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35

ORGANIC COATINGS MANUFACTURE 1964

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National Fire Protection Association

International

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Adopted Jan. 23, 1964. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

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Recommended Practices for the

Manufacture of Organic Coatings

NFPA No. 35 — 1964

1964 Edition of No. 35

This 1964 edition of Recommended Practices for the Manufacture of Organic Coatings was developed by the NFPA Sectional Committee on Coating Manufacture, approved by the NFPA Committee on Flammable Liquids, and adopted by the Association at its Annual Meeting, May 18–22, 1964. It supersedes the 1963 edition, identified as NFPA No. 35M.

Origin and Development of No. 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. These Recommended Practices reflect the enlargement of the scope of the project and was first officially adopted in 1963. The principal changes in this edition were made to follow the new basic classification of flammable and combustible liquids. Other changes were for clarity or for editorial reasons as a result of comments which have been received.

Committee on Flammable Liquids

Paul C. Lamb, *Chairman*,
Lever Brothers Company, 390 Park Ave., New York, N. Y. 10022

Miles E. Woodworth,† *Secretary*
National Fire Protection Assn., 60 Batterymarch St., Boston, Mass. 02110

J. Robert Adams, Improved Risk Mutuals.
R. H. Albisser, Manufacturing Chemists' Assn., Inc.
W. J. Baker, Conference of Special Risk Underwriters.
C. V. Batley, Bethlehem Steel Co. (Personal)
W. C. Bluhm, American Petroleum Institute.
Herbert R. Bogardus, Fire Insurance Rating Organization of New Jersey.
W. S. Brooks, Oklahoma Inspection Bureau.
R. G. Brown, American Reciprocal Insurers.
G. E. Cain, National Paint, Varnish & Lacquer Assn.
Harold Crouch, Eastman Kodak Co. (Personal)
W. H. Doyle, Factory Insurance Assn.
James J. Duggan, Charleston, W. Va. (Personal)
A. F. Dyer, American Petroleum Institute.
D. M. Dymond, Canadian Standards Assn.
E. H. Fallin, National Petroleum Refiners Assn.
G. G. Fleming, Manufacturing Chemists Assn., Inc.
Parker C. Folse, American Petroleum Institute.

†Non-voting member.

Roger D. Freriks, Federation of Societies for Paint Technology.
Ward A. Gill, National Automatic Laundry and Cleaning Council.
O. C. Haier, American Petroleum Institute.
S. L. Halac, National Soybean Processors Assn.
Raymond M. Hill, Fire Marshals Assn. of North America.
C. P. Hoffman, Jr., Truck Trailer Manufacturers Assn.
Charles H. Howe, Jr., Fire Marshals Assn. of North America.
Rodger R. Jackson, Laundry & Cleaners Allied Trades Assn.
O. W. Johnson, Palo Alto, Calif. (Personal)
Hugh V. Keepers, Fire Prevention and Engineering Bureau of Texas.
P. J. Keller, National Paint, Varnish & Lacquer Assn.
George F. Kennedy, Fire Marshals Assn. of North America.
Louis F. Langhurst, Vegetable Oil Extraction. (Personal)
Fred Loibl, National Institute of Drycleaning.
W. S. Marsh, Factory Mutual Engineering Division.
C. H. Mayhood, Manufacturing Chemists' Assn., Inc.
J. F. McKenna, American Petroleum Institute.
Dr. W. G. McKenna, Bureau of Explosives. (Personal)
L. S. Miller, Oil Insurance Assn.
N. H. Moore, The American Oil Chemists' Society.
J. W. Morris, Jr., South-Eastern Underwriters Assn.
J. H. Myers, American Petroleum Institute.
Dean Olds, Institute of Appliance Mfrs.
R. M. Patton, Joseph E. Seagram & Sons, Inc. (Personal)
George F. Prussing, Washington 7, D. C. (Personal)
George A. Quandee, Swift & Co. (Personal)
J. Sharp Queener, National Paint, Varnish & Lacquer Assn.
M. J. Reed, National Oil Fuel Institute.
Rudolph Schmidt, Jr., Assn. of Casualty & Surety Cos.
T. T. Singer, Western Actuarial Bureau.
Allan R. Smith, Steel Tank Institute.
Walton Smith, Hunt Foods and Industries, Inc.
E. C. Sommer, American Petroleum Institute.
S. F. Spence, Manufacturing Chemists' Assn., Inc.
R. I. Spencer, Factory Insurance Assn.
G. H. Steel, Ralston Purina Co. (Personal)
C. Austin Sutherland, National Tank Truck Carriers, Inc.
E. F. Tabisz, Underwriters' Laboratories of Canada.
Wm. H. Van Arnum, National Board of Fire Underwriters.
G. M. Walker, Fire Marshals Assn. of North America.
Wm. C. Whiting, New England Fire Insurance Rating Assn.
J. H. Witte, Underwriters' Laboratories, Inc.
T. H. Wright, Ohio Inspection Bureau.
Dr. M. G. Zabetakis, U.S. Bureau of Mines.

