NFPA 30 Flammable and Combustible Liquids Code 1984

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National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

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Flammable and Combustible Liquids Code

NFPA 30-1984

1984 Edition of NFPA 30

This edition of NFPA 30, *Flammable and Combustible Liquids Code*, was prepared by the Technical Committee on General Storage of Flammable Liquids, released by the Correlating Committee on Flammable Liquids, and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 21-24, 1984 in New Orleans, Louisiana. It was issued by the Standards Council on June 14, 1984, with an effective date of July 5, 1984, and supersedes all previous editions.

The 1984 edition of this standard has been approved by the American National Standards Institute.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Origin and Development of NFPA 30

From 1913 to 1957 this standard was written in the form of a municipal ordinance known as the *Suggested Ordinance for the Storage, Handling and Use of Flammable Liquids*. In 1957 the format was changed from a municipal ordinance to a Code, although the technical provisions were retained. During the 71-year existence of this suggested ordinance and code, numerous editions have been published as conditions and experiences have dictated. For details, see NFPA Technical Committee Reports.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Contents

Flammable and Combustible Liquids Code

NFPA 30-1984

Information on referenced publications can be found in Chapter 9 and Appendix E.

Foreword

This standard, known as the *Flammable and Combustible Liquids Code,* is recommended for use as the basis of legal regulations. Its provisions are intended to reduce the hazard to a degree consistent with reasonable public safety, without undue interference with public convenience and necessity which require the use of flammable and combustible liquids. Thus, compliance with this standard does not eliminate all hazard in the use of flammable and combustible liquids.

Chapter 1 General Provisions

1-1 Scope and Application.

1-1.1 This code applies to all flammable and combustible liquids except those that are solid at 100°F (37.8°C) or above.

1-1.2 Requirements for the safe storage and use of the great variety of flammable and combustible liquids commonly available depend primarily on their fire characteristics, particularly the flash point, which is the basis for the several classifications of liquids as defined in Section 1-2. It should be noted that the classification of a liquid can be changed by contamination. For example, filling a Class II liquid into a tank which last contained a Class I liquid can alter its classification, as can exposing a Class II liquid to the vapors of a Class I liquid via an interconnecting vapor line (*see 2-2.6.4 and 2-3.5.6*). Care shall be exercised in such cases to apply the requirements appropriate to the actual classification.

1-1.3 The volatility of liquids is increased by heating. When Class II or Class III liquids are heated above their flash points, ventilation and electrical classification may be necessary in the immediate area.

1-1.4 Additional requirements may be necessary for the safe storage and use of liquids which have unusual burning characteristics, which are subject to self-ignition when exposed to the air, which are highly reactive with other substances, which are subject to explosive decomposition, or have other special properties which dictate safeguards over and above those specified for a normal liquid of similar flash point classification.

1-1.5 In particular installations the provisions of this code may be altered at the discretion of the authority having jurisdiction after consideration of the special features such as topographical conditions, barricades, walls, adequacy of building exits, nature of occupancies, proximity to buildings or adjoining property and character of construction of such buildings, capacity and construction of proposed tanks and character of liquids to be stored, nature of process, degree of private fire protection to be provided and the adequacy of facilities of the fire department to cope with flammable or combustible liquid fires.

1-1.6 Existing plants, equipment, buildings, structures and installations for the storage, handling, or use of flammable or combustible liquids which are not in strict compliance with the terms of this code may be continued in use at the discretion of the authority having jurisdiction provided they do not constitute a recognized hazard to life or adjoining property. The existence of a situation which might result in an explosion or sudden escalation of a fire, such as inadequate ventilation of confined spaces, lack of adequate emergency venting of a tank, failure to fireproof the supports of elevated tanks, or lack of drainage or dikes to control spills may constitute such a hazard.

1-1.7 This code shall not apply to:

1-1.7.1 Transportation of flammable and combustible liquids. These requirements are contained in the U.S. Department of Transportation regulations or in NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids.*

1-1.7.2 Storage, handling and use of fuel oil tanks and containers connected with oil burning equipment. These requirements are covered separately in NFPA 31, *Standard for the Installation of Oil Burning Equipment.*

1-1.7.3 Storage of flammable and combustible liquids on farms and isolated construction projects. These requirements are covered separately in NFPA 395, *Standard for the Storage of Flammable and Combustible Liquids on Farms and Isolated Construction Projects.*

1-1.7.4 Liquids without flash points that can be flammable under some conditions, such as certain halogenated hydrocarbons and mixtures containing halogenated hydrocarbons. (*See NFPA 321, Standard on Basic Classification of Flammable and Combustible Liquids.*)

1-1.7.5 Mists, sprays or foams. (*Except flammable aerosols in containers, which are included in Chapter 4.*)

1-1.8 Installations made in accordance with the applicable requirements of standards of the National Fire Protection Association: NFPA 32, *Dry Cleaning Plants*; NFPA 33, *Spray Application Using Flammable and Combustible Materials*; NFPA 34, *Dipping and Coating Processes Using Flammable or Combustible Liquids*; NFPA 35, *Manufacture of Organic Coatings*; NFPA 36, *Solvent Extraction Plants*; NFPA 37, *Installation and Use of Stationary Combustion Engines and Gas Turbines*; NFPA 45, *Fire Protection for Laboratories Using Chemicals*; and Chapter 7 of NFPA 99-1984, *Standard for Health Care Facilities*, shall be deemed to be in compliance with this code.

1-1.9 Metrication. If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated is regarded as the requirement. The given equivalent value may be approximate.

1-2 Definitions.

Aerosol. A material which is dispensed from its container as a mist spray or foam by a propellant under pressure.

Apartment House. A building or that portion of a building containing more than two dwelling units.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or material nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Assembly Occupancy. The occupancy or use of a building or structure or any portion thereof by a gathering of persons for civic, political, travel, religious or recreational purposes.

Atmospheric Tank. A storage tank which has been designed to operate at pressures from atmospheric through 0.5 psig (760 mm Hg through 786 mm Hg) measured at the top of the tank.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Barrel. A volume of 42 U.S. gal (158.9 L).

Basement. A story of a building or structure having ½ or more of its height below ground level and to which access for fire fighting purposes is unduly restricted.

Boiling Point. The temperature at which a liquid exerts a vapor pressure of 14.7 psia (760 mm Hg). Where an accurate boiling point is unavailable for the material in question, or for mixtures which do not have a constant boiling point, for purposes of this code the 10 percent point of a distillation performed in accordance with ASTM D-86-82, *Standard Method of Test for Distillation of Petroleum Products*, may be used as the boiling point of the liquid.

Boil-Over. An event in the burning of certain oils in an open top tank when, after a long period of quiescent burning, there is a sudden increase in fire intensity associated with expulsion of burning oil from the tank. Boil-over occurs when the residues from surface burning become more dense than the unburned oil and sink below the surface to form a hot layer which progresses downward much faster than the regression of the liquid surface. When this hot layer, called a "heat wave," reaches water or water-in-oil emulsion in the bottom of the tank, the water is first superheated, and subsequently boils almost explosively, overflowing the tank. Oils subject to boil-over must have components having a wide range of boiling points, including both light ends and a viscous residue. These characteristics are present in most crude oils, and can be produced in synthetic mixtures.

NOTE: A boil-over is an entirely different phenomenon from a slop-over or froth-over. Slop-over involves a minor frothing which occurs when water is sprayed onto the hot surface of a burning oil. Froth-over is not associated with a fire but results when water is present or enters a tank containing hot viscous oil. Upon mixing, the sudden conversion of water to steam causes a portion of the tank contents to overflow.

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

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

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

Combustible Liquids. See Liquids.

Container. Any vessel of 60 U.S. gal (227 L) or less capacity used for transporting or storing liquids.

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

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

Dwelling. A building occupied exclusively for residence purposes and having not more than two dwelling units or as a boarding or rooming house serving not more than 15 persons with meals or sleeping accommodations or both.

Dwelling Unit. One or more rooms arranged for the use of one or more individuals living together as a single housekeeping unit, with cooking, living, sanitary and sleeping facilities.

Educational Occupancy. The occupancy or use of a building or structure or any portion thereof by persons assembled for the purpose of learning or of receiving educational instruction.

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

Flammable Aerosol. An aerosol which is required to be labeled "Flammable" under the U.S. Federal Hazardous Substances Labeling Act.

Flash Point. The minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitible mixture with air near the surface of the liquid within the vessel as specified by appropriate test procedure and apparatus as follows:

The flash point of a liquid having a viscosity less than 45 SUS at 100°F (37.8°C) and a flash point below 200°F (93°C) shall be determined in accordance with ASTM D-56-82, *Standard Method of Test for Flash Point by the Tag Closed Tester.*

The flash point of a liquid having a viscosity of 45 SUS or more at 100°F (37.8°C) or a flash point of 200°F (93°C) or higher shall be determined in accordance with ASTM D-93-80, *Standard Method of Test for Flash Point by the Pensky Martens Closed Tester.*

As an alternate, ASTM D-3828-81, *Standard Methods of Tests for Flash Point of Petroleum and Petroleum Products by Setaflash Closed Tester,* may be used for testing aviation turbine fuels within the scope of this procedure.

As an alternate, ASTM D-3278-82, *Standard Method of Tests for Flash Point of Liquids by Setaflash Closed Tester,* may be used for paints, enamels, lacquers, varnishes and related products and their components having flash points between 32°F (0°C) and 230°F (110°C), and having a viscosity lower than 150 stokes at 77°F (25°C).

As an alternate, ASTM D-3828-79, *Standard Test Methods for Flash Point of Liquids by Setaflash Closed Tester,* may be used for materials other than those for which specific Setaflash Methods exist (cf., ASTM D-3243-77 for aviation turbine fuels and ASTM D-3278-78 for paints, enamels, lacquers, varnishes, related products and their components.)

Hotel. Buildings or groups of buildings under the same management in which there are sleeping accommodations for hire, primarily used by transients who are lodged with or without meals including but not limited to inns, clubs, motels and apartment hotels.

Institutional Occupancy. The occupancy or use of a building or structure or any portion thereof by persons harbored or detained to receive medical, charitable or other care or treatment, or by persons involuntarily detained.

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

Liquid. For the purpose of this code, any material which has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D-5-78, *Test for Penetration for Bituminous Materials.* **When not otherwise identified, the term liquid shall mean both flammable and combustible liquids.**

Combustible Liquid. A liquid having a flash point at or above 100°F (37.8°C).

Combustible Liquids shall be subdivided as follows:

Class II liquids shall include those having flash points at or above 100°F (37.8°C) and below 140°F (60°C).

Class IIIA liquids shall include those having flash points at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB liquids shall include those having flash points at or above 200°F (93°C).

Flammable Liquid. A liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 lbs per sq in. (absolute) (2,068 mm Hg) at 100°F (37.8°C) shall be known as a Class I liquid.

Class I liquids shall be subdivided as follows:

Class IA shall include those having flash points below 73°F (22.8°C) and having a boiling point below 100°F (37.8°C).

Class IB shall include those having flash points below 73°F (22.8°C) and having a boiling point at or above 100°F (37.8°C).

Class IC shall include those having flash points at or above 73°F (22.8°C) and below 100°F (37.8°C).

Unstable (Reactive) Liquid. A liquid which in the pure state or as commercially produced or transported will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, pressure, or temperature.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Low Pressure Tank. A storage tank designed to withstand an internal pressure above 0.5 psig (3.5 kPa) but not more than 15 psig (103.4 kPa) measured at the top of the tank.

Mercantile Occupancy. The occupancy or use of a building or structure or any portion thereof for the displaying, selling or buying of goods, wares, or merchandise.

Office Occupancy. The occupancy or use of a building or structure or any portion thereof for the transaction of business, or the rendering or receiving of professional services.

Portable Tank. Any closed vessel having a liquid capacity over 60 U.S. gallons (227 L) and not intended for fixed installation.

Pressure Vessel. Any fired or unfired vessel within the scope of the applicable section of the ASME *Boiler and Pressure Vessel Code*, available from American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, NY 10017.

Protection for Exposures. Fire protection for structures on property adjacent to liquid storage. Fire protection for such structures shall be acceptable when located (1) within the jurisdiction of any public fire department, or (2) adjacent to plants having private fire brigades capable of providing cooling water streams on structures on property adjacent to liquid storage.

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

Safety Can. An approved container, of not more than 5 gal (18.9 L) capacity, having a spring-closing lid and spout cover and so designed that it will safely relieve internal pressure when subjected to fire exposure.

Separate Inside Storage Area. A room or building used for the storage of liquids in containers or portable tanks, separated from other types of occupancies. Such areas may include:

Inside Room. A room totally enclosed within a building and having no exterior walls.

Cut-Off Room. A room within a building and having at least one exterior wall.

Attached Building. A building having only one common wall with a building having other type occupancies.

Service Stations.

Automotive Service Station. That portion of property where liquids used as motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles and shall include any facilities available for the sale and service of tires, batteries and accessories, and for minor automotive maintenance work. Major automotive repairs, painting, body and fender work are excluded.

Marine Service Station. That portion of a property where liquids used as fuels are stored and dispensed from fixed equipment on shore, piers, wharves, or floating docks into the fuel tanks of self-propelled craft, and shall include all facilities used in connection therewith.

Service Station Located Inside Buildings. That portion of an automotive service station located within the perimeter of a building or building structure that also contains other occupancies. The service station may be enclosed or partially enclosed by the building walls, floors, ceilings, or partitions, or may be open to the outside. The service station dispensing area shall mean that area of the service station required for dispensing of fuels to motor vehicles. Dispensing of fuel at manufacturing, assembly, and testing operations is not included within this definition.

Vapor Pressure. The pressure, measured in lbs per sq in. (absolute), exerted by a volatile liquid as determined by ASTM D323-82, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*.

Vapor Processing Equipment. Those components of a vapor processing system which are designed to process vapors or liquids captured during filling operations at service stations, bulk plants, or terminals.

Vapor Processing System. A system designed to capture and process vapors displaced during filling operations at service stations, bulk plants, or terminals by use of mechanical and/or chemical means. Examples are systems using blower-assist for capturing vapors, and refrigeration, absorption and combustion systems for processing vapors.

Vapor Recovery System. A system designed to capture and retain, without processing, vapors displaced during filling operations at service stations, bulk plants, or terminals. Examples are balanced-pressure vapor displacement systems and vacuum-assist systems without vapor processing.

Ventilation. As specified in this code, ventilation is for the prevention of fire and explosion. It is considered adequate if it is sufficient to prevent accumulation of significant quantities of vapor-air mixtures in concentration over one-fourth of the lower flammable limit.

Warehouses.

General Purpose Warehouse. A separate, detached building or portion of a building used only for warehousing-type operations.

NOTE: Warehousing operations referred to above are those operations not accessible to the public and include general purpose, merchandise, distribution and industrial warehouse-type operations.

Liquid Warehouse. A separate, detached building or attached building used for warehousing-type operations for liquids.

1-3 Storage. Liquids shall be stored in tanks or in containers in accordance with Chapter 2 or Chapter 4.

1-4 Pressure Vessel. All new pressure vessels containing liquids shall comply with 1-4.1, 1-4.2 or 1-4.3, as applicable.

1-4.1 Fired pressure vessels shall be designed and constructed in accordance with Section I (Power Boilers) 1983, or Section VIII, Division 1 or Division 2 (Pressure Vessels) 1983, as applicable, of the ASME *Boiler and Pressure Vessel Code.*

1-4.2 Unfired pressure vessels shall be designed and constructed in accordance with Section VIII, Division 1 or Division 2, 1983 of the ASME *Boiler and Pressure Vessel Code.*

1-4.3 Fired and unfired pressure vessels which do not conform to 1-4.1 or 1-4.2 may be used provided approval has been obtained from the state or other governmental jurisdiction in which they are to be used. Such pressure vessels are generally referred to as "State Special."

1-5 Exits.

1-5.1 Egress from buildings and areas covered by this code shall be in accordance with NFPA *101®, Life Safety Code®.*

Chapter 2 Tank Storage

2-1 Design and Construction of Tanks.

2-1.1 Materials. Tanks shall be designed and built in accordance with recognized good engineering standards for the material of construction being used, and shall be of steel or approved noncombustible material with the following limitations and exceptions:

(a) The material of tank construction 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.

(b) Tanks constructed of combustible materials shall be subject to the approval of the authority having jurisdiction and limited to:

1. Installation underground, or

2. Use where required by the properties of the liquid stored, or

3. Storage of Class IIIB liquids aboveground in areas not exposed to a spill or leak of Class I or Class II liquid, or

4. Storage of Class IIIB liquids inside a building protected by an approved automatic fire extinguishing system.

(c) Unlined concrete tanks may be used for storing liquids having a gravity of 40 degrees API or heavier. Concrete tanks with special linings may be used for other services provided the design is in accordance with sound engineering practice.

(d) Tanks may have combustible or noncombustible linings.

(e) Special engineering consideration may be required 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 (-17.8°C).

2-1.2 Fabrication.

2-1.2.1 Tanks may be of any shape or type consistent with sound engineering design.

2-1.2.2 Metal tanks shall be welded, riveted and caulked, or bolted, or constructed by use of a combination of these methods.

2-1.3 Atmospheric Tanks.

2-1.3.1 Atmospheric tanks shall be built in accordance with recognized standards of design. Atmospheric tanks may be built and used within the scopes of the following:

(a) Underwriters Laboratories Inc., *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids,* UL142 — 1981; *Standard for Steel Underground Tanks for Flammable and Combustible Liquids,* UL58 — 1976; or *Standard for Steel Inside Tanks for Oil Burner Fuel,* UL80 — 1980.

(b) American Petroleum Institute Standard No. 650, *Welded Steel Tanks for Oil Storage,* Sixth Edition, 1980.

(c) American Petroleum Institute Specifications 12B, *Bolted Tanks for Storage of Production Liquids,* Twelfth Edition, January 1977; 12D, *Field Welded Tanks for Storage of Production Liquids,* Eighth Edition, January 1982; or 12F, *Shop Welded Tanks for Storage of Production Liquids,* Seventh Edition, January 1982.

(d) American Society for Testing and Materials, *Standard Specification for Glass-Fiber Reinforced Polyester Underground Petroleum Storage Tanks,* ASTM D 4021-81.

(e) Underwriters Laboratories Inc., *Standard for Glass-Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products,* UL 1316-83.

2-1.3.2 Low-pressure tanks and pressure vessels may be used as atmospheric tanks.

2-1.3.3 Atmospheric tanks shall not be used for the storage of a liquid at a temperature at or above its boiling point.

2-1.4 Low-Pressure Tanks.

2-1.4.1 The normal operating pressure of the tank shall not exceed the design pressure of the tank.

2-1.4.2 Low-pressure tanks shall be built in accordance with recognized standards of design. Low-pressure tanks may be built in accordance with:

(a) American Petroleum Institute Standard No. 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, Fifth Edition, 1982.

(b) The principles of the *Code for Unfired Pressure Vessels*, Section VIII, Division I of the ASME *Boiler and Pressure Vessel Code*, 1983 Edition.

2-1.4.3 Tanks built according to Underwriters Laboratories Inc. requirements in 2-1.3.1 may be used for operating pressures not exceeding 1 psig (6.9 kPa) and shall be limited to 2.5 psig (17.2 kPa) under emergency venting conditions.

2-1.4.4 Pressure vessels may be used as low-pressure tanks.

2-1.5 Pressure Vessels.

2-1.5.1 The normal operating pressure of the vessel shall not exceed the design pressure of the vessel.

2-1.5.2 Storage tanks designed to withstand pressures above 15 psig (103.4 kPa) shall meet the requirements of Section 1-4.

2-1.6 Provisions for Internal Corrosion.

2-1.6.1 When tanks are not designed in accordance with the American Petroleum Institute, American Society of Mechanical Engineers or the Underwriters Laboratories Inc. Standards, or if corrosion is anticipated beyond that provided for in the design formulas used, additional metal thickness or suitable protective coatings or linings shall be provided to compensate for the corrosion loss expected during the design life of the tank.

2-2 Installation of Outside Aboveground Tanks.

2-2.1 Location with Respect to Property Lines, Public Ways and Important Buildings on the Same Property.

2-2.1.1 Every aboveground tank for the storage of Class I, Class II or Class IIIA liquids, except as provided in 2-2.1.2 and those liquids with boil-over characteristics and unstable liquids, operating at pressures not in excess of 2.5 psig (17.2 kPa) and designed with a weak roof-to-shell seam (see 2-2.5.3) or equipped with emergency venting devices which will not permit pressures to exceed 2.5 psig (17.2 kPa), shall be located in accordance with Table 2-1. Where tank spacing is contingent on a weak roof-to-shell seam design, the user shall present evidence certifying such construction to the authority having jurisdiction, upon request.

