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NATIONAL FIRE PROTECTION ASSOCIATION, INC.
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SC-FM-81

Standard for the

Manufacture of Organic Coatings

NFPA 35-1982

1982 Edition of NFPA 35

This edition of NFPA 35, *Standard for the Manufacture of Organic Coatings*, was prepared by the Technical Committee on Manufacture of Organic Coatings, released by the Correlating Committee on Flammable Liquids, and was acted on by the National Fire Protection Association, Inc. on November 17, 1981, at its Fall Meeting in Toronto, Ontario, Canada. It was issued by the Standards Council on December 9, 1981, with an effective date of December 29, 1981.

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

The 1982 edition of this standard has been approved by the American National Standards Institute.

Origin and Development of NFPA 35

The *Standard on Lacquer Manufacturing Plants*, the predecessor text covering this subject, was originally developed by the NFPA Manufacturing Hazards Council. Following the discontinuance of this Council by the Association, jurisdiction over this standard was given to the NFPA Committee on Flammable Liquids.

The Committee decided to greatly expand the scope of the publication to include the manufacture of all flammable organic coatings. In 1963 this greatly expanded text was officially adopted as a recommended practice. In 1964 the text was revised, but the same format was maintained. In 1970 the format of this publication was changed from a recommended practice to a standard and further revised in 1971 and 1976.

Committee on Flammable Liquids

Correlating Committee

Paul C. Lamb, *Chairman*
Englewood, NJ

Martin F. Henry, *Secretary*
National Fire Protection Association
(Nonvoting)

G. E. Cain, Hercules Inc.
Rep. Chemical Manufacturers Assn.

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F. Owen Kubias, SCM Corp.

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Rep. Laundry-Cleaners Allied Trades Assn.

William R. Rucinski, Department of State Police, MI

W. J. Smith, Underwriters Laboratories Inc.

Nonvoting

Ing Gert Magnus, Mannheim, Germany

Technical Committee on Manufacture of Organic Coatings

G. E. Cain, *Chairman*
Hercules Inc.
(Rep. Chemical Manufacturers Assn.)

Martin F. Henry, *Secretary*
National Fire Protection Association
(Nonvoting)

Andrew W. Beilfuss Jr., M & M Protection Consultants

Royal A. Brown, National Paint & Coatings Assn.

Floyd T. Edwards, Industrial Risk Insurers

Howard J. Horton, SCM Corp.
Rep. FSCT

William I. Morton, E I Dupont De Nemours & Co.

J. Benjamin Roy Jr., Delaware State Fire Marshal's Office
Rep. Fire Marshals Assn. of North America

Damon W. Snow, Monsanto Co.
Rep. American Petroleum Institute

Alternates

Nicholas V. Corda, Hercules Inc.
(Alternate to G. E. Cain)

John Jaresko, Industrial Risk Insurers
(Alternate to F. T. Edwards)

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

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

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Appendix C.

Chapter 1 Introduction

1-1 Scope and Application.

1-1.1 This standard shall:

1-1.1.1 Apply to facilities and processes used for the manufacture of protective and decorative finishes or coatings for industrial, automotive, marine, transportation, institutional, household and other purposes.

1-1.1.2 Apply only to those organic coatings manufacturing facilities involving flammable and combustible liquids.

1-1.1.3 Prescribe reasonable measures for safety to life and property from fire and explosion in the operation of manufacturing organic coatings.

1-1.1.4 Provide a means by which plant management and supervisory personnel may evaluate the hazards of operations under their jurisdiction.

1-1.1.5 Provide a guide for design engineers, architects and others in planning new installations.

1-2 Where unique processes or unusual hazards to life and property are involved, the authority having jurisdiction may require safeguards in addition to those required by this standard or may modify the requirements provided equivalent safety is maintained.

1-3 Existing plants, equipment, buildings, structures and installations for the storage, handling or use of flammable and combustible liquids which are not in strict compliance with the terms of this standard may be continued in use provided they do not constitute a recognized hazard to life or adjoining property.

1-4 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.

1-5 This standard shall not apply to:

1-5.1 Operations involving the use or application of coatings materials. NFPA 33, *Standard for Spray Finishing*, and NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*, provide information on this subject.

1-5.2 Storage of organic coatings in locations other than the manufacturing facility. NFPA 30, *Flammable and Combustible Liquids Code*, provides information on this subject.

1-6 Definitions.

Approved. Acceptable to the "authority having jurisdiction."

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

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

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

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

Container. Any can, barrel or drum.

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

Combustible Liquids shall be subdivided as follows:

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

Class IIIA liquids shall include those having flash points at or above 140°F (60°C) and below 200°F (93.4°C).

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

NOTE: This classification does not apply to: (a) liquids without flash points that may be flammable under some conditions, such as certain halogenated hydrocarbons and mixtures containing petroleum fractions and halogenated hydrocarbons, (b) mists, sprays or foams.

The volatility of liquids is increased when they are heated. When heated to temperatures equal to or higher than their flash points, Class II and Class III liquids shall be subject to the applicable requirements for Class I or Class II liquids.

Fire Point. The lowest temperature of a liquid in an open container at which vapors are evolved fast enough to support continuous combustion. This shall be determined by ASTM D-92, *Cleveland Open Cup Test Method.*

Flammable Liquids. Any liquid having a flash point below 100°F (37.8°C) and having a vapor pressure not exceeding 40 lb per sq in. (absolute) (2068.6 mm) at 100°F (37.8°C) and shall be known as a Class I liquid.

Class I liquids shall be divided 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).

Flash Point. The minimum temperature at which a flammable or combustible liquid will give off sufficient flammable vapors to form an ignitible mixture with air near the surface of the liquid or within the vessel used as determined by the appropriate test procedure and apparatus as specified below:

The flash point of liquids having a viscosity less than 45 SUS (Saybolt Universal Seconds) at 100°F (37.8°C) [approximately 8 centipoise at 77°F (25°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.

The flash point of liquids having a viscosity of 45 SUS (Saybolt Universal Seconds) or more at 100°F (37.8°C) [approximately 8 centipoise at 77°F (25°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.

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

Hot Work. Work involving open flames, cutting and welding using open flames or electric arcs, grinding, buffing or open unguarded sources of ignition.

Inert Gas. Any gas which is noncombustible, nonreactive, incapable of supporting combustion, noncontaminating for the use intended, and oxygen deficient to the extent required.

Inerting. The use of an inert gas to render the atmosphere of an enclosure or within equipment substantially oxygen free or to reduce the oxygen content to a point at which combustion cannot take place. See NFPA 69, *Standard on Explosion Prevention Systems*.