Alternates.

B. H. Battaglin, Western Actuarial Bureau. (Alternate to T. T. Singer.)
C. E. Blome, National Oil Fuel Institute. (Alternate to M. J. Reed.)
Paul R. Deschere, Laundry & Cleaners Allied Trades Assn. (Alternate to Rodger R. Jackson.)
B. H. Lord, Jr., American Petroleum Institute. (Alternate to A. F. Dyer.)
J. B. Mathis, Institute of Appliance Manufacturers. (Alternate to Dean Olds.)
H. S. Robinson, Oil Insurance Assn. (Alternate to L. S. Miller.)
A. T. Schrage, Factory Insurance Assn. (Alternate to R. I. Spencer.)
Clay B. Wade, South-Eastern Underwriters Assn. (Alternate to J. W. Morris, Jr.)
Wm. B. White, National Automatic Laundry and Cleaning Council. (Alternate to Ward A. Gill.)

Corresponding Members.†

Dr. Ing. Gert Magnus, Mannheim, Germany.
Ingvar Stromdahl, Stockholm, Sweden.

†Non-voting members.

Sectional Committee on Coating Manufacture

R. D. Freriks, *Chairman*

G. E. Cain
G. G. Fleming
P. C. Folse
C. H. Howe, Jr.
P. J. Keller
J. W. Morris, Jr.
W. H. Van Arnum
C. B. Wade (Alternate to J. W. Morris, Jr.)
W. C. Whiting

Recommended Practices for the

Manufacture of Organic Coatings

NFPA No. 35 — 1964

CHAPTER I. GENERAL PROVISIONS

10. Purpose of Recommended Practices

101. To prescribe reasonable measures for safety to life and property from fire and explosion in the operation of organic coating manufacturing processes.

102. To provide a means by which plant management and supervisory personnel may evaluate the hazards of operations under their jurisdiction.

103. To provide a guide by which the authority having jurisdiction may determine if an operation is being conducted in accordance with reasonable safe practices.

104. To provide a guide for design engineers, architects and others in planning new installations.

11. Scope and Application of Recommended Practices

111. They are intended to apply to processes manufacturing protective and decorative finishes or coatings (paints) for industrial, automotive, marine, transportation, institutional, household and other purposes.

112. They are also intended to apply to the handling of flammable and combustible liquids, certain combustible solids, and potential dust explosion conditions.

113. They are not intended to cover the manufacture of nonflammable or water thinned coatings.

114. They are not intended to cover operations with respect to the application of coating materials.

NOTE: Reference should be made to the Flammable and Combustible Liquids Code, NFPA No. 30, for inside mixing and handling rooms; Standard for Spray Finishing, NFPA No. 33; and Standard for Dip Tanks, NFPA No. 34.

115. Where unique processes or unusual hazards to life and property are involved, the authority having jurisdiction may require safeguards in addition to those being suggested in this pamphlet or may modify the suggestions provided equivalent safety is obtained.

12. Existing Plants

121. These recommended practices pertaining to design, layout and construction are not intended to apply to existing plants. However, when major modifications or additions are made it is recommended that the practices in this pamphlet be considered.

