NFPA No.

30

FLAMMABLE AND COMBUSTIBLE LIQUIDS CODE 1976

NATIONAL FIRE PROTECTION ASSOCIATION
470 Atlantic Avenue, Boston, MA 02210

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See Inside Back Cover for Official NFPA Definitions

Flammable and Combustible Liquids Code

NFPA No. 30 — 1976

1976 Edition of No. 30

This 1976 edition of the Flammable and Combustible Liquids Code supersedes the 1973 edition and all previous editions. This Code was prepared by the Sectional Committee on General Storage of Flammable Liquids, approved by the NFPA Flammable Liquids Correlating Committee, and adopted by the National Fire Protection Association at its meeting, November 15–18, in Cincinnati, OH.

This edition reflects a change in the numbering system to comply with the Manual of Style for NFPA Codes and Standards. Major changes were made to Chapter 2, Tank Storage, and Chapter 7, Service Stations. Numerous other changes were made in Chapters 1, 3, and 5. All changes or revisions are indicated by a vertical line at the side of the new or revised material.

Origin and Development of No. 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 63-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.

Interpretations Procedure of the Committee on Flammable Liquids

Those desiring an interpretation shall supply the Chairman with five identical copies of a statement in which shall appear specific reference to a single problem, paragraph, or section. Such a statement shall be on the business stationery of the inquirer and shall be duly signed.

When applications involve actual field situations they shall so state and all parties involved shall be named.

The Interpretations Committee will reserve the prerogative to refuse consideration of any application that refers specifically to proprietary items of equipment or devices. Generally inquiries should be confined to interpretation of the literal text or the intent thereof.

Requests for interpretations should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210.

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 requires 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.

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Chapter 8 Processing Plants

Chapter 9 Refineries, Chemical Plants and Distilleries

Flammable and Combustible Liquids Code

NFPA No. 30 — 1976

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 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 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. However, the vapors from such heated liquids cool rapidly in the air, limiting the concern to that space in which the temperature of the vapors remains above the flash point of the liquid.

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 occu-

pancies, 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 provided they do not constitute a recognized hazard to life or adjoining property.

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 the *Recommended Regulatory Standard for Tank Vehicles for Flammable and Combustible Liquids*, NFPA No. 385.

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 the *Standard for the Installation of Oil Burning Equipment*, NFPA No. 31 (ANSI Z95.1).

1-1.7.3 Storage of flammable and combustible liquids on farms and isolated construction projects. These requirements are covered separately in the *Standard for the Storage of Flammable and Combustible Liquids on Farms and Isolated Construction Projects*, NFPA No. 395.

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.

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

1-1.8 Installations made in accordance with the applicable requirements of Standards of the National Fire Protection Association for *Dry Cleaning Plants*, NFPA No. 32; for *Spray Application Using Flammable and Combustible Materials*, NFPA No. 33; for *Dip Tanks Containing Flammable or Combustible Liquids*, NFPA No. 34; for the *Manufacture of Organic Coatings*, NFPA No. 35; for *Solvent Extraction Plants*, NFPA No. 36; for *Installation and Use of Stationary Combustion Engines and Gas Turbines*, NFPA No. 37; for *Fire Protection for Laboratories Using Chemicals*, NFPA No. 45; and for *Laboratories in Health-Related Institutions*, NFPA No. 56C, shall be deemed to be in compliance with this code.

1-2 Definitions.

AEROSOL shall mean a material which is dispensed from its container as a mist, spray or foam by a propellant under pressure.

APARTMENT HOUSE shall mean a building or that portion of a building containing more than two dwelling units.

APPROVED shall mean acceptable to the authority having jurisdiction. 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 nationally recognized testing laboratories, inspection agencies, or other organizations concerned with product evaluations which are in a position to determine compliance with appropriate standards for the current production of listed items, and the satisfactory performance of such equipment or materials in actual usage.

ASSEMBLY OCCUPANCY shall mean 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 shall mean a storage tank which has been designed to operate at pressures from atmospheric through 0.5 psig.

AUTHORITY HAVING JURISDICTION shall mean the organization, office or individual responsible for "approving" equipment, an installation, or a procedure.

BARREL shall mean a volume of 42 U.S. gallons.

BASEMENT shall mean 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 shall mean the boiling point of a liquid at a pressure of 14.7 psia (760 mm). 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 the *Standard Method of Test for Distillation of Petroleum Products*, ASTM D-86-72,* may be used as the boiling point of the liquid.

*Available from American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.

BOIL-OVER shall mean the expulsion of crude oil (or certain other liquids) from a burning tank. The light fractions of the crude oil burn off producing a heat wave in the residue, which on reaching a water strata may result in the expulsion of a portion of the contents of the tank in the form of froth.

BULK PLANT shall mean that portion of a property where liquids are received by tank vessel, pipe lines, tank car, or tank vehicle, and are stored or blended in bulk for the purpose of distributing such liquids by tank vessel, pipe line, tank car, tank vehicle, or container.

CHEMICAL PLANT shall mean 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 shall mean 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 shall mean any vessel of 60 U.S. gallons or less capacity used for transporting or storing liquids.

CRUDE PETROLEUM shall mean hydrocarbon mixtures that have a flash point below 150° F and which have not been processed in a refinery.

DISTILLERY shall mean 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 shall mean 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 shall mean 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 shall mean 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 shall mean an area of a building separated from the remainder of the building by construction having a fire resis-

tance of at least one hour and having all communicating openings properly protected by an assembly having a fire resistance rating of at least one hour.

FLAMMABLE AEROSOL shall mean an aerosol which is required to be labeled "Flammable" under the U.S. Federal Hazardous Substances Labeling Act. For the purposes of this Code (Chapter 4) such aerosols are considered Class IA liquids.

FLASH POINT of a liquid shall mean the minimum temperature at which it 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 (93.4° C) shall be determined in accordance with the *Standard Method of Test for Flash Point by the Tag Closed Tester*, ASTM D-56-75.*

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 (93.4° C) or higher shall be determined in accordance with the *Standard Method of Test for Flash Point by the Pensky Martens Closed Tester*, ASTM D-93-73.*

As an alternate, the *Standard Methods of Tests for Flash Point of Aviation Turbine Fuels by Setaflash Closed Tester*, ASTM D-3243-73T, may be used for testing aviation turbine fuels within the scope of this procedure.

As an alternate, the *Standard Method of Tests for Flash Point of Liquids by Setaflash Closed Tester*, ASTM D-3278-73, 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).

HOTEL shall mean 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 shall mean 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.

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*Available from American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.

LABELED shall mean equipment or materials to which has been attached a label, symbol or other identifying mark of a nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling is indicated compliance with nationally recognized standards or tests to determine suitable usage in a specified manner.

LIQUID shall mean, for the purpose of this Code, any material which has a fluidity greater than that of 300 penetration asphalt when tested in accordance with *Test for Penetration for Bituminous Materials*, ASTM D-5-73.* **When not otherwise identified, the term liquid shall mean both flammable and combustible liquids.**

COMBUSTIBLE LIQUID shall mean 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 (93.4° C).

Class IIIB liquids shall include those having flash points at or above 200° F (93.4° C).

FLAMMABLE LIQUID shall mean a liquid having a flash point below 100° F (37.8° C) and having a vapor pressure not exceeding 40 pounds per square inch (absolute) at 100° F (37.8° C) and 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 shall mean 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 shall mean equipment or materials included in a list published by a nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation

*Available from American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.

that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

The means for identifying listed equipment can vary for each testing laboratory, inspection agency or other 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. Low pressure tank shall mean a storage tank designed to withstand an internal pressure above 0.5 psig but not more than 15 psig.

MERCANTILE OCCUPANCY shall mean 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 shall mean 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 shall mean any closed vessel having a liquid capacity over 60 U.S. gallons and not intended for fixed installation.

PRESSURE VESSEL shall mean any fired or unfired vessel within the scope of the applicable section of the ASME Boiler and Pressure Vessel code.

PROTECTION FOR EXPOSURES shall mean 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 shall mean 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 shall mean an approved container, of not more than five gallons capacity, having a spring-closing lid and spout cover and so designed that it will safely relieve internal pressure when subjected to fire exposure.