Liquid. For the purpose of this standard, any material which has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D-5, *Test for Penetration for Bituminous Materials* (approximately equal to a viscosity of less than 60,000 Poise when tested in accordance with ASTM D-2196, *Standard Method of Test for Rheological Properties of Non-Newtonian Materials*). When not otherwise identified, the term liquid shall include both flammable and combustible liquids.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspec-

tion of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

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

Mix Tank. A portable or fixed agitated vessel in which intermediate or finished products are manufactured, adjusted, and held, pending disposition.

Monomers. Unsaturated organic compounds, containing a reactive group, which polymerize by themselves or with other monomers to produce polymers. These monomers may be liquids (styrene, ethyl acrylate), gases (butadiene, vinyl chloride), or solids (acrylamide), and exhibit the same flammability characteristics that would be expected of any organic compound with their physical constants. These monomers represent an additional hazard because of the exothermic heat that would be evolved if uncontrolled polymerization occurred.

Nitrocellulose. A nitrated cellulose (cotton linters or wood pulp) with a nitrogen content ranging from 10.5 percent to 12.6 percent. It is a fibrous, granular, cubed or flake-like material wetted with not less than 25 percent alcohol or other organic liquid having a flash point not lower than 30°F (-1°C). Nitrocellulose may also be wetted with not less than 25 percent water.

Organic Coatings. Liquid mixtures of binders such as alkyd, nitrocellulose, acrylic, or oil, and flammable and combustible solvents such as hydrocarbon, ester, ketone, or alcohol, which when spread in a thin film convert to a durable protective and decorative finish. These mixtures may contain pigments.

Organic Peroxides. Those organic compounds which are identified by their active oxygen (-O-O-) being combined with the organic radical. This group of reactive chemicals are derivatives of hydrogen peroxides in which one or both hydrogen atoms are replaced by a hydrocarbon or heterocyclic or acid radical. Some peroxides are heat and shock sensitive and are known as "potentially explosive chemicals." Examples of such peroxides are benzoyl peroxide and methyl ethyl ketone peroxide.

Portable Shipping Tank. Any tank having a liquid capacity in excess of 60 U.S. Gallons (227.1 L) and not exceeding 660 U.S.

Gallons (2498.1 L) which is readily movable from place to place either with or without special handling equipment and which is not permanently attached to its transporting vehicle.

Safety Can. A listed container, of not more than 5 gal (18.9 L) capacity, having a spring-closing lid and spout cover and so designed that it will safely relieve internal pressure when exposed to external heat.

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

Vapor Pressure. 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 D-323.

Chapter 2 Location of Plants and Buildings

2-1 Location.

2-1.1 An organic coatings manufacturing operation shall not be conducted in the same building with other occupancies. Operations incidental to or in connection with organic coatings manufacturing shall not be classed as "other occupancies."

2-1.2 An organic coatings manufacturing operation shall be located so that it is accessible from at least two sides for the purpose of fire control.

2-1.3 Where topographical conditions are such that flammable and combustible liquids may flow from the organic coatings manufacturing operation so as to constitute a fire hazard to other facilities, drainage shall be provided as covered in Section 3-2.

2-2 General Layout and Design.

2-2.1 Congestion shall be avoided in planning an organic coatings manufacturing operation.

2-2.2 Research laboratories, general offices, and storage areas when located in the same building housing manufacturing operations shall be cut off from the manufacturing operations by a wall having a fire resistance rating of at least 2 hours, and openings shall be equipped with approved fire doors.

2-2.3 Areas where unstable liquids are handled or processed shall be cut off from the remainder of the plant by a wall having a fire resistance rating of at least 2 hours and openings equipped with approved fire doors.

2-2.4 The location of each processing vessel shall be based upon its flammable or combustible liquid capacity. Processing vessels shall be located, with respect to distances to lines of adjoining property which may be built upon, in accordance with Table 2-2.4(a) and Table 2-2.4(b) except when the processing plant is designed in accordance with 2-2.5.

2-2.5 The distances required in 2-2.4 may be waived when the vessels are housed within a building and the exterior wall facing the line of adjoining property which may be built upon is a blank wall having a fire resistance rating of not less than 2 hours.

When Class IA or unstable liquids are handled, the blank wall shall have explosion resistance in accordance with good engineering practice. The balance of the building shall be designed in accordance with Section 3-5.

Table 2-2.4(a)

Processing Vessels With emergency relief Venting to permit pressure	Stable Liquids	Unstable Liquids
Not in excess of 2.5 psig	Table 2-2.4(b)	2½ times Table 2[1]
Over 2.5 psig	1½ times Table 2-2.4(b)	4 times Table 2[1]

[1]Double distances where protection from exposure is not provided. Protection for exposures shall mean fire protection for structures on property adjacent to tanks. When acceptable to the authority having jurisdiction, such structures located (1) within the jurisdiction of any public fire department or (2) within or adjacent to plants having private fire brigades shall be considered as having adequate protection for exposures.

Table 2-2.4(b)

Capacity Vessel Gal	Minimum Distance in Ft from Property Line Which May Be Built Upon, Including the Opposite Side of a Public Way	Minimum Distance in Ft from Nearest Side of any Public Way or from Nearest Important Building
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

For SI Units: 1 gal = 3.785 L; 1 ft = 0.3048 m

Chapter 3 Building Construction

3-1 General Construction.

3-1.1* Buildings shall be of fire-resistive or noncombustible construction without basements. The first floor shall be at or above the grade to permit water drainage and vapor diffusion.

3-1.2* Flammable raw materials and finished stock storage shall be detached or cut off from manufacturing buildings by a wall having a fire resistance rating of at least 2 hours, and openings shall be equipped with approved fire doors.

3-1.3 Internal partitions, where used, shall not interfere with ventilation and exit facilities and shall be of noncombustible construction.

3-1.4 In multistory buildings, stairways and elevators shall be enclosed by walls having a fire resistance rating of at least 2 hours and be equipped with approved fire doors.

3-1.5 Each manufacturing room shall have at least two exits, well separated and leading to the outside or other safe area. Access to all exits shall be kept clear, and doors shall open in the direction of exit. Door fastenings shall be equipped with panic hardware. Supervisory management offices and change and locker rooms located in the manufacturing buildings shall be provided with adequate exits. See NFPA *101®*, *Life Safety Code®*.

3-2 Drainage.

3-2.1 Drainage facilities shall be provided to direct flammable and combustible liquid leakage and fire protection water to a safe location away from the building, any other items of important value, or adjoining property. This may require pitched floors with drains, curbs, scuppers, impounding basins, or special drainage systems. Traps and special ditch construction may be needed to control the spread of fire where drainage is by an open plant ditch serving other plant areas and possibly offering some fire exposure. NFPA 15, *Standard for Water Spray Fixed Systems*, provides information on this protection.

3-2.2 Emergency drainage systems may contain flammable and combustible liquids. If connected to public sewers or discharged into public waterways, they shall be equipped with traps or separator pits designed to pass water and retain the flammable and combustible liquid.