(a) For the purpose of Section 2-2, a floating roof tank is defined as one which incorporates either:

1. A pontoon or double deck metal floating roof in an open top tank in accordance with API Standard 650, or

2. A fixed metal roof with ventilation at the top and roof eaves in accordance with API Standard 650 and containing a metal floating roof or cover meeting any one of the following requirements:

a. A pontoon or double deck metal floating roof meeting the requirements of API Standard 650.

b. A metal floating cover supported by liquid-tight metal pontoons or floats which provide sufficient buoyancy to prevent sinking of the cover when half of the pontoons or floats are punctured.

(b) An internal metal floating pan, roof or cover which does not meet the requirements of (a) 2., or one which uses plastic foam (except for seals) for flotation even if encapsulated in metal or fiber glass shall be considered as being a fixed roof tank.

2-2.1.2 Vertical tanks having a weak roof-to-shell seam (see 2-2.5.3) and storing Class IIIA liquids may be located at one-half the distances specified in Table 2-1, provided the tanks are not within a diked area or drainage path for a tank storing a Class I or Class II liquid.

2-2.1.3 Every aboveground tank for the storage of Class I, Class II or Class IIIA liquids, except those liquids with boil-over characteristics and unstable liquids, operating at pressures exceeding 2.5 psig (17.2 kPa) or equipped with emergency venting which will permit pressures to exceed 2.5 psig (17.2 kPa), shall be located in accordance with Table 2-2.

2-2.1.4 Every aboveground tank for storage of liquids with boil-over characteristics shall be located in accordance with Table 2-3.

(a) Liquids with boil-over characteristics shall not be stored in fixed roof tanks larger than 150 ft (45.7 m) diameter, unless an approved inerting system is provided on the tank.

2-2.1.5 Every aboveground tank for the storage of unstable liquids shall be located in accordance with Table 2-4.

2-2.1.6 Every aboveground tank for the storage of Class IIIB liquids, excluding unstable liquids, shall be located in accordance with Table 2-5 except when located within a diked area or drainage path for a tank or tanks storing a Class I or Class II liquid. When a Class IIIB liquid storage tank is within the diked area or drainage path for a Class I or Class II liquid, 2-2.1.1 or 2-2.1.2 shall apply.

2-2.1.7 Where two tank properties of diverse ownership have a common boundary, the authority having jurisdiction may, with the written consent of the owners of the two properties, substitute the distances provided in 2-2.2.1 through 2-2.2.6 for the minimum distances set forth in 2-2.1.

Table 2-1 Stable Liquids (Operating Pressure 2.5 psig or Less) (17.2 kPa)

Type of Tank	Protection	Minimum Distance in Feet from Property Line Which Is or Can Be Built Upon, Including the Opposite Side of a Public Way and Shall Be Not Less Than 5 Feet	Minimum Distance in Feet from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property and Shall Be Not Less Than 5 Feet
Floating Roof [See 2-2.1.1(a)]	Protection for Exposures*	½ times diameter of tank	⅙ times diameter of tank
	None	Diameter of tank but need not exceed 175 feet	⅙ times diameter of tank
Vertical with Weak Roof to Shell Seam (See 2-2.5.3)	Approved foam or inerting system** on tanks not exceeding 150 feet in diameter***	½ times diameter of tank	⅙ times diameter of tank
	Protection for Exposures*	Diameter of tank	⅙ times diameter of tank
	None	2 times diameter of tank but need not exceed 350 feet	⅙ times diameter of tank
Horizontal and Vertical with Emergency Relief Venting to Limit Pressures to 2.5 psig	Approved inerting system** on the tank or approved foam system on vertical tanks	½ times Table 2-6	½ times Table 2-6
	Protection for Exposures*	Table 2-6	Table 2-6
	None	2 times Table 2-6	Table 2-6

* See definition for "Protection for Exposures."
** See NFPA 69, *Explosion Prevention Systems.*
*** For tanks over 150 ft in diameter use "Protection for Exposures" or "None" as applicable.
SI Units: 1 ft = 0.30 m.

Table 2-2 Stable Liquids (Operating Pressure Greater Than 2.5 psig) (17.2 kPa)

Type of Tank	Protection	Minimum Distance in Feet from Property Line Which Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance in Feet from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
Any Type	Protection for Exposures*	1½ times Table 2-6 but shall not be less than 25 feet	1½ times Table 2-6 but shall not be less than 25 feet
	None	3 times Table 2-6 but shall not be less than 50 feet	1½ times Table 2-6 but shall not be less than 25 feet

* See definition for "Protection for Exposures."
SI Units: 1 ft = 0.30 m.

Table 2-3 Boil-over Liquids

Type of Tank	Protection	Minimum Distance in Feet from Property Line Which Is or Can Be Built Upon, Including the Opposite Side of a Public Way and Shall Be Not Less Than 5 Feet	Minimum Distance in Feet from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property and Shall Be Not Less Than 5 Feet
Floating Roof [See 2-2.1.1(a)]	Protection for Exposures*	½ times diameter of tank	⅙ times diameter of tank
	None	Diameter of tank	⅙ times diameter of tank
Fixed Roof [See 2-2.1.4(a)]	Approved foam or inerting system**	Diameter of tank	⅓ times diameter of tank
	Protection for Exposures*	2 times diameter of tank	⅔ times diameter of tank
	None	4 times diameter of tank but need not exceed 350 feet	⅔ times diameter of tank

* See definition for "Protection for Exposures."
** See NFPA 69, *Explosion Prevention Systems.*
SI Units: 1 ft = 0.30 m.

Table 2-4 Unstable Liquids

Type of Tank	Protection	Minimum Distance in Feet from Property Line Which Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance in Feet from Nearest Side of Any Public Way or from Nearest Important Building on the Same Property
Horizontal and Vertical Tanks with Emergency Relief Venting to Permit Pressure Not in Excess of 2.5 psig	Tank protected with any one of the following: Approved water spray, Approved inerting,* Approved insulation and refrigeration, Approved barricade	Table 2-6 but not less than 25 feet	Not less than 25 feet
	Protection for Exposures**	2½ times Table 2-6 but not less than 50 feet	Not less than 50 feet
	None	5 times Table 2-6 but not less than 100 feet	Not less than 100 feet
Horizontal and Vertical Tanks with Emergency Relief Venting to Permit Pressure Over 2.5 psig	Tank protected with any one of the following: Approved water spray, Approved inerting,* Approved insulation and refrigeration, Approved barricade	2 times Table 2-6 but not less than 50 feet	Not less than 50 feet
	Protection for Exposures**	4 times Table 2-6 but not less than 100 feet	Not less than 100 feet
	None	8 times Table 2-6 but not less than 150 feet	Not less than 150 feet

* See NFPA 69, *Explosion Prevention Systems.*
** See definition for "Protection for Exposures."
SI Units: 1 ft = 0.30 m.

Table 2-5 Class IIIB Liquids

Capacity Gallons	Minimum Distance in Feet from Property Line Which Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance in Feet 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

SI Units: 1 ft = 0.30 m; 1 gal = 3.8 L.

Table 2-6
Reference Table for Use in Tables 2-1 to 2-4

Capacity Tank Gallons	Minimum Distance in Feet from Property Line Which Is or Can Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance in Feet 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

SI Units: 1 ft = 0.30 m; 1 gal = 3.8 L.

2-2.1.8 Where end failure of horizontal pressure tanks and vessels can expose property, the tank shall be placed with the longitudinal axis parallel to the nearest important exposure.

2-2.2 Spacing (Shell-to-Shell) between Any Two Adjacent Aboveground Tanks.

2-2.2.1 Tanks storing Class I, II or IIIA stable liquids shall be separated in accordance with Table 2-7, except as provided in 2-2.2.2.

2-2.2.2 Crude petroleum tanks having individual capacities not exceeding 126,000 gal (3,000 barrels), when located at production facilities in isolated locations, need not be separated by more than 3 ft (0.90 m).

2-2.2.3 Tanks used only for storing Class IIIB liquids may be spaced no less than 3 ft (0.90 m) apart unless within a diked area or drainage path for a tank storing a Class I or II liquid, in which case the provisions of Table 2-7 apply.

2-2.2.4 For unstable liquids, the distance between such tanks shall not be less than one-half the sum of their diameters.

2-2.2.5 When tanks are in a diked area containing Class I or Class II liquids, or in the drainage path of Class I or Class II liquids, and are compacted in three or more rows or in an irregular pattern, greater spacing or other means may be required by the authority having jurisdiction to make tanks in the interior of the pattern accessible for fire fighting purposes.

Table 2-7 Minimum Tank Spacing (Shell-to-Shell)

	Floating Roof Tanks	Fixed Roof or Horizontal Tanks	
		Class I or II Liquids	Class IIIA Liquids
All tanks not over 150 feet diameter	¼ sum of adjacent tank diameters but not less than 3 feet	¼ sum of adjacent tank diameters but not less than 3 feet	¼ sum of adjacent tank diameters but not less than 3 feet
Tanks larger than 150 feet diameter			
If remote impounding is in accordance with 2-2.3.2	¼ sum of adjacent tank diameters	¼ sum of adjacent tank diameters	¼ sum of adjacent tank diameters
If impounding is around tanks in accordance with 2-2.3.3	¼ sum of adjacent tank diameters	⅓ sum of adjacent tank diameters	¼ sum of adjacent tank diameters

SI Units: 1 ft = 0.30 m.

2-2.2.6 The minimum horizontal separation between an LP-Gas container and a Class I, Class II or Class IIIA liquid storage tank shall be 20 ft (6 m) except in the case of Class I, Class II or Class IIIA liquid tanks operating at pressures exceeding 2.5 psig (17.2 kPa) or equipped with emergency venting which will permit pressures to exceed 2.5 psig (17.2 kPa) in which case the provisions of 2-2.2.1 and 2-2.2.2 shall apply. Suitable means shall be taken to prevent the accumulation of Class I, Class II or Class IIIA liquids under adjacent LP-Gas containers such as by dikes, diversion curbs or grading. When flammable or combustible 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. The foregoing provisions shall not apply when LP-Gas containers of 125 gal (475 L) or less capacity are installed adjacent to fuel oil supply tanks of 660 gal (2498 L) or less capacity. No horizontal separation is required between aboveground LP-Gas containers and underground flammable and combustible liquid tanks installed in accordance with Section 2-3.

2-2.3 Control of Spillage from Aboveground Tanks.

2-2.3.1 Facilities shall be provided so that any accidental discharge of any Class I, II or IIIA liquids will be prevented from endangering important facilities, adjoining property or reaching waterways, as provided for in 2-2.3.2 or 2-2.3.3. Tanks storing Class IIIB liquids do not require special drainage or diking provisions for fire protection purposes.

2-2.3.2 Remote Impounding. Where protection of adjoining property or waterways is by means of drainage to a remote impounding area, so that impounded liquid will not be held against tanks, such systems shall comply with the following:

(a) A slope of not less than 1 percent away from the tank shall be provided for at least 50 ft (15 m) toward the impounding area.

(b) The impounding area shall have a capacity not less than that of the largest tank that can drain into it.

(c) The route of the drainage system shall be so located that, if the liquids in the drainage system are ignited, the fire will not seriously expose tanks or adjoining property.

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

2-2.3.3 Impounding Around Tanks by Diking. When protection of adjoining property or waterways is by means of impounding by diking around the tanks, such system shall comply with the following:

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

(b) The volumetric capacity of the diked area shall not be less than the greatest amount of liquid that can be released from the largest tank within the diked area, assuming a full tank. To allow for volume occupied by tanks, the capacity of the diked area enclosing more than one tank shall be calculated after deducting the volume of the tanks, other than the largest tank, below the height of the dike.

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

(d) Walls of the diked area shall be of earth, steel, concrete or solid masonry designed to be liquidtight and to withstand a full hydrostatic head. Earthen walls 3 ft (0.90 m) or more in height shall have a flat section at the top not less than 2 ft (0.60 m) wide. The slope of an earthen wall shall be consistent with the angle of repose of the material of which the wall is constructed. Diked areas for tanks containing Class I liquids located in extremely porous soils may require special treatment to prevent seepage of hazardous quantities of liquids to low-lying areas or waterways in case of spills.

(e) Except as provided in (f) below, the walls of the diked area shall be restricted to an average interior height of 6 ft (1.8 m) above interior grade.

(f) Dikes may be higher than an average of 6 ft (1.8 m) above interior grade where provisions are made for normal access and necessary emergency access to tanks, valves and other equipment, and safe egress from the diked enclosure.

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

2. Piping passing through dike walls shall be designed to prevent excessive stresses as a result of settlement or fire exposure.

3. The minimum distance between tanks and toe of the interior dike walls shall be 5 ft (1.5 m).

(g) Each diked area containing two or more tanks shall be subdivided, preferably by drainage channels or at least by intermediate curbs in order to prevent spills from endangering adjacent tanks within the diked area as follows:

1. When storing normally stable liquids in vertical cone roof tanks constructed with weak roof-to-shell seam or floating roof tanks or when storing crude petroleum in producing areas in any type of tank, one subdivision for each tank in excess of 10,000 bbls. and one subdivision for each group of tanks (no tank exceeding 10,000 bbls. capacity) having an aggregate capacity not exceeding 15,000 bbls.

2. When storing normally stable liquids in tanks not covered in subsection (1), one subdivision for each tank in excess of 2,380 bbls. (378,500 L) and one subdivision for each group of tanks [no tank exceeding 2,380 bbls. (378,500 L) capacity] having an aggregate capacity not exceeding 3,570 bbls. (567,750 L).

3. When storing unstable liquids in any type of tank, one subdivision for each tank except that tanks installed in accordance with the drainage requirements of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, shall require no additional subdivision. Since unstable liquids will react more rapidly when heated than when at ambient temperatures, subdivision by drainage channels is the preferred method.

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

5. The drainage channels or intermediate curbs shall be located between tanks so as to take full advantage of the available space with due regard for the individual tank capacities. Intermediate curbs, where used, shall be not less than 18 in. (45 cm) in height.

(h) Where provision is made for draining water from diked areas, such drains shall be controlled in a manner so as to prevent flammable or combustible liquids from entering natural water courses, public sewers, or public drains, if their presence would constitute a hazard. Control of drainage shall be accessible under fire conditions from outside the dike.

(i) Storage of combustible materials, empty or full drums, or barrels, shall not be permitted within the diked area.

2-2.4 Normal Venting for Aboveground Tanks.

2-2.4.1 Atmospheric storage tanks shall be adequately vented to prevent the development of vacuum or pressure sufficient to distort the roof of a cone roof tank or exceeding the design pressure in the case of other atmospheric tanks, as a result of filling or emptying, and atmospheric temperature changes.

2-2.4.2 Normal vents shall be either sized in accordance with: (1) the American Petroleum Institute Standard No. 2000, *Venting Atmospheric and Low-Pressure Storage Tanks, 1982*, or (2) other accepted standard; or shall be at least as large as the filling or withdrawal connection, whichever is larger, but in no case less than 1¼ in. (3 cm) nominal inside diameter.

2-2.4.3 Low-pressure tanks and pressure vessels shall be adequately vented to prevent development of pressure or vacuum, as a result of filling or emptying and atmospheric temperature changes, from exceeding the design pressure of the tank or vessel. Protection 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.

2-2.4.4 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.

2-2.4.5 The outlet of all vents and vent drains on tanks equipped with venting to permit pressures exceeding 2.5 psig (17.2 kPa) shall be arranged to discharge in such a way as to prevent localized overheating of, or flame impingement on, any part of the tank, in the event vapors from such vents are ignited.

2-2.4.6 Tanks and pressure vessels storing Class IA liquids shall be equipped with venting devices which shall be normally closed except when venting to pressure or vacuum conditions. Tanks and pressure vessels storing Class IB and IC liquids shall be equipped with venting devices which shall be normally closed except when venting under pressure or vacuum conditions, or with listed flame arresters. Tanks of 3,000 bbls. (476,910 L) capacity or less containing crude petroleum in crude-producing areas, and outside aboveground atmospheric tanks under 23.8 bbls. (3,785 L) capacity containing other than Class IA liquids may have open vents. (*See 2-2.6.2.*)

2-2.4.7 Flame arresters or venting devices required in 2-2.4.6 may be omitted for IB and IC liquids where conditions are such that their use may, in case of obstruction, result in tank damage. Liquid properties justifying the omission of such devices include, but are not limited to, condensation, corrosiveness, crystallization, polymerization, freezing or plugging. When any of these conditions exist, consideration may be given to heating, use of devices employing special materials of construction, the use of liquid seals, or inerting (*see* NFPA 69, *Standard on Explosion Prevention Systems*).

2-2.5 Emergency Relief Venting for Fire Exposure for Aboveground Tanks.

2-2.5.1 Except as provided in 2-2.5.2, every aboveground storage tank shall have some form of construction or device that will relieve excessive internal pressure caused by exposure fires.

2-2.5.2 Tanks larger than 285 bbls. (45,306 L) capacity storing Class IIIB liquids and not within the diked area or the drainage path of Class I or Class II liquids do not require emergency relief venting.

2-2.5.3 In a vertical tank the construction referred to in 2-2.5.1 may take the form of a floating roof, lifter roof, a weak roof-to-shell seam, or other approved pressure relieving construction. The weak roof-to-shell seam shall be constructed to fail preferential to any other seam. Design methods which will provide a weak roof-to-shell seam construction are contained in API 650, *Welded Steel Tanks for Oil Storage*, and UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.*

2-2.5.4 Where entire dependence for emergency relief is placed upon pressure relieving devices, the total venting capacity of both normal and emergency vents shall be enough to prevent rupture of the shell or bottom of the tank if vertical, or of the shell or heads if horizontal. If unstable liquids are stored, the effects of heat or gas resulting from polymerization, decomposition, condensation, or self-reactivity shall be taken into account. The total capacity of both normal and emergency venting devices shall be not less than that derived from Table 2-8 except as provided in 2-2.5.6 or 2-2.5.7. Such device may be a self-closing manhole cover, or one using long bolts that permit the cover to lift under internal pressure, or an additional or larger relief valve or valves. The wetted area of the tank shall be calculated on the basis of 55 percent of the total exposed area of a sphere or spheroid, 75 percent of the total exposed area of a horizontal tank and the first 30 ft (9 m) abovegrade of the exposed shell area of a vertical tank. (*See Appendix A for the square footage of typical tank sizes.*)

2-2.5.5 For tanks and storage vessels designed for pressures over 1 psig (6.9 kPa), the total rate of venting shall be determined in accordance with Table 2-8, except that when the exposed wetted area of the surface is greater than 2,800 sq ft (260 m²), the total rate of venting shall be in accordance with Table 2-9 or calculated by the following formula:

$$CFH = 1{,}107\ A^{0.82}$$

Where:

CFH = venting requirement, in cubic feet of free air per hour

A = exposed wetted surface, in square feet

The foregoing formula is based on $Q = 21{,}000\ A^{0.82}$.

2-2.5.6 The total emergency relief venting capacity for any specific stable liquid can be determined by the following formula:

$$\text{Cubic feet of free air per hour} = V\frac{1{,}337}{L\sqrt{M}}$$

V = cubic feet of free air per hour from Table 2-8

L = latent heat of vaporization of specific liquid in Btu per pound

M = molecular weight of specific liquids

Table 2-8

Wetted Area Versus Cubic Feet Free Air per Hour*
(14.7 psia and 60°F) (101.3 kPa and 15.6°C)

Sq Ft	CFH	Sq Ft	CFH	Sq Ft	CFH
20	21,100	200	211,000	1,000	524,000
30	31,600	250	239,000	1,200	557,000
40	42,100	300	265,000	1,400	587,000
50	52,700	350	288,000	1,600	614,000
60	63,200	400	312,000	1,800	639,000
70	73,700	500	354,000	2,000	662,000
80	84,200	600	392,000	2,400	704,000
90	94,800	700	428,000	2,800	742,000
100	105,000	800	462,000	and over	
120	126,000	900	493,000		
140	147,000	1,000	524,000		
160	168,000				
180	190,000				
200	211,000				

SI Units: 10 ft² = 0.93 m²; 36 ft³ = 1.0 m³
*Interpolate for intermediate values.

Table 2-9

Wetted Area Over 2,800 sq ft and Pressures Over 1 psig

Sq Ft	CFH	Sq Ft	CFH
2,800	742,000	9,000	1,930,000
3,000	786,000	10,000	2,110,000
3,500	892,000	15,000	2,940,000
4,000	995,000	20,000	3,720,000
4,500	1,100,000	25,000	4,470,000
5,000	1,250,000	30,000	5,190,000
6,000	1,390,000	35,000	5,900,000
7,000	1,570,000	40,000	6,570,000
8,000	1,760,000		

SI Units: 10 ft² = 0.93 m²; 36 ft³ = 1.0 m³
*Interpolate for intermediate values.

2-2.5.7 For tanks containing stable liquids, the required airflow rate of 2-2.5.4 or 2-2.5.6 may be multiplied by the appropriate factor listed in the following schedule when protection is provided as indicated. Only one factor can be used for any one tank.

.5 for drainage in accordance with 2-2.3.2 for tanks over 200 sq ft (18.6 m²) of wetted area

.3 for water spray in accordance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, and drainage in accordance with 2-2.3.2

.3 for insulation in accordance with 2-2.5.7(a)

.15 for water spray with insulation in accordance with 2-2.5.7(a) and drainage in accordance with 2-2.3.2 (*see Appendix A*)

(a) Insulation systems for which credit is taken shall meet the following performance criteria:

1. Remain in place under fire exposure conditions.

2. Withstand dislodgment when subjected to hose stream impingement during fire exposure. This requirement may be waived where use of solid hose streams is not contemplated or would not be practical.

3. Maintain a maximum conductance value of 4.0 Btu's per hour per square foot per degree F (Btu/hr/sq ft/°F) when the outer insulation jacket or cover is at a temperature of 1,660°F (904.4°C) and when the mean temperature of the insulation is 1,000°F (537.8°C).

2-2.5.8 The outlet of all vents and vent drains on tanks equipped with emergency venting to permit pressures exceeding 2.5 psig (17.2 kPa) shall be arranged to discharge in such a way as to prevent localized overheating of or flame impingement on any part of the tank, in the event vapors from such vents are ignited.

2-2.5.9 Each commercial tank venting device shall have stamped on it the opening pressure, the pressure at which the valve reaches the full open position and the flow capacity at the latter pressure. If the start to open pressure is less than 2.5 psig (17.2 kPa) and the pressure at full open position is greater than 2.5 psig (17.2 kPa), the flow capacity at 2.5 psig (17.2 kPa) shall also be stamped on the venting device. The flow capacity shall be expressed in cubic feet per hour of air at 60°F (15.6°C) and 14.7 psia (760 mm Hg).

(a) The flow capacity of tank venting devices under 8 in. (20 cm) in nominal pipe size shall be determined by actual test of each type and size of vent. These flow tests may be conducted by the manufacturer if certified by a qualified impartial observer, or may be conducted by a qualified, impartial outside agency. The flow capacity of tank venting devices 8 in. (20 cm) nominal pipe size and larger, including manhole covers with long bolts or equivalent, may be calculated provided that the opening pressure is actually measured, the rating pressure and corresponding free orifice area are stated, the word "calculated" appears on the nameplate, and the computation is based on a flow coefficient of 0.5 applied to the rated orifice area.

(b) A suitable formula for this calculation is:

$$CFH = 1{,}667\ C_f\ A\sqrt{P_t - P_a}$$

where CFH = venting requirement in cubic feet of free air per hour

C_f = 0.5 [the flow coefficient]

A = the orifice area in sq in.

P_t = the absolute pressure inside the tank in inches of water

P_a = the absolute atmospheric pressure outside the tank in inches of water

2-2.6 Vent Piping for Aboveground Tanks.

2-2.6.1 Vent piping shall be constructed in accordance with Chapter 3.

2-2.6.2 Where vent pipe outlets for tanks storing Class I liquids are adjacent to buildings or public ways, they shall be located so that the vapors are released at a safe point outside of buildings and not less than 12 ft (3.6 m) above the adjacent ground level. In order to aid their dispersion, vapors shall be discharged upward or horizontally away from closely adjacent walls. Vent outlets shall be located so that flammable vapors will not be trapped by eaves or other obstructions and shall be at least 5 ft (1.5 m) from building openings.

2-2.6.3 The manifolding of tank vent piping shall be avoided except where required for special purposes such as vapor recovery, vapor conservation or air pollution control. When tank vent piping is manifolded, pipe sizes shall be such as to discharge, within the pressure limitations of the system, the vapors they may be required to handle when manifolded tanks are subject to the same fire exposure.

2-2.6.4 Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II or Class III liquids unless positive means are provided to prevent the vapors from Class I liquids from entering tanks storing Class II or Class III liquids, to prevent contamination (*see 1-1.2*) and possible change in classification of the less volatile liquid.

2-2.7 Tank Openings Other Than Vents for Aboveground Tanks.

2-2.7.1 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.

2-2.7.2 Each connection below the liquid level through which liquid does not normally flow shall be provided with a liquidtight closure. This may be a valve, plug or blind, or a combination of these.

2-2.7.3 Openings for gaging on tanks storing Class I liquids shall be provided with a vaportight cap or cover. Such covers shall be closed when not gaging.

2-2.7.4 For Class IB and Class IC liquids other than crude oils, gasolines and asphalts, the fill pipe shall be so designed and installed as to minimize the possibility of generating static electricity. A fill pipe entering the top of a tank shall terminate within 6 in. (15 cm) of the bottom of the tank and shall be installed to avoid excessive vibration.

2-2.7.5 Filling and emptying connections for Class I, Class II and Class IIIA liquids which are made and broken shall be located outside of buildings at a location free from any source of ignition and not less than 5 ft (1.5 m) away from any building opening. Such connections for any liquid shall be closed and liquidtight when not in use and shall be properly identified.

2-3 Installation of Underground Tanks.

2-3.1 Location. Excavation for underground storage tanks shall be made with due care to avoid undermining of foundations of existing structures. Underground tanks or tanks under buildings shall be so located with respect to existing building foundations and supports that the loads carried by the latter cannot be transmitted to the tank. The distance from any part of a tank storing Class I liquids to the nearest wall of any basement or pit shall be not less than 1 ft (0.30 m), and to any property line that can be built upon, not less than 3 ft (0.90 m). The distance from any part of a tank storing Class II or Class III liquids to the nearest wall of any basement, pit or property line shall be not less than 1 ft (0.30 m).

2-3.2 Burial Depth and Cover.

2-3.2.1 Steel underground tanks shall be set on firm foundations and surrounded with at least 6 in. (15 cm) of noncorrosive inert material such as clean sand or gravel well-tamped in place. The tank shall be placed in the hole with care, since dropping or rolling the tank into the hole can break a weld, puncture or damage the tank, or scrape off the protective coating of coated tanks.

2-3.2.2 Steel underground tanks shall be covered with a minimum of 2 ft (0.60 m) of earth, or shall be covered with not less than 1 ft (0.30 m) of earth, on top of which shall be placed a slab of reinforced concrete not less than 4 in. (10 cm) thick. When they are, or are likely to be, subjected to traffic, they shall be protected against damage from vehicles passing over them by at least 3 ft (0.90 m) of earth cover, or 18 in. (45.7 cm) of well-tamped earth plus either 6 in. (15 cm) of reinforced concrete or 8 in. (20 cm) of asphaltic concrete. When asphaltic or reinforced concrete paving is used as part of the protection, it shall extend at least 1 ft (0.30 m) horizontally beyond the outline of the tank in all directions.

2-3.2.3 Nonmetallic underground tanks shall be installed in accordance with the manufacturer's instructions. The minimum depth of cover shall be as specified in 2-3.2.2 for steel tanks.

2-3.2.4 For tanks built in accordance with 2-1.3.1(a), the burial depth shall be such that the static head imposed at the bottom of the tank will not exceed 10 psig (68.9 kPa) if the fill or vent pipe are filled with liquid. If the depth of cover is greater than the tank diameter, the tank manufacturer shall be consulted to determine if reinforcement is required.

2-3.3 Corrosion Protection. Tanks and their piping shall be protected by either:

(a) A properly engineered, installed and maintained cathodic protection system in accordance with recognized standards of design, such as:

1) American Petroleum Institute Publication 1632-1983, *Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems.*

2) Underwriters Laboratories of Canada ULC-S603.1-M 1982, *Standard for Galvanic Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids.*

3) Steel Tank Institute Standard No. sti-P_3®, *Specifications for sti-P_3® System for External Corrosion Protection of Underground Steel Storage Tanks — 1983.*

4) National Association of Corrosion Engineers Standard RP-01-69 (1983 Rev.) Recommended Practice, *Control of External Corrosion of Underground or Submerged Metallic Piping Systems.*

(b) Corrosion resistant materials of construction such as special alloys, fiber glass reinforced plastic, or fiber glass reinforced plastic coatings, or equivalent approved system. Selection of the type of protection to be employed shall be based upon the corrosion history of the area and the judgment of a qualified engineer.

The authority having jurisdiction may waive the requirements for corrosion protection where evidence is provided that such protection is not necessary.

(*See API Publication 1615-1979, Installation of Underground Petroleum Storage Systems, for further information.*)

2-3.4 Abandonment or Reuse of Underground Tanks.

2-3.4.1 Underground tanks taken out of service shall be safeguarded or disposed of in a safe manner. (*See Appendix B.*)

2-3.4.2 Only those used tanks that comply with the applicable sections of this Code and are approved by the authority having jurisdiction shall be installed for flammable or combustible liquids service.

2-3.5 Vents for Underground Tanks.

2-3.5.1 Location and Arrangement of Vents for Class I Liquids. Vent pipes from underground storage tanks storing Class I liquids shall be so located 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. 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. Vent outlets and devices shall be protected to minimize the possibility of blockage from weather, dirt or insect nests, and shall be so located and directed that flammable vapors will not accumulate or travel to an unsafe location, enter building openings or be trapped under eaves. Tanks containing Class IA liquids shall be equipped with pressure and vacuum venting devices which shall be normally closed except when venting under pressure or vacuum conditions. Tanks storing Class IB or Class IC liquids shall be equipped with pressure-vacuum vents or with listed flame arresters. Tanks storing gasoline are exempt from the requirements for pressure and vacuum venting devices, except as required to prevent excessive back pressure, or flame arresters, provided the vent does not exceed 3 in. (7.6 cm) nominal inside diameter. (*See also 2-1.1 of NFPA 30A, Automotive and Marine Service Station Code.*)

2-3.5.2 Vent Capacity. Tank venting systems shall be provided with sufficient capacity to prevent blowback of vapor or liquid at the fill opening while the tank is being filled. Vent pipes shall not be less than 1¼ in. (3 cm) nominal inside diameter. The required venting capacity depends upon the filling or withdrawal rate, whichever is greater, and the vent line length. Unrestricted vent piping sized in accordance with Table 2-10 will prevent back-pressure development in tanks from exceeding 2.5 psig (17.2 kPa). Where tank venting devices are installed in vent lines, their flow capacities shall be determined in accordance with 2-2.5.9.

2-3.5.3 Location and Arrangement of Vents for Class II or Class IIIA Liquids. Vent pipes from tanks storing Class II or Class IIIA liquids shall terminate outside of

Table 2-10
Vent Line Diameters

Maximum Flow GPM	Pipe Length* 50 Ft	100 Ft	200 Ft
100	1 ¼-inch	1 ¼-inch	1 ¼-inch
200	1 ¼-inch	1 ¼-inch	1 ¼-inch
300	1 ¼-inch	1 ¼-inch	1 ½-inch
400	1 ¼-inch	1 ½-inch	2-inch
500	1 ½-inch	1 ½-inch	2-inch
600	1 ½-inch	2-inch	2-inch
700	2-inch	2-inch	2-inch
800	2-inch	2-inch	3-inch
900	2-inch	2-inch	3-inch
1,000	2-inch	2-inch	3-inch

SI Units: 1 in. = 2.5 cm; 1 ft = 0.30 m; 1 gal = 3.8 L.
*Vent lines of 50 ft, 100 ft and 200 ft of pipe plus 7 ells.

building and higher than the fill pipe opening. Vent outlets shall be above normal snow level. They may be fitted with return bends, coarse screens or other devices to minimize ingress of foreign material.

2-3.5.4 Vent piping shall be constructed in accordance with Chapter 3. Tank vent pipes and vapor return piping shall be installed without sags or traps in which liquid can collect. Condensate tanks, if utilized, shall be installed and maintained so as to preclude the blocking of the vapor return piping by liquid. The 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.

2-3.5.5 When tank vent piping is manifolded, pipe sizes shall be such as to discharge, within the pressure limitations of the system, the vapors they can be required to handle when manifolded tanks are filled simultaneously. Float-type check valves installed in tank openings connected to manifolded vent piping to prevent product contamination may be used provided that the tank pressure will not exceed that permitted by 2-3.2.4 when the valves close.

Exception: For service stations, the capacity of manifolded vent piping shall be sufficient to discharge vapors generated when two manifolded tanks are simultaneously filled.

2-3.5.6 Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II or Class III liquids unless positive means are provided to prevent the vapors from Class I liquids from entering tanks storing Class II or Class III liquids, to prevent contamination (*see 1-1.2*) and possible change in classification of the less volatile liquid.

2-3.6 Tank Openings Other Than Vents for Underground Tanks.

2-3.6.1 Connections for all tank openings shall be liquidtight.

2-3.6.2 Openings for manual gaging, if independent of the fill pipe, shall be provided with a liquidtight cap or cover. Covers shall be kept closed when not gaging. If inside a building, each such opening shall be protected against liquid overflow and possible vapor release by means of a spring loaded check valve or other approved device.

2-3.6.3 Fill and discharge lines shall enter tanks only through the top. Fill lines shall be sloped toward the tank. Underground tanks for Class I liquids having a capacity of more than 1,000 gal (3,785 L) shall be equipped with a tight fill device for connecting the fill hose to the tank.

2-3.6.4 For Class IB and Class IC liquids other than crude oils, gasolines and asphalts, the fill pipe shall be so designed and installed as to minimize the possibility of generating static electricity by terminating within 6 in. (15 cm) of the bottom of the tank.

2-3.6.5 Filling and emptying and vapor recovery connections for Class I, Class II or Class IIIA liquids which are made and broken shall be located outside of buildings at a location free from any source of ignition and not less than 5 ft (1.5 m) away from any building opening. Such connections shall be closed and liquidtight when not in use and shall be properly identified.

2-3.6.6 Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connection, or other approved device, unless the opening is pipe-connected to a vapor processing system. Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. All connections shall be vaportight.

2-4 Installation of Tanks Inside of Buildings.

2-4.1 Location. Tanks shall not be permitted inside of buildings except as provided in Chapters 5, 6, 7, 8 or NFPA 30A, *Automotive and Marine Service Station Code*.

2-4.2 Vents. Vents for tanks inside of buildings shall be as required in 2-2.4, 2-2.5, 2-2.6.2 and 2-3.5, except that emergency venting by the use of weak roof seams on tanks shall not be permitted. Automatic sprinkler systems designed in accordance with the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, may be accepted by the authority having jurisdiction as equivalent to water spray systems for purposes of calculating the required air flow rates for emergency vents in 2-2.5.7. Except for tanks containing Class IIIB liquids, vents shall terminate outside the buildings.

2-4.3 Vent Piping. Vent piping shall be constructed in accordance with Chapter 3.

2-4.4 Tank Openings Other Than Vents for Tanks Inside Buildings.

2-4.4.1 Connections for all tank openings shall be liquidtight.

2-4.4.2 Each connection to a tank inside of buildings 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.

2-4.4.3 Tanks for storage of Class I or Class II liquids inside buildings shall be provided with either:

(a) a normally closed remotely activated valve,

(b) an automatic-closing heat-activated valve, or

(c) another approved device on each liquid transfer connection below the liquid level, except for connections used for emergency disposal, to provide for quick cutoff of flow in the event of fire in the vicinity of the tank.

This function can be incorporated in the valve required in 2-4.4.2, and if a separate valve, shall be located adjacent to the valve required in 2-4.4.2.

2-4.4.4 Openings for manual gaging of Class I or Class II liquids, if independent of the fill pipe, shall be provided with a vaportight cap or cover. Openings shall be kept closed when not gaging. Each such opening for any liquid shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other approved device. Substitutes for manual gaging include, but are not limited to, heavy-duty flat gage glasses, magnetic, hydraulic or hydrostatic remote reading devices and sealed float gages.

2-4.4.5 For Class IB and Class IC liquids other than crude oils, gasolines and asphalts, the fill pipe shall be so designed and installed as to minimize the possibility of generating static electricity by terminating within 6 in. (15 cm) of the bottom of the tank.

2-4.4.6 The fill pipe inside of the tank shall be installed to avoid excessive vibration of the pipe.

2-4.4.7 The inlet of the fill pipe and the outlet of a vapor recovery line for which connections are made and broken shall be located outside of buildings at a location free from any source of ignition and not less than 5 ft (1.5 m) away from any building opening. Such connections shall be closed and tight when not in use and shall be properly identified.

2-4.4.8 Tanks storing Class I, Class II and Class IIIA liquids inside buildings shall be equipped with a device, or other means shall be provided, to prevent overflow into the building. Suitable devices include, but are not limited to, a float valve, a preset meter on the fill line, a valve actuated by the weight of the tank contents, a low head pump which is incapable of producing overflow, or a liquidtight overflow pipe at least one pipe size larger than the fill pipe discharging by gravity back to the outside source of liquid or to an approved location.

2-4.4.9 Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connections, or other approved device, unless the opening is pipe-connected to a vapor processing system. Openings designed for combined fill and vapor recovery shall also be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. All connections shall be vaportight.

2-5 Supports, Foundations and Anchorage for All Tank Locations.

2-5.1 Tanks shall rest on the ground or on foundations made of concrete, masonry, piling or steel. 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. Appendix E of API Standard 650-1980, *Specification for Welded Steel Tanks for Oil Storage*, and Appendix B of API Standard 620-1982, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, provide information on tank foundations.

2-5.2 When tanks are supported above the foundations, tank supports shall be installed on firm foundations. Supports for tanks storing Class I, Class II or Class IIIA liquids shall be of concrete, masonry or protected steel. Single wood timber supports (not cribbing) laid horizontally may be used for outside aboveground tanks if not more than 12 in. (0.30 m) high at their lowest point.

2-5.3 Steel supports or exposed piling for tanks storing Class I, Class II or Class IIIA liquids shall be protected by materials having a fire resistance rating of not less than 2 hrs, except that steel saddles need not be protected if less than 12 in. (0.30 m) high at their lowest point. At the discretion of the authority having jurisdiction, water spray protection in accordance with NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, or NFPA 13, *Standard for the Installation of Sprinkler Systems*, or equivalent may be used.

2-5.4 The design of the supporting structure for tanks such as spheres shall require special engineering consideration. Appendix N of the API Standard 620-1982, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, contains information regarding supporting structures.

2-5.5 Every tank shall be so supported as to prevent the excessive concentration of loads on the supporting portion of the shell.

2-5.6 Tanks in Areas Subject to Flooding.

2-5.6.1 Where a tank is located in an area subject to flooding, provisions shall be taken to prevent tanks, either full or empty, from floating during a rise in water level up to the established maximum flood stage.

2-5.6.2 Aboveground Tanks.

2-5.6.2.1 Each vertical tank shall be located so that its top extends above the maximum flood stage by at least 30 percent of its allowable storage capacity.

2-5.6.2.2 Horizontal tanks located so that more than 70 percent of the tank's storage capacity will be submerged at the established flood stage shall be anchored; attached to a foundation of concrete or of steel and concrete of sufficient weight to provide adequate load for the tank when filled with flammable or combustible liquid and submerged by flood water to the established flood stage; or adequately secured from floating by other means. Tank vents or other openings which are not liquidtight shall be extended above maximum flood stage water level.

2-5.6.2.3 A dependable water supply shall be available for filling an empty or partially filled tank, except that where filling the tank with water is impractical or hazardous because of the tank's contents, tanks shall be protected by other means against movement or collapse.

2-5.6.2.4 Spherical or spheroid tanks shall be protected by applicable methods as specified for either vertical or horizontal tanks.

2-5.6.3 Underground Tanks.

2-5.6.3.1 At locations where there is an ample and dependable water supply available, underground tanks containing flammable or combustible liquids, so placed that more than 70 percent of their storage capacity will be submerged at the maximum flood stage, shall be so anchored, weighted or secured as to prevent movement when filled or loaded with water and submerged by flood water to the established flood stage. Tank vents or other openings which are not liquidtight shall be extended above maximum flood stage water level.

2-5.6.3.2 At locations where there is no ample and dependable water supply or where filling of underground tanks with water is impractical because of the contents, each tank shall be safeguarded against movement when empty, and submerged by high ground water or flood water by anchoring or by securing by other means. Each such tank shall be so constructed and installed that it will safely resist external pressures if submerged.

2-5.6.4 Water Loading. The filling of a tank to be protected by water loading shall be started as soon as flood waters are predicted to reach a dangerous flood stage. Where independently fueled water pumps are relied upon, sufficient fuel shall be available at all times to permit continuing operations until all tanks are filled. Tank valves shall be closed and locked in closed position when water loading has been completed.