13. Definitions

APPROVED signifies acceptance, by the authority having jurisdiction, of design, equipment, installation or intended use.

NOTE: Devices having been tested and accepted for a specific purpose by a nationally recognized testing laboratory may be deemed to be acceptable.

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.

CONTAINER shall mean any can, bucket, barrel or drum.

FLASH POINT shall mean the minimum temperature of a liquid at which sufficient vapor is given off to form an ignitible mixture with the air near the surface of the liquid or within the vessel used as determined by appropriate test procedure and apparatus as specified.

The flash point of liquids having a flash point at or below 175°F (79.4°C), except for fuel oils and certain viscous materials, shall be determined in accordance with the standard method of test for Flash Point by the Tag Closed Tester, ASTM D–56–61.

The flash point of liquids having a flash point above 175°F (79.4°C), except for fuel oils, shall be determined in accordance with the standard method of test for Flash Point by the Cleveland Open Cup Tester, ASTM D–92–57.

The flash point of fuel oil, and certain viscous materials having a flash point at or below 175°F (79.4°C), shall be determined in accordance with the standard method of test for Flash Point by the Pensky-Martens Closed Tester, ASTM D–93–62.

INERT GAS shall mean any gas which is nonflammable, chemically inactive, and noncontaminating for the use intended and oxygen deficient to the extent required.

NOTE: See Standard for Inerting for Fire and Explosion Prevention, NFPA No. 69.

INERTING shall mean 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.

LIQUID shall mean, when not otherwise identified, to include both flammable and combustible liquids.

COMBUSTIBLE LIQUIDS shall mean any liquid having a flash point at or above 140°F (60°C).

FLAMMABLE LIQUIDS shall mean any liquid having a flash point below 140°F (60°C) and having a vapor pressure not exceeding 40 pounds per square inch (absolute) at 100°F (37.8°C).

Flammable liquids shall be divided into two classes of liquids as follows:

Class I liquids shall include those having flash points below 100°F (37.8°C).

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

NOTE: This classification does not apply to:

(1) Materials that are solid at 100°F (37.8°C) or above,

(2) Liquids without flash points that may be flammable under some conditions, such as certain halogenated hydrocarbons and mixtures containing petroleum fractions and halogenated hydrocarbons,

(3) Mists, sprays or foams.

ORGANIC COATINGS are 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 shall mean those organic compounds which are identified by their active oxygen (–0–0–) 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. These oxygen active compounds which are heat and shock sensitive are known as "potentially explosive chemicals." Examples of such peroxides are benzoyl peroxides and methyl ethyl ketone peroxide.

PURGING shall mean the process of displacing the flammable vapors from an enclosure or from equipment.

SAFETY CAN shall mean an approved container, of not over five gallons capacity, having a spring-closing lid and spout cover.

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 D–323–58.

14. Location

141. Each organic coating manufacturing operation within 50 feet of the line of adjoining property that may be built upon or public thoroughfare should have the exposing wall constructed as indicated in the schedule below.

Distances in Feet from Line of Adjoining Property That May Be Built Upon or Public Thoroughfare	Construction of Exposing Wall Expressed in Terms of Fire Resistance Rating
Less than 10	At least 4 hours
10 to 30	At least 3 hours
Over 30 but less than 50	At least 2 hours

When automatic sprinkler systems are installed in accordance with NFPA No. 13, Sprinkler Systems, a 50 per cent reduction in the distances to property lines and the fire resistance ratings of the exposing walls may be made.

142. An organic coating manufacturing operation should not be carried on in the same building with other occupancies. Operations incidental to or in connection with organic coating manufacturing shall not be classed as "other occupancies" for the purpose of this recommendation.

143. An organic coating manufacturing operation should be located so that it is accessible from at least one side for the purpose of fire control.

144. Where topographical conditions are such that flammable and combustible liquids may flow from the organic coating manufacturing operation so as to constitute a fire hazard to properties of others, drainage facilities should be provided as covered in Section 35.

CHAPTER II. STORAGE OF RAW MATERIALS AND FINISHED PRODUCTS

20. