. These tests shall be permitted to be conducted by a qualified outside agency or by the manufacturer, if certified by a qualified observer. [30:19.7.2.3.3]

66.19.7.2.3.4\*

Normal vents shall be permitted to discharge inside the building. [30:19.7.2.3.4]

66.19.7.2.4 Emergency Venting

66.19.7.2.4.1

Cooking oil storage tanks shall be provided with emergency relief venting in accordance with Section 66.22. [30:19.7.2.4.1]

66.19.7.2.4.2\*

For nonmetallic cooking oil storage tanks, emergency relief venting by form of construction shall be permitted. This shall include the low melting point of the material of construction of the tank. [30:19.7.2.4.2]

66.19.7.2.4.3

For metallic cooking oil storage tanks, emergency relief venting by form of construction shall be prohibited. [30:19.7.2.4.3]

66.19.7.2.4.4

Emergency vents shall be permitted to discharge inside the building. [30:19.7.2.4.4]

66.19.7.2.5\* Prevention of Overfilling of Cooking Oil Storage Tanks

Every cooking oil storage tank shall be provided with means to prevent an accidental overfill. Such means shall be automatic and fail-safe in nature. [30:19.7.2.5]

66.19.7.2.6 Tank Heating

66.19.7.2.6.1\*

Electrical equipment used for heating cooking oil shall be listed to UL 499, Electrical Heating Appliances, and shall comply with NFPA 70. [30:19.7.2.6.1]

66.19.7.2.6.2\*

Electrical equipment used for heating cooking oil shall comply with NFPA 70 and shall be equipped with automatic means to limit the temperature of the oil to less than 140°F (60°C). [30:19.7.2.6.2]

66.19.7.2.6.3

Use of electrical immersion heaters in nonmetallic tanks shall be prohibited. [30:19.7.2.6.3]

66.19.7.3 Tank Installation and Testing

66.19.7.3.1 Location of Cooking Oil Storage Tanks

Tanks shall be installed in locations appropriate for storage of foodstuffs or inventory and shall not be installed in areas designated as cooking areas. [30:19.7.3.1]

66.19.7.3.1.1\*

Tanks shall be spaced at least 3 ft (0.9 m) away from any cooking appliance or any surface heated to a temperature above 140°F (60°C) continuous and at least 6 ft (1.8 m) away from any open flame. [30:19.7.3.1.1]

66.19.7.3.1.2\*

Tanks shall not be installed under commercial kitchen ventilation hoods. [30:19.7.3.1.2]

66.19.7.3.1.3

Tanks shall not be required to be separated from one another. [30:19.7.3.1.3]

66.19.7.3.2 Foundations for and Anchoring of Cooking Oil Storage Tanks

66.19.7.3.2.1\*

Tanks shall be secured to prevent the tank from tipping over. [30:19.7.3.2.1]

66.19.7.3.2.2

In areas subject to earthquakes, tank supports, the foundation, and anchoring shall meet the requirements of the applicable building code for the specific seismic zone. Engineering evaluation by a qualified, impartial outside agency shall be an acceptable method of meeting this requirement. [30:19.7.3.2.2]

66.19.7.3.2.3

Where a tank is located in areas subject to flooding, the method for anchoring the tank shall be capable of preventing the tank, either full or empty, from floating during a rise in water level up to the established maximum flood stage. Engineering evaluation by a qualified, impartial outside agency shall be an acceptable method of meeting this requirement. [30:19.7.3.2.3]

66.19.7.3.3 Tank Openings Other Than Vents

66.19.7.3.3.1

Each connection to the tank below the normal liquid level through which liquid can normally flow shall be provided with an internal or external valve located as close as possible to the shell of the tank, in accordance with Section 66.22. [30:19.7.3.3.1]

66.19.7.3.3.2\*

Connections to the tank above the normal liquid level through which liquid can normally flow shall not be required to have a valve, provided there exists a liquid-tight closure at the opposite end of the line. The liquidtight closure shall be in the form of a valve, a plug, or a coupling or fitting with positive shutoff. [30:19.7.3.3.2]

66.19.7.3.4 Field Testing

66.19.7.3.4.1\*

As an alternate method to the testing requirements in Section 66.21, cooking oil storage tanks shall be tested for leaks at the time of installation by filling the tank with cooking oil to a liquid level above the highest tank seam or connection within the normal liquid level. Before the tank is placed in service, all leaks shall be corrected in an approved manner or the tank shall be replaced. [30:19.7.3.4.1]

66.19.7.3.4.2

An approved listing mark on a cooking oil storage tank shall be considered to be evidence of compliance with tank testing requirements. [30:19.7.3.4.2]

66.19.7.4 Fire Protection for Cooking Oil Storage Tanks

66.19.7.4.1 Identification for Emergency Responders

A sign or marking that meets the requirements of NFPA 704 or another approved system, shall be applied to each cooking oil storage tank in accordance with Section 66.21. Additional signage shall be applied to each tank identifying the contents of the tank as cooking oil, either fresh or waste. [30:19.7.4.1]

66.19.7.4.2\*

In areas where tanks are located, no additional ventilation shall be required beyond that necessary for comfort ventilation, provided that all cooking equipment is equipped with exhaust systems in accordance with NFPA 96. [30:19.7.4.2]

66.19.7.4.3

If ventilation is not provided as specified in 66.19.7.4.2, then the tank shall be vented to another room inside the building that meets these requirements, or the tank shall be vented to the outside of the building. [30:19.7.4.3]

66.19.7.5 Transfer Lines

66.19.7.5.1\* Design and Construction of Fresh Cooking Oil Transfer Lines

Transfer lines for fresh cooking oil shall be permitted to be constructed of metallic or nonmetallic materials that are compatible with cooking oil and food products. Nonmetallic transfer lines shall also meet the following requirements:

Transfer lines in pressure applications shall be rated for a working gauge pressure of 100 psi (689 kPa) at 70°F (21°C), or the maximum output pressure of the transfer pump, whichever is higher.