3-3 Building Heating. Building heating in areas handling Class I liquids, if required, shall be provided by indirect means such as water, steam or warm air. Ignition sources such as open flames or electrical heating elements, except units approved for Class I, Group D locations, shall not be used within the hazardous area.

3-4 Ventilation.

3-4.1 Open Containers and Equipment.

3-4.1.1 Enclosed buildings in which Class I liquids are processed or handled in open containers and equipment shall be continuously ventilated at a rate not less than 1 ft^3 per minute (4.25 m^3) per sq ft of solid floor area during operation of any equipment. This shall be accomplished by exhaust fans taking suction at floor level and discharging to a safe location outside the building or by natural ventilation. Where there is a potential for vapor emission due to evaporation of Class I liquids, sufficient ventilation shall be provided during a shut-down period to maintain a safe atmosphere.

3-4.1.2 Additional local ventilation may be needed for control of health hazards. Such ventilation, if provided, may be utilized for up to 75 percent of the recommended ventilation in 3-4.1.1. Ventilation shall be arranged to include all pits or other low points where flammable vapors may collect. NFPA 91, *Standard for Blower and Exhaust Systems*, provides information on this subject.

3-4.2 Closed Containers and Equipment.

3-4.2.1 Enclosed buildings in which Class I liquids are processed or handled in closed containers and equipment shall be equipped with a point-of-use and point-of-emission local exhaust ventilation system designed to prevent accumulation of flammable vapors during the operation of the equipment. This shall be accomplished by exhaust fans taking suction at all potential points of flammable vapor release from the equipment. During a shut-down period, when equipment is open and there is a potential for vapor emission, sufficient ventilation shall be provided to maintain a safe atmosphere.

3-4.2.2 Additional floor level ventilation is required in stagnant areas, such as corners and sumps, pits and other low points where flammable vapors may collect.

3-5 Explosion Venting.

3-5.1 Structures in which Class I liquids, unstable liquids, or finely divided flammable solids are processed shall be provided with explosion venting by one or more of the following methods:

(a) Open air construction.

(b) Lightweight noncombustible walls and roof.

(c) Lightweight noncombustible wall panels and roof hatches.

(d) Windows of the explosion relief type.

3-5.2 Enclosures shall be vented according to the nature of the materials processed and the type structure. Small enclosures where the whole area may contain an explosive mixture need to be vented more generously than larger areas where only a portion may contain an explosive mixture.

3-5.3 In the selection of suitable venting, the following factors shall be considered:

(a) Strength of structure or enclosure.

(b) The maximum explosion pressure.

(c) The position of the vents with respect to the origin of potential explosions.

(d) The bursting strength of the vent closure, or the minimum pressure required to open the vent closure if movable as a whole. NFPA 68, *Guide for Explosion Venting*, provides information on this subject.

3-6 Electrical Equipment.

3-6.1 All electrical wiring and equipment shall be installed and maintained in accordance with nationally recognized good practice. NFPA 70, *National Electrical Code®*, provides information regarding such installations.

3-6.2 Where Class I liquids are exposed to the air, the design of equipment and ventilation of buildings shall be such as to limit the Class I, Division 1 location to pits, to the interior of equipment and the "immediate vicinity" of pumps or equipment locations such as dispensing stations, sand mills, open centrifuges, plate and frame filters, opened vacuum filters, change cans, and the surfaces of open equipment. Immediate vicinity means a zone extending from the vapor liberation point 5 ft (1.5 m) horizontally in all directions and vertically from the floor to a level 3 ft (1 m) above the highest point of vapor liberation. Beyond the immediate area, it shall be Class I,

Division 2, within the confines of the manufacturing room. (*See Table 5-1 of NFPA 30, Flammable and Combustible Liquids Code, and NFPA 497, Classification of Class I Hazardous Locations for Electrical Installations.*)

3-6.3 If only Class II or Class III liquids are processed and their temperatures are not raised above their flash point, general purpose electrical equipment is safisfactory.

3-6.4 Where the provisions of 3-6.2 would require the installation of explosionproof switch gear, general purpose electrical equipment, including switch gear, may be used if located in a nonclassified area or installed in a room or enclosure which is maintained under positive pressure with respect to the classified area. All conduits running from classified to nonclassified areas shall be sealed. Air for pressurization shall be taken from a location where entrainment of flammable vapor is improbable. Refer to NFPA 496, *Standard on Purged Enclosures for Electrical Equipment.*

Chapter 4 Process Equipment and Operations

4-1 Transfer of Flammable and Combustible Liquids.

4-1.1 As far as practical, processes involving the use of flammable and combustible liquids shall be carried out in closed systems of equipment, containers and piping.

4-1.2 The transfer of large quantities of flammable and combustible liquids shall be through piping, preferably by means of pumps. Where gravity flow is utilized, fail-safe remote actuated valves shall be provided with emergency shutoffs at points of use and at liquid storage tanks.

4-1.3 The use of compressed air as a transferring or displacement medium shall be prohibited.

4-1.4 Pumps shall be selected that are designed for the flammable and combustible liquid used, the working pressures and the structural stresses to which they may be subjected.

4-1.5 Where flammable or combustible liquids are pumped from storage to points of use, an emergency switch shall be provided in the processing areas at the normal exit door or at other safe locations outside the fire area and at the pumps to shut down all pumps in cases of fire. The intent is to stop the flow of flammable or combustible liquids.

4-1.6 The dispensing of small quantities of Class I liquids from drums shall be by means of an approved drum pump or by gravity from drums on racks using an approved self-closing faucet and bung vent.

4-1.7 Open containers shall be covered when being transported from one place to another.

4-2 Piping, Valves and Fittings.

4-2.1 All piping, valves and fittings in flammable or combustible liquid service shall be designed for the working pressures and structural stresses to which they may be subjected. They shall be of steel or other material approved for the service intended. Cast-iron valves, fittings and pipe shall not be used.

4-2.2 Valves shall be of an indicating type to show whether open or closed, for example a rising stem, plug, or ball valve. Such valves shall be mounted in a manner that vibration will not cause them to open.

4-2.3 Terminal valves on remote pumping systems shall be of the spring-loaded, self-closing type. They may be manual or held open with a fusible link. The pump shall be controlled by the valve or meter operation.

4-2.4 Piping systems shall be substantially supported and protected against physical damage.

4-2.5 The use of tunnels, stair or elevator towers for flammable and combustible liquid piping shall be avoided. If trenches are unavoidable, they shall be covered with grating trench covers. Trenches shall be filled with sand or bulkheaded at frequent intervals. See Figure A-4-6.2(b) of NFPA 15, *Water Spray Fixed Systems for Fire Protection*, for use of grating trench covers.

4-2.6 A method of relieving trapped liquids, such as relief valves or drainage, shall be provided on piping systems. Approved flexible connectors may be used where vibration exists or where frequent movement is necessary. Approved hose may be used at dispensing stations.

4-2.7 Solvent piping entering equipment such as mixers and kettles shall be bonded to the equipment and designed to minimize the generation of static electricity build-up from free fall or excessive agitation.

4-2.8 Before being placed in service, all piping shall be free of leaks when hydrostatically tested to a minimum of 1½ times the working pressure maintained for a minimum of 30 minutes.

4-3 Kettles, Reactors and Vessels.

4-3.1 Open Fire Resin Cooking and Thinning.

4-3.1.1 Adequate fire protection shall be provided based on inert gases or dry chemical. Water shall be avoided.

4-3.1.2 Open fire kettles shall be located in an outside area, provided with a protective roof, or in a separate building of noncombustible construction, or separated from other areas by means of a wall or partition having a fire resistance rating of 2 hours and openings equipped with approved fire doors.

4-3.1.3 Adequate stacks or other fume disposal system shall be provided to eliminate the fumes or vent them to a safe location.

4-3.1.4 Thinning or reducing operations where portable kettles are used shall be performed in a well-ventilated area separated from the open fires. This area shall be designed so that fumes from the operation are handled in a positive manner to prevent any return to the cooking area. Vapors shall be collected through a vented condenser of adequate size to eliminate any vapor fog.

4-3.2 Closed Reactors and Thin-Down Tanks.

4-3.2.1 Reactors involving the use of solvents are preferably heated by a heat transfer medium. The vaporizer or heat producing equipment shall be remotely located from the process area or otherwise safeguarded as outlined in 4-3.2.2 and 4-3.2.3.

4-3.2.2 The following safeguards shall be provided for all reactors:

(a) Furnace room ventilation shall be maintained with a high level exit and a low level entry.

(b) For gas furnaces, there shall be an accessible identified external gas shut-off valve for emergency use.

(c) The reactor shall be provided with a rupture disc located as close as possible to the vessel in case the normal vent becomes inoperative. The discharge piping from the rupture disc shall be directed to a blow-down tank or to a safe location.

4-3.2.3 The following additional safeguards shall be provided for:

(a) The fire box shall be instrumented to shut down fuel in case of flame-out to prevent explosions within. For fuel safety controls see NFPA 86A, *Standard for Ovens and Furnaces*.

(b) The external area under the kettle where the fire box or furnace is located shall be completely sealed from the process area, particularly the operating floor, to prevent any spills from being ignited. The furnace air intake shall be remotely located from the process area. The exhaust of the hot combustion gases from the fire box shall be piped or ducted away from the process area to prevent its igniting flammable materials due to spills or upsets in process. Under no circumstances shall any combustible material be stored in the furnace room, nor shall the room contain any piping of flammable materials except those connected to the kettle or fire box as part of the process.

(c) The reactor shall be provided with a high temperature limit switch.

4-3.2.4 To prevent a violent foaming or boilover, reactors and thin-down tanks shall be designed and procedures established to avoid uncontrolled introduction of cold liquids into the hot reaction mass.

4-4 Dispersion Equipment.

4-4.1 Two-roll mills or other mills operating with close clearances and which are used for the processing of flammable and heat sensitive materials, such as nitrocellulose, shall be located in a detached building or in a noncombustible structure without other occupancy. The amount of nitrocellulose or other flammable material brought into the area shall be no more than that required for a batch. A remote manually operated water spray system with an adequate number of heads shall be provided for mill protection.

4-4.2 For the protection of roll mill operators, an emergency shutoff shall be located within easy reach, so that the mill can be stopped if any part of the operator's clothes or body becomes caught in the mill or if the mill should catch fire.

4-4.3 Open mills shall be provided with adequate local ventilation exhausted to outside the building.

4-4.4 **High-Speed Dispersers.** In a multiple tank installation, the common disperser agitator shall be equipped with a positive locking device. The agitator and tanks shall be bonded and grounded. Covers for the tanks shall be provided.

4-4.5 Pebble Mills and Steel Ball Mills.

4-4.5.1* Ball and pebble mills shall be grounded. Metal chutes or funnels used for adding flammable or combustible liquids to mills shall be extended into the mill as far as possible to minimize free fall and they shall be bonded to the mill or to ground.

4-4.5.2 When pressurizing of pebble and steel ball mills to unload is necessary, inert gas shall be used. Air pressure shall not be used. To protect the mills from overpressure, a relief valve shall be provided and set not to exceed the design pressure of the vessel.

4-5 Mixers and Mixing Tanks.

4-5.1 Processing tanks, day tanks, mix tanks and other vessels needed for processing are permitted in the area and are not to be considered storage tanks.

4-5.2 Mixers used for flammable or combustible products shall be equipped with either full or partial covers consistent with the process being carried out. Such covers shall be closed except for access.

4-5.3 Where gravity flow is used, a shut-off valve shall be installed as close as practical to the vessel being unloaded, and a control valve shall be provided near the end of the discharge pipe. A bond shall be provided between the discharging piping and the receiving container.

Chapter 5 Material Storage and Handling

5-1 Tank Car and Tank Vehicle Unloading and Loading.

5-1.1 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 may be built upon by a distance of 25 ft (7.6 m) for Class I liquids and 15 ft (4.5 m) for Class II and Class III liquids, measured from the nearest position of any fill stem. Buildings for pumps or shelters for personnel may be a part of the facility. Operations of the facility shall comply with appropriate portions of NFPA 30, *Flammable and Combustible Liquids Code*. For information on tank vehicles, see NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids*.

5-2 Flammable and Combustible Liquid Storage.

5-2.1 The storage of flammable or combustible liquids in tanks shall be in accordance with the applicable provisions of NFPA 30, *Flammable and Combustible Liquids Code*.

5-2.2 If the storage of flammable or combustible liquids in outside aboveground or underground tanks is not practical because of temperature considerations or production considerations, tanks inside of buildings or structures shall be in accordance with the applicable provisions of NFPA 30, *Flammable and Combustible Liquids Code*.

5-2.3 Storage tanks inside of buildings shall be permitted only in areas at or above grade which have adequate drainage and are separated from the processing area by construction having a fire resistance rating of at least 2 hours. Openings to other rooms or buildings shall be provided with noncombustible liquidtight raised sills or ramps at least 4 in. (101 mm) in height, or the floor in the storage area shall be at least 4 in. (101 mm) below the surrounding floor. A permissible alternate can be an open-grated trench inside of the room which drains to a safe location. Openings shall be provided with approved self-closing fire doors. The room shall be liquidtight where the walls join the floor.

5-2.4 The storage of flammable or combustible liquids in portable shipping tanks or containers shall be in accordance with the applicable provisions of NFPA 30, *Flammable and Combustible Liquids Code.*

5-2.5 When storing water-borne materials with a flash point but no fire point up to the boiling point of the materials, the reduced fire hazards associated with such storage shall be taken into consideration.

5-3 Storage of Finished Product.

5-3.1 Finished products that are flammable and combustible shall be stored outside of buildings, in a separate building, or in a separate room cut off from the processing area by a wall or partition having at least a 2-hour fire resistance rating, and openings shall be equipped with approved fire doors. The storage of finished products shall be in closed containers or in tanks in accordance with nationally recognized good practice. NFPA 30, *Flammable and Combustible Liquids Code,* provides information on such storage.

5-3.2 Except for custom tinting, flammable and combustible liquids shall not be dispensed, blended or otherwise exposed in an area used for the storage of finished product.

5-3.3 When storing water-borne materials with a flash point but no fire point up to the boiling point of the materials, the reduced fire hazards associated with such storage shall be taken into consideration.

5-4 Container Storage.

5-4.1 Empty containers previously used for flammable and combustible liquids may be potentially dangerous. Drum plugs shall be replaced, and all empty containers shall be removed to a well-detached, outside location and, if not cleaned on the premises, removed from the plant as soon as practical.

5-4.2 Where containers are stored outside, the area shall be free of grass, weeds and underbrush.

5-4.3 A maximum of 1,100 gal (4163 L) per pile of flammable or combustible liquids, in closed containers, may be stored adjacent to any building located on the same premises and under the same management provided that:

(a) Such a building one or more stories in height has exterior walls of 2-hour fire-resistive construction with no openings above the

storage or within 10 ft (3 m) horizontally of such storage pile and,

(b) Each pile of 1,100 gal (4163 L) stored along a common wall is separated by 10 ft (3 m).

5-4.3.1 Where the quantity exceeds 1,100 gal (4163 L) or provisions of 5-4.3 cannot be met, a minimum distance of 10 ft (3 m) between the building and the nearest container of flammable or combustible liquids shall be maintained. See Chapter 4 of NFPA 30, *Flammable and Combustible Liquids Code* for further information on container storage.

5-5 Portable Shipping Tanks.

5-5.1 In-Plant Transportation and Storage.

5-5.1.1 The storage of portable shipping tanks shall be in accordance with NFPA 30, *Flammable and Combustible Liquids Code*, and the construction shall comply with NFPA 386, *Portable Shipping Tanks*.

5-5.1.2 Full or part-full portable shipping tanks may be stacked two high, providing they are of the "nesting" design.

5-5.1.3 All materials handling equipment used for transporting or lifting portable shipping tanks shall be of ample capacity to lift or transport the full load safely and shall conform to NFPA 505, *Standard for Powered Industrial Trucks*.

5-5.1.4 Floors of buildings and shipping docks shall be structurally able to carry the wheel loads resulting from transporting full portable shipping tanks by means of materials handling equipment.

5-5.2* Discharging Portable Shipping Tanks.

5-5.2.1 The contents of portable shipping tanks may be discharged by three methods:

(a) The material may be pumped from the top. The portable shipping tanks may or may not have a bottom valve. The pump, pipelines, hoses or other containers or tanks shall be bonded and grounded.

(b) The material may be pumped from the valve at the bottom of the portable shipping tank. The pump, pipelines, hoses or other containers or tanks shall be bonded and grounded.

(c) The material may be discharged by gravity from the valve at the bottom of the portable shipping tank. The portable shipping tank, pipelines, hoses and receiving vessel shall be bonded and grounded.

5-5.2.2 Portable shipping tanks shall not be pressure unloaded.

5-5.3 Filling Portable Shipping Tanks. Portable shipping tanks may be filled by gravity or pump. When filling through an open manhole, bonding shall be provided between the filling pipe and the portable shipping tank.

5-6 Industrial Trucks.

5-6.1 Power operated industrial trucks that are approved and designated as EX shall be used in areas where flammable vapors exist under normal operating conditions in quantities sufficient to produce ignitible mixtures (Class I, Division 1, Group D electrical classification). Refer to NFPA 70, *National Electrical Code*, for additional information on the interpretation of the electrical classifications referred to herein and NFPA 505, *Standard for Powered Industrial Trucks*, for an explanation of the designations of industrial trucks.

5-6.2 Power operated industrial trucks that are approved and designated as EX, EE or DY shall be used in areas where Class I liquids and their vapors are normally within a closed system or container from which the liquid or vapor can escape only in the event of accidental rupture or breakdown of such equipment (Class I, Division 2, Group D electrical classification).

5-6.3 Power operated industrial trucks that are approved and designated as GS, LPS, DS, ES, EX, EE or GS/LPS may be used in areas where Class I liquids are stored in sealed containers if permitted by the authority having jurisdiction.

5-6.4 Power operated industrial trucks that are approved and designated as EX shall be used in areas where combustible dusts are or may be in suspension in the air continuously, intermittently or periodically under normal operating conditions in quantities sufficient to produce ignitible mixtures (Class II, Division 1, Group G electrical classification).

5-6.5 Power operated industrial trucks that are approved and designated as EE, EX, or DY shall be used in areas where combustible dusts are present but not normally in suspension in the air and will not be thrown into suspension in the air by the normal operation of equipment in sufficient quantities to produce ignitible mixtures but where deposits of such dust may be ignited by arcs or sparks originating in the truck (Class II, Division 2, Group G electrical classification).

Chapter 6 Special Hazards

6-1 Nitrocellulose.

6-1.1 Hazards.

6-1.1.1 Nitrocellulose is a flammable material with a variable burning rate. When alcohol-wet or completely dry it is easily ignited. When completely dry it burns with a rapid intensity. When water-wet it is difficult to ignite and slower burning when it does.

6-1.1.2 When nitrocellulose burns, toxic gases such as oxides of nitrogen and carbon monoxide are evolved. Personnel shall avoid exposure to these gases.

6-1.2 Handling.

6-1.2.1 The dragging or pushing of drums on hard surfaces shall be avoided because of possible frictional heat.

6-1.2.2 Drums may be moved by means of a two-wheel hand truck fitted with a nonferrous "grab" to hold the top of the drum. A power-driven industrial lift truck of the approved type may also be used as defined in Section 5-6.

6-1.2.3 Drums shall not be dropped. If there is a difference in elevation, the handling equipment shall not drop, puncture or damage the drums.

6-1.3 Storage.

6-1.3.1 Nitrocellulose shall be stored as follows:

(a) In a room or building attached to the production area, separation shall be by a fire wall with openings equipped with approved fire doors. The room shall be equipped with an automatic sprinkler system providing a density of 0.35 gpm per sq ft (1.3 L/min) over the entire storage area.

(b) In a detached noncombustible building located within 50 ft (15 m) of a property line which may be built upon or an important building, when protected by an automatic sprinkler system providing a density of 0.35 gpm per sq ft (1.3 L/min). When the storage building is separated by a distance less than 25 ft (7.6 m) the wall facing the exposure shall have a fire resistance rating of at least 2 hours.

(c) If the plant area is adequate for a detached storage over 50 ft (15 m) from a property line which may be built upon or an important building, a suitable structure would be a roofed shed constructed of noncombustible material. An automatic sprinkler system is not mandatory.

6-1.3.2* The electrical classification of an attached storage area [*see 6-1.2.1(a)*] shall be based on the classification of the adjacent process area. In detached storage areas [*see 6-1.3.1(b) and (c)*], a general purpose electrical lighting system is satisfactory. The above is based on the storage areas meeting all the requirements of 6-1.3.

6-1.3.3 Storage of other commodities in the same area as nitrocellulose may be permitted if limited to inert materials which are chemically compatible with the nitrocellulose and the nitrocellulose storage is separated by a distance of 20 ft (6 m). Storage of other flammable liquids shall not be permitted. Nitrocellulose shall be stored only in closed DOT-approved containers. Drums or other containers of nitrocellulose shall not be opened in the main storage area but at the point of use or other location set aside for the purpose.

6-1.3.4 Drums shall be stored in an upright position with the lid up and shall not be tiered more than two high.

6-1.3.5 Nitrocellulose shall be stored in such a manner that the stock will be rotated to assure the oldest material is used first.

6-1.4 Process Area.

6-1.4.1 The amount of nitrocellulose brought into the operating area shall not exceed that required for a shift.

6-1.4.2 The retaining ring holding the drum cover in place shall be removed by the use of a suitable spark resistant wrench. If necessary to fork or scoop the material out of a barrel, spark resistant tools shall be used.

6-1.4.3 Any nitrocellulose which may be spilled on the floor or elsewhere shall be promptly swept up, put into a pail of water, and removed at the end of the day or shift and disposed of properly. (*See 6-1.5.1.*)

6-1.4.4 After emptying, drums shall be wiped clean with a dry rag or cloth, the cover shall be replaced, and the sealing ring tightened. Rags, after use, shall be placed in a covered waste container, wet down with water, and disposed of daily.

6-1.5 Waste Disposal.

6-1.5.1 Sweepings and other waste nitrocellulose shall be placed in a covered metal container and wet down with water immediately. Dispose of the waste material by burning in a safe, isolated location. Disposal shall not be by burning in a boiler fire box, incinerator, or other confined equipment. Burning shall only be conducted in accordance with federal, state, or local regulations regarding pollution.

6-1.6 Fire Protection.

6-1.6.1 Water is the most effective fire extinguishing medium for nitrocellulose and shall be used in large quantities.

6-1.6.2 Exposure of drums of nitrocellulose to fire or high heat will cause vaporization of the wetting medium resulting in an increase in pressure which will cause release of the drum lid. Fire fighters shall keep out of range when encountering such situations and avoid breathing fumes given off by burning nitrocellulose. Self-contained breathing apparatus shall be used by fire fighting personnel or others who may be exposed to such fumes in the performance of their duties.

6-2 Monomers.

6-2.1 Hazards.

6-2.1.1 Monomers may be liquids, solids, or gases. They are reactive chemicals and present special hazards because of their chemical composition. They are usually highly flammable, and their vapors, which are normally heavier than air, can form explosive vapor-air mixtures. They usually contain an inhibitor to prevent self-polymerization. At elevated temperatures, such as fire exposure, polymerization may take place. If this occurs in a closed container, a violent rupture may occur.

6-2.1.2 Monomer vapors are usually toxic, and personnel shall avoid exposure to them at all times. Adequate ventilation is mandatory. Personal protective equipment must be used.

6-2.1.3 Suppliers shall be contacted for advice concerning the storage, handling and use of specific monomers.

6-2.2 Process and Handling.

6-2.2.1 Precautions in handling of monomers shall parallel those outlined for flammable and combustible liquids. Since vapors can be more toxic, the need for adequate ventilation and the availability of respiratory protection for emergencies is of the utmost importance.

6-2.2.2 For specific information on explosion venting and structural design requirements for areas involved with handling of monomers, refer to Section 2-2 (General Layout and Design) and Section 3-5 (Explosion Venting) in this standard.

6-2.3 Storage—Liquids and Gases.

6-2.3.1 Aboveground monomer storage tanks shall be located in a remote area. Topography or diversionary diking shall be used to drain spilled monomer from the storage tank area and to prevent exposure from fires in other flammable and combustible liquid storage tanks. Where drainage is impracticable, liquid monomer storage tanks shall be surrounded with an individual dike to contain the monomer in the event of a large leak or overflow. In cases of diversionary diking, an impounding basin is usually required to provide effective fire containment and minimize contamination problems. NFPA 30, *Flammable and Combustible Liquids Code*, specifies locations for liquid monomer storage and drainage and diking methods.

6-2.3.2 Monomers may need to be individually piped to prevent contamination which may promote polymerization.

6-2.3.3 Monomer storage tanks shall have a normal vent and a separate emergency vent. See NFPA 30, *Flammable and Combustible Liquids Code*, for venting requirements. The emergency vent shall be designed on the basis of the effects of heat or gas resulting from polymerization or self-reactivity.

6-2.3.4 Some monomers are sensitive to temperature extremes. The storage tanks shall be provided with a means to control the temperature. Water spray, cooling coils, reflective paints, overhead cover, or insulation are all methods which can be used.

6-2.3.5 Since monomers are reactive chemicals having inhibitors to prevent reaction in storage, the strength of these inhibitors shall be checked periodically to make sure they are at a safe level. Some systems, such as hydroquinone in styrene, lose their effectiveness to inhibit polymerization under certain time and temperature conditions.

6-2.3.6 Some monomers are not highly flammable and can be stored under an air atmosphere. Others, which have low flash points (Class I liquids), may be stored under an inert gas atmosphere to minimize polymer formation and improve fire safety.

6-2.3.7 Materials of construction for tanks, pipelines, pumps, and auxiliary equipment shall conform to the recommendation of the supplier of the monomer.

6-2.4 Storage—Solid. Solid monomers may be shipped in drums or bags. Normally solid monomers are not subject to self-polymerization unless they are liquefied or subjected to elevated temperatures. Storage therefore shall be at ambient temperature, isolated, where drums and bags will not be damaged, and free from any possibility of contamination with reactive chemicals or moisture.

6-2.5 Waste Disposal.

6-2.5.1 All quantities of waste monomers or material contaminated with monomers shall be disposed of according to federal, state, and local regulations regarding hazardous waste.

6-2.5.2 When a waste disposal problem arises as a result of a major spill or equipment rupture, only properly protected personnel shall remain in the area.

6-2.6 Fire Protection.

6-2.6.1 Fires involving monomers can generally be controlled and extinguished using dry chemical, water spray, proper type foam and carbon dioxide.

6-2.6.2 Self-contained respiratory equipment shall be used to avoid exposure to toxic vapors.

6-3 Organic Peroxides.

6-3.1 Organic peroxides are considered to be "unstable" chemicals and present a serious problem in safe handling. They may be powerful oxidizing agents and may react violently with reducing agents and some on exposure to heat or shock. Only general details can be offered here, and the authority having jurisdiction shall be consulted wherever these materials are to be used.

6-3.2 In general organic peroxides are stored in cool locations. In very hot weather artificial cooling may be necessary to prevent decomposition of the peroxide. In cold climates artificial heat may be necessary to prevent the formation of shock sensitive crystals. For example, acetyl peroxide (25 percent solution in dimethyl phthalate) shall not be exposed to temperatures above 90°F (32.2°C), violent decomposition may occur above 122°F (50°C), and shock sensitive crystals may be formed below 17°F (-8°C). Further information may be found in NFPA 49, *Hazardous Chemicals Data*.

6-3.3 The storage of organic peroxides shall be isolated from flammable and combustible liquid storage, any important building, or line of adjoining property that may be built upon. Large quantity

storage of organic peroxides in highly populated areas shall be avoided. Only quantities sufficient for one day's operation shall be present in the operating areas.

6-3.4 The size of the package containing the organic peroxide shall be selected so that, as nearly as practical, full packages are utilized at one time, thus minimizing exposure to personnel and contamination of the product. Any peroxide spilled shall be promptly cleaned up and disposed of as recommended by the supplier.

6-3.5 The hazards incident to the storage and use of organic peroxides may be materially reduced when protected by a properly designed automatic sprinkler system.

Chapter 7 Fire Protection

7-1 Ignition Sources.

7-1.1 When electrical equipment is repaired or replaced, caution shall be exercised to assure that the integrity of the area electrical classification is maintained in accordance with Section 3-6.

7-1.2 Relocation, redirection or replacement of fittings and piping may negate previous bonding and/or grounding arrangements. Piping installations made under any maintenance activity shall conform to Sections 4-1, 4-2 and 7-2.

7-1.3 Open flames and direct-fired heating devices shall be prohibited in areas where flammable vapor-air mixtures may exist.

7-1.4 Smoking shall be prohibited except in designated safe areas.

7-2 Static Electricity.

7-2.1 All equipment such as tanks, machinery and piping where an ignitible mixture may be present shall be bonded and connected to a ground. The bond or ground or both shall be physically applied or shall be inherently present by the nature of the installation. For static dissipation purposes, this electrically conductive path shall not have a resistance of more than one million ohms to ground. NFPA 77, *Recommended Practice on Static Electricity*, provides information on this subject.

7-2.2 Electrically isolated sections of metallic piping or equipment shall be bonded to the other portions of the system or grounded to prevent external ignition hazards.

7-2.3 When flammable liquids are transferred to or from any portable container, all metallic elements, including the container, greater than 1 gal (3.785 L) in size, shall be bonded together and one element shall be grounded.

7-2.4 A bond or ground shall be composed of suitable conductive materials having adequate mechanical strength, corrosion resistance and flexibility for the service intended. No. 10 AWG wire, preferably uninsulated, is the minimum size which shall be used. Permanent connections may be made with electrical cable lugs, bolted clamps, by brazing, welding, or other suitable means.

7-2.5 Ordinary rubber or leather flat belts generate static. Such belts used to transmit power shall be made of conductive material or treated with a conductive belt dressing. Such coatings shall be checked periodically to assure reliability.

7-2.6 When flammable and combustible liquids are permitted to fall an appreciable distance through space, a static charge may be generated due to the breaking up into a spray or droplets. A method used to reduce this hazard is to extend the fill pipe to the bottom of the equipment or container, or divert the flow to the side of the equipment or container. This will help to keep the flow in a solid stream and reduce splashing.

7-3 Lightning Protection.

7-3.1 High masonry stacks and chimneys shall be provided with approved lightning protection.

7-3.2 Where needed, approved lightning protection shall be provided for buildings, structures and equipment.

7-3.3 Steel framing of buildings shall be grounded with resistance of not more than five ohms. NFPA 78, *Lightning Protection Code*, provides information on this subject.

7-4 Outside Fire Protection. Where good public fire protection facilities are not readily available, private outside protection facilities shall be provided in accordance with NFPA 24, *Standard for Outside Protection*. Even with good public protection facilities, it may be necessary to provide private outside protection facilities for large or remote facilities.

7-5 Fire Alarm Systems. A method of notifying personnel and the fire brigade of a fire or emergency shall be provided.

7-6 Sprinkler Systems.

7-6.1 Important manufacturing and storage buildings shall be protected by sprinkler systems installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

7-6.1.1 In sections where large quantities of flammable liquids may be involved or where flammable vapor may be present, the sprinkler system shall be wet pipe, pre-action or deluge type.

7-6.1.2 Water supply for sprinklers and other water systems shall be of adequate pressure and capacity for the highest fire flow demand in any one fire with ample reserve for necessary hose streams.

Where severe hazards are involved, including areas with high-piled stock, the sprinkler systems shall be hydraulically calculated and supplied accordingly. Although fires involving some solvents may not be extinguished by water, a liberal supply of water from sprinklers controls the flames and helps keep the structure, equipment and the supports cool, thereby preventing collapses. (*See NFPA 231, Indoor General Storage, and NFPA 231C, Rack Storage of Materials.*)

7-6.1.3 Adequate drainage facilities shall be provided for water from sprinkler systems or other water extinguishing systems (*see Section 3-2*).

7-7 Standpipe and Hose Systems. A standpipe and hose system shall be provided in important operating buildings. A system designed for in-plant (Class II or Class III) service in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, shall be provided. Only combination nozzles or spray nozzles shall be used. The use of a straight stream type of nozzle or play pipe shall be avoided as a stream from such a nozzle tends to spread a flammable liquid fire or stir up a dust cloud.

7-8* Portable Fire Extinguishers. An adequate supply of portable fire extinguishers suitable for flammable and combustible liquid fires shall be provided. NFPA 10, *Standard for Portable Fire Extinguishers*, provides additional information.

7-9 Fixed Extinguishing Systems.

7-9.1* Equipment such as mixers, solvent tanks or fixed open containers may be protected by foam, inert gas, halogenated agent or dry chemical extinguishing systems.

7-9.2 When desired, a combination automatic sprinkler system and high expansion foam system properly designed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 11A, *Standard for High Expansion Foam Systems*, may be permitted.

7-9.3 When desired, an automatic sprinkler system may be equipped to inject aqueous film-forming foam (AFFF) into it when properly designed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*; NFPA 11B, *Standard on Synthetic Foam and Combined Agent Systems*, and NFPA 16, *Standard for the Installation of Deluge Foam-Water Spray Systems*.

Chapter 8 Personnel Training

8-1* Fire Brigade. In manufacturing plants, a fire brigade shall be organized and trained to fight fires promptly and efficiently. Fire brigade training shall be conducted at periodic intervals using the various kinds of fire fighting equipment provided. For further information see NFPA 27, *Recommendations for the Organization, Training and Equipment of Private Fire Brigades.*

8-2* Personnel Training.

8-2.1 Personnel shall be made aware of special hazards and shall be trained in proper procedures for safe operation of processes, as well as emergency shut-down procedures for unusual conditions.

8-2.2 Personnel shall be trained in the use of portable fire extinguishers, methods of actuating fixed special extinguishing systems, and methods of notifying plant fire brigade, public fire department and emergency organization.

8-2.3 Personnel involved shall be periodically instructed as to the identity and potential dangers of hazardous materials.

8-2.4 All employees shall be trained to prevent and contain spills and to report solvent leaks, faulty equipment, missing or worn static bonding lines, and other matters requiring correction.

Chapter 9 Maintenance

9-1 Maintenance of Fire Protection Equipment. All plant fire protection facilities shall be so maintained and periodically inspected and tested as to make sure that they are in satisfactory operating condition to serve their purpose in time of emergency.

9-2 Hot Work and Confined Space Entry Permits.

9-2.1 When necessary to make repairs involving "hot work," the work shall be authorized in writing by the responsible individual in charge before the work is started.

9-2.2 When necessary to enter a tank, pit, manhole or other confined spaces, such entry shall be authorized by the responsible individual in charge. Another employee shall stand by while the person is in the confined space.

9-2.3 Prior to initiating tank entry or hot work, the following steps shall be taken:

9-2.3.1 Tanks, vessels, piping and traps shall be emptied of all material, cleaned and purged. All such materials shall be removed to a safe location.

9-2.3.2 All pipelines except air or cold water attached to vessel shall be disconnected, blanked off or capped with suitable material of construction which will prevent leakage. Where more than one unit is connected by a common duct, the duct openings to the vessel to be entered shall be disconnected or blanked. Steam jets in stacks shall be removed or disconnected if the stack is not disconnected from the vessel.

9-2.3.3 If a vessel is fitted with power-driven internal equipment, the power source shall be disconnected completely before entry; that is, the motor disconnect switch shall be padlocked in the off position and the key of the padlock shall remain in the possession of the person doing the work.

9-3 Cleaning Tanks or Vessels.

9-3.1 The cleaning of tanks or vessels which have contained flammable or combustible liquids shall only be done under the supervision of persons who understand the fire and explosion potential,

assisted by properly trained personnel in order to safely carry out the operations. This article is directed towards the cleaning operations of tanks and vessels preparatory to entry by plant personnel or for the performance of "hot work." For hot work permits, see Section 9-2. NFPA 327, *Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers*, provides detailed information on the procedures to be followed for the various methods of cleaning or safeguarding a tank or vessel.

9-3.2 The removal of residues and the cleaning of the tanks or vessels shall be accomplished by one of the following methods:

9-3.2.1 When the solvents that have been used are water soluble, such as ethyl alcohol and methyl ethyl ketone, the cleaning operation may be accomplished by filling with water and draining, repeating the operation several times. Drainage of the contaminated waste water shall be to a safe location.

9-3.2.2 When needed, a suitable hot chemical solution or a nonflammable proprietary cleaning agent may be used. Since these cleaning agents are potentially harmful, suitable protective goggles and clothing shall be worn to protect against possible injury to the eyes or skin. Tanks which have contained reactive or unstable materials shall not be cleaned or repaired until instructions have been obtained from the manufacturer or supplier. Safe cleaning procedures require care in the selection of nonreactive cleaning media or other special precautions. Avoid the use of hot water in making up caustic solutions. In preparing caustic solutions the caustic shall be added at a controlled rate to cold water. When using a proprietary cleaning solution, the manufacturer's instructions shall be followed. The drainage of the solution shall be to a safe location.

9-3.2.3 Where alkali cleaners are not feasible or safe, a suitable flammable solvent agitated or injected in the interior of a closed vessel to be cleaned may be used safely providing the vapor space is reliably inerted prior to adding the solvent by using an inert gas such as carbon dioxide or nitrogen. When carbon dioxide is used for inerting, vaporizing means shall be provided to assure that only gas is applied to the vessel. Carbon dioxide fire extinguishers shall not be used to inert a vessel as they will produce electrostatic sparks that could cause ignition. The inert gas piping shall be bonded to the vessel into which the gas is to be discharged, making sure the vessel in fact is properly grounded. The cleaning solvent and residue shall be drained to appropriate containers. Such containers shall also be properly bonded to the vessel from which the solvent is being drained.

9-3.2.4 Vapor freeing may be accomplished by purging with air, and a safe atmosphere may be sustained by continued ventilation. When fixed ventilating equipment is not provided, air movers may be attached so that air is drawn into the equipment and discharged through the air mover, or air may be introduced through the air mover and discharged through another opening. Discharge shall be to a safe location. Air movers shall be approved for such locations. In air purging, the concentration of vapor in air usually will go through the flammable range before a safe atmosphere is obtained; therefore, precautions shall be taken to ensure that the air mover is bonded to the equipment in order to minimize the hazard of ignition by static electricity. By first purging the equipment with an inert gas and then ventilating with air, the hazards incident to passing through the flammable range are minimized.

9-3.2.5 The need for personal protective equipment must be evaluated before each tank cleaning operation. Needed personal protective equipment shall be provided, and use enforced, during cleaning operations.

9-3.3 To ensure safe conditions for vessel entry and work, the following tests shall be conducted:

9-3.3.1 A test for oxygen deficiency and, where indicated, for toxicity shall be made before entry. If these conditions are present and cannot be overcome by cleaning and ventilation, then self-contained respiratory equipment shall be used. A minimum allowable oxygen concentration of 18 percent without toxic contaminants shall be indicated by readings taken at varying heights within the vessel to ensure a safe breathable atmosphere.

9-3.3.2 Tests for flammable vapors with a combustible gas indicator or other approved means shall be made: (1) before commencing alterations or repairs, including welding, cutting or heating operations; (2) immediately after starting any welding, cutting or heating operations; and (3) frequently during the course of such work. All such work shall be stopped immediately when the presence of solvent vapor is indicated. The source of the vapor shall be located and removed, and the procedure outlined above shall be followed before such work is resumed.

9-3.4 If it is desired to clean a tank solely for the purpose of product purity or change of product, one of the procedures outlined in 9-3.3 may be followed.