2-5.6.5 Operating Instructions.

2-5.6.5.1 Operating instructions or procedures to be followed in a flood emergency shall be readily available.

2-5.6.5.2 Personnel relied upon to carry out flood emergency procedures shall be informed of the location and operation of valves and other equipment necessary to effect the intent of these requirements.

2-5.7 In areas subject to earthquakes, the tank supports and connections shall be designed to resist damage as a result of such shocks.

2-6 Sources of Ignition.

2-6.1 In locations where flammable vapors may be present, precautions shall be taken to prevent ignition by eliminating or controlling sources of ignition. Sources of ignition may include open flames, lightning, smoking, cutting and welding, hot surfaces, frictional heat, sparks (static, electrical and mechanical), spontaneous ignition, chemical and physical-chemical reactions and radiant heat. NFPA 77, *Recommended Practice on Static Electricity*, and NFPA 78, *Lightning Protection Code*, provide information on such protection.

2-7 Testing.

2-7.1 All tanks, whether shop-built or field-erected, shall be tested before they are placed in service in accordance with the applicable paragraphs of the Code under which they were built. The ASME Code stamp or the Listing Mark of Underwriters Laboratories Inc. on a tank shall be evidence of compliance with this test. Tanks not marked in accordance with the above Codes shall be tested before they are placed in service in accordance with good engineering principles and reference shall be made to the sections on testing in the Codes listed in 2-1.3.1, 2-1.4.2, or 2-1.5.2.

2-7.2 When the vertical length of the fill and vent pipes is such that when filled with liquid the static head imposed upon the bottom of the tank exceeds 10 lbs per sq in. (68.9 kPa), the tank and related piping shall be tested hydrostatically to a pressure equal to the static head thus imposed. In special cases where the height of the vent above the top of the tank is excessive, the hydrostatic test pressure shall be determined by using recognized engineering practice.

2-7.3 In addition to the test called for in 2-7.1 and 2-7.2, all tanks and connections shall be tested for tightness. Except for underground tanks, this tightness shall be made at operating pressure with air, inert gas or water prior to placing the tank in service. In the case of field-erected tanks the test called for in 2-7.1 or 2-7.2 may be considered to be the test for tank tightness. Underground tanks and piping, before being covered, enclosed, or placed in use, shall be tested for tightness hydrostatically, or with air pressure at not less than 3 lbs per sq in. (20.6 kPa) and not more than 5 lbs per sq in. (34.5 kPa). (*See 3-7.1 for testing pressure piping.*)

2-7.4 Before the tank is initially placed in service, all leaks or deformations shall be corrected in an acceptable manner. Mechanical caulking is not permitted for correcting leaks in welded tanks except pinhole leaks in the roof.

2-7.5 Tanks to be operated at pressures below their design pressure may be tested by the applicable provisions of 2-7.1 or 2-7.2 based upon the pressure developed under full emergency venting of the tank.

2-8 Fire Protection and Identification.

2-8.1 A fire extinguishing system in accordance with an applicable NFPA standard shall be provided or be available for vertical atmospheric fixed roof storage tanks larger than 50,000 gal (189,250 L) capacity storing Class I liquids if located in a congested area where there is an unusual exposure hazard to the tank from adjacent property or to adjacent property from the tank. Fixed roof tanks storing Class II or III liquids at temperatures below their flash points and floating roof tanks storing any liquid generally do not require protection when installed in compliance with Section 2-2.

2-8.2 The application of NFPA 704, *Identification of the Fire Hazards of Materials*, to storage tanks containing liquids shall not be required except when the contents have a health or reactivity degree of hazard of 2 or more

or a flammability rating of 4. The marking need not be applied directly to the tank but located where it can readily be seen, such as on 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 readily be identified.

2-9 Prevention of Overfilling of Tanks.

2-9.1 Terminals receiving transfer of Class I liquids from mainline pipelines or marine vessels shall follow formal written procedures to prevent overfilling of tanks utilizing one of the following methods of protection:

(a) Tanks gaged at frequent intervals by personnel continuously on the premises during product receipt with frequent acknowledged communication maintained with the supplier so that flow can be promptly shut down or diverted.

(b) Tanks equipped with a high level detection device which is independent of any tank gaging equipment. Alarms shall be located where personnel who are on duty throughout product transfer can promptly arrange for flow stoppage or diversion.

(c) Tanks equipped with an independent high level detection system that will automatically shut down or divert flow.

(d) Alternatives to instrumentation described in (b) and (c) where approved by the authority having jurisdiction as affording equivalent protection.

2-9.1.1 Instrumentation systems covered in 2-9.1(b) and (c) shall be electrically supervised or equivalent.

2-9.2 Formal written procedures required in 2-9.1 shall include:

(a) Instructions covering methods to check for proper line up and receipt of initial delivery to tank designated to receive shipment.

(b) Provision for training and monitoring the performance of operating personnel by terminal supervision.

(c) Schedules and procedures for inspection and testing of gaging equipment and high level instrumentation and related systems. Inspection and testing intervals shall be acceptable to the authority having jurisdiction, but shall not exceed one year.

2-10 Leakage Detection and Inventory Records for Underground Tanks.

2-10.1 Accurate inventory records or a leak detection program shall be maintained on all Class I Liquid Storage Tanks for indication of possible leakage from the tanks or associated piping. (*See NFPA 329, Underground Leakage of Flammable and Combustible Liquids.*)

Chapter 3 Piping, Valves and Fittings

3-1 General.

3-1.1 The design, fabrication, assembly, test and inspection of piping systems containing liquids shall be suitable for the expected working pressures and structural stresses. Conformity with the applicable sections of ANSI B31, *American National Standard Code for Pressure Piping*, and the provisions of this chapter shall be considered prima facie evidence of compliance with the foregoing provisions.

3-1.2 This chapter does not apply to any of the following:

(a) Tubing or casing on any oil or gas wells and any piping connected directly thereto.

(b) Motor vehicle, aircraft, boat or portable or stationary engine.

(c) Piping within the scope of any applicable boiler and pressure vessel code.

3-1.3 Piping systems consist of pipe, tubing, flanges, bolting, gaskets, valves, fittings, the pressure containing parts of other components such as expansion joints and strainers, and devices which serve such purposes as mixing, separating, snubbing, distributing, metering, or controlling flow.

3-2 Materials for Piping, Valves and Fittings.

3-2.1 Pipe, valves, faucets, fittings and other pressure containing parts as covered in 3-1.3 shall meet the material specifications and pressure and temperature limitations of ANSI B31.3-1980, *Petroleum Refinery Piping*, or ANSI B31.4-1979, *Liquid Petroleum Transportation Piping Systems*, except as provided by 3-2.2, 3-2.3, and 3-2.4. Plastic or similar materials, as permitted by 3-2.4, shall be designed to specifications embodying recognized engineering principles and shall be compatible with the fluid service.

3-2.2 Nodular iron shall conform to ASTM A395—80, *Ferritic Ductile Iron Pressure Retaining Castings for Use at Elevated Temperatures.*

3-2.3 Valves at storage tanks, as required by 2-2.7.1 and 2-4.4.2, and their connections to the tank shall be of steel or nodular iron except as provided in 3-2.3.1 or 3-2.3.2.

3-2.3.1 Valves at storage tanks may be other than steel or nodular iron when the chemical characteristics of the liquid stored are not compatible with steel or when installed internally to the tank. When installed externally to the tank, the material shall have a ductility and melting point comparable to steel or nodular iron so as to withstand reasonable stresses and temperatures involved in fire exposure, or otherwise be protected such as by materials having a fire resistance rating of not less than 2 hrs.

3-2.3.2 Cast iron, brass, copper, aluminum, malleable iron, and similar materials may be used on tanks described in 2-2.2.2 or for tanks storing Class IIIB liquids when the tank is located outdoors and not within a diked area or drainage path of a tank storing a Class I, Class II or Class IIIA liquid.

3-2.4 Low melting point materials, such as aluminum, copper and brass; or materials which soften on fire exposure, such as plastics; or nonductile material, such as cast iron, may be used underground for all liquids within the pressure and temperature limits of ANSI B31, *American National Standard Code for Pressure Piping.* If such materials are used outdoors in aboveground piping systems handling Class I, Class II or Class IIIA liquids or within buildings handling any liquid, they shall be either: (a) suitably protected against fire exposure, or (b) so located that any leakage resulting from the failure would not unduly expose persons, important buildings or structures, or (c) located where leakage can readily be controlled by operation of an accessible remotely located valve or valves.

3-2.5 Piping, valves and fittings may have combustible or noncombustible linings.

3-3 Pipe Joints.

3-3.1 Joints shall be made liquidtight and shall be either welded, flanged or threaded, except that listed flexible connectors may be used when installed in accordance with 3-3.2. Threaded joints shall be made up tight with a suitable thread sealant or lubricant. Joints in piping systems handling Class I liquids shall be welded when located in concealed spaces within buildings.

3-3.2 Pipe joints dependent upon the friction characteristics or resiliency of combustible materials for mechanical continuity or liquidtightness of piping shall not be used inside buildings. They may be used outside of buildings above or below ground. If used aboveground outside of buildings, the piping shall either be secured to prevent disengagement at the fitting, or the piping system shall be so designed that any spill resulting from disengagement could not unduly expose persons, important buildings or structures, and could be readily controlled by remote valves.

3-4 Supports.

3-4.1 Piping systems shall be substantially supported and protected against physical damage and excessive stresses arising from settlement, vibration, expansion or contraction. The installation of nonmetallic piping shall be in accordance with the manufacturer's instructions.

3-5 Protection Against Corrosion.

3-5.1 All piping for liquids, both aboveground and underground, where subject to external corrosion, shall be painted or otherwise protected. (*See 2-3.3 for protection of piping connected to underground tanks.*)

3-6 Valves.

3-6.1 Piping systems shall contain a sufficient number of valves to operate the system properly and to protect the plant. Piping systems in connection with pumps shall contain a sufficient number of valves to control properly the flow of liquid in normal operation and in the event of physical damage. Each connection to piping by which equipment such as tank cars, tank vehicles or marine vessels discharge liquids into storage tanks shall be provided with a check valve for automatic protection against back-flow if the piping arrangement is such that back-flow from the system is possible. (*See also 2-2.7.1.*)

3-7 Testing.

3-7.1 Unless tested in accordance with the applicable sections of ANSI B31, *American National Standard Code for Pressure Piping*, all piping before being covered, enclosed or placed in use shall be hydrostatically tested to 150 percent of the maximum anticipated pressure of the system, or pneumatically tested to 110 percent of the maximum anticipated pressure of the system, but not less than 5 lbs per sq in. (34.5 kPa) gage at the highest point of the system. This test shall be maintained for a sufficient time to complete visual inspection of all joints and connections, but for at least 10 minutes.

Chapter 4 Container and Portable Tank Storage

4-1 Scope.

4-1.1 This chapter shall apply to the storage of liquids, including flammable aerosols, in drums or other containers not exceeding 60 gal (227 L) individual capacity and portable tanks not exceeding 660 gal (2,498 L) individual capacity and limited transfers incidental thereto. For portable tanks exceeding 660 gal (2,498 L), Chapter 2 shall apply.

4-1.2 This chapter shall not apply to the following:

(a) Storage of containers in bulk plants, service stations, refineries, chemical plants and distilleries.

(b) Liquids in the fuel tanks of motor vehicles, aircraft, boats or portable or stationary engines.

(c) Beverages when packaged in individual containers not exceeding a capacity of one gallon.

(d) Medicines, foodstuffs, cosmetics and other consumer products containing not more than 50 percent by volume of water miscible liquids and with the remainder of the solution not being flammable when packaged in individual containers not exceeding one gallon in size.

(e) The storage of liquids that have no fire point when tested by ASTM D 92-78, the Cleveland Open Cup Test Method, up to the boiling point of the liquid, or up to a temperature at which the sample being tested shows an obvious physical change.

(f) The storage of distilled spirits and wines in wooden barrels or casks.

4-1.3 For the purpose of this chapter, unstable liquids and flammable aerosols shall be treated as Class IA liquids.

4-2 Design, Construction, and Capacity of Containers.

4-2.1 Only approved containers and portable tanks shall be used. Metal containers and portable tanks meeting the requirements of, and containing products authorized by, Chapter I, Title 49 of the *Code of Federal Regulations* (DOT Regulations), or NFPA 386, *Standard for Portable Shipping Tanks*, shall be acceptable. Polyethylene containers meeting the requirements of, and containing products authorized by, DOT Specification 34, and polyethylene drums authorized by DOT Exemption Procedures, shall be acceptable. Plastic containers meeting the requirements of ANSI/ASTM D3435-80, *Plastic Containers (Jerry Cans) for Petroleum Products*, used for petroleum products within the scope of that specification shall be acceptable.

4-2.2 Each portable tank 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 10 psig (68.9 kPa), or 30 percent of the bursting pressure of the tank, whichever is greater. The total venting capacity shall be not less than that specified in 2-2.5.4 or 2-2.5.6. At least one pressure-actuated vent having a minimum capacity of 6,000 cu ft (170 m^3) of free air per hour [14.7 psia (760 mm Hg) and 60°F (15.6°C)] shall be used. It shall be set to open at not less than 5 psig (34.5 kPa). If fusible vents are used, they shall be actuated by elements that operate at a temperature not exceeding 300°F (148.9°C). When used for paints, drying oils and similar materials where plugging of the pressure-actuated vent can occur, fusible vents or vents of the type that soften to failure at a maximum of 300°F (148.9°C) under fire exposure may be used for the entire emergency venting requirement.

4-2.3 Containers and portable tanks for liquids shall conform to Table 4-2.3 except as provided in 4-2.3.1 or 4-2.3.2.

Table 4-2.3
Maximum Allowable Size of Containers and Portable Tanks

	Flammable Liquids			Combustible Liquids	
Container Type	Class IA	Class IB	Class IC	Class II	Class III
Glass	1 pt	1 qt	1 gal	1 gal	5 gal
Metal (other than DOT drums) or approved plastic	1 gal	5 gal	5 gal	5 gal	5 gal
Safety Cans	2 gal	5 gal	5 gal	5 gal	5 gal
Metal Drum (DOT Spec.)	60 gal	60 gal	60 gal	60 gal	60 gal
Approved Portable Tanks	660 gal	660 gal	660 gal	660 gal	660 gal
Polyethylene DOT Spec. 34, or as authorized by DOT Exemption	1 gal	5 gal	5 gal	60 gal	60 gal

SI Units: 1 pt = 0.473 L; 1 qt = 0.95 L; 1 gal = 3.8 L.

4-2.3.1 Medicines, beverages, foodstuffs, cosmetics and other common consumer products, when packaged according to commonly accepted practices for retail sales, shall be exempt from the requirements of 4-2.1 and 4-2.3.

4-2.3.2 DOT Type III polyethylene nonreusable containers, constructed and tested in accordance with DOT specification 2U, treated if necessary to prevent permeation, may be used for storage of Class II and Class III liquids, in all capacities not to exceed 2½ gal.

4-2.3.3 Class IA and Class IB liquids may be stored in glass containers of not more than one gallon capacity if the required liquid purity (such as ACS analytical reagent grade or higher) would be affected by storage in metal containers or if the liquid would cause excessive corrosion of the metal container.

4-3 Design, Construction, and Capacity of Storage Cabinets.

4-3.1 Not more than 120 gal (454 L) of Class I, Class II and Class IIIA liquids may be stored in a storage cabinet. Of this total, not more than 60 gal (227 L) may be of Class I and Class II liquids and not more than three (3) such cabinets may be located in a single fire area, except that, in an industrial occupancy, additional cabinets may be located in the same fire area if the additional cabinet, or group of not more than three (3) cabinets, is separated from other cabinets or group of cabinets by at least 100 ft (30 m).

4-3.2 Storage cabinets shall be designed and constructed to limit the internal temperature at the center, 1 in. (2.5 cm) from the top to not more than 325°F (162.8°C) when subjected to a 10-minute fire test with burners simulating a room fire exposure using the standard time-temperature curve as given in ASTM E152—81a. All joints and seams shall remain tight and the door shall remain securely closed during the fire test. Cabinets shall be labeled in conspicuous lettering, "FLAMMABLE — KEEP FIRE AWAY." The cabinet is not required to be vented.

4-3.2.1 Metal cabinets constructed in the following manner are acceptable. The bottom, top, door and sides of cabinet shall be at least No. 18 gage sheet steel and double walled with 1½ in. (3.8 cm) 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. (5 cm) above the bottom of the cabinet to retain spilled liquid within the cabinet.

4-3.2.2 Wooden cabinets constructed in the following manner are acceptable. The bottom, sides and top shall be constructed of exterior grade plywood at least 1 in. (2.5 cm) in thickness, which shall not break down or delaminate under fire conditions. All joints shall be rabbetted and shall be fastened in two directions with wood screws. When more than one door is used, there shall be a rabbetted overlap of not less than 1 in. (2.5 cm). 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. (5-cm) depth of liquid shall be provided at the bottom of the cabinet to retain spilled liquid within the cabinet.

4-3.2.3 Listed cabinets which have been constructed and tested in accordance with 4-3.2 shall be acceptable.

4-4 Design, Construction, and Operation of Separate Inside Storage Areas. *(See Section 1-2, Definitions.) (For additional information, see Appendix C.)*

4-4.1 Inside Rooms.

4-4.1.1 Inside rooms shall be constructed to meet the selected fire resistance rating as specified in 4-4.1.4. Such construction shall comply with the test specifications given in NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*. Except for drains, floors shall be liquidtight and the room shall be liquidtight where the walls join the floor. Where an automatic fire protection system is provided, as indicated in 4-4.1.4, the system shall be designed and installed in accordance with the appropriate NFPA standard for the type of system selected.

4-4.1.2 Openings in interior walls to adjacent rooms or buildings shall be provided with:

(a) Normally closed, listed 1½ hr (B) fire doors for interior walls with fire resistance rating of 2 hr or less. Where interior walls are required to have greater than 2 hr fire resistance rating, the listed fire doors shall be compatible with the wall rating. Doors may be arranged to stay open during material handling operations if doors are designed to close automatically in a fire emergency by provision of listed closure devices. Fire doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Windows*.

(b) Noncombustible liquidtight raised sills or ramps at least 4 in. (10 cm) in height or otherwise designed to prevent the flow of liquids to the adjoining areas. A permissible alternative to the sill or ramp is an open-grated trench, which drains to a safe location, across the width of the opening inside of room.

4-4.1.3 Wood at least 1 in. (2.5 cm) nominal thickness may be used for shelving, racks, dunnage, scuffboards, floor overlay and similar installations.

4-4.1.4 Storage in inside rooms shall comply with the following:

Automatic Fire Protection* Provided	Fire Resistance	Maximum Floor Area	Total Allowable Quantities — Gallons/ Sq Ft/Floor Area
YES	2 hr	500 sq ft	10
NO	2 hr	500 sq ft	4**
YES	1 hr	150 sq ft	5
NO	1 hr	150 sq ft	2

SI Units: 1 sq ft = 0.09 m²; 1 gal = 3.8 L.

*Fire protection system shall be sprinkler, water spray, carbon dioxide, dry chemical, halon or other approved system.

**Total allowable quantities of Class IA and IB Liquids shall not exceed that permitted in Table 4-4.2.7 and the provisions of 4-4.2.9.

4-4.1.5 Electrical wiring and equipment located in inside rooms used for Class I liquids shall be suitable for Class I, Division 2 classified locations; for Class II and Class III liquids, shall be suitable for general use. NFPA 70, *National Electrical Code®*, provides information on the design and installation of electrical equipment.

4-4.1.6 Every inside room shall be provided with either a gravity or a continuous mechanical exhaust ventilation system. Mechanical ventilation shall be used if Class I liquids are dispensed within the room.

(a) Exhaust air shall be taken from a point near a wall on one side of the room and within 12 in. (30 cm) of the floor with one or more make-up inlets located on the opposite side of the room within 12 in. (30 cm) from the floor. The location of both the exhaust and inlet air openings shall be arranged to provide, as far as practicable, air movements across all portions of the floor to prevent accumulation of flammable vapors. Exhaust from the room shall be directly to the exterior of the building without recirculation.

Exception: Recirculation is permitted where 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 concentration over one-fourth of the lower flammable limit are detected.

If ducts are used, they shall not be used for any other purpose and shall comply with NFPA 91, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*. If make-up air to a mechanical system is taken from within the building,

the opening shall be equipped with a fire door or damper, as required in NFPA 91, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying*. For gravity systems, the make-up air shall be supplied from outside the building.

(b) Mechanical ventilation systems shall provide at least one cubic foot per minute of exhaust per square foot of floor area (1 m^3 per 3 m^2), but not less than 150 CFM (4 m^3). The mechanical ventilation system for dispensing areas shall be equipped with an airflow switch or other equally reliable methods which is interlocked to sound an audible alarm upon failure of the ventilation system.

4-4.1.7 In every inside room, an aisle at least 3 ft (0.90 m) wide shall be maintained so that no container is more than 12 ft (3.6 m) from the aisle. Containers over 30 gal (113.5 L) capacity storing Class I or Class II liquids shall not be stored more than one container high.

4-4.1.8 Where dispensing is being done in inside rooms, operations shall comply with the provisions of Chapter 5.

4-4.1.9 Basement Storage Areas. Class I liquids shall not be permitted in inside storage rooms in basement areas.

4-4.2 Cutoff Rooms and Attached Buildings.

4-4.2.1 Construction design of exterior walls shall provide ready accessibility for fire fighting operations through provision of access openings, windows or lightweight noncombustible wall panels. Where Class IA or IB liquids are dispensed, or where Class IA liquids are stored in containers larger than one gallon, the exterior wall or roof construction shall be designed to include explosion venting features, such as lightweight wall assemblies, lightweight roof assemblies, roof hatches or windows of the explosion venting type. NFPA 68, *Guide for Explosion Venting*, provides information on this subject.

4-4.2.2 Where other portions of buildings or other properties are exposed, each opening in the exposing wall shall be protected with a listed 1½ hr (D) fire door installed in accordance with NFPA 80, *Standard for Fire Doors and Windows*, and the walls shall have a fire resistance rating of not less than 2 hr.

4-4.2.3 Except as noted in 4-4.2.6, interior walls, ceiling and floors shall have a fire resistance rating of not less than 2 hrs where floor area of the room or building exceeds 300 sq ft (27 m^2) or a fire resistance rating of not less than one hour for a floor area of 300 sq ft (27 m^2) or less. Such construction shall comply with the test specifications given in NFPA 251, *Standard Methods of Fire Tests of Building Construction and Materials*. Walls shall be liquidtight at the floor level.

4-4.2.4 Openings in interior walls to adjacent rooms or buildings shall be in accordance with 4-4.1.2 (a).

4-4.2.5 Curbs, scuppers, special drains or other suitable means shall be provided to prevent the flow of liquids under emergency conditions into adjacent building areas except where the individual container capacity is 5 gal (18.9 L) or less or if the liquids stored are only Class III liquids. The drainage system, if used, shall have sufficient capacity to carry off expected discharge of water from fire protection systems and hose streams.

4-4.2.6 Roofs of attached buildings, one story in height, may be lightweight noncombustible construction if the separating interior wall as specified in 4-4.2.3 has a minimum 3-ft (0.90-m) parapet.

4-4.2.7 Unprotected storage in cutoff rooms and attached buildings shall comply with Table 4-4.2.7. (*See 4-4.2.10 for mixed storage of liquids.*)

4-4.2.8 Protected storage in cutoff rooms and attached buildings shall comply with Section 4-6 as applicable. (*See 4-4.2.10 for mixed storage of liquids.*)

4-4.2.9 Wood at least 1-in. (2.5-cm) nominal thickness may be used for shelving, racks, dunnage, scuffboards, floor overlay and similar installations.

4-4.2.10 Where two or more classes of liquids are stored in a single pile or rack section, the maximum quantities and height of storage permitted in that pile or rack sec-

Table 4-4.2.7 Indoor Unprotected Storage of Liquids in Containers and Portable Tanks

	Container Storage			Portable Tank Storage		
Class	Max. Pile Height (ft)	Max. Quant. per Pile (gal)	Max. Total Quant. (gal)	Max. Pile Height (ft)	Max. Quant. per Pile (gal)	Max. Total Quant. (gal)
IA	5	660	660	—	Not Permitted	—
IB	5	1,375	1,375	7	2,000	2,000
IC	5	2,750	2,750	7	4,000	4,000
II	10	4,125	8,250	7	5,500	11,000
IIIA	15	13,750	27,500	7	22,000	44,000
IIIB	15	13,750	55,000	7	22,000	88,000

SI Units: 1 ft = 0.30 m; 1 gal = 3.8 L.

tion shall be the smallest of the two or more separate quantities and heights. The maximum total quantities permitted shall be limited to a sum of proportional amounts that each class of liquid present bears to the maximum total permitted for its respective class; sum of proportional amounts not to exceed 100 percent.

4-4.2.11 Dispensing operations of Class I or Class II liquids are not permitted in cutoff rooms or attached buildings exceeding 1000 sq ft (93 m²) floor area. In rooms where dispensing of Class I liquids is permitted, electrical systems shall comply with 4-4.1.5, except that within 3 ft (0.90 m) of a dispensing nozzle area, the electrical system shall be suitable for Class I Division I; ventilation shall be provided per 4-4.1.6; and operations shall comply with the provisions of Chapter 5.

4-4.2.12 Basement Storage Areas. Class I liquids shall not be permitted in the basement areas of cutoff rooms and attached buildings. Class II and Class IIIA liquids may be stored in basements provided that automatic sprinkler protection and other fire protection facilities are provided in accordance with Section 4-6.

4-5 Indoor Storage.

4-5.1 Basic Conditions.

4-5.1.1 The storage of any liquids shall not physically obstruct a means of egress. Class I liquids in other than separate inside storage areas or warehouses shall be so placed that a fire in the liquid storage would not preclude egress from the area.

4-5.1.2 The storage of liquids in containers or portable tanks shall comply with 4-5.2 through 4-5.7 as applicable. Where separate inside storage areas are required, they shall conform to Section 4-4. Where other factors substantially increase or decrease the hazard, the authority having jurisdiction may modify the quantities specified.

4-5.1.3 Liquids used for building maintenance painting or other similar infrequent maintenance purposes may be stored temporarily in closed containers outside of storage cabinets or separate inside storage areas, if limited in amount, not to exceed a 10-day supply at anticipated rates of consumption.

4-5.2 Dwellings and Residential Buildings Containing Not More Than Three Dwelling Units and Accompanying Attached and Detached Garages. Storage in excess of 25 gal (94.6 L) of Class I and Class II liquids combined shall be prohibited. In addition, storage in excess of 60 gal (227 L) of Class IIIA liquid shall be prohibited.

4-5.3 Assembly Occupancies, Buildings Containing More Than Three Dwelling Units, and Hotels. Storage in excess of 10 gal (37.8 L) of Class I and Class II liquids combined or 60 gal (227 L) of Class IIIA liquids shall be in containers stored in storage cabinets, in safety cans, or in a separate inside storage area not having an opening communicating with that portion of the building used by the public.

4-5.4 Office, Educational and Institutional Occupancies. Storage shall be limited to that required for operation of office equipment, maintenance, demonstration and laboratory work. This storage shall comply with the provisions of 4-5.4.1 through 4-5.4.4 except that the storage for industrial and educational laboratory work shall comply with NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals.*

4-5.4.1 Containers for Class I liquids outside of a separate inside storage area shall not exceed a capacity of 1 gal (3.8 L) except that safety cans can be of 2 gal (7.6 L) capacity.

4-5.4.2 Not more than 10 gal (37.8 L) of Class I and Class II liquids combined shall be stored in a single fire area outside of a storage cabinet or a separate inside storage area unless in safety cans.

4-5.4.3 Not more than 25 gal (94.6 L) of Class I and Class II liquids combined shall be stored in a single fire area in safety cans outside of a separate inside storage area or storage cabinet.

4-5.4.4 Not more than 60 gal (227 L) of Class IIIA liquids shall be stored outside of a separate inside storage area or storage cabinet.

4-5.5 Mercantile Occupancies and Retail Stores and Other Related Areas Accessible to the Public.

4-5.5.1 In rooms or areas accessible to the public, storage of Class I, Class II and Class IIIA liquids shall be limited to quantities needed for display and normal merchandising purposes but shall not exceed 2 gal per sq ft (81 L per m²) of gross floor area. Storage of Class IA liquids shall be prohibited in basement display areas and limited to 1 gal per sq ft (40 L per m²) on other floors. In areas not protected, storage of Class IB, IC and II liquids on other than the ground floor shall be limited to 1 gal per sq ft (40 L per m²) of gross floor area. Protected shall mean protected with automatic sprinklers installed at least in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, requirements for ordinary hazard Group 2 occupancies. The gross floor area used for computing the maximum quantity permitted shall be considered as that portion of the floor actually being used for merchandising liquids and immediately adjacent aisles.

4-5.5.2 The aggregate quantity of additional stock in areas not accessible to the public shall not exceed the greater of that which would be permitted if the area were accessible to the public, or 60 gal (227 L) of Class IA, 120 gal (454 L) of Class IB, 180 gal (681 L) of Class IC, 240 gal (908 L) of Class II, or 660 gal (2498 L) of Class IIIA liquids, or 240 gal (908 L) in any combination of Class I and Class II liquids subject to the limitations of the individual class. These quantities may be doubled for areas protected as defined in 4-5.5.1. Storage of Class IA liquids shall be prohibited in basement storage areas.

4-5.5.3 Quantities in excess of those permitted in 4-5.5.2 shall be stored in accordance with other appropriate sections of this code.

4-5.5.4 Containers shall not be stacked more than 3 ft (0.90 m) or 2 containers high, whichever is the greater,

unless on fixed shelving or otherwise satisfactorily secured.

4-5.5.5 Shelving shall be of stable construction, of sufficient depth and arrangement such that containers displayed thereon shall not easily be displaced.

4-5.5.6 Leaking containers shall be removed immediately to an adequately ventilated area, and the contents transferred to an undamaged container.

4-5.6 General Purpose Warehouses. (*See 1-2 Definitions.*)

4-5.6.1 General purpose warehouses shall be separate, detached buildings or shall be separated from other type occupancies by a standard 4 hr fire wall, or, if approved, a fire partition having a fire resistance rating of not less than 2 hr. Each opening in a fire wall shall be protected with an automatic closing listed 3 hr (A) fire door with the fusible link or other automatic actuating mechanism located in the opening or on both sides of the opening. Each opening in a fire partition shall be protected with an automatic-closing listed 1½ hr (B) fire door. The doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Windows.*

4-5.6.2 Warehousing operations that involve storage of liquids shall be restricted to separate inside storage areas or to liquid warehouses in accordance with Section 4-4 or 4-5.7, as applicable, except as provided in 4-5.6.3.

4-5.6.3 Class IB and IC liquids in containers of 1 gal (3.8 L) or less capacity, Class II liquids in containers of 5 gal (18.9 L) or less capacity, Class III liquids in containers of 60 gal (227 L) or less capacity may be stored in warehouses handling combustible commodities, as defined in the scope of NFPA 231, *Standard for Indoor General Storage*, provided that the storage area is protected with automatic sprinklers in accordance with the provisions of this standard for 20 ft (6 m) storage of Class IV commodities and the quantities and height of liquid storage are limited to:

(a) Class IB & IC 660 gal (2498 L) — 5 ft (1.5 m) high

(b) Class II 1375 gal (5204 L) — 5 ft (1.5 m) high

(c) Class IIIA 2750 gal (10409 L) — 10 ft (3.0 m) high

(d) Class IIIB 13,750 gal (52044 L) — 15 ft (4.6 m) high

The liquid storage shall also conform to 4-5.6.4, 4-5.6.5, 4-5.6.6 and 4-5.6.7.

4-5.6.4 Basement Storage Areas. Class I liquids shall not be permitted in the basement areas of buildings. Class II and Class IIIA liquids may be stored in basements provided that automatic sprinkler protection and other fire protection facilities are provided in accordance with Section 4-6.

4-5.6.5 Palletized, Solid Pile or Rack Storage. Liquids in containers may be stored on pallets, in solid piles or on racks subject to the quantities and heights limits of 4-5.6.3 provided the protection is in accordance with Section 4-6, as applicable.

4-5.6.6 Separation and Aisles. Palletized or solid pile storage shall be arranged so that piles permitted in 4-5.6.3 are separated from each other by at least 4-ft (1.2-m) aisles. Aisles shall be provided so that no container is more than 12 ft (3.6 m) from an aisle. Where the storage of liquids is on racks, a minimum 4-ft (1.2-m) wide aisle shall be provided between adjacent rows of racks and adjacent storage of liquids. Main aisles shall be a minimum of 8 ft (2.4 m) wide. Where ordinary combustible commodities are stored in the same area as liquids in containers, the minimum distance between the two types of storage shall be 8 ft (2.4 m).

4-5.6.7 Mixed Storage. Liquids shall not be stored in the same pile or in the same rack sections as ordinary combustible commodities. Where liquids are packaged together with ordinary combustibles, as in kits, the storage shall be considered on the basis of whichever commodity predominates. When two or more classes of liquids are stored in a single pile or single rack section, the maximum quantities permitted in the pile or rack section shall be the smallest of the two or more separate maximum quantities, and the height of storage permitted in that pile or rack section shall be the least of the two or more separate heights. The maximum total quantities permitted shall be limited to the sum of proportional amounts that each class of liquid present bears to the maximum total permitted for its respective class. The sum of proportional amounts shall not exceed 100 percent.

4-5.7 Liquid Warehouses. (*See 1-2 Definitions.*)

4-5.7.1 Liquid warehouses shall be separate, detached buildings or shall be separated from other type occupancies by standard 4 hr fire walls, with communicating openings protected on each side of the wall with automatic-closing listed 3 hr (A) fire doors. Fire doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Windows.*

4-5.7.2 If the warehouse building is located more than 10 ft (3 m) but less than 50 ft (15 m) from an important building or line of adjoining property than can be built upon, the exposing wall shall have a fire resistance rating of at least 2 hr with each opening protected with a listed 1½ hr (D) fire door.

4-5.7.3 If the warehouse is located 10 ft (3 m) or less from an important building or line of adjoining property that can be built upon, the exposing wall shall have a fire resistance rating of 4 hr with each opening protected with a listed 3 hr (A) fire door.

4-5.7.4 An attached warehouse, having communicating openings in the required 4 hr fire wall separation from the adjacent building area, shall have these openings protected by:

(a) Normally closed listed 3 hr (A) fire doors on each side of the wall. These doors may be arranged to stay open during material handling operations, only if the doors are designed to close automatically in a fire emergency by provision of listed closure devices.

(b) Noncombustible liquidtight, raised sills or ramps, at least 4 in. (10 cm) in height, or other design features to prevent flow of liquids to the adjoining area.

4-5.7.5 Fire doors shall be installed in accordance with NFPA 80, *Standard for Fire Doors and Windows.*

4-5.7.6 The total quantity of liquids within a liquid warehouse shall not be restricted. The maximum pile heights and maximum quantity per pile, arranged as palletized and/or solid pile storage, shall comply with Table 4-4.2.7, if unprotected, or Table 4-6.1(a) if protected in accordance with Section 4-6. The storage heights of containers on protected racks shall comply with Table 4-6.1(b) as applicable.

Exception: An unprotected liquid warehouse located a minimum of 100 ft (30 m) from exposed buildings or adjoining property that can be built upon is not required to conform to Table 4-4.2.7, if there is protection for exposures. Where protection for exposures is not provided, a minimum 200 ft (61 m) distance is required.

4-5.7.7 Class I liquids shall not be permitted in the basement areas of liquid warehouses. Class II and Class IIIA liquids may be stored in basements provided that automatic sprinkler protection and other fire protection facilities are provided in accordance with Section 4-6.

4-5.7.8 Limited amounts of combustible commodities, as defined in the scope of NFPA 231, *Standard for Indoor General Storage*, and NFPA 231C, *Standard for Rack Storage of Materials*, may be stored in liquid warehouses if protection is provided in accordance with Section 4-6, and the ordinary combustibles, other than those used for packaging the liquids, are separated a minimum of 8 ft (2.4 m) horizontally, by aisles or open racks, from the liquids in storage.

4-5.7.9 Empty or idle combustible pallet storage shall be limited to a maximum pile size of 2500 sq ft (232 m^2) and to a maximum storage height of 6 ft (1.8 m). Idle pallet storage shall be separated from liquids by at least 8-ft (2.4-m) wide aisleways. However, pallet storage in accordance with NFPA 231, *Standard for Indoor General Storage*, shall be acceptable.

4-5.7.10 Containers in piles shall be separated by pallets or dunnage to provide stability and to prevent excessive stress on container walls. Portable tanks stored over one tier high shall be designed to nest securely, without dunnage. (*See NFPA 386, Standard for Portable Shipping Tanks, for information on portable tank design.*) Materials handling equipment shall be suitable to handle containers and tanks safely at the upper tier level.

4-5.7.11 No container or portable tank shall be stored closer than 36 in. (0.90 m) to the nearest beam, chord, girder or other roof member in an unprotected warehouse.

4-5.7.12 Solid pile and palletized storage shall be arranged so that piles are separated from each other by at least 4 ft (1.2 m). Aisles shall be provided so that no container or tank is more than 12 ft (3.6 m) from an aisle. Where storage on racks exists as permitted in this code, a minimum 4-ft (1.2-m) wide aisle shall be provided between adjacent rows of racks and any adjacent storage of liquids. Main aisles shall be a minimum of 8 ft (2.4 m) wide, and access shall be maintained to all doors required for egress.

4-5.7.13 **Mixed Storage.** When two or more classes of liquids are stored in a single pile, the maximum quantity permitted in that pile shall be the smallest of the two or more separate maximum quantities and the heights of storage permitted in that pile shall be the least of the two or more separate heights as given in Tables 4-4.2.7 or 4-6.1(a) as applicable. When two or more classes of liquids are stored in the same racks as permitted in this code, the maximum height of storage permitted shall be the least of the two or more separate heights given in Table 4-6.1(b).

4-6 Protection Requirements for Protected Storage of Liquids.

4-6.1 Containers and portable tanks storing flammable and combustible liquids may be stored in the quantities and arrangements specified in Tables 4-6.1(a) and 4-6.1(b) provided the storage is protected in accordance with 4-6.2 and 4-6.5, as applicable.

4-6.1.1 Other quantities and arrangements may be used where suitably protected and approved by the authority having jurisdiction.

4-6.2 Where automatic sprinklers are used, they shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and approved by the authority having jurisdiction. (*For additional information, see Appendix C.*)

4-6.2.1 Other systems such as automatic foam-water systems, automatic water-spray systems, or other combinations of systems may be considered acceptable if approved by the authority having jurisdiction. (*For additional information, see Appendix C.*)

4-6.3 Racks storing Class I or Class II liquids shall be either single-row or double-row as described in NFPA 231C, *Standard for Rack Storage of Materials.*

4-6.4 Ordinary combustibles other than those used for packaging the liquids shall not be stored in the same rack section as liquids, and shall be separated a minimum of 8 ft (2.4 m) horizontally, by aisles or open racks, from liquids stored in racks.

4-6.5 In-rack sprinklers shall be installed in accordance with the provisions of NFPA 231C, *Standard for Rack Storage of Materials*, except as modified by 4-6.2. Alternate lines of in-rack sprinklers shall be staggered. Multiple levels of in-rack sprinkler heads shall be provided with water shields unless otherwise separated by horizontal barriers, or unless the sprinkler heads are listed for such installations.

4-7 Fire Control.

4-7.1 Suitable fire extinguishers or preconnected hose lines, either 1½ in. (3.8 cm) lined or 1 in. (2.5 cm) hard rubber, shall be provided where liquids are stored. Where 1½ in. (3.8 cm) fire hose is used, it shall be installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems.*

Table 4-6.1(a) Storage Arrangements for Protected Palletized or Solid Pile Storage of Liquids in Containers and Portable Tanks

Class	Storage Level	Max. Stge. Height (ft.)		Max. Quantity per Pile (gal.)		Max. Quantity (gal.)	
		Containers	Port. Tanks	Containers	Port. Tanks	Containers	Port. Tanks
IA	Ground Floor	5	—	3,000	—	12,000	—
	Upper Floors	5	—	2,000	—	8,000	—
	Basements	Not Permitted		—	—	—	—
IB	Ground Floor	6½	7	5,000	20,000	15,000	40,000
	Upper Floors	6½	7	3,000	10,000	12,000	20,000
	Basements	Not Permitted		—	—	—	—
IC	Ground Floor	*6½	7	5,000	20,000	15,000	40,000
	Upper Floors	*6½	7	3,000	10,000	12,000	20,000
	Basements	Not Permitted		—	—	—	—
II	Ground Floor	10	14	10,000	40,000	25,000	80,000
	Upper Floors	10	14	10,000	40,000	25,000	80,000
	Basements	5	7	7,500	20,000	7,500	20,000
III	Ground Floor	20	14	15,000	60,000	50,000	100,000
	Upper Floors	20	14	15,000	60,000	50,000	100,000
	Basements	10	7	10,000	20,000	25,000	40,000

SI Units: 1 ft = 0.30 m; 1 gal = 3.8 L.

* These height limitations may be increased to 10 ft for containers of 5 gal or less in capacity.

Note: See Section 4-6 for protection requirements as applicable to this type of storage.

Table 4-6.1(b) Storage Arrangements for Protected Rack Storage of Liquids in Containers

Class	Type Rack	Storage Level	Max. Stge. Height (ft)	Max. Quantity (gal)
			Containers	Containers
IA	Double Row	Ground Floor	25'	7,500
	or	Upper Floor	15'	4,500
	Single Row	Basements	Not Permitted	—
IB	Double Row	Ground Floor	25'	15,000
	or	Upper Floor	15'	9,000
IC	Single Row	Basements	Not Permitted	—
II	Double Row	Ground Floor	25'	24,000
	or	Upper Floor	25'	24,000
	Single Row	Basements	15'	9,000
III	Multi-Row	Ground Floor	40'	48,000
	Double Row	Upper Floor	20'	48,000
	or Single Row	Basements	20'	24,000

SI Units: 1 ft = 0.30 m; 1 gal = 3.8 L.

NOTE: See Section 4-6 for protection requirements as applicable to this type of storage.

4-7.1.1 At least one portable fire extinguisher having a rating of not less than 20-B shall be located outside of, but not more than 10 ft (3 m) from, the door opening into any separate inside storage area.

4-7.1.2 At least one portable fire extinguisher having a rating of not less than 20-B shall be located not less than 10 ft (3 m), nor more than 50 ft (15 m), from any Class I or Class II liquid storage area located outside of a separate inside storage area.

4-7.1.3 In protected general purpose and liquid warehouses, hand hose lines shall be provided in sufficient number to reach all liquid storage areas.

4-7.1.4 The water supply shall be sufficient to meet the fixed fire protection demand, plus a total of at least 500 gal (1892 L) per minute for inside and outside hose lines. (*See C-4-6.2.*)

4-7.2 Control of Ignition Sources. Precautions shall be taken to prevent the ignition of flammable vapors. Sources of ignition include but are not limited to: open flames; lightning; smoking; cutting and welding; hot surfaces; frictional heat; static, electrical and mechanical sparks; spontaneous ignition, including heat-producing chemical reactions; and radiant heat.

4-7.3 Dispensing of Class I and Class II liquids in general purpose or liquid warehouses shall not be permitted unless the dispensing area is suitably cut off from other ordinary combustible or liquid storage areas, as specified in Section 4-4, and otherwise conforms with the applicable provisions of Section 4-4.

4-7.4 Materials with a water reactivity degree of 2 or higher as outlined in NFPA 704, *Standard System for the Identification of the Fire Hazards of Materials*, shall not be stored in the same area with other liquids.

Table 4-8 Outdoor Liquid Storage in Containers and Portable Tanks

	1		2		3	4	5
Class	Container Storage-Max. per Pile		Portable Tank Storage Max. per Pile Gallons (1)		Distance Between Piles or Racks (ft)	Distance to Property Line That Can Be Built Upon (ft)(2)(3)	Distance to Street, Alley, or a Public Way (ft)(3)
	Gallons (1) (4)	Height (ft)	Gallons (1) (4)	Height (ft)			
IA	1,100	10	2,200	7	5	50	10
IB	2,200	12	4,400	14	5	50	10
IC	4,400	12	8,800	14	5	50	10
II	8,800	12	17,600	14	5	25	5
III	22,000	18	44,000	14	5	10	5

SI Units: 1 ft = 0.30 m; 1 gal = 3.8 L.

Notes: (1) See 4-8.1.1 regarding mixed class storage.
(2) See 4-8.1.3 regarding protection for exposures.
(3) See 4-8.1.4 for smaller pile sizes.
(4) For storage in racks, the quantity limits per pile do not apply, but the rack arrangement shall be limited to a maximum of 50 feet in length and two rows or 9 feet in depth.

4-8 Outdoor Storage.

4-8.1 Outdoor storage of liquids in containers and portable tanks shall be in accordance with Table 4-8, as qualified by 4-8.1.1 through 4-8.1.4 and 4-8.2, 4-8.3, and 4-8.4.

4-8.1.1 When two or more classes of materials are stored in a single pile, the maximum gallonage in that pile shall be the smallest of the two or more separate gallonages.

4-8.1.2 No container or portable tank in a pile shall be more than 200 ft (60 m) from a 12 ft (3.6 m) wide access way to permit approach of fire control apparatus under all weather conditions.

4-8.1.3 The distances listed in Table 4-8 apply to properties that have protection for exposures as defined. If there are exposures, and such protection for exposures does not exist, the distances in column 4 shall be doubled.

4-8.1.4 When total quantity stored does not exceed 50 percent of maximum per pile, the distances in columns 4 and 5 may be reduced 50 percent, but to not less than 3 ft (0.90 m).

4-8.2 A maximum of 1,100 gal (4163 L) of liquids in closed containers and portable tanks may be stored adjacent to a building located on the same premises and under the same management provided that:

(a) The building is limited to a one-story building of fire-resistive or noncombustible construction and is devoted principally to the storage and handling of liquids, or

(b) The building has an exterior wall with a fire resistance rating of not less than 2 hr and having no opening to above grade areas within 10 ft (3 m) horizontally of such storage and no openings to below grade areas within 50 ft (15 m) horizontally of such storage.

4-8.2.1 The quantity of liquids stored adjacent to a building protected in accordance with 4-8.2(b) may exceed that permitted in 4-8.2, provided the maximum quantity per pile does not exceed 1,100 gal (4163 L) and each pile is separated by a 10-ft (3-m) minimum clear space along the common wall.

4-8.2.2 Where the quantity stored exceeds the 1,100 gal (4163 L) permitted adjacent to the building given in 4-8.2(a), or the provisions of 4-8.2(b) cannot be met, a minimum distance in accordance with column 4 of Table 4-8 shall be maintained between buildings and nearest container or portable tank.

4-8.3 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. (15 cm) high. When curbs are used, provisions shall be made for draining of accumulations of ground or rain water or spills of liquids. Drains shall terminate at a safe location and shall be accessible to operation under fire conditions.

4-8.4 Storage area shall be protected against tampering or trespassers where necessary and shall be kept free of weeds, debris and other combustible materials not necessary to the storage.

Chapter 5 Industrial Plants

5-1 Scope.

5-1.1 This chapter shall apply to those industrial plants where (1) the use of liquids is incidental to the principal business (*see Section 5-2*), or (2) where liquids are handled or used only in unit physical operations such as mixing, drying, evaporating, filtering, distillation, and similar operations which do not involve chemical reaction (*see Section 5-3*). This chapter shall not apply to chemical plants, refineries or distilleries, as defined, which are covered in Chapter 8, Refineries, Chemical Plants and Distilleries.

5-1.2 Where portions of such plants involve chemical reactions such as oxidation, reduction, halogenation, hydrogenation, alkylation, polymerization, and other chemical processes, those portions of the plant shall be in accordance with Chapter 7, Processing Plants.

5-2 Incidental Storage or Use of Liquids.

5-2.1 Section 5-2 shall be applicable to those portions of an industrial plant where the use and handling of liquids is only incidental to the principal business, such as automobile assembly, construction of electronic equipment, furniture manufacturing or other similar activities.

5-2.2 Liquids shall be stored in tanks or closed containers.

5-2.2.1 Except as provided in 5-2.2.2 and 5-2.2.3, all storage shall comply with Chapter 4, Container Storage.

5-2.2.2 The quantity of liquid that may be located outside of an inside storage room or storage cabinet or in any one fire area of a building shall not exceed the greater of that given in (a) or (b), (c), (d) and (e) below:

(a) A supply for one day, or

(b) 25 gal (94 L) of Class IA liquids in containers, and

(c) 120 gal (454 L) of Class IB, IC, II or III liquids in containers, and

(d) Two portable tanks not exceeding 660 gal (2498 L) of Class IB, IC, Class II or Class IIIA liquids, and

(e) Twenty portable tanks not exceeding 660 gal (2498 L) each of Class IIIB liquids.

5-2.2.3 Where large quantities of liquids are necessary, storage may be in tanks, which shall comply with the applicable requirements of Chapter 2, Tank Storage, and Sections 5-3, 5-4, 5-5, 5-6, 5-7 and 5-8.

5-2.3 Areas in which liquids are transferred from one tank or container to another container shall be separated from other operations in the building by adequate distance or by construction having adequate fire resistance. Drainage or other means shall be provided to control spills. Adequate natural or mechanical ventilation shall be provided. NFPA 91, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*, provides information on the design and installation of mechanical ventilation.

5-2.4 Handling Liquids at Point of Final Use.

5-2.4.1 Class I and Class II liquids shall be kept in covered containers when not actually in use.

5-2.4.2 Where liquids are used or handled, except in closed containers, means shall be provided to dispose promptly and safely of leakage or spills.

5-2.4.3 Class I liquids may be used only where there are no open flames or other sources of ignition within the possible path of vapor travel.

5-2.4.4 Class I and Class II liquids shall be drawn from or transferred into vessels, containers, or portable tanks within a building only from (1) original shipping containers with a capacity of 5 gal (18.9 L) or less, or (2) from safety cans, or (3) through a closed piping system, or (4) from a portable tank or container by means of a device drawing through an opening in the top of the tank or container, or (5) by gravity through a listed self-closing valve or self-closing faucet.

5-2.4.5 Transferring liquids by means of pressurizing the container with air is prohibited. Transferring liquids by pressure of inert gas is permitted only if controls, including pressure relief devices, are provided to limit the pressure so it cannot exceed the design pressure of the vessel, tank or container.

5-3 Unit Physical Operations.

5-3.1 Section 5-3 shall be applicable in those portions of industrial plants where liquids are handled or used in unit physical operations such as mixing, drying, evaporating, filtering, distillation, and similar operations which do not involve chemical change. Examples are plants compounding cosmetics, pharmaceuticals, solvents, cleaning fluids, insecticides and similar types of activities.

5-3.2 Industrial plants shall be located so that each building or unit of equipment is accessible from at least one side for fire fighting and fire control purposes. Buildings shall be located with respect to lines of adjoining property which may be built upon as set forth in 7-2.1 and 7-2.1.1, except that the blank wall referred to in 7-2.1.1 shall have a fire resistance rating of at least 2 hr.

5-3.3 Areas where unstable liquids are handled or small scale unit chemical processes are carried on shall be separated from the remainder of the plant by a fire wall having a fire resistance rating of not less than 2 hr.

5-3.4 Drainage.

5-3.4.1 Emergency drainage systems shall be provided to direct flammable or combustible liquid leakage and fire protection water to a safe location. This may require curbs, scuppers, or special drainage systems to control the spread of fire (*see 2-2.3.1*). Appendix A of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, provides information on such protection.

5-3.4.2 Emergency drainage systems, if connected to public sewers or discharged into public waterways, shall be equipped with traps or separators.

5-3.4.3 The industrial plant shall be designed and operated to prevent the normal discharge of flammable or combustible liquids into public waterways, public sewers, or adjoining property.

5-3.5 Ventilation.

5-3.5.1 Areas as defined in 5-3.1 using Class I liquids shall be ventilated at a rate of not less than 1 cu ft per min per sq ft of solid floor area (1 m^3 per 3 m^2). This shall be accomplished by natural or mechanical ventilation with discharge or exhaust to a safe location outside of the building without recirculation.

Exception: Recirculation is permitted where it is monitored continuously using a fail-safe system that is designed to automatically sound an alarm, stop recircula-

tion, and provide full exhaust to the outside in the event that vapor-air mixtures in concentration over one-fourth of the lower flammable limit are detected.

Provision shall be made for introduction of make-up air in such a manner as not to short circuit the ventilation. Ventilation shall be arranged to include all floor areas or pits where flammable vapors can collect. Local or spot general ventilation may be needed for the control of special fire or health hazards. Such ventilation, if provided, may be utilized for up to 75 percent of the required ventilation. NFPA 91, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*, and NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, of other than residence type, provide information on this subject.

5-3.5.2 Equipment used in a building and the ventilation of the building shall be designed so as 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 which exposes Class I liquids to the air. Examples of such equipment are dispensing stations, open centrifuges, plate and frame filters, open vacuum filters, and surfaces of open equipment.

5-3.6 The storage, transfer and handling of liquids shall comply with Section 7-4 of Chapter 7, Processing Plants.

5-4 Tank Vehicle and Tank Car Loading and Unloading.

5-4.1 Tank vehicle and tank car loading or unloading facilities shall be separated from aboveground tanks, warehouses, other plant buildings or nearest line of adjoining property which can be built upon by a distance of 25 ft (7.6 m) for Class I liquids and 15 ft (4.5 m) for Class II and Class III liquids, measured from the nearest position of any fill stem. Buildings for pumps or shelters for personnel can be a part of the facility. Operations of the facility shall comply with the appropriate portions of Section 6-3 of Chapter 6, Bulk Plants.

5-5 Fire Control.

5-5.1 Portable fire extinguishment and control equipment shall be provided in such quantities and types as are needed for the special hazards of operation and storage. NFPA 10, *Standard for Portable Fire Extinguishers*, provides information as to the suitability of various types of extinguishers and their number and location.

5-5.2 Water shall be available in volume and at adequate pressure to supply water hose streams, foam-producing equipment, automatic sprinklers or water spray systems as the need is indicated by the special hazards of operation, dispensing and storage.

5-5.3 Special extinguishing equipment such as that utilizing foam, inert gas, or dry chemical shall be provided as the need is indicated by the special hazards of operation, dispensing and storage.

5-5.4 Where the need is indicated by special hazards of operation, liquid processing equipment, major piping, and supporting steel shall be protected by approved water spray systems, deluge systems, approved fire resistant coatings, insulation, or any combination of these. NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, provide information on this subject.

5-5.5 An approved fire alarm system is recommended for prompt notification of fire. Where service is available, it is recommended that a public fire alarm box be located nearby. It may be advisable to connect the plant system with the public system. NFPA 72D, *Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems for Watchman, Fire Alarm and Supervisory Sevice*, provides information on this subject.

5-5.6 All plant fire protection facilities shall be adequately maintained and periodically inspected and tested to make sure they are always in satisfactory operating condition, and they will serve their purpose in time of emergency.

5-6 Sources of Ignition.

5-6.1 Precautions shall be taken to prevent the ignition of flammable vapors. Sources of ignition include but are not limited to: open flames; lightning; smoking; cutting and welding; hot surfaces; frictional heat; static, electrical and mechanical sparks; spontaneous ignition, including heat-producing chemical reactions; and radiant heat.

5-6.2 Class I liquids or Class II or Class III liquids at a temperature above their flash points (*see 1-1.3*) shall not be dispensed into metal containers unless the nozzle or fill pipe is in electrical contact with the container. This can be accomplished by maintaining metallic contact during filling, by a bond wire between them, or by other conductive path having an electrical resistance not greater than 10^6 ohms. Bonding is not required where a container is filled through a closed system, or the container is made of glass or other nonconducting material. NFPA 77, *Recommended Practice on Static Electricity*, provides information on static protection; NFPA 78, *Lightning Protection Code*, provides information on lightning protection.

5-7 Electrical Equipment.

5-7.1 This Section, 5-7, shall apply to areas where Class I liquids are stored or handled or where Class II or Class III liquids are stored or handled at a temperature above their flash points (*see 1-1.3.*) For areas where Class II or Class III liquids only are stored or handled at a temperature below their flash points, the electrical equipment may be installed in accordance with provisions of NFPA 70, *National Electrical Code*, for ordinary locations; however, care shall be used in locating electrical apparatus to prevent hot metal from falling into open equipment.

5-7.2 All electrical equipment and wiring shall be of a type specified by and shall be installed in accordance with NFPA 70, *National Electrical Code*.

5-7.3 So far as it applies, Table 5-7.3 shall be used to delineate and classify areas for the purpose of installation

of electrical equipment under normal circumstances. In the application of classified areas, a classified area shall not extend beyond an unpierced floor, wall, roof or other solid partition. The designation of classes and divisions is defined in Chapter 5, Article 500, of NFPA 70, *National Electrical Code*.

5-7.4 The area classifications listed in Table 5-7.3 are based on the premise that the installation meets the applicable requirements of this code in all respects. Should this not be the case, the authority having jurisdiction shall have the authority to determine the extent of the classified areas.

5-7.5 Extent of classified areas shall be as shown in Table 5-7.3.

5-7.6 Where the provisions of 5-7.1, 5-7.2, 5-7.3, 5-7.4 and 5-7.5 require the installation of electrical equipment suitable for Class I, Division 1 or Division 2 locations, ordinary electrical equipment including switchgear may be used if installed in a room or enclosure which is maintained under positive pressure with respect to the classified area. Ventilation makeup air shall be uncontaminated by flammable vapors. NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical*

Table 5-7.3

Location	NEC Class I Division	Extent of Classified Area
Indoor equipment installed in accordance with 5-3.5.2 where flammable vapor-air mixtures may exist under normal operations.	1	Area within 5 feet of any edge of such equipment, extending in all directions.
	2	Area between 5 feet and 8 feet of any edge of such equipment, extending in all directions. Also, area up to 3 feet above floor or grade level within 5 feet to 25 feet horizontally from any edge of such equipment.*
Outdoor equipment of the type covered in 5-3.5.2 where flammable vapor-air mixtures may exist under normal operations.	1	Area within 3 feet of any edge of such equipment, extending in all directions.
	2	Area between 3 feet and 8 feet of any edge of such equipment extending in all directions. Also, area up to 3 feet above floor or grade level within 3 feet to 10 feet horizontally from any edge of such equipment.
TANK — ABOVEGROUND**		
Shell, Ends, or Roof and Dike Area	2	Within 10 feet from shell, ends or roof of tank. Area inside dikes to level of top of dike.
Vent	1	Within 5 feet of open end of vent, extending in all directions.
	2	Area between 5 feet and 10 feet from open end of vent, extending in all directions.
Floating Roof	1	Area above the roof and within the shell.
DRUM AND CONTAINER FILLING		
Outdoors, or Indoors with Adequate Ventilation	1	Within 3 feet of vent and fill opening, extending in all directions.
	2	Area between 3 feet and 5 feet from vent or fill opening, extending in all directions. Also up to 18 inches above floor or grade level within a horizontal radius of 10 feet from vent or fill opening.
PUMPS, BLEEDERS, WITHDRAWAL FITTINGS, METERS AND SIMILAR DEVICES		
Indoors	2	Within 5 feet of any edge of such devices, extending in all directions. Also up to 3 feet above floor or grade level within 25 feet horizontally from any edge of such devices.
Outdoors	2	Within 3 feet of any edge of such devices, extending in all directions. Also up to 18 inches above grade level within 10 feet horizontally from any edge of such devices.
PITS		
Without Mechanical Ventilation	1	Entire area within pit if any part is within a Division 1 or 2 classified area.
With Mechanical Ventilation	2	Entire area within pit if any part is within a Division 1 or 2 classified area.
Containing Valves, Fittings or Piping, and Not Within a Division 1 or 2 Classified Area	2	Entire pit.
DRAINAGE DITCHES, SEPARATORS, IMPOUNDING BASINS	2	Area up to 18 inches above ditch, separator or basin. Also up to 18 inches above grade within 15 feet horizontally from any edge.

* The release of Class I liquids may generate vapors to the extent that the entire building, and possibly a zone surrounding it, should be considered a Class I, Division 2 location.

** For Tanks — Underground, see Chapter 5 of NFPA 30A, *Automotive and Marine Service Station Code*.

SI Units: 1 in. = 2.5 cm; 1 ft = 0.30 m.

Equipment in Hazardous (Classified) Locations, provides details for these types of installations.

5-8 Repairs to Equipment.

5-8.1 Hot work, such as welding or cutting operations, use of spark-producing power tools, and chipping operations shall be permitted only under supervision of an individual in responsible charge. The individual in responsible charge shall make an inspection of the area to be sure that it is safe for the work to be done and that safe procedures will be followed for the work specified. NFPA 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*, and NFPA 36, *Standard for Solvent Extraction Plants*, provide information on such operations.

5-9 Housekeeping.

5-9.1 Maintenance and operating practices shall be in accordance with established procedures which will tend to control leakage and prevent the accidental escape of flammable or combustible liquids. Spills shall be cleaned up promptly.

5-9.2 Adequate aisles shall be maintained for unobstructed movement of personnel and so that fire protection equipment can be brought to bear on any part of flammable or combustible liquid storage, use, or any unit physical operation.