SERVICE STATIONS

AUTOMOTIVE SERVICE STATION shall mean 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, bat-

teries and accessories, and for minor automotive maintenance work. Major automotive repairs, painting, body and fender work are excluded.

MARINE SERVICE STATION shall mean 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.

VAPOR PRESSURE shall mean the pressure, measured in pounds per square inch (absolute), exerted by a volatile liquid as determined by the "Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)," (ASTM D323-72).*

VAPOR PROCESSING EQUIPMENT shall mean those components of a vapor processing system which are designed to process vapors or liquids captured during filling of tanks or containers or during fueling of vehicles.

VAPOR PROCESSING SYSTEM shall mean a system designed to capture and process vapors displaced during filling of tanks or containers or during fueling of vehicles 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 shall mean a system designed to capture and retain, without processing, vapors displaced during filling of tanks or containers or during fueling of vehicles. An example is a balanced-pressure vapor displacement system.

VENTILATION as specified in this Code 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.

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) 1971, or Section VIII,

*Available from American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.

Division 1 or Division 2 (Pressure Vessels) 1974, 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, 1974 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 the *Life Safety Code*, NFPA No. 101.

*Available from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, N.Y. 10017.

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 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 shall 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.

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 in accordance with:

(a) Underwriters Laboratories Inc., *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*, UL142 — 1972; *Standard for Steel Underground Tanks for Flammable and Combustible Liquids*, UL58 — 1971; or *Standard for Steel Inside Tanks for Oil Burner Fuel*, UL80 — 1974.*

(b) American Petroleum Institute Standard No. 650, *Welded Steel Tanks for Oil Storage*, Fifth Edition, 1973.**

(c) American Petroleum Institute Standards No. 12B, *Specification for Bolted Production Tanks*, Eleventh Edition, May 1958 and Supplement I, April 1962;** No. 12D, *Specification for Large Welded Production Tanks*, Seventh Edition, August 1957 and Supplement I, March 1965;** or No. 12F, *Specification for Small Welded Production Tanks*, Sixth Edition, March 1968.** Tanks built in accordance with these standards shall be used only as production tanks for storage of crude petroleum in oil-producing areas.

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, 1973.**

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*Available from Underwriters Laboratories Inc., 207 E. Ohio St., Chicago, Ill. 60611.

**Available from American Petroleum Institute, 2101 L St., N.W., Washington, DC 20037.

(b) The principles of the *Code for Unfired Pressure Vessels*, Section VIII, Division I of the ASME Boiler and Pressure Vessels Code, 1974 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 and shall be limited to 2.5 psig 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 shall meet the requirements of 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 and designed with a weak roof-to-shell seam or equipped with emergency venting devices which will not permit pressures to exceed 2.5 psig, shall be located in accordance with Table 2-1.

(a) For the purpose of 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

*Available from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, N.Y. 10017.

(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 liquidtight 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 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 or equipped with emergency venting which will permit pressures to exceed 2.5 psig 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 feet 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.

Table 2-1

Stable Liquids (Operating Pressure 2.5 psig or Less)

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 2-2.1.1)	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	⅓ times diameter of tank
	None	2 times diameter of tank but need not exceed 350 feet	⅓ 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."

**For tanks over 150 ft. in diameter use "Protection for Exposures" or "None" as applicable.

Table 2-2

Stable Liquids (Operating Pressure Greater Than 2.5 psig)

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."

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	1/6 times diameter of tank
	None	Diameter of tank	1/6 times diameter of tank
Fixed Roof [See 2-2.1.4(a)]	Approved foam or inerting system	Diameter of tank	1/3 times diameter of tank
	Protection for Exposures*	2 times diameter of tank	2/3 times diameter of tank
	None	4 times diameter of tank but need not exceed 350 feet	2/3 times diameter of tank

*See definition for "Protection for Exposures."

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 definition for "Protection for Exposures."

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

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

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.

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 gallons (3,000 barrels), when located at production facilities in isolated locations, need not be separated by more than 3 feet.

2-2.2.3 Tanks used only for storing Class IIIB liquids may be spaced no less than 3 feet 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 Tanks	
		Class I or II Liquids	Class IIIA Liquids
All tanks not over 150 feet diameter	1/6 sum of adjacent tank diameters but not less than 3 feet	1/6 sum of adjacent tank diameters but not less than 3 feet	1/6 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	1/6 sum of adjacent tank diameters	1/4 sum of adjacent tank diameters	1/6 sum of adjacent tank diameters
If impounding is around tanks in accordance with 2-2.3.3	1/4 sum of adjacent tank diameters	1/3 sum of adjacent tank diameters	1/4 sum of adjacent tank diameters

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 feet except in the case of Class I, Class II or Class IIIA liquid tanks operating at pressures exceeding 2.5 psig or equipped with emergency venting which will permit pressures to exceed 2.5 psig 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 feet away from the center line of the wall of the diked area. The foregoing provisions shall not apply when LP-Gas containers of 125 gallons or less capacity are installed adjacent to fuel oil supply tanks of 660 gallons or less capacity. No horizontal separation is required between aboveground LP-Gas containers and underground flammable and combustible liquid tanks installed in accordance with 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 feet 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 feet 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 im-

pounding 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 feet 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 feet 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 feet or more in height shall have a flat section at the top not less than 2 feet 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 feet above interior grade.

(f) Dikes may be higher than an average of 6 feet 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 feet 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 feet.

(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 approved 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 100,000 gallons (2,500 bbls.) and one subdivision for each group of tanks (no tank exceeding 100,000 gallons capacity) having an aggregate capacity not exceeding 150,000 gallons (3,570 bbls.).

(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 the *Standard for Water Spray Fixed Systems for Fire Protection*, NFPA No. 15, 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 feet 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 inches 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 sized either in accordance with: (1) the American Petroleum Institute Standard No. 2000, *Venting Atmospheric and Low-Pressure Storage Tanks*, 1973*; or (2) other accepted standard; or (3) shall be at least as large as the filling or withdrawal connection, whichever is larger but in no case less than 1¼ inch 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 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.

*Available from American Petroleum Institute, 2101 L St., N.W., Washington, DC 20037.

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. capacity or less containing crude petroleum in crude-producing areas, and outside aboveground atmospheric tanks under 1,000 gallons capacity containing other than Class 1A 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 Standard on Explosion Prevention Systems*, NFPA No. 69).

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 12,000 gallons 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.

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 feet abovegrade of the exposed shell area of a vertical tank. (*See Appendix A for the square footage of typical tank sizes.*)

Table 2-8

Wetted Area Versus Cubic Feet Free Air per Hour*

(14.7 psia and 60° F)

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				

*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		

2-2.5.5 For tanks and storage vessels designed for pressures over 1 psig, 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, 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 lb.

M = molecular weight of specific liquids.

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 square feet of wetted area.

.3 for water spray in accordance with *Standard for Water Spray Fixed Systems for Fire Protection*, NFPA No. 15, 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.

(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 and when the mean temperature of the insulation is 1,000° F.

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 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 and the pressure at full open position is greater than 2.5 psig, the flow capacity at 2.5 psig shall also be stamped on the venting device. The flow capacity shall be expressed in cubic feet per hour of air at 60° F and 14.7 psia.

(a) The flow capacity of tank venting devices under 8 in. 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. 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 feet 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 feet 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 liquid-tight 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 six inches 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 feet 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 foot, and to any property line that can be built upon, not less than 3 feet. 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 foot.

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 inches 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 feet of earth, or shall be covered with not less than 1 foot of earth, on top of which shall be placed a slab of reinforced concrete not less than 4 inches 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 three feet of earth cover, or 18 inches of well-tamped earth plus 6 inches of reinforced concrete or 8 inches of asphaltic concrete. When asphaltic or reinforced concrete paving is used as part of the protection, it shall extend at least 1 foot 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 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. Corrosion protection for the tank and its piping shall be provided by one or more of the following methods: (1) use of protective coatings or wrappings; (2) cathodic protection; or (3) corrosion resistant materials of construction. 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.

2-3.4 Abandoned Underground Tanks.

2-3.4.1 Underground tanks taken out of service shall be safeguarded or disposed of in a safe manner. Compliance with the provisions contained within Appendix C shall be considered to meet the intent of 2-3.4.1.

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 feet 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. nominal inside diameter. (*See also 7-2.1.1.*)

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. 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. Where tank venting devices are installed in vent lines, their flow capacities shall be determined in accordance with 2-2.5.9.

Table 2-10
Vent Line Diameters

Maximum Flow GPM	Pipe Length* 50 ft.	100 ft.	200 ft.
100	1¼-inch	1¼-inch	1¼-inch
200	1¼-inch	1¼-inch	1¼-inch
300	1¼-inch	1¼-inch	1½-inch
400	1¼-inch	1½-inch	2-inch
500	1½-inch	1½-inch	2-inch
600	1½-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
1000	2-inch	2-inch	3-inch

*Vent lines of 50 ft., 100 ft. and 200 ft. of pipe plus 7 ells.

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 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. Vent pipes shall be so laid as to drain toward the tank without sags or traps in which liquid can collect. They 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.

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.

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 six inches 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 feet 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, 7, 8 or 9.

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 the *Standard for the Installation of Sprinkler Systems*, NFPA No. 13, 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 liquid-tight.

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 cut-off 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 six inches 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 feet 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 vapor-tight.

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, *Specification for Welded Steel Tanks for Oil Storage*, and Appendix B of API Standard 620, *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 inches 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 two hours, except that steel saddles need not be protected if less than 12 inches high at their lowest point. At the discretion of the authority having jurisdiction, water spray protection in accordance with the *Standard for Water Spray Fixed Systems for Fire Protection*, NFPA No. 15, or *Standard for the Installation of Sprinkler Systems*, NFPA No. 13, 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, *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 Where a tank is located in an area that may be subjected to flooding, the applicable precautions outlined in Appendix B shall be observed.

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. *Recommended Practice on Static Electricity*, NFPA No. 77, and *Lightning Protection Code*, NFPA No. 78 (ANSI C5.1), provide information on such protection.

*Available from American Petroleum Institute, 2101 L St., N.W., Washington, DC 20037.

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, API monogram, 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 pounds per square inch, 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 pounds per square inch and not more than 5 pounds per square inch. *(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 pin hole 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

gallons 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 2-2.

2-8.2 The application of *Identification of the Fire Hazards of Materials*, NFPA No. 704, to storage tanks containing liquids shall not be required except when the contents have a health, flammability or reactivity degree of hazard of 2 or more. 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 Tanks receiving transfer of Class I liquids from mainline pipelines or marine vessels and located in an area where overfilling may endanger a place of habitation or public assembly shall be either:

(a) Gaged at frequent intervals while receiving transfer of product and communications maintained with mainline pipeline or marine personnel so that flow can be promptly shut down or diverted, or

(b) Equipped with an independent high level alarm located where personnel are on duty during the transfer and can promptly arrange for flow stoppage or diversion, or

(c) Equipped with an independent high level alarm system that will automatically shut down or divert flow.

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 *Petroleum Refinery Piping*, ANSI B31.3–1973*, or *Liquid Petroleum Transportation Piping Systems*, ANSI B31.4–1974*, 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 A395–74, *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.

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*Available from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, N.Y. 10017.

**Available from American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103.

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 two hours.

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

*Available from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, N.Y. 10017.

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.

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 pipe lines, by which equipment such as tank cars or tank vehicles discharge liquids by means of pumps 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 pounds per square inch 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.

*Available from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York, N.Y. 10017.

Chapter 4 Container and Portable Tank Storage

4-1 Scope.

4-1.1 This chapter shall apply only to the storage of liquids in drums or other containers (including flammable aerosols) not exceeding 60 gallons individual capacity and those portable tanks not exceeding 660 gallons individual capacity.

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 a motor vehicle, aircraft, boat or portable or stationary engine.

(c) Flammable or combustible paints, oils, varnishes and similar mixtures used for painting or maintenance when not kept for a period in excess of 30 days.

(d) Beverages when packaged in individual containers not exceeding one gallon in size.

(e) Medicines, foodstuffs, cosmetics and other consumer items 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.

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 No. 386, *Standard for Portable Shipping Tanks*, shall be deemed to 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, 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 cubic feet of free air per hour (14.7 psia and 60° F) shall be used. It shall be set to open at not less than 5 psig. If fusible vents are used, they shall be actuated by elements that operate at a temperature not exceeding

300° F. When used for paints, drying oils, and similar materials where plugging of the pressure-actuated vent may occur, fusible vents or vents of the type that soften to failure at a maximum of 300° F 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 4-1 except as provided in 4-2.3.1 or 4-2.3.2.

Table 4-1

Maximum Allowable Size of Containers and Portable Tanks

Container Type	Flammable Liquids			Combustible Liquids	
	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.

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

4-2.3.2 Class IA and Class IB liquids may be stored in glass containers of not more than 1-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 gallons of Class I, Class II and Class IIIA liquids may be stored in a storage cabinet. Of this total, not more than 60 gallons may be of Class I and Class II liquid. Not more than three 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 cabinets, is separated from any other cabinets or group of cabinets by at least 100 feet.

4-3.2 Storage cabinets shall be designed and constructed to limit the internal temperature to not more than 325° F when subjected to a ten-minute fire test using the standard time temperature curve as set forth in *Standard Methods of Fire Tests of Building Construction and Materials*, NFPA No. 251. 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."

4-3.2.1 Metal cabinets constructed in the following manner shall be deemed to be in compliance with 4-3.2. The bottom, top, door and sides of cabinet shall be at least No. 18 gage sheet iron and double walled with 1½-inch air space. Joints shall be riveted, welded or made tight by some equally effective means. The door shall be provided with a three-point lock, and the door sill shall be raised at least 2 inches above the bottom of the cabinet.

4-3.2.2 Wooden cabinets constructed in the following manner shall be deemed in compliance with 4-3.2. The bottom, sides and top shall be constructed of an approved grade of plywood at least 1 inch 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 flathead wood screws. When more than one door is used, there shall be a rabbetted overlap of not less than 1 inch. Hinges shall be mounted in such a manner as to not lose their holding capacity due to loosening or burning out of the screws when subjected to the fire test.

4-4 Design and Construction of Inside Storage Rooms.

4-4.1 Inside storage rooms shall be constructed to meet the required fire-resistive rating for their use. Such construction shall comply with the test specifications set forth in *Standard Methods of Fire Tests of Building Construction and Materials*, NFPA No. 251. Where an automatic sprinkler system is provided, the system shall be designed and installed in an approved manner. Openings to other rooms or buildings shall be provided with noncombustible liquidtight raised sills or ramps at least 4 inches in height, or the floor in the storage area shall be at least 4 inches below the surrounding floor. Openings shall be provided with approved self-closing fire doors. The room shall be liquidtight where the walls join the floor. A permissible alternate to the sill or ramp is an open-grated trench inside of the room which drains to a safe location. Where other portions of the building or other properties are exposed, windows shall be protected as set forth in the *Standard for Fire Doors and Windows*, NFPA No. 80, for Class E or F openings. Wood at least 1 inch nominal thickness may be used for shelving, racks, dunnage, scuffboards, floor overlay and similar installations.

4-4.1.1 Storage in inside storage 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 hour	500 sq. ft.	10
NO	2 hour	500 sq. ft.	4
YES	1 hour	150 sq. ft.	5
NO	1 hour	150 sq. ft.	2

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

4-4.1.2 Electrical wiring and equipment located in inside storage rooms used for Class I liquids shall be approved for Class I, Division 2 locations; for Class II and Class III liquids, shall be approved for general use. *National Electrical Code*, NFPA No. 70 (ANSI C1), provides information on the design and installation of electrical equipment.

4-4.1.3 Every inside storage 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 inches of the floor with one or more make-up air inlets located on the opposite side of the room within 12 inches 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. If ducts are used they shall not be used for any other purpose and shall comply with the *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*, NFPA No. 91 (ANSI Z33.1). If make-up air to a mechanical system is taken from within the building, the opening shall be equipped with an approved fire door or damper, as required in the *Standard for the Installation of Blower and Exhaust Systems, for Dust, Stock and Vapor Removal or Conveying*, NFPA No. 91, (ANSI Z33.1). For gravity systems, the make-up air shall be supplied from outside the building.

(b) Mechanical ventilation systems shall provide at least 1 cubic foot per minute of exhaust per square foot of floor area, but not less than 150 CFM.

4-4.2 Storage in Inside Storage Rooms.

4-4.2.1 In every inside storage room there shall be maintained one clear aisle at least 3 feet wide. Containers over 30 gallons capacity storing Class I or Class II liquids shall not be stacked one upon the other. Dispensing shall be by approved pump or self-closing faucet only. (*See 3-2.1.*)

4-5 Storage Inside Buildings.

4-5.1 Liquids, including stock for sale, shall not be stored so as to limit use of exits, stairways or areas normally used for the safe egress of people.

4-5.2 The storage of liquids in containers or portable tanks shall comply with 4-5.3 through 4-5.8, except that the authority having jurisdiction may impose a quantity limitation or require greater protection where unusual hazard to life or property is involved. Increase of these amounts may be authorized where the type of construction, fire protection provided, or other factors substantially reduce the hazard.

4-5.3 Dwellings and Buildings Containing Not More than Three Dwelling Units and Accompanying Attached and Detached Garages. Storage in excess of 25 gallons of Class I and Class II liquids combined shall be prohibited. In addition, storage in excess of 60 gallons of Class IIIA liquid shall be prohibited.

4-5.4 Assembly Occupancies, Buildings Containing More than Three Dwelling Units, and Hotels. Storage in excess of 10 gallons of Class I and Class II liquids combined or 60 gallons of Class IIIA liquids shall be in containers stored in a storage cabinet or in safety cans or in an inside storage room not having an opening communicating with that portion of the building used by the public.

4-5.5 Office, Educational and Institutional Occupancies. Storage shall be limited to that required for operation of office equipment, maintenance, demonstration, treatment, and laboratory work. All liquids in laboratories and at other points of use shall meet the following storage provisions:

(a) No container for Class I or Class II liquids shall exceed a capacity of 1 gallon except that safety cans can be of 2 gallons capacity.

(b) Not more than 10 gallons of Class I and Class II liquids combined shall be stored outside of a storage cabinet or storage room, except in safety cans.

(c) Not more than 25 gallons of Class I and Class II liquids combined shall be stored in safety cans outside of a storage room or storage cabinet.

(d) Not more than 60 gallons of Class IIIA liquids shall be stored outside of a storage room or storage cabinet.

(e) Quantities of liquids in excess of those set forth in this section shall be stored in an inside storage room or storage cabinet.

4-5.6 Mercantile Occupancies and Other Retail Stores.

(a) 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 gallons per square foot of gross floor area. The gross floor area used for computing the maximum quantity permitted shall be considered as that portion of the store actually being used for merchandising liquids.

(b) Where the aggregate quantity of additional stock exceeds 60 gallons of Class IA, 120 gallons of Class IB, 180 gallons of Class IC, 240 gallons of Class II, or 660 gallons of Class IIIA liquids or any combination of Class I and Class II liquids exceeding 240 gallons, the excess shall be stored in a room or portion of the building that complies with the construction provisions for an inside storage room as provided in 4-4. For water miscible liquids, these quantities may be doubled.

(c) Containers in display area shall not be stacked more than 3 feet or 2 containers high, whichever is the greater, unless on fixed shelving or otherwise satisfactorily secured.

(d) Shelving shall be of stable construction, of sufficient depth and arrangement such that containers displayed thereon shall not be easily displaced.

(e) Leaking containers shall be removed to a storage room or taken to a safe location outside the building and the contents transferred to an undamaged container.

4-5.7 General Purpose or Industrial Plant Warehouses. Storage shall be in accordance with Table 4-2 or 4-3 and in buildings or in portions of such buildings cut off by standard fire walls. Material creating no fire exposure hazard to the liquids may be stored in the same area.

4-5.8 Liquid Warehouses or Storage Buildings.

(a) If storage building is located 50 feet or less from a building or line of adjoining property that may be built upon, the exposing walls shall have a fire-resistance rating of at least 2 hours with any openings protected by approved fire doors. In particular installations, the distance requirements between the storage building and other buildings may be altered at the discretion of the authority having jurisdiction after consideration of the height, size and character of construction and occupancy of the exposed buildings.

(b) The total quantity of liquids within a building shall not be restricted, but the arrangement of storage shall comply with Table 4-2 or 4-3.

(c) Containers in piles shall be separated by pallets or dunnage where necessary to provide stability and to prevent excessive stress on container walls.

(d) Portable tanks stored over one tier high shall be designed to nest securely, without dunnage, and adequate materials handling equipment shall be available to handle tanks safely at the upper tier level.

(e) No pile shall be closer than 3 feet to the nearest beam, chord, girder or other obstructions, and shall be 3 feet below sprinkler deflectors or discharge orifices of water spray, or other overhead fire protection systems.

(f) Aisles at least 3 feet wide shall be provided where necessary for reasons of access to doors, windows or standpipe connections.

4-6 Storage Outside Buildings.

4-6.1 Storage outside buildings shall be in accordance with Table 4-4 or 4-5 and 4-6.2 and 4-6.4.

4-6.2 A maximum of 1,100 gallons of liquids may be located adjacent to buildings located on the same premises and under the same management provided the provisions of 4-6.2.1 and 4-6.2.2 are complied with.

4-6.2.1 The building shall be a one-story building devoted principally to the handling and storing of liquids or the building shall have 2 hour fire-resistive exterior walls having no opening within 10 feet of such storage.

Table 4-2 Indoor Container Storage

Class Liquid	Storage Level	Protected Storage* Maximum per Pile Gals.	Protected Storage* Height (See Note 3)	Unprotected Storage Maximum per Pile Gals.	Unprotected Storage Height (See Note 3)
IA	Ground & Upper Floors	2,750 (50)	3 ft. (1)	660 (12)	3 ft. (1)
	Basement	Not Permitted		Not Permitted	
IB	Ground & Upper Floors	5,500 (100)	6 ft. (2)	1,375 (25)	3 ft. (1)
	Basement	Not Permitted		Not Permitted	
IC	Ground & Upper Floors	16,500 (300)	6 ft. (2)	4,125 (75)	3 ft. (1)
	Basement	Not Permitted		Not Permitted	
II	Ground & Upper Floors	16,500 (300)	9 ft. (3)	4,125 (75)	9 ft. (3)
	Basement	5,500 (100)	9 ft. (3)	Not Permitted	
III	Ground & Upper Floors	55,000 (1,000)	15 ft. (5)	13,750 (250)	12 ft. (4)
	Basement	8,250 (150)	9 ft. (3)	Not Permitted	

*A sprinkler or equivalent fire protection system installed in accordance with the applicable NFPA Standard and approved by the authority having jurisdiction. (Numbers in parentheses indicate corresponding number of 55-gallon drums.)

NOTE 1: When two or more classes of materials are stored in a single pile, the maximum gallonage permitted in that pile shall be the smallest of the two or more separate maximum gallonages.

NOTE 2: Aisles shall be provided so that no container is more than 12 feet from an aisle. Main aisles shall be at least 8 feet wide and side aisles at least 4 feet wide.

NOTE 3: Each pile shall be separated from each other pile by at least 4 feet. When stored on suitably protected racks or when the storage is suitably protected, containers may be piled up to the height limits in 4-5.8 (e) where approved by the authority having jurisdiction.

Table 4-3 Indoor Portable Tank Storage

Class Liquid	Storage Level	Protected Storage* Maximum per Pile Gals.	Protected Storage* Maximum per Pile Height (See Note 3)	Unprotected Storage Maximum per Pile Gals.	Unprotected Storage Maximum per Pile Height (See Note 3)
IA	Ground & Upper Floors	Not Permitted		Not Permitted	
	Basement	Not Permitted		Not Permitted	
IB	Ground & Upper Floors	20,000	7 ft.	2,000	7 ft.
	Basement	Not Permitted		Not Permitted	
IC	Ground & Upper Floors	40,000	14 ft.	5,500	7 ft.
	Basement	Not Permitted		Not Permitted	
II	Ground & Upper Floors	40,000	14 ft.	5,500	7 ft.
	Basement	20,000	7 ft.	Not Permitted	
III	Ground & Upper Floors	60,000	14 ft.	22,000	7 ft.
	Basement	20,000	7 ft.	Not Permitted	

*A sprinkler or equivalent fire protection system installed in accordance with the applicable NFPA Standard and approved by the authority having jurisdiction.

NOTE 1: When two or more classes of materials are stored in a single pile, the maximum gallonage permitted in that pile shall be the smallest of the two or more separate maximum gallonages.

NOTE 2: Aisles shall be provided so that no portable tank is more than 12 feet from an aisle. Main aisles shall be at least 8 feet wide and side aisles at least 4 feet wide.

NOTE 3: Each pile shall be separated from each other pile by at least 4 feet. When stored on suitably protected racks or when the storage is suitably protected, portable tanks may be piled up to the height limits in 4-5.8 (e) where approved by the authority having jurisdiction.

4-6.2.2 Where quantity stored exceeds 1,100 gallons, or provisions of 4-6.2.1 cannot be met, a minimum distance of 10 feet between buildings and nearest container of liquid shall be maintained.

4-6.3 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 inches high. When curbs are used, provisions shall be made for draining of accumulations of ground or rain water or spills of flammable or combustible liquids. Drains shall terminate at a safe location and shall be accessible to operation under fire conditions.

4-6.4 Storage area shall be protected against tampering or trespassers where necessary and shall be kept free of weeds, debris and other combustible material not necessary to the storage.

4-7 Fire Control.

4-7.1 Suitable fire control devices, such as small hose or portable fire extinguishers, shall be available at locations where liquids are stored.

4-7.1.1 At least one portable fire extinguisher having a rating of not less than 10-B units shall be located outside of, but not more than 10 feet from, the door opening into any room used for storage.

4-7.1.2 At least one portable fire extinguisher having a rating of not less than 10-B units shall be located not less than 10 feet, nor more than 25 feet, from any Class I or Class II liquid storage area located outside of a storage room but inside a building.

4-7.2 When sprinklers are provided, they shall be installed in an approved manner. The *Standard for the Installation of Sprinkler Systems,* NFPA No. 13, provides information on the installation of sprinkler systems.

4-7.3 Open flames and smoking shall not be permitted in liquid storage areas.

Table 4-4 Outdoor Container Storage

1 Class	2 Maximum per Pile Gallons (See Note 1)	3 Distance Between Piles (See Note 2)	4 Distance to Property Line that Can Be Built Upon (See Notes 3 & 4)	5 Distance to Street, Alley, Public Way (See Note 4)
IA	1,100	5 ft.	20 ft.	10 ft.
IB	2,200	5 ft.	20 ft.	10 ft.
IC	4,400	5 ft.	20 ft.	10 ft.
II	8,800	5 ft.	10 ft.	5 ft.
III	22,000	5 ft.	10 ft.	5 ft.

NOTE 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.

NOTE 2: Within 200 feet of each container, there shall be a 12-foot wide access way to permit approach of fire control apparatus.

NOTE 3: The distances listed 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 four shall be doubled.

NOTE 4: When total quantity stored does not exceed 50 percent of maximum per pile, the distances in columns four and five may be reduced 50 percent, but not less than 3 feet.

4-7.4 Materials which will react with water shall not be stored in the same room with flammable or combustible liquids.

4-7.5 Containers and portable tanks used for Class I liquids shall be electrically bonded or grounded during transfer of liquids in accordance with *Recommended Practice on Static Electricity*, NFPA No. 77.

Table 4-5 Outdoor Portable Tank Storage

1 Class	2 Maximum per Pile Gallons	3 Distances Between Piles	4 Distance to Property Line that Can Be Built Upon	5 Distance to Street, Alley, Public Way
IA	2,200	5 ft.	20 ft.	10 ft.
IB	4,400	5 ft.	20 ft.	10 ft.
IC	8,800	5 ft.	20 ft.	10 ft.
II	17,600	5 ft.	10 ft.	5 ft.
III	44,000	5 ft.	10 ft.	5 ft.

NOTE 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.

NOTE 2: Within 200 feet of each portable tank, there shall be a 12-foot wide access way to permit approach of fire control apparatus.

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 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 5-3*). This chapter shall not apply to chemical plants, refineries or distilleries, as defined, which are covered in Chapter 9, 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 8, 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), (b), (c) or (d) below:

(a) A supply for one day

(b) 25 gallons of Class IA liquids in containers and

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

(d) One portable tank not exceeding 660 gallons of Class IB, IC, Class II or Class III 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 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. The *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*, NFPA No. 91 (ANSI Z33.1), 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 five gallons 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 8-2.1 and 8-2.1.1, except that the blank wall referred to in 8-2.1.1 shall have a fire resistance rating of at least two hours.

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 two hours.

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 2172.* Appendix A of the *Standard for Water Spray Fixed Systems for Fire Protection*, NFPA No. 15, 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 one cubic foot per minute per square foot of solid floor area. This shall be accomplished by natural or mechanical ventilation with discharge or exhaust to a safe location outside of the building. 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. *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*, NFPA No. 91 (ANSI Z33.1), and *Standard for the Installation of Air Conditioning and Ventilating Systems*, NFPA No. 90A, 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 feet 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 8-4 of Chapter 8, 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 feet for Class I liquids and 15 feet 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 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. The *Standard for Portable Fire Extinguishers*, NFPA No. 10 (ANSI Z112.1), 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. The *Standard for the Installation of Sprinkler Systems*, NFPA No. 13, and the *Standard for Water Spray Fixed Systems for Fire Protection*, NFPA No. 15, 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. The *Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems for Watchman, Fire Alarm and Supervisory Service*, NFPA No. 72D, 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 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. *Recommended Practice on Static Electricity*, NFPA No. 77, provides information on static protection; *Lightning Protection Code*, NFPA No. 78 (ANSI C5.1), 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 1-7.3*). 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 the *National Electrical Code*, NFPA No. 70 (ANSI C1), 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 the *National Electrical Code*, NFPA No. 70 (ANSI C1).

5-7.3 So far as it applies, Table 5-1 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 the *National Electrical Code*, NFPA No. 70 (ANSI C1).

5-7.4 The area classifications listed in Table 5-1 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 5-1.

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. The *Standard for Purged Enclosures for Electrical Equipment in Hazardous Locations*, NFPA No. 496 (ANSI C106.1), 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. The *Standard Procedures for the Standard for Cleaning or Safeguarding Small Tanks and Containers*, NFPA No. 327, and the *Standard for Solvent Extraction Plants*, NFPA No. 36, 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.

Table 5-1

Location	NEC Class I Division	Extent of Classified Area
Indoors 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.

*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 7-5 of Chapter 7.

Table 5-1 — *continued*

Location	NEC Class I Division	Extent of Classified Area
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.

Chapter 6 Bulk Plants

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. The *Life Safety Code*, NFPA No. 101 (ANSI A9.1), 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. The *Standard for the Installation of Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying*, NFPA No. 91 (ANSI Z33.1), 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 25 feet for Class I liquids and 15 feet for Class II and Class III liquids measured from the nearest position of any fill spout. 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 Except for Class III liquids, valves used for the final control for filling tank vehicles shall be of the self-closing type and manually held open except where automatic means are provided for shutting off the flow when the vehicle is full or after filling of a preset amount.

6-3.4 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.

6-3.4.1 Protection as required in 6-3.4 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.

6-3.4.2 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.

6-3.4.3 Bonding as specified in 6-3.4, 6-3.4.1, and 6-3.4.2 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.

6-3.4.4 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. *Recommended Practice on Static Electricity*, NFPA No. 77, provides additional information on static electricity protection.

6-3.5 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.

6-3.6 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. *Recommended Practice on Static Electricity*, NFPA No. 77, 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 the *Standard for the Construction and Protection of Piers and Wharves*, NFPA No. 87, 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 feet 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 feet 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 Piping systems shall contain a sufficient number of valves to operate the system properly and to control the flow of liquid in normal operation and in the event of physical damage.