Transfer lines in suction applications shall be rated for full vacuum at 70°F (21°C).

Transfer lines shall be rated for temperatures up to 120°F (49°C) continuous.

The maximum nominal inside diameter shall be no larger than 1.25 in. (32 mm).

Leakage shall be controlled through the use of check valves or antisiphon valves at points where the lines connect to the fresh oil tank.

[30:19.7.5.1]

66.19.7.5.2\* Design and Construction of Waste Cooking Oil Transfer Lines

Waste cooking oil transfer lines shall be permitted to be constructed of metallic or nonmetallic materials that are compatible with cooking oil. [30:19.7.5.2]

66.19.7.5.2.1

Transfer lines shall be rated for use with cooking oil at elevated temperatures of 275°F (135°C) continuous and 350°F (177°C) intermittent. [30:19.7.5.2.1]

66.19.7.5.2.2

Nonmetallic transfer lines shall be rated for working pressures up to 250 psi (1724 kPa) at 275°F (135°C). [30:19.7.5.2.2]

66.19.7.5.3 Flow Control

Cooking oil transfer lines shall be equipped with means to prevent unintended transfer or dispensing of cooking oil. These means shall be permitted to be in the form of momentary control switches, valves, check valves, antisiphon valves, plugs, couplings, fittings, or any combination thereof that are fail-safe in nature. [30:19.7.5.3]

66.19.7.5.4 Pressure Control

Pumping systems used to transfer cooking oil shall have means to prevent overpressurization of transfer lines. These means shall be in the form of relief valves, bypass valves, pressure sensor devices, or the pressure limitation of the pump itself. [30:19.7.5.4]

66.19.7.5.5 Installation of Cooking Oil Transfer Lines in Plenum-Rated Spaces

Cooking oil transfer lines installed in plenum-rated spaces shall be enclosed in noncombustible raceways or enclosures, or shall be covered with a material listed and labeled for installation within a plenum. [30:19.7.5.5]

66.19.7.5.6 Testing of Cooking Oil Transfer Lines

Cooking oil transfer lines shall be tested after installation and prior to use. Testing shall be with cooking oil at the normal operating pressures. Any leaks discovered in transfer lines as a result of testing shall be repaired or the transfer lines replaced prior to placing the transfer lines into service. [30:19.7.5.6]

66.20 Reserved

66.21 Storage of Ignitible (Flammable or Combustible) Liquids in Tanks — Requirements for All Storage Tanks

66.21.1 Scope

This section shall apply to the following:

The storage of liquids, as defined in 3.3.178.1 and 3.3.178.2 and Section 66.4, in fixed tanks that exceed 60 gal (230 L) capacity

The storage of liquids in portable tanks that exceed 660 gal (2500 L) capacity

The storage of liquids in intermediate bulk containers that exceed 793 gal (3000 L) capacity

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 following definitions shall apply. [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 [FP ≥ 100°F (37.8°C)] heated at or above their FP shall follow the requirements for Class I liquids [FP < 100°F (37.8°C)], 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 in accordance with 66.21.4.1.1 through 66.21.4.1.4, or of combustible materials in accordance with 66.21.4.1.1 and 66.21.4.1.3 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

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. [30:21.4.1.2]

66.21.4.1.3

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. [30:21.4.1.3]

66.21.4.1.4

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). [30:21.4.1.4]

66.21.4.1.5 Combustible Materials

66.21.4.1.5.1

Tanks shall be permitted to be constructed of combustible materials where approved. [30:21.4.1.5.1]

66.21.4.1.5.2

Tanks constructed of combustible materials shall be limited to any of the following:

Underground installation

Use where required by the properties of the ignitible (flammable or combustible) liquid stored

Aboveground storage of Class IIIB liquids [FP ≥ 200°F (93°C)] in areas not exposed to a spill or leak of Class I or Class II liquids [FP < 140°F (60°C)]

Storage of Class IIIB liquids [FP ≥ 200°F (93°C)] inside a building protected by an approved automatic fire-extinguishing system

[30:21.4.1.5.2]

66.21.4.1.5.3\*

Use of electrical immersion heaters in nonmetallic tanks shall be prohibited. [30:21.4.1.5.3]

66.21.4.1.5.4

Exposed combustible components of nonmetallic tanks shall be spaced at least 3 ft (0.9 m) away from any surface heated to a temperature above 140°F (60°C) and at least 6 ft (1.8 m) away from any open flame. [30:21.4.1.5.4]

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 designed and constructed in accordance with any of the following recognized engineering standards shall be deemed as meeting the requirements of 66.21.4.2.1:

API Specification 12B, Bolted Tanks for Storage of Production Liquids

API Specification 12D, Field Welded Tanks for Storage of Production Liquids

API Specification 12F, Shop Welded Tanks for Storage of Production Liquids

API Standard 650, Welded Tanks for Oil Storage

UL 58, Steel Underground Tanks for Flammable and Combustible Liquids

UL 80, Steel Tanks for Oil Burner Fuels and Other Combustible Liquids

UL 142, Steel Aboveground Tanks for Flammable and Combustible Liquids

UL 142A, Safety for Special Purpose Aboveground Tanks for Specific Flammable or Combustible Liquids

UL 1316, Glass-Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures

UL 2080, Fire Resistant Tanks for Flammable and Combustible Liquids

UL 2085, Protected Aboveground Tanks for Flammable and Combustible. Liquids

UL 2258, Aboveground Nonmetallic Tanks for Fuel Oil and Other Combustible Liquids, where used in accordance with the provisions in 66.21.4.1.5

[30:21.4.2.1.1]

66.21.4.2.1.2

Tanks shall be limited to operation from atmospheric to a gauge pressure of 0.5 psi (3.5 kPa) unless permitted in 66.21.4.2.1.3 through 66.21.4.2.1.5. [30:21.4.2.1.2]