5-9.3 Combustible waste material and residues in a building or unit operating area shall be kept to a minimum, stored in covered metal receptacles and disposed of daily.

5-9.4 Ground area around buildings and unit operating areas shall be kept free of weeds, trash or other unnecessary combustible materials.

Chapter 6 Bulk Plants and Terminals

6-1 Storage.

6-1.1 Class I liquids shall be stored in closed containers, or in storage tanks aboveground outside of buildings, or underground in accordance with Chapter 2.

6-1.2 Class II and Class III liquids shall be stored in containers, or in tanks within buildings or aboveground outside of buildings, or underground in accordance with Chapter 2.

6-1.3 Containers of liquids when piled one upon the other shall be separated by dunnage sufficient to provide stability and to prevent excessive stress on container walls. The height of pile shall be consistent with stability and strength of containers.

6-1.4 Piping, Valves and Fittings. Piping systems shall be in accordance with Chapter 3.

6-2 Buildings.

6-2.1 Exits. Rooms in which liquids are stored or handled by pumps shall have exit facilities arranged to prevent occupants being trapped in the event of fire. NFPA 101, *Life Safety Code*, provides information on the number and location of exits.

6-2.2 Heating. Rooms in which Class I liquids are stored or handled shall be heated only by means not constituting a source of ignition, such as steam or hot water. Rooms containing heating appliances involving sources of ignition shall be located and arranged to prevent entry of flammable vapors.

6-2.3 Ventilation.

6-2.3.1 Ventilation shall be provided for all rooms, buildings, or enclosures in which Class I liquids are pumped or dispensed. Design of ventilation systems shall take into account the relatively high specific gravity of the vapors. Ventilation may be provided by adequate openings in outside walls at floor level unobstructed except by louvers or coarse screens. Where natural ventilation is inadequate, mechanical ventilation shall be provided. NFPA 91, *Standard for Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*, provides information on the installation of mechanical exhaust systems.

6-2.3.2 Class I liquids shall not be stored or handled within a building having a basement or pit into which flammable vapors may travel, unless such area is provided with ventilation designed to prevent the accumulation of flammable vapors therein.

6-2.3.3 Containers of Class I liquids shall not be drawn from or filled within buildings unless provision is made to prevent the accumulation of flammable vapors in hazardous concentrations. Where mechanical ventilation is required, it shall be kept in operation while flammable liquids are being handled.

6-3 Loading and Unloading Facilities.

6-3.1 Tank vehicle and tank car loading or unloading facilities shall be separated from aboveground tanks, warehouses, other plant buildings or nearest line of adjoining property that can be built upon by a distance of at least 25 ft (7.6 m) for Class I liquids and at least 15 ft (4.5 m) for Class II and Class III liquids, measured from the nearest fill spout or (liquid or vapor) transfer connection. These distances may be reduced by utilizing fixed fire protection systems, fire rated barriers, or combinations of the two. Buildings for pumps or shelters for personnel may be a part of the facility.

6-3.2 Equipment such as piping, pumps, and meters used for the transfer of Class I liquids between storage tanks and the fill stem of the loading rack shall not be used for the transfer of Class II or Class III liquids.

6-3.3 Remote pumps located in underground tanks shall have installed on the pump discharge side a listed leak detection device which will provide an indication if the piping system is not essentially liquidtight. This device shall be checked and tested at least annually ac-

cording to the manufacturer's specifications to insure proper installation and operation.

6-3.4 Top Loading.

6-3.4.1 When top loading a tank vehicle with Class I and Class II liquids without vapor control, 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.

6-3.4.2 When top loading a tank vehicle with vapor control, flow control shall be in accordance with 6-3.5.1 and 6-3.5.2.

6-3.5 Bottom Loading.

6-3.5.1 When bottom loading a tank vehicle, with or without vapor control, a positive means shall be provided for loading a predetermined quantity of liquid, together with an automatic secondary shutoff control to prevent overfill. The connecting components between the loading rack and the tank vehicle required to operate the secondary control shall be functionally compatible.

6-3.5.2 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 to prevent pressurization of the tank. Such venting shall be at a height not lower than the top of the cargo tank on the vehicle.

6-3.5.3 When bottom loading a tank vehicle, the coupling between the liquid loading hose or pipe and the truck piping shall be by means of a dry disconnect coupling.

6-3.6 Vapor Control.

6-3.6.1 Connections to the plant vapor control system shall be designed to prevent the escape of vapor to the atmosphere when not connected to a tank vehicle.

6-3.7 Static Protection. Bonding facilities for protection against static sparks during the loading of tank vehicles through open domes shall be provided (a) where Class I liquids are loaded, or (b) where Class II or Class III liquids are loaded into vehicles which may contain vapors from previous cargoes of Class I liquids.

6-3.7.1 Protection as required in 6-3.7 shall consist of a metallic bond wire permanently electrically connected to the fill stem or to some part of the rack structure in electrical contact with the fill stem. The free end of such wire shall be provided with a clamp or equivalent device for convenient attachment to some metallic part in electrical contact with the cargo tank of the tank vehicle.

6-3.7.2 Such bonding connection shall be made fast 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.

6-3.7.3 Bonding as specified in 6-3.7, 6-3.7.1, and 6-3.7.2 is not required:

(a) where vehicles are loaded exclusively with products not having a static accumulating tendency, such as asphalts, including cutback asphalts, most crude oils, residual oils and water soluble liquids;

(b) where no Class I liquids are handled at the loading facility and the tank vehicles loaded are used exclusively for Class II and Class III liquids; and

(c) where vehicles are loaded or unloaded through closed bottom or top connections whether the hose or pipe is conductive or nonconductive.

6-3.7.4 Filling through open domes into the tanks of tank vehicles or tank cars that contain vapor-air mixtures within the flammable range, or where the liquid being filled can form such a mixture, shall be by means of a downspout which extends near the bottom of the tank. This precaution is not required when loading liquids which are nonaccumulators of static charges. NFPA 77, *Recommended Practice on Static Electricity*, provides additional information on static electricity protection.

6-3.8 Stray Currents. Tank car loading facilities where flammable and combustible liquids are loaded or unloaded through open domes shall be protected against stray currents by permanently bonding the pipe to at least one rail and to the rack structure, if of metal. Multiple pipes entering the rack area shall be permanently electrically bonded together. In addition, in areas where excessive stray currents are known to exist, all pipe entering the rack area shall be provided with insulating sections to electrically isolate the rack piping from the pipe lines. These precautions are not necessary where Class II or Class III liquids are handled exclusively and there is no probability that tank cars will contain vapors from previous cargoes of Class I liquids. Temporary bonding is not required between the tank car and the rack or piping during either loading or unloading irrespective of the class of liquid handled.

6-3.9 Container Filling Facilities. Class I liquids shall not be dispensed into metal containers unless the nozzle or fill pipe is in electrical contact with the container. This can be accomplished by maintaining metallic contact during filling, by a bond wire between them, or by other conductive path having an electrical resistance not greater than 10^6 ohms. Bonding is not required where a container is filled through a closed system, or is made of glass or other non-conducting material. NFPA 77, *Recommended Practice on Static Electricity*, provides information on static protection.

6-4 Wharves.

6-4.1 The term wharf shall mean any wharf, pier, bulkhead or other structure over or contiguous to navigable water, the primary function of which is the transfer of liquid cargo in bulk between shore installations and any tank vessel, ship, barge, lighter boat or other mobile floating craft; and this section shall apply to all such installations except marine service stations as covered in Chapter 7. If liquids are handled in bulk quantities across general purpose piers or wharves, NFPA 87, *Standard for the Construction and Protection of Piers and Wharves*, shall be followed.

6-4.1.1 Package cargo of liquids, including full and empty drums, bulk fuel and stores may be handled over a wharf during cargo transfer at such times and places as agreed upon by the wharf superintendent and the senior deck officer on duty.

6-4.1.2 Wharves at which liquid cargoes are to be transferred in bulk quantities to or from tank vessels shall be at least 100 ft (30 m) from any bridge over a navigable waterway, or from an entrance to or superstructure of any vehicular or railroad tunnel under a waterway. The termination of the wharf loading or unloading fixed piping shall be at least 200 ft (61 m) from a bridge or from an entrance to or superstructure of a tunnel.

6-4.2 Substructure and deck shall be substantially designed for the use intended. Deck may employ any material which will afford the desired combination of flexibility, resistance to shock, durability, strength and fire resistance. Heavy timber construction is acceptable.

6-4.3 Tanks used exclusively for ballast water or Class II or Class III liquids may be installed on suitably designed wharves.

6-4.4 Loading pumps capable of building up pressures in excess of the safe working pressure of cargo hose or loading arms shall be provided with by-passes, relief valves, or other arrangement to protect the loading facilities against excessive pressure. Relief devices shall be tested at not more than yearly intervals to determine that they function satisfactorily at the pressure at which they are set.

6-4.4.1 All pressure hoses and couplings shall be inspected at intervals appropriate to the service. With the hose extended, test the hose and couplings using the "in service maximum operating pressures." Any hose showing material deteriorations, signs of leakage, or weakness in its carcass or at the couplings shall be withdrawn from service and repaired or discarded.

6-4.5 Piping, valves and fittings shall be in accordance with Chapter 3, with the following exceptions and additions:

6-4.5.1 Flexibility of piping shall be assured by appropriate 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 pipe to repeated strain beyond the elastic limit.

6-4.5.2 Pipe joints depending upon the friction characteristics of combustible materials or grooving of pipe ends for mechanical continuity of piping shall not be used.

6-4.5.3 Swivel joints may be used in piping to which hoses are connected, and for articulated swivel-joint transfer systems, provided that the design is such that the mechanical strength of the joint will not be impaired if the packing material should fail, as by exposure to fire.

6-4.5.4 In addition to the requirements of 3-6.1, each line conveying Class I and Class II liquids leading to a wharf shall be provided with a readily accessible block valve located on shore near the approach to the wharf and outside of any diked area. Where more than one line is involved, the valves shall be grouped in one location.

6-4.5.5 Means of easy access shall be provided for cargo line valves located below the wharf deck.

6-4.5.6 Pipe lines on wharves shall be adequately bonded and grounded if Class I and Class II liquids are handled. If excessive stray currents are encountered, insulating joints shall be installed. Bonding and grounding connections on all pipe lines shall be located on wharf side of hose riser insulating flanges, if used, and shall be accessible for inspection.

6-4.5.7 Hose or articulated swivel-joint pipe connections used for cargo transfer shall be capable of accommodating the combined effects of change in draft and maximum tidal range, and mooring lines shall be kept adjusted to prevent surge of the vessel from placing stress on the cargo transfer system.

6-4.5.8 Hose shall be supported so as to avoid kinking and damage from chafing.

6-4.6 Suitable portable fire extinguishers with a rating of not less than 20-B shall be located within 75 ft (23 m) of those portions of the facility where fires are likely to occur, such as hose connections, pumps and separator tanks.

6-4.6.1 Where piped water is available, ready-connected fire hose in size appropriate for the water supply shall be provided so that manifolds where connections are made and broken can be reached by at least one hose stream.

6-4.6.2 Material shall not be placed on wharves in such a manner as to obstruct access to fire fighting equipment or important pipeline control valves.

6-4.6.3 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.

6-4.7 Loading or discharging shall not commence until wharf superintendent and officer in charge of tank vessel agree that tank vessel is properly moored and all connections are properly made.

6-4.7.1 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.

6-5 Electrical Equipment.

6-5.1 This section shall apply to areas where Class I liquids are stored or handled. For areas where Class II or Class III liquids only are stored or handled, the electrical equipment may be installed in accordance with the provisions of NFPA 70, *National Electrical Code*, for ordinary locations.

Table 6-5.3 — Electrical Equipment Classified Areas — Bulk Plants

Location	NEC Class I, Group D Division	Extent of Classified Area
TANK VEHICLE AND TANK CAR*		
Loading Through Open Dome	1	Within 3 feet of edge of dome, extending in all directions.
	2	Area between 3 feet and 15 feet from edge of dome, extending in all directions.
Loading Through Bottom Connections With Atmospheric Venting	1	Within 3 feet of point of venting to atmosphere extending in all directions.
	2	Area between 3 feet and 15 feet from point of venting to atmosphere, extending in all directions. Also up to 18 inches above grade within a horizontal radius of 10 feet from point of loading connection.
Loading Through Closed Dome With Atmospheric Venting	1	Within 3 feet of open end of vent, extending in all directions.
	2	Area between 3 feet and 15 feet from open end of vent, extending in all directions. Also within 3 feet of edge of dome, extending in all directions.
Loading Through Closed Dome With Vapor Control	2	Within 3 feet of point of connection of both fill and vapor lines, extending in all directions.
Bottom Loading With Vapor Control. Any Bottom Unloading	2	Within 3 feet of point of connections extending in all directions. Also up to 18 inches above grade within a horizontal radius of 10 feet from point of connection.
DRUM AND CONTAINER FILLING		
Outdoors, or Indoors With Adequate Ventilation	1	Within 3 feet of vent and fill opening, extending in all directions.
	2	Area between 3 feet and 5 feet from vent or fill opening, extending in all directions. Also up to 18 inches above floor or grade level within a horizontal radius of 10 feet from vent or fill opening.
TANK — ABOVEGROUND**		
Shell, Ends, or Roof and Dike Area	2	Within 10 feet from shell, ends, or roof of tank. Area inside dikes to level of top of dike.
Vent	1	Within 5 feet of open end of vent, extending in all directions.
	2	Area between 5 feet and 10 feet from open end of vent, extending in all directions.
Floating Roof	1	Area above the roof and within the shell.
PITS		
Without Mechanical Ventilation	1	Entire area within pit if any part is within a Division 1 or 2 classified area.
With Mechanical Ventilation	2	Entire area within pit if any part is within a Division 1 or 2 classified area.
Containing Valves, Fittings or Piping, and Not Within a Division 1 or 2 Classified Area.	2	Entire pit.
PUMPS, BLEEDERS, WITHDRAWAL FITTINGS, METERS AND SIMILAR DEVICES		
Indoors	2	Within 5 feet of any edge of such devices, extending in all directions. Also up to 3 feet above floor or grade level within 25 feet horizontally from any edge of such devices.
Outdoors	2	Within 3 feet of any edge of such devices, extending in all directions. Also up to 18 inches above grade level within 10 feet horizontally from any edge of such devices.
STORAGE AND REPAIR GARAGE FOR TANK VEHICLES	1	All pits or spaces below floor level.
	2	Area up to 18 inches above floor or grade level for entire storage or repair garage.
DRAINAGE DITCHES, SEPARATORS, IMPOUNDING BASINS	2	Area up to 18 inches above ditch, separator or basin. Also up to 18 inches above grade within 15 feet horizontally from any edge.
GARAGE FOR OTHER THAN TANK VEHICLES	Ordinary	If there is any opening to these rooms within the extent of an outdoor classified area, the entire room shall be classified the same as the area classification at the point of the opening.
OUTDOOR DRUM STORAGE	Ordinary	
INDOOR WAREHOUSING WHERE THERE IS NO FLAMMABLE LIQUID TRANSFER	Ordinary	If there is any opening to these rooms within the extent of an indoor classifed area, the room shall be classified the same as if the wall, curb or partition did not exist.
OFFICE AND REST ROOMS	Ordinary	

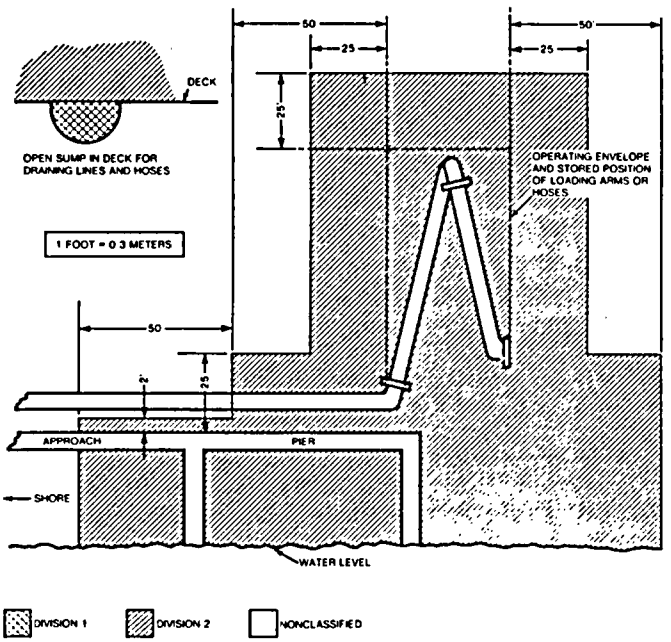
* When classifying extent of area, consideration shall be given to fact that tank cars or tank vehicles may be spotted at varying points. Therefore, the extremities of the loading or unloading positions shall be used.

** For Tanks — Underground, see Chapter 5 of NFPA 30A, *Automotive and Marine Service Station Code.*

SI Units: 1 in. = 2.5 cm; 1 ft = 0.30 m.

6-5.2 All electrical equipment and wiring shall be of a type specified by and shall be installed in accordance with NFPA 70, *National Electrical Code*.

6-5.3 So far as it applies, Table 6-5.3 shall be used to delineate and classify areas for the purpose of installation of electrical equipment under normal circumstances. In Table 6-5.3 a classified area shall not extend beyond an unpierced wall, roof or other solid partition. The designation of classes and divisions is defined in Chapter 5, Article 500, of NFPA 70, *National Electrical Code*.



Notes:
1. The "source of vapor" shall be the operating envelope and stored position of the outboard flange connection of the loading arm (or hose).
2. The berth area adjacent to tanker and barge cargo tanks is to be Division 2 to the following extent:
a. 25 ft (7.6 m) horizontally in all directions on the pier side from that portion of the hull containing cargo tanks.
b. From the water level to 25 ft (7.6 m) above the cargo tanks at their highest position.
3. Additional locations may have to be classified as required by the presence of other sources of flammable liquids on the berth, or by Coast Guard or other regulations.

Figure 6-5.3 Refinery Marine Terminal Handling Flammable Liquids

6-5.4 The area classifications listed in 6-5.3 shall be based on the premise that the installation meets the applicable requirements of this code in all respects. Should this not be the case, the authority having jurisdiction shall have the authority to classify the extent of the classified area.

6-6 Sources of Ignition.

6-6.1 Class I liquids shall not be handled, drawn, or dispensed where flammable vapors may reach a source of ignition. Smoking shall be prohibited except in designated localities. "NO SMOKING" signs shall be conspicuously posted where hazard from flammable vapors is normally present; NFPA 78, *Lightning Protection Code*, provides information on lightning protection.

6-7 Drainage and Waste Disposal.

6-7.1 Provision shall be made to prevent liquids which can be spilled at loading or unloading points from entering public sewers and drainage systems, or natural waterways. Connection to such sewers, drains, or waterways by which liquids might enter shall be provided with separator boxes or other approved means whereby such entry is precluded. Crankcase drainings and liquids shall not be dumped into sewers, but shall be stored in tanks or tight drums outside of any building until removed from the premises.

6-8 Fire Control.

6-8.1 Listed portable fire extinguishers of appropriate size, type and number shall be provided. NFPA 10, *Standard for Portable Fire Extinguishers*, provides information on this subject. At least one extinguisher with a minimum classification of 20-B shall be provided at each loading or unloading facility. Where piped water is available, ready-connected hose in size appropriate for the water supply shall be provided at locations where fires are likely to occur.

6-8.2 All plant fire protection facilities shall be adequately maintained and periodically inspected and tested to make sure they are always in satisfactory operating condition, and they will serve their purpose in time of emergency.

6-8.3 Bulk plants and terminals shall have a written emergency procedure plan. The plan shall be designed to minimize the hazard to the public and to plant employees in the event of a fire or other emergency conditions. The plan shall be posted, or located in a strategic and accessible location. Plant personnel assigned to emergency duties shall be trained in these duties.

Chapter 7 Processing Plants

7-1 Scope.

7-1.1 This chapter shall apply to those plants or buildings which contain chemical operations such as oxidation, reduction, halogenation, hydrogenation, alkylation, polymerization, and other chemical processes but shall not apply to chemical plants, refineries or distilleries as defined and covered in Chapter 8, Refineries, Chemical Plants and Distilleries.

7-2 Location.

7-2.1 The location of each processing vessel shall be based upon its liquid capacity. Processing vessels shall be located, with respect to distances to lines of adjoining property which can be built upon, in accordance with Table 7-2.1, except when the processing plant is designed in accordance with 7-2.1.1.

Table 7-2.1
Location of Processing Vessels from Property Lines

Processing Vessels with Emergency Relief Venting to Permit Pressure	Stable Liquids	Unstable Liquids
Not in excess of 2.5 psig (17.2 kPa)	Table 2-6*	2½ times Table 2-6*
Over 2.5 psig (17.2 kPa)	1½ times Table 2-6*	4 times Table 2-6*

*Double distances where protection of exposure is not provided.

7-2.1.1 The distances required in 7-2.1 may be waived when the vessels are housed within a building and the exterior wall facing the line of adjoining property which can be built upon is a blank wall having a fire resistance rating of not less than four hours. When Class IA or unstable liquids are handled, the blank wall shall have explosion resistance in accordance with good engineering practice (*see 7-3.4*).

7-3 Processing Buildings.

7-3.1 Construction.

7-3.1.1 Processing buildings shall be of fire-resistive or noncombustible construction, except heavy timber construction with load-bearing walls may be permitted for plants utilizing only stable Class II or Class III liquids. Except as provided in 7-2.1.1 or in the case of explosion resistant walls used in conjunction with explosion relieving facilities (*see 7-3.4*), load-bearing walls shall be prohibited. Buildings handling Class I or Class II liquids shall be without basements or covered pits. Processing buildings are normally limited in height and area, depending upon the type of construction and private fire protection provided, to minimize the possibility of fire of such extent as to jeopardize public safety. Processing buildings with numerous accessible exterior openings offer favorable features for fire fighting. Provision for smoke and heat venting may be desirable to assist access for fire fighting. NFPA 204M, *Guide for Smoke and Heat Venting*, provides information on this subject.

7-3.1.2 Areas shall have adequate exit facilities arranged to prevent occupants from being trapped in the event of fire. Exits shall not be exposed by the drainage facilities described in 7-3.2. NFPA 101, *Life Safety Code*, provides information on this subject.

7-3.2 Drainage.

7-3.2.1 Emergency drainage systems shall be provided to direct flammable or combustible liquid leakage and fire protection water to a safe location. This may require curbs, scuppers, or special drainage systems to control the spread of fire (*see 2-2.3.1*). Appendix A of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, provides information on this subject.

7-3.2.2 Emergency drainage systems, if connected to public sewers or discharged into public waterways, shall be equipped with traps or separators.

7-3.2.3 The processing plant shall be designed and operated to prevent the normal discharge of flammable or combustible liquids to public waterways, public sewers, or adjoining property.

7-3.3 Ventilation.

7-3.3.1 Enclosed processing buildings handling Class I or Class II liquids shall be ventilated at a rate of not less than 1 cu ft per minute per sq ft of solid floor area (1 m^3 per 3 m^2). This shall be accomplished by natural or mechanical ventilation with discharge or exhaust to a safe location outside of the building without recirculation.

Exception: Recirculation is permitted where 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 concentration over one-fourth of the lower flammable limit are detected.

Provision shall be made for introduction of make-up air in such a manner as not to short circuit the ventilation. Ventilation shall be arranged to include all floor areas or pits where flammable vapors may collect. Local or spot general ventilation may be needed for the control of special fire or health hazards. Such ventilation, if provided, can be utilized for up to 75 percent of the required ventilation. NFPA 91, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*, and NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, provide information on this subject.

7-3.3.2 Equipment used in a building and the ventilation of the building shall be designed so as 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 which exposes Class I liquids to the air. Examples of such equipment are dispensing stations, open centrifuges, plate and frame filters, open vacuum filters, and surfaces of open equipment.

7-3.4 Explosion Relief.

7-3.4.1 Areas where Class IA or unstable liquids are processed shall have explosion venting through one or more of the following methods: (a) open air construction; (b) lightweight walls and roof; (c) lightweight wall panels and roof hatches; (d) windows of explosion venting type. NFPA 68, *Guide for Explosion Venting*, provides information on this subject.

7-4 Liquid Handling.

7-4.1 Storage.

7-4.1.1 The storage of liquids in tanks shall be in accordance with the applicable provisions of Chapter 2, Tank Storage.

7-4.1.2 If the storage of liquids in outside aboveground or underground tanks is not practical because of government regulations, temperature considerations or production considerations, tanks may be permitted inside of buildings or structures in accordance with the applicable provisions of Chapter 2, Tank Storage. Production considerations necessitating storage inside of buildings include but are not limited to high viscosity, purity,

sterility, hydroscopicity, sensitivity to temperature change, and need to store temporarily pending completion of sample analysis.

7-4.1.3 Storage tanks inside of buildings shall be permitted only in areas at or above grade which have adequate drainage and are separated from the processing area by construction having a fire resistance rating of at least 2 hrs. Day tanks, running tanks and surge tanks are permitted in process areas. Openings to other rooms or buildings shall be provided with noncombustible liquidtight raised sills or ramps at least 4 in. (10 cm) in height, or the floor in the storage area shall be at least 4 in. (10 cm) below the surrounding floor. As a minimum, each opening shall be provided with a listed, self-closing 1½-hr (B) fire door installed in accordance with NFPA 80, *Standard for Fire Doors and Windows*, or a listed fire damper installed where required by NFPA 90A, *Standard for Air Conditioning and Ventilating Systems*, or NFPA 91, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying*. The room shall be liquidtight where the walls join the floor.

7-4.1.4 The storage of liquids in containers shall be in accordance with the applicable provisions of Chapter 4, Container and Portable Tank Storage.

7-4.2 Piping, Valves and Fittings.

7-4.2.1 Piping, valves and fittings shall be in accordance with Chapter 3, Piping, Valves and Fittings.

7-4.2.2 Listed flexible connectors may be used where vibration exists or where frequent movement is necessary. Approved hose may be used at transfer stations.

7-4.2.3 Piping containing liquids shall be identified.

7-4.3 Transfer.

7-4.3.1 The transfer of large quantities of liquids shall be through piping by means of pumps or water displacement. Except as required in process equipment, gravity flow shall not be used. The use of compressed air as a transferring medium shall be prohibited.

7-4.3.2 Positive displacement pumps shall be provided with pressure relief discharging back to the tank or to pump suction.

7-4.4 Equipment.

7-4.4.1 Equipment shall be designed and arranged to prevent the unintentional escape of liquids and vapors and to minimize the quantity escaping in the event of accidental release.

7-4.4.2 Where the vapor space of equipment is usually within the flammable range, the probability of explosion damage to the equipment can be limited by inerting, by providing an explosion suppression system, or by designing the equipment to contain the peak explosion pressure which can be modified by explosion relief. Where the special hazards of operation, sources of ignition, or exposures indicate a need, consideration shall be given to providing protection by one or more of the above means. NFPA 69, *Standard on Explosion Prevention Systems*, provides information on inerting.

7-5 Tank Vehicle and Tank Car Loading and Unloading.

7-5.1 Tank vehicle and tank car loading or unloading facilities shall be separated from aboveground tanks, warehouses, other plant buildings or nearest line of adjoining property which can be built upon by a distance of 25 ft (7.6 m) for Class I liquids and 15 ft (4.5 m) for Class II and Class III liquids measured from the nearest position of any fill stem. Buildings for pumps or shelters for personnel may be a part of the facility. Operations of the facility shall comply with the appropriate portions of Section 6-3 of Chapter 6, Bulk Plants.

7-6 Fire Control.

7-6.1 Listed portable fire extinguishers of appropriate size, type and number shall be provided. NFPA 10, *Standard for Portable Fire Extinguishers*, provides information on this subject.

7-6.2 Where the special hazards of operation or exposure indicate a need, the following fire control provisions shall be provided.

7-6.2.1 A reliable water supply shall be available in pressure and quantity adequate to meet the probable fire demands.

7-6.2.2 Hydrants shall be provided in accordance with accepted good practice. NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, provides information on this subject.

7-6.2.3 Hose connected to a source of water shall be installed so that all vessels, pumps, and other equipment containing flammable or combustible liquids can be reached with at least one hose stream. Nozzles that are capable of discharging a water spray shall be provided. NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, provides information on this subject.

7-6.2.4 Processing plants shall be protected by an approved automatic sprinkler system or equivalent extinguishing system. If special extinguishing systems including but not limited to those employing foam, carbon dioxide or dry chemical are provided, listed equipment shall be used and installed in accordance with NFPA 11, *Standard for Low Expansion Foam and Combined Agent Systems*; NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*; NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*; and NFPA 17, *Standard for Dry Chemical Extinguishing Systems*.

7-6.3 An approved means for prompt notification of fire to those within the plant and the public fire department available shall be provided. Where service is available, a public fire alarm box shall be located nearby if required by the authority having jurisdiction. It may be advisable to connect the plant system with the public system. NFPA 71, *Standard for the Installation, Maintenance and Use of Central Station Signaling Systems*; NFPA 72B, *Standard for the Installation, Maintenance and Use of Auxiliary Protective Signaling Systems for Fire*

Alarm Service; NFPA 72A, *Standard for the Installation, Maintenance and Use of Local Protective Signaling Systems for Watchman, Fire Alarm and Supervisory Service*; NFPA 72C, *Standard for the Installation, Maintenance and Use of Remote Station Protective Signaling Systems*; NFPA 72D, *Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems*; and NFPA 1221, *Standard for the Installation, Maintenance and Use of Public Fire Service Communications*, provide information on these subjects.

7-6.4 All plant fire protection facilities shall be adequately maintained and periodically inspected and tested to make sure they are always in satisfactory operating condition and they will serve their purpose in time of emergency.

7-7 Sources of Ignition.

7-7.1 General.

7-7.1.1 Precautions shall be taken to prevent the ignition of flammable vapors. Sources of ignition include but are not limited to open flames; lightning; smoking; cutting and welding; hot surfaces; frictional heat; static, electrical and mechanical sparks; spontaneous ignition, including heat-producing chemical reactions; and radiant heat.

7-7.1.2 Class I liquids or Class II or Class III liquids at a temperature above their flashpoints (*see 1-1.3*) shall not be dispensed into metal containers unless the nozzle or fill pipe is in electrical contact with the container. This can be accomplished by maintaining metallic contact during filling, by a bond wire between them, or by other conductive path having an electrical resistance not greater than 10^6 ohms. Bonding is not required where a container is filled through a closed system, or the container is made of glass or other nonconducting material. NFPA 77, *Recommended Practice on Static Electricity*, provides information on static protection; NFPA 78, *Lightning Protection Code*, provides information on lightning protection.

7-7.2 Maintenance and Repair.

7-7.2.1 When necessary to do maintenance work in a liquid processing area, the work shall be authorized by a responsible member of supervision.

7-7.2.2 Hot work, such as welding or cutting operations, use of spark-producing power tools, and chipping operations shall be permitted only under supervision of an individual in responsible charge. The individual in responsible charge shall make an inspection of the area to be sure that it is safe for the work to be done and that safe procedures will be followed for the work specified. NFPA 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*; NFPA 36, *Standard for Solvent Extraction Plants*; and NFPA 51, *Standard for the Installation and Operation of Oxygen-Fuel Gas Systems for Welding and Cutting*, provide information on such operations.

7-7.3 Electrical Equipment.

7-7.3.1 Section 7-7.3 shall apply to areas where Class I liquids are stored or handled or where Class II or Class III liquids are stored or handled at a temperature above their flash points (*see 1-1.3*). For areas where Class II or Class III liquids only are stored or handled at a temperature below their flash points, the electrical equipment may be installed in accordance with the provisions of NFPA 70, *National Electrical Code*, for ordinary locations; however, care shall be used in locating electrical apparatus to prevent hot metal from falling into open equipment.

7-7.3.2 All electrical equipment and wiring shall be of a type specified by and shall be installed in accordance with NFPA 70, *National Electrical Code*.

7-7.3.3 So far as it applies, 7-7.3.5 shall be used to delineate and classify areas for the purpose of installation of electrical equipment under normal circumstances. In the application of classified areas, a classified area shall not extend beyond an unpierced floor, wall, roof or other solid partition. The designation of classes and divisions is defined in Chapter 5, Article 500, of NFPA 70, *National Electrical Code*.

7-7.3.4 The area classifications listed in 7-7.3.5 are based on the premise that the installation meets the applicable requirements of this code in all respects. Should this not be the case, the authority having jurisdiction shall have the authority to classify the extent of the area.

7-7.3.5 Extent of classified areas shall be as follows:

7-7.3.6 Where the provisions of 7-7.3.1, 7-7.3.2, 7-7.3.3, 7-7.3.4, and 7-7.3.5 require the installation of electrical equipment suitable for Class I, Division 1 or Division 2 locations, ordinary electrical equipment including switchgear may be used if installed in a room or enclosure which is maintained under positive pressure with respect to the classified area. Ventilation make-up air shall be uncontaminated by flammable vapors. NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment in Hazardous (Classified) Locations*, provides details for these types of installations.

7-8 Housekeeping.

7-8.1 Maintenance and operating practices shall be in accordance with established procedures which will tend to control leakage and prevent the accidental escape of liquids. Spills shall be cleaned up promptly.

7-8.2 Adequate aisles shall be maintained for unobstructed movement of personnel and so that fire protection equipment can be brought to bear on any part of the processing equipment.

7-8.3 Combustible waste material and residues in a building or operating area shall be kept to a minimum, stored in closed metal waste cans, and disposed of daily.

7-8.4 Ground area around buildings and operating areas shall be kept free of tall grass, weeds, trash or other combustible materials.

Table 7-7.3

Location	NEC Class I Division	Extent of Classified Area
Indoor equipment installed in accordance with 5-3.5.2 where flammable vapor-air mixtures may exist under normal operations.	1	Area within 5 feet of any edge of such equipment, extending in all directions.
	2	Area between 5 feet and 8 feet of any edge of such equipment, extending in all directions. Also, area up to 3 feet above floor or grade level within 5 feet to 25 feet horizontally from any edge of such equipment.*
Outdoor equipment of the type covered in 5-3.5.2 where flammable vapor-air mixtures may exist under normal operations.	1	Area within 3 feet of any edge of such equipment, extending in all directions.
	2	Area between 3 feet and 8 feet of any edge of such equipment extending in all directions. Also, area up to 3 feet above floor or grade level within 3 feet to 10 feet horizontally from any edge of such equipment.
TANK — ABOVEGROUND**		
Shell, Ends, or Roof and Dike Area	2	Within 10 feet from shell, ends or roof of tank. Area inside dikes to level of top of dike.
Vent	1	Within 5 feet of open end of vent, extending in all directions.
	2	Area between 5 feet and 10 feet from open end of vent, extending in all directions.
Floating Roof	1	Area above the roof and within the shell.
DRUM AND CONTAINER FILLING		
Outdoors, or Indoors with Adequate Ventilation	1	Within 3 feet of vent and fill opening, extending in all directions.
	2	Area between 3 feet and 5 feet from vent or fill opening, extending in all directions. Also up to 18 inches above floor or grade level within a horizontal radius of 10 feet from vent or fill opening.
PUMPS, BLEEDERS, WITHDRAWAL FITTINGS, METERS AND SIMILAR DEVICES		
Indoors	2	Within 5 feet of any edge of such devices, extending in all directions. Also up to 3 feet above floor or grade level within 25 feet horizontally from any edge of such devices.
Outdoors	2	Within 3 feet of any edge of such devices, extending in all directions. Also up to 18 inches above grade level within 10 feet horizontally from any edge of such devices.
PITS		
Without Mechanical Ventilation	1	Entire area within pit if any part is within a Division 1 or 2 classified area.
With Mechanical Ventilation	2	Entire area within pit if any part is within a Division 1 or 2 classified area.
Containing Valves, Fittings or Piping, and Not Within a Division 1 or 2 Classified Area	2	Entire pit.
DRAINAGE DITCHES, SEPARATORS, IMPOUNDING BASINS	2	Area up to 18 inches above ditch, separator or basin. Also up to 18 inches above grade within 15 feet horizontally from any edge.

* The release of Class I liquids may generate vapors to the extent that the entire building, and possibly a zone surrounding it, should be considered a Class I, Division 2 location.

** For Tanks — Underground, see Chapter 5 of NFPA 30A, *Automotive and Marine Service Station Code.*

SI Units: 1 in. = 2.5 cm; 1 ft = 0.30 m.

Chapter 8 Refineries, Chemical Plants and Distilleries

8-1 Storage.

8-1.1 Liquids shall be stored in tanks, in containers, or in portable tanks. Tanks shall be installed in accordance with Chapter 2 of this code.

8-1.2 Tanks for the storage of liquids in tank farms and in locations other than process areas shall be located in accordance with 2-2.1 and 2-2.2.

8-1.3 Piping, Valves and Fittings. Piping systems shall be in accordance with Chapter 3.

8-2 Wharves.

8-2.1 Wharves handling flammable or combustible liquids shall be in accordance with Section 6-4.

8-3 Location of Process Units.

8-3.1 Process units shall be located so that they are accessible from at least one side for the purpose of fire control. Where topographical conditions are such that liq-

uids can flow from a processing area so as to constitute a fire hazard to property of others, provision shall be made to divert or impound the flow by curbs, drains, or other suitable means.

8-4 Fire Control.

8-4.1 Smoking shall be permitted only in approved areas.

8-4.2 Hot work, such as welding or cutting operations, use of spark-producing power tools, and chipping operations shall be permitted only under supervision of an individual in responsible charge. The individual in responsible charge shall make an inspection of the area to be sure that it is safe for the work to be done and that safe procedures will be followed for the work specified. NFPA 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*, and NFPA 36, *Standard for Solvent Extraction Plants*, provide information on such operations.

8-4.3 Maintenance and operating practices shall be in accordance with established procedures which will tend to control leakage and prevent the accidental escape of flammable or combustible liquids. Spills shall be cleaned up promptly.

8-4.4 Portable fire extinguishment and control equipment shall be provided in such quantities and types as are needed for the special hazards of operation and storage. NFPA 10, *Standard for Portable Fire Extinguishers*, provides information as to the suitability of various types of extinguishers.

8-4.5 Water shall be available in volume and at adequate pressure to supply water hose streams, foam producing equipment, automatic sprinklers or water spray systems as the need is indicated by the special hazards of operation and storage.

8-4.6 Special extinguishing equipment such as that utilizing foam, inert gas, or dry chemical shall be provided as the need is indicated by the special hazards of operation and storage.

8-4.7 An approved fire alarm system is recommended for prompt notification of fire. Where service is available, it is recommended that a public fire alarm box be located nearby. It may be advisable to connect the plant system with the public system. NFPA 72D, *Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems*, provides information on this subject.

8-4.8 An emergency control organization consistent with provided equipment and available personnel shall be established, and appropriate procedures specified, to cope with fire or other emergencies. Plant personnel assigned to the emergency control organization shall be trained in their duties.

8-4.9 An approved means for prompt notification of fire to those within the plant and the public fire department available shall be provided.

Chapter 9 Mandatory Referenced Publications

9-1 This chapter lists publications referenced within this document which, in whole or in part, are part of the requirements of this document.

9-1.1 NFPA Publications. The following publications are available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 11-1983, *Standard for Low Expansion Foam and Combined Agent Systems*

NFPA 12-1980, *Standard on Carbon Dioxide Extinguishing Systems*

NFPA 12A-1980, *Standard on Halon 1301 Fire Extinguishing Systems*

NFPA 13-1983, *Standard for the Installation of Sprinkler Systems*

NFPA 15-1982, *Standard for Water Spray Fixed Systems for Fire Protection*

NFPA 17-1980, *Standard for Dry Chemical Extinguishing Systems*

NFPA 30A-1984, *Automotive and Marine Service Station Code*

NFPA 45-1982, *Standard on Fire Protection for Laboratories Using Chemicals*

NFPA 69-1978, *Standard on Explosion Prevention Systems*

NFPA 70-1984, *National Electrical Code*

NFPA 80-1983, *Standard for Fire Doors and Windows*

NFPA 87-1980, *Standard for the Construction and Protection of Piers and Wharves*

NFPA 90A-1981, *Standard for the Installation of Air Conditioning and Ventilating Systems.*

NFPA 91-1983, *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying*

NFPA 99-1984, *Standard for Health Care Facilities*

NFPA 101-1981, *Life Safety Code*

NFPA 231-1979, *Standard for Indoor General Storage*

NFPA 231C-1980, *Standard for Rack Storage of Materials*

NFPA 251-1979, *Standard Methods of Fire Tests of Building Construction and Materials*

NFPA 302-1984, *Fire Protection Standard for Pleasure and Commercial Motor Craft*

NFPA 303-1984, *Fire Protection Standard for Marinas and Boatyards*

NFPA 321-1982, *Standard on Basic Classification of Flammable and Combustible Liquids*

NFPA 329-1983, *Recommended Practice for Handling Underground Leakage of Flammable and Combustible Liquids*

NFPA 385-1979, *Standard for Tank Vehicles for Flammable and Combustible Liquids*

NFPA 386-1979, *Standard for Portable Shipping Tanks for Flammable and Combustible Liquids*