6-4.5.5 In addition to the requirements of 6-4.5.4, 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.

6-4.5.6 Means of easy access shall be provided for cargo line valves located below the wharf deck.

6-4.5.7 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.

6-4.5.8 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.

6-4.5.9 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 feet 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 pipe line 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 the *National Electrical Code*, NFPA No. 70 (ANSI C1), for ordinary locations.

6-5.2 All electrical equipment and wiring shall be of a type specified by and shall be installed in accordance with the *National Electrical Code*, NFPA No. 70 (ANSI C1).

6-5.3 So far as it applies Table 6-1 shall be used to delineate and classify areas for the purpose of installation of electrical equipment under normal circumstances. In Table 6-1 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 the *National Electrical Code*, NFPA No. 70 (ANSI C1).

Table 6-1 — 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 Recovery	2	Within 3 feet of point of connection of both fill and vapor lines, extending in all directions.
Bottom Loading With Vapor Recovery or 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.

*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.

Table 6-1 — *continued*

Location	NEC Class I, Group D Division	Extent of Classified Area
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.

*For Tanks — Underground, see 7-5 of Chapter 7.

Table 6-1 — *continued*

Location	NEC Class I, Group D Division	Extent of Classified Area
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.
GARAGES 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 classified area, the room shall be classified the same as if the wall, curb or partition did not exist.
OFFICE AND REST ROOMS	Ordinary	

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 the Flammable and Combustible Liquids 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; *Lightning Protection Code*, NFPA No. 78 (ANSI C5.1), 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 Suitable fire-control devices, such as small hose or portable fire extinguishers, shall be available to locations where fires are likely to occur.

Chapter 7 Service Stations

7-1 Scope.

7-1.1 This chapter applies to both automotive and marine service stations. Reference shall also be made to *Fire Protection Standard for Motor Craft*, NFPA No. 302, for safety precautions while fueling at marine service stations and to *Fire Protection Standard for Marinas and Boatyards*, NFPA No. 303, for additional requirements applicable to marine service stations.

7-2 Storage.

7-2.1 General Provisions.

7-2.1.1 Liquids shall be stored in approved closed containers not exceeding 60 gallons capacity, in tanks in special enclosures as described in 7-2.2, in aboveground tanks as provided for in 7-2.1.5, or in tanks located underground as in 2-3. Vent pipes on tanks storing gasoline shall be in accordance with 2-3.5.1, 2-3.5.2 and 2-3.5.6, as applicable, and shall discharge only upward in order to disperse vapors. (*Also see 7-7.3.4 and 7-7.3.5.*)

7-2.1.2 Aboveground tanks, located at an adjoining bulk plant, may be connected by piping to service station underground tanks if, in addition to valves at aboveground tanks, a valve is also installed within control of service station personnel. Apparatus dispensing Class I liquids into the fuel tanks of motor vehicles of the public shall not be located at a bulk plant unless separated by a fence or similar barrier from the area in which bulk operations are conducted.

7-2.1.3 Class I liquids shall not be stored or handled within a building having a basement or pit into which flammable vapors can travel, unless such area is provided with ventilation which will prevent the accumulation of flammable vapors therein.

7-2.1.4 Accurate inventory records shall be maintained and reconciled on all Class I liquid storage tanks for indication of possible leakage from tanks or piping.

7-2.1.5 Tanks supplying marine service stations and pumps not integral with the dispensing unit shall be on shore or on a pier of the solid-fill type, except as provided in (a) and (b).

(a) Where shore location would require excessively long supply lines to dispensers, the authority having jurisdiction may authorize the installation of tanks on a pier provided that applicable portions of Chapter 2 relative to spacing, diking and piping are complied with and the quantity so stored does not exceed 1,100 gallons aggregate capacity.

(b) Shore tanks supplying marine service stations may be located aboveground where rock ledges or high water tables make underground tanks impractical.

7-2.1.6 Where tanks are at an elevation which produces a gravity head on the dispensing unit, the tank outlet shall be equipped with a device, such as a solenoid valve, positioned adjacent to and downstream from the valve specified in 2-2.7.1, so installed and adjusted that liquid cannot flow by gravity from the tank in case of piping or hose failure when the dispenser is not in use.

7-2.2 Special Enclosures.

7-2.2.1 When installation of tanks in accordance with Section 2-3 is impractical because of property or building limitations, tanks for liquids may be installed in buildings if enclosed as described in 7-2.2.2 and upon specific approval of the authority having jurisdiction.

7-2.2.2 Enclosure shall be substantially liquid and vapor-tight without backfill. Sides, top and bottom of the enclosure shall be of reinforced concrete at least 6 inches thick, with openings for inspection through the top only. Tank connections shall be so piped or closed that neither vapors nor liquid can escape into the enclosed space. Means shall be provided to use portable equipment to discharge to the outside any liquid or vapors which might accumulate should leakage occur.

7-2.2.3 At automotive service stations provided in connection with tenant or customer parking facilities at or below grade level in large buildings of commercial, mercantile or residential occupancy, tanks containing Class I liquids installed in accordance with 7-2.2.2 shall not exceed 6,000 gallons individual or 18,000 gallons aggregate capacity.

7-2.3 Inside Buildings.

7-2.3.1 Except where stored in tanks as provided in 7-2.2, no Class I liquids shall be stored within any service station building except in closed containers of aggregate capacity not exceeding 120 gallons. One container not exceeding 60 gallons capacity equipped with a listed pump is permitted.

7-2.3.2 Class I liquids may be transferred from one container to another in lubrication or service rooms of a service station building provided the electrical installation complies with Table 7-1 and provided that any heating equipment complies with 7-6. See also 7-8.1 for other possible sources of ignition.

7-2.3.3 Class II and Class III liquids may be stored and dispensed inside service station buildings from tanks of not more than 120 gallons each.

7-3 Piping, Valves and Fittings.

7-3.1 The design, fabrication, assembly, test and inspection of the piping system shall be in accordance with Chapter 3 except that, where dispensing is from a floating structure, suitable lengths of oil-resistant flexible hose may be employed between the shore piping and the piping on the floating structure as made necessary by change in water level or shore line.

7-3.1.1 Where excessive stray currents are encountered, piping handling Class I and Class II liquids at marine service stations shall be electrically insulated from the shore piping.

7-3.1.2 Piping shall be located so as to be protected from physical damage.

7-3.1.3 A readily accessible valve to shut off the supply from shore shall be provided in each pipeline at or near the approach to the pier and at the shore end of each marine pipeline adjacent to the point where a flexible hose is attached.

7-3.1.4 After completion of the installation, including any paving, that section of the pressure piping system between the pump discharge and the connection for the dispensing facility shall be tested for at least 30 minutes at the maximum operating pressure of the system.

7-3.2 Remote Pumping Systems.

7-3.2.1 This section shall apply to systems for dispensing Class I liquids where such liquids are transferred from storage to individual or multiple dispensing units by pumps located elsewhere than at the dispensing units.

7-3.2.2 Pumps shall be designed or equipped so that no part of the system will be subjected to pressures above its allowable working pressure. Each pump shall have installed on the discharge side an approved leak detection device which will provide an indication if the piping and dispensers are not essentially liquid-tight.

7-3.2.3 Pumps installed above grade, outside of buildings, shall be located not less than 10 feet from lines of adjoining property which can be built upon, and not less than 5 feet from any building opening. When an outside pump location is impractical, pumps may be installed inside buildings as provided for dispensers in

7-4.1.2, or in pits as provided in 7-3.2.4. Pumps shall be substantially anchored and protected against physical damage.

7-3.2.4 Pits for subsurface pumps or piping manifolds of submersible pumps shall withstand the external forces to which they can be subjected without damage to the pump, tank or piping. The pit shall be no larger than necessary for inspection and maintenance, and shall be provided with a fitted cover.

7-3.2.5 A listed rigidly anchored emergency shutoff valve, incorporating a fusible link or other thermally actuated device, designed to close automatically in event of severe impact or fire exposure shall be properly installed in the supply line at the base of each individual island-type dispenser or at the inlet of each overhead dispensing unit. If a coupling incorporating a slip-joint feature is used to join the emergency valve to the dispenser piping, the emergency valve shall automatically close before the slip joint can disengage. The automatic closing feature of this valve shall be checked at the time of initial installation and at least once a year thereafter by manually tripping the hold-open linkage.

7-4 Fuel Dispensing System.

7-4.1 Location.

7-4.1.1 Dispensing devices at an automotive service station shall be so located that all parts of the vehicle being served will be on the premises of the service station. Openings beneath dispenser enclosure shall be sealed to prevent the flow of leaking fuel to lower building spaces. Dispensing devices at marine service stations may be located on open piers, wharves, or floating docks or on shore or on piers of the solid-fill type and shall be located from other structures so as to provide room for safe ingress and egress of craft to be fueled. Dispensing units shall be in all cases at least 20 feet from any activity involving fixed sources of ignition.

7-4.1.2 Listed dispensing units may be located inside buildings upon specific approval of the authority having jurisdiction. The dispensing area shall be separated from other areas in a manner approved by the authority having jurisdiction. The dispensing area shall be provided with an approved mechanical or gravity ventilation system.

7-4.1.3 When dispensing units are located below grade, only approved mechanical ventilation shall be used and the entire dispensing area shall be protected by an approved automatic sprinkler system. Ventilating systems shall be electrically interlocked with gasoline dispensing units so that the dispensing units cannot be operated unless the ventilating fan motors are energized.

7-4.2 Emergency Power Cutoff. A clearly identified and easily accessible switch(es) or circuit breaker(s) shall be provided at a location remote from dispensing devices, including remote pumping systems, to shut off the power to all dispensing devices in the event of an emergency.

7-4.3 Fuel Dispensing Units.

7-4.3.1 Class I liquids shall be transferred from tanks by means of fixed pumps designed and equipped to allow control of the flow and prevent leakage or accidental discharge.

7-4.3.2 Dispensing devices for Class I liquids shall be listed.

7-4.3.3 A control shall be provided that will permit the pump to operate only when a dispensing nozzle is removed from its bracket or normal position with respect to the dispensing unit, and the switch on this dispensing unit is manually actuated. This control shall also stop the pump when all nozzles have been returned, either to their brackets or to the normal nondispensing position.

7-4.3.4 Liquids shall not be dispensed by applying pressure to drums, barrels and similar containers. Listed pumps taking suction through the top of the container or listed self-closing faucets shall be used.

7-4.3.5 The dispensing unit and its piping, except those attached to containers, shall be mounted on a concrete island or protected against collision damage by suitable means. If located indoors, the dispenser shall also be mounted either on a concrete island or protected against collision damage by suitable means and shall be located in a position where it cannot be struck by a vehicle that is out of control descending a ramp or other slope.

7-4.4 Vapor Recovery Systems.

7-4.4.1 Dispensing devices incorporating provisions for vapor recovery shall be listed.

7-4.4.2 Existing listed or labeled dispensing devices may be modified for vapor recovery provided that the modifications made are "Listed by Report" by a nationally recognized testing laboratory. The "Listing by Report" shall contain a description of the component parts used in the modifications and the recommended method of installation on specific dispensers and it shall be made available on request to the authority having jurisdiction.

7-4.4.3 Hose nozzle valves used on vapor recovery systems shall be listed.

7-4.4.4 Means shall be provided to close off each vapor return hose except when product is being dispensed.

7-4.5 Vapor Processing Systems.

7-4.5.1 Vapor processing system components consisting of hose nozzle valves, blowers or vacuum pumps, flame arresters or systems for prevention of flame propagation, controls, and vapor processing equipment shall be individually listed for use in a specified manner.

7-4.5.2 Dispensing devices used with a vapor processing system shall be listed. Existing listed or labeled dispensing devices may be modified for use with vapor processing systems provided they are "Listed by Report" as specified in 7-4.4.2.

7-4.5.3 Means shall be provided to close off each vapor return hose except when product is being dispensed.

7-4.5.4 Vapor processing systems employing blower-assist shall not be used unless the system is designed to prevent flame propagation through system piping, processing equipment and tanks.

7-4.5.5 If a component is likely to contain a flammable vapor-air mixture under operating conditions, and can fail in a manner to ignite the mixture, it shall be designed to withstand an internal explosion without failure to the outside.

7-4.5.6 Vapor processing equipment shall be located outside of buildings at least 10 feet from adjacent property lines which can be built upon, except as provided for in 7-4.5.7. Vapor processing equipment shall be located a minimum of 20 feet from dispensing devices. Processing equipment shall be protected against physical damage by the provision of guard rails, curbs, or fencing.

7-4.5.7 Where the required distance to adjacent property lines which can be built upon as specified in 7-4.5.6 cannot be obtained, means shall be provided to protect vapor processing equipment against fire exposure. Such means may include protective enclosures which extend at least 18 inches above the equipment, constructed of fire resistant or noncombustible materials, installation in below-grade spaces, or protection with an approved water spray system. If protective enclosures or below-grade spaces are used, positive means shall be provided to ventilate the volume within the enclosure to prevent pocketing of flammable vapors. In no case shall vapor processing equipment so protected be located within 5 feet of adjacent property lines which can be built upon.

7-4.5.8 Electrical equipment shall be in accordance with Table 7-1.

Table 7-1

Electrical Equipment Classified Areas — Service Stations

Location	NEC Class I, Group D Division	Extent of Classified Area
UNDERGROUND TANK		
Fill Opening	1	Any pit, box or space below grade level, any part of which is within the Division 1 or 2 classified area.
	2	Up to 18 inches above grade level within a horizontal radius of 10 feet from a loose fill connection and within a horizontal radius of 5 feet from a tight fill connection.
Vent — Discharging Upward	1	Within 3 feet of open end of vent, extending in all directions.
	2	Area between 3 feet and 5 feet of open end of vent, extending in all directions.
DISPENSING UNITS (except overhead type)		
Pits	1	Any pit, box or space below grade level, any part of which is within the Division 1 or 2 classified area.
Dispenser	1	The area within a dispenser enclosure up to 4 feet vertically above the base except that area defined as Division 2. Any area within a nozzle boot.
	2	Areas within a dispenser enclosure above the Division 1 area. Areas within a dispenser enclosure isolated from Division 1 by a solid partition or a solid nozzle boot but not completely surrounded by Division 1 area. Within 18 inches horizontally in all directions from the Division 1 area located within the dispenser enclosure. Within 18 inches horizontally in all directions from the opening of a nozzle boot not isolated by a vapor-tight partition, except that the classified area need not be extended around a 90° or greater corner.

Table 7-1 — *continued*

Location	NEC Class I, Group D Division	Extent of Classified Area
Outdoor	2	Up to 18 inches above grade level within 20 feet horizontally of any edge of enclosure.
INDOOR with Mechanical Ventilation	2	Up to 18 inches above grade or floor level within 20 feet horizontally of any edge of enclosure.
with Gravity Ventilation	2	Up to 18 inches above grade or floor level within 25 feet horizontally of any edge of enclosure.
DISPENSING UNITS,		
OVERHEAD TYPE	1	Within the dispenser enclosure and 18 inches in all directions from the enclosure where not suitably cut off by ceiling or wall. All electrical equipment integral with the dispensing hose or nozzle.
	2	An area extending 2 feet horizontally in all directions beyond the Division 1 area and extending to grade below this classified area.
	2	Up to 18 inches above grade level within 20 feet horizontally measured from a point vertically below the edge of any dispenser enclosure.
REMOTE PUMP — OUTDOOR	1	Any pit, box or space below grade level if any part is within a horizontal distance of 10 feet from any edge of pump.
	2	Within 3 feet of any edge of pump, extending in all directions. Also up to 18 inches above grade level within 10 feet horizontally from any edge of pump.
REMOTE PUMP — INDOOR	1	Entire area within any pit.
	2	Within 5 feet of any edge of pump, extending in all directions. Also up to 3 feet above floor or grade level within 25 feet horizontally from any edge of pump.