66.21.4.2.1.3

Atmospheric tanks designed and constructed in accordance with Appendix F of API Standard 650, Welded Tanks for Oil Storage, shall be permitted to operate at pressures from atmospheric to a gauge pressure of 2.5 psi (17.2 kPa). [30:21.4.2.1.3]

66.21.4.2.1.3.1

Tanks shall be anchored as required by Annex F of API Standard 650, Welded Tanks for Oil Storage. [30:21.4.2.1.3.1]

66.21.4.2.1.4

Atmospheric tanks that are not designed and constructed in accordance with Appendix F of API Standard 650, Welded 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. [30:21.4.2.1.4]

66.21.4.2.1.5

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. [30:21.4.2.1.5]

66.21.4.2.1.6

Low-pressure tanks and pressure vessels shall be permitted to be used as atmospheric tanks. [30:21.4.2.1.6]

66.21.4.2.1.7

Atmospheric tanks shall not be used to store an ignitible (flammable or combustible) liquid at a temperature at or above its boiling point. [30:21.4.2.1.7]

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:

API 620, Design and Construction of Large, Welded, Low-Pressure Storage Tanks

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:

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.

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 Tank

66.21.4.3.1 Storage Tank Venting

66.21.4.3.1.1\*

Storage tanks shall be vented to prevent the development of vacuum or pressure that can distort the tank or exceed the rated design vacuum or rated design pressure of the tank when the tank is filled or emptied or because of atmospheric temperature changes. [30:21.4.3.1.1]

66.21.4.3.1.2

Normal vents shall be located above the maximum normal liquid level. [30:21.4.3.1.2]

66.21.4.3.2\*

Atmospheric storage tanks shall be vented so as not to exceed the tank's design operating pressure or a gauge pressure of 1.0 psi (6.9 kPa), whichever is less, and shall be vented to prevent the development of vacuum. [30:21.4.3.2]

66.21.4.3.3

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. [30:21.4.3.3]

66.21.4.3.4

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. [30:21.4.3.4]

66.21.4.3.5

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 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. [30:21.4.3.5]

66.21.4.3.6

Tanks and pressure vessels that store Class IA liquids [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)] shall be equipped with venting devices that are closed, except when venting under pressure or vacuum conditions. [30:21.4.3.6]

66.21.4.3.7

Tanks and pressure vessels that store Class IB and Class IC liquids [FP < 100°F (37.8°C) and BP ≥ 100°F (37.8°C)] 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. [30:21.4.3.7]

66.21.4.3.8

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 [FP < 73°F (22.8°C) and BP < 100°F (37.8°C)] shall be permitted to have open vents. [30:21.4.3.8]

66.21.4.3.9\*

Flame arresters or venting devices required in 66.21.4.3.6 and 66.21.4.3.7 shall be permitted to be omitted on tanks that store Class IB or Class IC liquids [FP < 100°F (37.8°C) and BP ≥ 100°F (37.8°C)] where conditions are such that their use can, in case of obstruction, result in damage to the tank. [30:21.4.3.9]

66.21.4.3.10

Piping for normal vents shall be designed in accordance with Section 66.27. [30:21.4.3.10]

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 ignitible (flammable or combustible) 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

66.21.5.1.1

All tanks, whether shop-built or field-erected, shall be in accordance with NFPA 30.

66.21.5.1.2

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 standards 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]

66.21.5.2 Tightness Testing

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:

For aboveground tanks, the tank is set on the site at the location where it is intended to be installed.

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 liquids or vapors. (See Section 27.7 of NFPA 30 for testing pressure piping.) [30:21.5.2.2]

66.21.5.2.3

For field-erected tanks, the tests required by 66.21.5.1.2 or 21.5.1.2 of NFPA 30 shall be permitted to be considered the test for tank tightness. [30:21.5.2.3]

66.21.5.2.4

Horizontal shop-fabricated aboveground tanks shall be tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 3 psi (20 kPa) and not more than a gauge pressure of 5 psi (35 kPa). [30:21.5.2.4]

66.21.5.2.5

Vertical shop-fabricated aboveground tanks shall be tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 1.5 psi (10 kPa) and not more than a gauge pressure of 2.5 psi (17 kPa). [30:21.5.2.5]

66.21.5.2.6

Single-wall underground tanks and piping, before being covered, enclosed, or placed in use, shall be tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 3 psi (20 kPa) and not more than a gauge pressure of 5 psi (35 kPa). [30:21.5.2.6]

66.21.5.2.7\*

Underground secondary containment tanks and horizontal aboveground secondary containment tanks shall have the primary (inner) tank tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 3 psi (20 kPa) and not more than a gauge pressure of 5 psi (35 kPa). [30:21.5.2.7]

66.21.5.2.7.1

The interstitial space of such tanks shall be tested either hydrostatically or with air pressure at a gauge pressure of 3 to 5 psi (20 to 35 kPa), by vacuum at 5.3 in. Hg (18 kPa), or in accordance with the tank's listing or the manufacturer's instructions. These limits shall not be exceeded. [30:21.5.2.7.1]

66.21.5.2.7.2

The pressure or vacuum shall be held for not less than 1 hour or for the duration specified in the listing procedures for the tank. [30:21.5.2.7.2]

66.21.5.2.8

Vertical aboveground secondary containment-type tanks shall have their primary (inner) tank tested for tightness either hydrostatically or with air pressure at not less than a gauge pressure of 1.5 psi (10 kPa) and not more than a gauge pressure of 2.5 psi (17 kPa). [30:21.5.2.8]

66.21.5.2.8.1

The interstitial space of such tanks shall be tested either hydrostatically or with air pressure at a gauge pressure of 1.5 to 2.5 psi (10 to 17 kPa), by vacuum at 5.3 in. Hg (18 kPa), or in accordance with the tank's listing or manufacturer's instructions. These limits shall not be exceeded. [30:21.5.2.8.1]

66.21.5.2.8.2

The pressure or vacuum shall be held for not less than 1 hour or for the duration specified in the listing procedures for the tank. [30:21.5.2.8.2]

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

Management techniques and fire control methods shall be in accordance with NFPA 30.

66.21.6.2 Emergency Planning and Training

66.21.6.2.1

Emergency procedures shall be kept available in an operating area. The procedures shall be reviewed and updated in accordance with 66.6.4.2. [30:21.6.5.5]

66.21.6.2.2

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]

66.21.6.3 Inspection and Maintenance of Fire Protection and Emergency Response Equipment

66.21.6.3.1\*

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]

66.21.6.3.2

Maintenance and operating procedures and practices at tank storage facilities shall be established and implemented to control leakage and prevent spillage and release of ignitible (flammable or combustible) liquids. [30:21.6.6.2]

66.21.6.3.3

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

66.21.6.3.4

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]

66.21.6.3.5

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]

66.21.6.3.6

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

The procedures or equipment to prevent the overfilling of storage tanks shall comply with NFPA 30.

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 or another approved system, shall be applied to storage tanks containing ignitible (flammable or combustible) 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 Tank Loading

66.21.7.3.1.1

The filling of a tank to be protected by water or product 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 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 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\* 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 [FP < 100°F (37.8°C)] storage tanks for indication of leakage from the tanks or associated piping. [30:21.7.5]

66.21.8 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 Ignitible (Flammable or Combustible) Liquids in Tanks — Aboveground Storage Tanks

66.22.1 Scope

This section shall apply to the following:

The storage of liquids, as defined in 3.3.178.1 and 3.3.178.2 and Section 66.4, in fixed tanks that exceed 60 gal (230 L) capacity

The storage of liquids in portable tanks that exceed 660 gal (2500 L) capacity

The storage of liquids in intermediate bulk containers that exceed 793 gal (3000 L)

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 definitions 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, 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:

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

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

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 UL 2085, 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 [FP ≥ 100°F (37.8°C)] heated at or above their FP shall follow the requirements for Class I liquids [FP < 100°F (37.8°C)], 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 [FP < 200°F (93°C)] 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)

Minimum Distance (ft)

Type of Tank

Protection

From Property Line That Is or Can Be Built Upon, Including the Opposite Side of a Public Waya

From Nearest Side of Any Public Way or from Nearest Important Building on the Same Propertya

Floating roof

Protection for exposuresb

1/2 × diameter of tank

1/6 × diameter of tank

None

Diameter of tank but need not exceed 175 ft

1/6 × diameter of tank

Vertical with weak roof-to-shell seam

Approved foam or inerting systemc on tanks not exceeding 150 ft in diameterd

1/2 × diameter of tank

1/6 × diameter of tank

Protection for exposuresb

Diameter of tank

1/3 × diameter of tank

None

2 × diameter of tank but need not exceed 350 ft

1/3 × 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 systemc on the tank or approved foam system on vertical tanks

1/2 × value in Table 66.22.4.1.1(b)

1/2 × value in Table 66.22.4.1.1(b)

Protection for exposuresb

Value in Table 66.22.4.1.1(b)

Value in Table 66.22.4.1.1(b)

None

2 × value in Table 66.22.4.1.1(b)

Value in Table 66.22.4.1.1(b)

Protected

aboveground tank

None

1/2 × value in Table 66.22.4.1.1(b)

1/2 × 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.

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

Minimum Distance (ft)

Tank Capacity (gal)

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 22.7.2 of NFPA 30) that store Class IIIA liquids [FP < 200°F (93°C)] 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 [FP < 140°F (60°C)]. [30:22.4.1.2]

66.22.4.1.3

Tanks storing Class I, Class II, or Class IIIA stable liquids [FP < 200°F (93°C)] 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]

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)

Minimum Distance (ft)

Type of Tank

Protection

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\*

11/2 x value in Table 66.22.4.1.1(b) but not less than 25 ft

11/2 x value in Table 66.22.4.1.1(b) but not less than 25 ft

None

3 x value in Table 66.22.4.1.1(b) but not less than 50 ft

11/2 x 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]

66.22.4.1.4

Tanks storing ignitible (flammable or combustible) 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]

Table 66.22.4.1.4 Location of Aboveground Storage Tanks Storing Boil-Over Ignitible (Flammable or Combustible) Liquids

Minimum Distance (ft)

Type of Tank

Protection

From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Waya

From Nearest Side of Any Public Way or from Nearest Important Building on the Same Propertya

Floating roof

Protection for exposuresb

1/2 x diameter of tank

1/6 x diameter of tank

None

Diameter of tank

1/6 x diameter of tank

Fixed roof

Approved foam or inerting systemc

Diameter of tank

1/3 x diameter of tank

Protection for exposuresb

2 x diameter of tank

2/3 x diameter of tank

None

4 x diameter of tank but need not exceed 350 ft

2/3 x 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.

[30:Table 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]

Table 66.22.4.1.5 Location of Aboveground Storage Tanks Storing Unstable Liquids

Minimum Distance (ft)

Type of Tank

Protection

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 Propertya

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 inserting,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 exposuresb

21/2 x value in Table 66.22.4.1.1(b) but not less than 50 ft

Not less than 50 ft

None

5 x 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 x value in Table 66.22.4.1.1(b) but not less than 50 ft

Not less than 50 ft

Protection for exposuresb

4 x value in Table 66.22.4.1.1 (b) but not less than 100 ft

Not less than 100 ft

None

8 x 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.

bSee definition 3.3.46 of NFPA 30, Protection for Exposures.

[30:Table 22.4.1.5]

66.22.4.1.6

Tanks storing Class IIIB stable liquids [FP ≥ 200°F (93°C)] shall be located in accordance with Table 66.22.4.1.6.

Exception: If located within the same diked area as, err within the drainage path of, a tank storing a Class I or Class II liquid [FP < 140°F (60°C)], the tank storing Class IIIB liquid [FP ≥ 200°F (93°C)[ shall be located in accordance with 66.22.4.1.1.

[30:22.4.1.6]

Table 66.22.4.1.6 Location of Aboveground Storage Tanks Storing Class IIIB Liquids [FP ≥ 200°F (93°C)]

Minimum Distance (ft)

Tank Capacity (gal)

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]

66.22.4.1.7

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]

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 [FP < 200°F (93°C) and any BP] shall be separated by the distances given in Table 66.22.4.2.1. [30:22.4.2.1]

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

Fixed Roof or Horizontal Tanks

Tank Diameter

Floating Roof Tanks

Class I or II Liquids [FP < 140°F (60°C)

Class IIIA Liquids [140°F (60°C) ≤ FP < 200°F (93°C)]

All tanks not over 150 ft (45 m) in diameter

1/6 x sum of adjacent tank diameters but not less than 3 ft (0.9 m)

1/6 x sum of adjacent tank diameters but not less than 3 ft (0.9 m)

1/6 x 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

1/6 x sum of adjacent tank diameters

1/4 x sum of adjacent tank diameters

1/6 x sum of adjacent tank diameters

If open diking is provided in accordance with 66.22.11.2

1/4 x sum of adjacent tank diameters

1/3 x sum of adjacent tank diameters

1/4 x 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]

66.22.4.2.1.1

Tanks that store crude petroleum, have individual capacities not exceeding 3000 bbl [126,000 gal (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 [FP ≥ 200°F (93°C) ] 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 [FP < 140°F (60°C)]. If located within the same diked area as, or within the drainage path of, a tank storing a Class I or Class II liquid [FP < 140°F (60°C)], the tank storing Class IIIB liquid [FP ≥ 200°F (93°C)] shall be spaced in accordance with the requirements for Class IIIA liquids [140°F (60°C) ≤ FP < 200°F (93°C)] in Table 66.22.4.2.1. [30:22.4.2.1.2]

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, Class II, or Class III liquid (any FP or BP) 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 [FP < 140°F (60°C)] or in the drainage path of Class I or Class II liquids [FP < 140°F (60°C)] 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 [FP< 200°F (93°C)] 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 [FP< 200°F (93°C)] 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 liquid storage tanks are within a diked area, the LP-Gas containers shall be outside the diked area and at least 10 ft (3 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 [FP < 200°F (93°C)] 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 [FP < 200°F (93°C)] 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 [FP < 200°F (93°C)] 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 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 or sliding 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 [FP ≥ 200°F (93°C)] 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 [FP < 140°F (60°C)] 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]

66.22.7.2 Pressure-Relieving Devices

66.22.7.2.1\*

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]

66.22.7.2.2

Emergency relief vent devices shall be vaportight and restricted to one of the following:

Self-closing manway cover

Manway cover provided with long bolts that permit the cover to lift under internal pressure

Additional or larger relief valve or valves

[30:22.7.3.2.1]

66.22.7.2.3

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 of or flame impingement on any part of the tank will not occur if vapors from the vents are ignited. [30:22.7.3.9]

66.22.7.2.4

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.

Start-to-open pressure

Pressure at which the valve reaches the full open position

Flow capacity at the pressure indicated by 66.22.7.2.4(2)

[30:22.7.3.10]

66.22.7.3\* 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 Protection for Aboveground Storage Tanks

A fire-extinguishing system in accordance with an applicable NFPA standard shall be provided or made available for a storage tank where all of the following conditions apply:

The tank is a vertical atmospheric storage tank that has a capacity of 50,000 gal (190 m3) or more.

The tank contains a Class I liquid [FP < 100°F (37.8°C)].

The tank is 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.

The tank has a fixed-roof or a combination fixed- and floating-roof that does not meet the requirements of 66.22.2.2(2) or (3) to be classified as a floating roof tank.

[30:22.8]

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, 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 UL 2085, 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 [FP < 200°F (93°C)] 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 ignitible (flammable or combustible) 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 22.11.2.1 through 22.11.2.8 of NFPA 30. [30:22.11.2]

66.22.11.2.1

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

66.22.11.2.1.1

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

66.22.11.2.2

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 NFPA 30.

66.22.11.3.1

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

66.22.11.3.2

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

66.22.11.4 Secondary Containment-Type Aboveground Storage Tanks

Where a secondary containment-type tank is used to provide spill control, the tank shall meet the requirements of NFPA 30.

66.22.11.4.1

Spacing between adjacent tanks shall comply with Table 66.22.4.2.1. [30:22.11.4.6]

66.22.11.4.2

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]

66.22.11.4.3

Where the means of secondary containment is enclosed, it shall be provided with emergency venting in accordance with NFPA 30.

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 ignitible (flammable or combustible) 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 [FP < 100°F (37.8°C)] shall be provided with a vapor-tight cap or cover. [30:22.13.3]

66.22.13.4

Filling and emptying connections for Class I, Class II, and Class IIIA liquids [FP < 200°F (93°C)] 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 ignitible (flammable or combustible) 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:

Anchored to resist movement

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

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 be in accordance with NFPA 30.

66.23 Storage of Ignitible (Flammable or Combustible) Liquids in Tanks — Underground Tanks

66.23.1 Underground Storage Tanks Located in Areas Subject to Flooding

66.23.1.1\*

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]

66.23.1.1.1

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]

66.23.1.1.2

Tank vents and other openings that are not liquidtight shall be extended above maximum flood stage water level. [30:23.14.1.2]

66.23.1.1.3

Each tank shall be so constructed and installed that it will safely resist external pressures if submerged. [30:23.14.1.3]

66.23.2 Reserved

66.23.3 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]

66.23.4 Inspection and Maintenance of Underground Storage Tanks

Inspection and maintenance for underground tanks shall be in accordance with NFPA 30.

66.24 Storage Tank Buildings

66.24.1

Storage tank buildings shall be in accordance with NFPA 30.