Table 7-1 — *continued*

Location	NEC Class I, Group D Division	Extent of Classified Area
LUBRICATION OR SERVICE ROOM — with Dispensing	1	Any pit within any unventilated area.
	2	Any pit with ventilation.
	2	Area up to 18 inches above floor or grade level and 3 feet horizontally from a lubrication pit.
Dispenser for Class I Liquids	2	Within 3 feet of any fill or dispensing point, extending in all directions.
LUBRICATION OR SERVICE ROOM — WITHOUT DISPENSING	2	Entire area within any pit used for lubrication or similar services where Class I liquids may be released.
	2	Area up to 18 inches above any such pit, and extending a distance of 3 feet horizontally from any edge of the pit.
SPECIAL ENCLOSURE INSIDE BUILDING PER 7-2.2	1	Entire enclosure.
SALES, STORAGE AND REST ROOMS	Non-classified	If there is any opening to these rooms within the extent of a Division 1 area, the entire room shall be classified as Division 1.
VAPOR PROCESSING SYSTEMS PITS	1	Any pit, box or space below grade level, any part of which is within a Division 1 or 2 classified area or which houses any equipment used to transport or process vapors.
VAPOR PROCESSING EQUIPMENT LOCATED WITHIN PROTECTIVE ENCLOSURES (See 7-4.5.7)	2	Within any protective enclosure housing vapor processing equipment.

Table 7-1 — *continued*

Location	NEC Class I, Group D Division	Extent of Classified Area
VAPOR PROCESSING EQUIPMENT NOT WITHIN PROTECTIVE ENCLOSURES (excluding piping and combustion devices)	2	The space within 18 inches in all directions of equipment containing flammable vapor or liquid extending to grade level. Up to 18 inches above grade level within 10 ft. horizontally of the vapor processing equipment.
EQUIPMENT ENCLOSURES	1	Any area within the enclosure where vapor or liquid is present under normal operating conditions.
	2	The entire area within the enclosure other than Division 1.
VACUUM ASSIST BLOWERS	2	The space within 18 inches in all directions extending to grade level. Up to 18 inches above grade level within 10 feet horizontally.

7-4.5.9 Vents on vapor processing systems shall be not less than 12 feet above adjacent ground level, with outlets so directed and located that flammable vapors will not accumulate or travel to an unsafe location or enter buildings.

7-4.5.10 Combustion or open flame type devices shall not be installed in a classified area. See Table 7-1.

7-5 Electrical Equipment.

7-5.1 Section 7-5 shall apply to areas where Class I liquids are stored, handled or dispensed. For areas where Class II or Class III liquids are stored, handled or dispensed, the electrical equipment may be installed in accordance with the provisions of the *National Electrical Code*, NFPA No. 70 (ANSI C1), for non-classified locations.

7-5.2 All electrical equipment and wiring shall be of a type specified by and shall be installed in accordance with the *National Electrical Code*, NFPA No. 70 (ANSI C1). All electrical equipment integral with the dispensing hose or nozzle shall be suitable for use in Division 1 locations.

7-5.3 Table 7-1 shall be used to delineate and classify areas for the purpose of installation of electrical equipment under normal circumstances. 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 the *National Electrical Code*, NFPA No. 70 (ANSI C1).

7-5.4 The area classifications listed in 7-5.3 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 determine the extent of the classified area.

7-6 Heating Equipment.

7-6.1 Heating equipment shall be installed as provided in 7-6.2 through 7-6.6.

7-6.2 Heating equipment may be installed in the conventional manner except as provided in 7-6.3, 7-6.4, 7-6.5, or 7-6.6.

7-6.3 Heating equipment may be installed in a special room separated from an area classified as Division 1 or Division 2 in Table 7-1 by walls having a fire resistance rating of at least one hour and without any openings in the walls within 8 feet of the floor into an area classified as Division 1 or Division 2 in Table 7-1. This room shall not be used for combustible storage, and all air for combustion purposes shall come from outside the building.

7-6.4 Heating equipment using gas or oil fuel may be installed in the lubrication or service room where there is no dispensing or transferring of Class I liquids provided the bottom of the combustion chamber is at least 18 inches above the floor and the heating equipment is protected from physical damage.

7-6.5 Heating equipment using gas or oil fuel listed for use in garages may be installed in the lubrication or service room where Class I liquids are dispensed provided the equipment is installed at least 8 feet above the floor.

7-6.6 Electrical heating equipment shall conform to 7-5.

7-7 Operational Requirements.

7-7.1 Fuel Delivery Nozzles.

7-7.1.1 A listed automatic-closing type hose nozzle valve with latch-open device is permitted on any island-type dispenser accessible to the public only when all dispensing of Class I liquids is to be done by the service station attendant.

7-7.1.2 If the dispensing of Class I liquids at a service station available and open to the public is to be done by a person other than the service station attendant, the nozzle shall be a listed automatic-closing type without a latch-open device.

7-7.1.3 Overhead-type dispensing units shall be provided with a listed automatic-closing type hose nozzle valve without a latch-open device.

(a) A listed automatic-closing type hose nozzle valve with latch-open device may be used if the design of the system is such that the hose nozzle valve will close automatically in the event the valve is released from a fill opening or upon impact with a driveway.

7-7.1.4 Dispensing nozzles used at marine service stations shall be of the automatic-closing type without a latch-open device.

7-7.1.5 Hose nozzle valves of either the manual or automatic-closing type for dispensing Class I liquids into a container shall be manually held open during the dispensing operation.

7-7.2 Dispensing into Portable Containers. No delivery of any Class I or Class II liquid shall be made into portable containers unless the container is constructed of metal or is approved by the authority having jurisdiction, has a tight closure and is fitted with spout or so designed that the contents can be poured without spilling.

7-7.2.1 No sale or purchase of any Class I, Class II or Class III liquids shall be made in containers unless such containers are clearly marked with the name of the product contained therein.

7-7.3 Attendance or Supervision of Dispensing.

7-7.3.1 Each service station open to the public shall have an attendant or supervisor on duty whenever the station is open for business.

7-7.3.2 Listed "self-service" dispensing devices are permitted at service stations available and open to the public provided that all dispensing of Class I liquids by a person other than the service station attendant is under the supervision and control of a qualified attendant and the dispensing nozzle is a listed automatic-closing type without a latch-open device.

7-7.3.3 Dispensing of Class I liquids at locations not open to the public does not require an attendant or supervisor. Such locations may be used by commercial, industrial, governmental or manufacturing establishments for fueling vehicles used in connection with their businesses.

7-7.3.4 The provisions of 7-2.1.1 shall not prohibit the temporary use of movable tanks in conjunction with the dispensing of flammable or combustible liquids into the fuel tanks of motor vehicles or other motorized equipment on premises not normally accessible to the public. Such installations shall only be made under permit from the enforcing authority. The permit shall include a definite time limit.

7-7.3.5 The provisions of 7-2.1.1 shall not prohibit the dispensing of Class I and Class II liquids in the open from a tank vehicle to a motor vehicle. Such dispensing shall be permitted provided:

(a) An inspection of the premises and operations has been made and approval granted by the authority having jurisdiction.

(b) The tank vehicle complies with the requirements covered in the *Recommended Regulatory Standard for Tank Vehicles for Flammable and Combustible Liquids*, NFPA No. 385.

(c) The dispensing is done on premises not open to the public.

(d) The dispensing hose does not exceed 50 feet in length.

(e) The dispensing nozzle is a listed automatic-closing type without a latch-open device.

(f) Nighttime deliveries shall only be made in adequately lighted areas.

(g) The tank vehicle flasher lights shall be in operation while dispensing.

(h) Fuel expansion space shall be left in each fuel tank to prevent overflow in the event of temperature increase.

7-7.4 Self-Service Stations.

7-7.4.1 Self-service station shall mean that portion of property where liquids used as motor fuels are stored and subsequently dispensed from fixed approved dispensing equipment into the fuel tanks of motor vehicles by persons other than the service station attendant, and may include facilities available for sale of other retail products.

7-7.4.2 Listed dispensing devices such as, but not limited to, coin-operated, card-operated and remote controlled types are permitted at self-service stations.

7-7.4.3 All self-service stations shall have at least one attendant on duty while the station is open to the public. The attendant's primary function shall be to supervise, observe and control the dispensing of Class I liquids while said liquids are actually being dispensed.