66.24.2 Definitions Specific to Section 66.24. (Reserved)

66.24.3 Fire Protection for Storage Tank Buildings

66.24.3.1 Manual Fire Control Equipment for Storage Tank Buildings

66.24.3.1.1\*

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 21.6.1.2 of NFPA 30. [30:24.6.1.1]

66.24.3.1.2\*

Where the need is indicated in accordance with 21.6.3 of NFPA 30, 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]

66.24.3.1.3

Where the need is indicated in accordance with 21.6.3 of NFPA 30, mobile foam apparatus shall be provided. [30:24.6.1.3]

66.24.3.2 Fixed Fire Control Equipment for Tank Buildings

66.24.3.2.1

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 21.6.3 of NFPA 30. [30:24.6.2.1]

66.24.3.2.2\*

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 21.6.3 of NFPA 30. [30:24.6.2.2]

66.24.3.2.3\*

Where the need is indicated by the hazards of storage or exposure as determined by 21.6.3 of NFPA 30, 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]

66.24.3.2.3.1

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 liquids to be protected. [30:24.6.2.3.1]

66.24.3.2.4

If provided, fire control systems shall be designed, installed, and maintained in accordance with the following NFPA standards:

NFPA 11

NFPA 12

NFPA 12A

NFPA 13

NFPA 15

NFPA 16

NFPA 17

NFPA 25

[30:24.6.2.4]

66.24.4 Electrical Systems for Storage Tank Buildings

66.24.4.1

Installation of electrical utilization equipment and wiring shall meet the requirements of Section 66.7. [30:24.8.1]

66.24.4.2

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]

66.24.4.2.1

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]

66.24.5 Containment, Drainage, and Spill Control From Storage Tank Buildings

66.24.5.1

Drainage systems shall be designed to minimize fire exposure to other tanks and adjacent properties or waterways. Compliance with 66.24.5.2 through 66.24.5.6 shall be deemed as meeting the requirements of 66.24.5.1. [30:24.9.1]

66.24.5.2

The facility shall be designed and operated to prevent the discharge of liquids to public waterways, public sewers, or adjoining property under normal operating conditions. [30:24.9.2]

66.24.5.3

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]

66.24.5.4

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 ignitible (flammable or combustible) liquids to the adjoining areas. [30:24.9.4]

66.24.5.4.1

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]

66.24.5.5

Means shall be provided to prevent ignitible (flammable or combustible) liquid spills from running into basements. [30:24.9.5]

66.24.5.6

The containment shall have a capacity not less than that of the largest tank that can drain into it. [30:24.9.6]

66.24.5.7

Emergency drainage systems shall be provided to direct liquid leakage and fire-protection water to a safe location. [30:24.9.7]

66.24.5.8

Curbs, scuppers, or special drainage systems shall be permitted to be used. [30:24.9.8]

66.24.5.9

Emergency drainage systems, if connected to public sewers or discharged into public waterways, shall be equipped with traps or separators. [30:24.9.9]

66.24.6 Ventilation for Storage Tank Buildings

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 in accordance with NFPA 30.

66.24.7 Reserved

66.24.8 Reserved

66.24.9 Vents for Tanks Inside Storage Tank Buildings

66.24.9.1

Vents for tanks inside tank buildings shall be designed to ensure that vapors are not released inside the building. Compliance with 66.24.9.2 through 66.24.9.6 shall be deemed as meeting the requirements of 66.24.9.1. [30:24.13.1]

66.24.9.2

Vents for tanks inside tank buildings shall be as required in 66.21.4.3 and 66.22.7. [30:24.13.2]

66.24.9.3

Emergency venting by the use of a weak roof-to-shell seam shall not be permitted. [30:24.13.3]

66.24.9.4

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]

66.24.9.5

Vents shall terminate outside the building in accordance with 66.27.7.1. [30:24.13.5]

66.24.9.5.1

Emergency relief vents on protected aboveground tanks complying with UL 2085 containing Class II and Class III liquids [FP ≥ 100°F (37.8°C)] shall be allowed to discharge inside the building. [30: 24.13.5.1]

66.24.9.6

Piping for normal and emergency relief venting shall meet the requirements of Section 66.27. [30:24.13.6]

66.24.10 Tank Openings Other Than Vents for Tanks Inside Storage Tank Buildings

Tank openings other than vents for tanks inside tank buildings shall be designed in accordance with NFPA 30.

66.24.11 Detection and Alarm Systems for Storage Tank Buildings

66.24.11.1

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]

66.24.11.2

Those areas, including buildings, where the potential exists for a Class I liquid [FP < 100°F (37.8°C)] spill shall be monitored as appropriate. Such methods shall include both of the following:

Personnel observation or patrol

Monitoring equipment that indicates a spill or leak has occurred in an unattended area

[30:24.15.2]

66.24.12 Inspection and Maintenance for Storage Tank Buildings

66.24.12.1

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]

66.24.12.2

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, 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. [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:

Any property line that is or can be built upon

The near and far sides of a public way

The nearest important building on the same property

[30:25.4]

66.25.5 Construction and Installation of Storage Tank Vaults

Vaults shall be designed and constructed in accordance with NFPA 30.

66.25.6 Reserved

66.25.7 Detection and Alarm Systems for Storage Tank Vaults

66.25.7.1

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]

66.25.7.2

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]

66.25.7.3

Vapor detectors shall be located no higher than 12 in. (300 mm) above the lowest point in the vault. [30:25.15.3]

66.25.7.4

The liquid detection system shall sound an alarm upon detection of any liquid, including water. [30:25.15.4]

66.25.7.5

Liquid detectors shall be located in accordance with the manufacturer's instructions. [30:25.15.5]

66.25.7.6

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]

66.25.8 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 liquids or flammable 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:

Tubing or casing on any oil or gas wells and any piping connected directly thereto

Motor vehicles, aircraft, boats, or piping that is integral to a stationary engine assembly

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 ignitible (flammable or combustible) liquid or vapor from the piping system due to failure of the piping system. [30:27.2.3]

66.27.2.4 Low Melting Point Materials

Materials that melt at a low temperature, including but not limited to aluminum, copper, or brass; materials that soften on fire exposure, such as plastics; or nonductile materials, such as cast iron. [30:27.2.4]

66.27.2.5 Secondary Containment

Containment that is external to and separate from the primary piping system. [30:27.2.5]

66.27.3 General Requirements

66.27.3.1 Performance Standards

66.27.3.1.1

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. [30:27.3.1.1]

66.27.3.1.2

Compliance with ASME B31.1, Power Piping; ASME B31.3, Process Piping; or ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries, and the provisions of this section shall be considered prima facie evidence of compliance with the foregoing provisions. [30:27.3.1.2]

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 B31.1, Power Piping; ASME B31.3, Process Piping; or ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries, 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 A395/A395M, 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 22.14 of NFPA 30 and 66.22.13, 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 [flash point ≥ 200°F (93°C)] 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 [FP < 200°F (93°C)]. [30:27.4.3.3]

66.27.4.4 Low Melting Point Materials

66.27.4.4.1

Low melting point materials, as defined in 66.27.2.4, shall be compatible with the ignitible (flammable or combustible) liquids being handled and shall be used within the pressure and temperature limitations of ASME B31.1, Power Piping; ASME B31.3, Process Piping; or ASME B31.4, Pipeline Transportation Systems for Liquids and Slurries. [30:27.4.4.1]

66.27.4.4.2

Low melting point materials shall not be used as part of a tank's normal or emergency vent piping. [30:27.4.4.2]

66.27.4.4.3

Low melting point materials shall be permitted to be used underground. [30:27.4.4.3]

66.27.4.4.4

Low melting point materials shall be permitted to be used outdoors aboveground, outside a dike, outside a remote impounding area, or inside buildings, provided they meet one of the following conditions:

They are resistant to damage by fire.

They are located so that any leakage resulting from failure will not expose persons, important buildings, tanks, or structures.

They are located where leakage can be controlled by operation of one or more accessible, remotely located valves.

\* They are included in valves or piping components connected to an aboveground secondary containment tank and located above the tank and within ten feet of a thermally activated fire valve that is upstream of the low melting point materials.

[30:27.4.4.4]

66.27.4.4.5

Low melting point materials shall be permitted to be used within a dike or within a remote impounding area, provided they meet one of the following:

They are connected above the normal operating liquid level of the tank.

They are connected below the normal operating liquid level of the tank and one of the following conditions is met:

The stored liquid is a Class IIIB liquid [FP ≥ 200°F (93°C)], the tank is located outdoors, and the piping is not exposed to a potential spill or leak of a Class I, Class II or Class IIIA liquid [FP < 200°F (93°C)].

The low melting point material is protected from fire exposure, such as by using materials that have a fire resistance rating of not less than 2 hours.

[30:27.4.4.5]

66.27.4.4.6

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. [30:27.4.4.6]

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, 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 [FP < 100°F (37.8°C)] shall be welded when located in concealed spaces within buildings. [30:27.5.1.4]

66.27.5.2 Flexible Connectors

Flexible connectors shall be listed and labeled in accordance with UL 2039, Flexible Connector Pipe for Fuels. [30:27.5.2]

66.27.5.3 Friction Joints

Pipe joints dependent upon the friction characteristics of combustible materials for mechanical continuity or liquidtightness of piping shall be in accordance with NFPA 30.

66.27.6 Installation of Piping Systems

Piping systems shall be in accordance with NFPA 30.

66.27.6.1 Installation of Underground Piping

Underground piping shall be installed in accordance with 27.6.5 of NFPA 30.

66.27.7 Vent Piping

Vent piping shall be designed, constructed, and installed in accordance with this section. [30:27.8]

66.27.7.1 Vent Piping for Aboveground Storage Tanks

66.27.7.1.1

Where the outlets of vent pipes for tanks storing Class I liquids [FP < 100°F (37.8°C)] 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]

66.27.7.1.2

Vapors shall be discharged upward or horizontally away from adjacent walls. [30:27.8.1.2]

66.27.7.1.3

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]

66.27.7.1.4

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]

66.27.7.1.4.1

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]

66.27.7.1.5

Vent piping for tanks storing Class I liquids [FP < 100°F (37.8°C)] shall not be manifolded with vent piping for tanks storing Class II or Class III liquids [FP ≥ 100°F (37.8°C)] unless positive means are provided to prevent the following:

Vapors of Class I liquids [FP < 100°F (37.8°C)] from entering tanks storing Class II or Class III liquids [FP ≥ 100°F (37.8°C)]

Contamination

Possible change in classification of the less volatile liquid

[30:27.8.1.5]

66.27.7.1.6\* Extension of Emergency Vent Piping

Piping to or from approved emergency vents 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 vents for pressure vessels shall be sized in accordance with the ASME Boiler and Pressure Vessel Code. Calculations demonstrating compliance with this paragraph shall include the start-to-open pressure of an approved emergency vent device, where provided. [30:27.8.1.6]

66.27.7.2 Vent Piping for Underground Tanks

66.27.7.2.1\*

Vent pipes from underground tanks storing Class I liquids [FP < 100°F (37.8°C)] 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]

66.27.7.2.2

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]

66.27.7.2.3

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]

66.27.7.2.4

Vent outlets and devices shall be protected to minimize the possibility of blockage from weather, dirt, or insect nests. [30:27.8.2.4]

66.27.7.2.5

Vent piping shall be sized in accordance with Table 23.6.2 of NFPA 30. [30:27.8.2.5]

66.27.7.2.6

Vent pipes from tanks storing Class II or Class IIIA liquids [100°F (37.8°C) ≤ FP < 200°F (93°C)] shall terminate outside of the building and higher than the fill pipe opening. [30:27.8.2.6]

66.27.7.2.7

Vent outlets shall be above normal snow level. [30:27.8.2.7]

66.27.7.2.8

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]

66.27.7.2.9

Vent pipes and vapor return piping shall be installed without sags or traps in which liquid can collect. [30:27.8.2.9]

66.27.7.2.10

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]

66.27.7.2.11

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]

66.27.7.2.12

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]

66.27.7.2.12.1

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]

66.27.7.2.13

Vent piping for tanks storing Class I liquids [FP < 100°F (37.8°C)] shall not be manifolded with vent piping for tanks storing Class II or Class III liquids [FP ≥ 100°F (37.8°C)] unless positive means are provided to prevent the following:

Vapors of Class I liquids [FP < 100°F (37.8°C)] from entering tanks storing Class II or Class III liquids [FP ≥ 100°F (37.8°C)]

Contamination

Possible change in classification of the less volatile liquid

[30:27.8.2.13]

66.27.8 Bonding and Grounding

Piping systems shall be bonded and grounded in accordance with 66.6.5.4. [30:27.9]

66.27.9\* 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]

66.27.10 Special Requirements for Marine Piping Systems

66.27.10.1

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]

66.27.10.2

The interior of the flexible connectors shall be compatible with the ignitible (flammable or combustible) liquid handled. [30:27.11.2]

66.27.10.3\*

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]

66.27.10.4

The flexible connectors shall be suitable for the intended pressures and shall be tested in accordance with 27.7 of NFPA 30. [30:27.11.4]

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:

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 ignitible (flammable or combustible) liquids

Where no Class I liquids [FP < 100°F (37.8°C)] 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 [FP ≥ 100°F (37.8°C)]at temperatures below their flash points

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 ignitible (flammable or combustible) 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 ignitible (flammable or combustible) 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 [FP ≥ 100°F (37.8°C)], 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 [FP < 100°F(37.8°C)]. [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 [FP < 100°F (37.8°C)] and for Class II and Class III liquids [FP ≥ 100°F (37.8°C)] handled at temperatures at or above their FP and at least 15 ft (4.6 m) for Class II and Class III liquids [FP ≥ 100°F (37.8°C)] handled at temperatures below their FP, 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 [FP < 100°F (37.8°C)] 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 [FP ≥ 100°F (37.8°C)] unless one of the following conditions exists:

Only water-miscible ignitible (flammable or combustible) liquid mixtures are handled, and the class of the mixture is determined by the concentration of liquid in water.

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

Ignitible (flammable or combustible) 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 [FP < 100°F (37.8°C)], or Class II or Class III liquids [FP ≥ 100°F (37.8°C)] at temperatures at or above their FP, 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 [FP < 100°F (37.8°C)]. [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 [FP < 140°F (60°C)] 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 ignitible (flammable or combustible) liquids, 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 ignitible (flammable or combustible) liquids being handled. [30:28.11.1.11]

66.28.11.2 Loading and Unloading of Tank Cars

66.28.11.2.1

Ignitible (flammable or combustible) 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 ignitible (flammable or combustible) 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 ignitible (flammable or combustible) liquids being handled. [30:28.11.2.5]

66.28.11.3\* Switch Loading

To prevent hazards due to a change in FP of liquids, any tank car or tank vehicle that has previously contained a Class I liquid [FP < 100°F (37.8°C)] shall not be loaded with a Class II or Class III liquid [FP ≥ 100°F (37.8°C)] unless proper precautions are taken. [30:28.11.3]

66.28.11.4

The person responsible for loading or unloading shall remain in attendance during the operation or be able to locally or remotely monitor and control the operation for the duration of the operation. [30:28.11.4]

Exception: A responsible person shall not be required where a hazards analysis shows that the loading or unloading operation can be safely shut down in an emergency. [30:28.11.4]

66.28.11.4.1\*

The responsible person shall be trained to recognize unsafe conditions and take appropriate actions. [30:28.11.4.1]

66.29 Wharves

66.29.1 Scope

66.29.1.1

This section shall apply to all wharves, as defined in 3.3.302, whose primary purpose is the bulk transfer of ignitible (flammable or combustible) liquids. [30:29.1.1]

66.29.1.2

This section shall not apply to the following:

Marine service stations, as covered in Chapter 30 and NFPA 30A

Marinas and boatyards, as covered in Chapter 28 and NFPA 303

Wharves that handle liquefied petroleum gas, as covered in Chapter 69 and NFPA 58, or liquefied natural gas, as covered in NFPA 59A

[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 ignitible (flammable or combustible) liquids and other commodities shall meet the requirements of Section 28.2 and NFPA 307. [30:29.3.1]

66.29.3.2

Incidental handling of packaged cargo of ignitible (flammable or combustible) 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 ignitible (flammable or combustible) 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 [FP ≥ 100°F (37.8°C)] stored at temperatures below their flash points shall be permitted to be installed on a wharf designed to support the weight of the tanks and their 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 ignitible (flammable or combustible) 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:

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.

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.

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.

Each line conveying Class I or Class II liquids [FP < 140°F (60°C)] 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.

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 [FP < 140°F (60°C)], or Class III liquids [FP ≥ 140°F (60°C)] at temperatures at or above their FP, 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 Class I liquids [FP < 100°F (37.8°C)] and Class II and Class III liquids [FP ≥ 100°F (37.8°C)] at temperatures at or above their FP, 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]

FIGURE 66.29.3.22 Area Classification for a Marine Terminal Handling Class I Liquids [FP < 100°F (37.8°C)]. [30: Figure 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 ignitible (flammable or combustible) 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 ignitible (flammable or combustible) 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:

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.

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]

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. [29.3.28.3]

66.29.3.28.4

Where no fire water main is provided, a minimum of two wheeled dry chemical extinguishers with minimum ratings of 240-B:C each 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. Existing 150 lb (68 kg) dry chemical extinguishers that continue to be maintained in accordance with NFPA 10 shall be permitted to remain in service. [30:29.3.28.4]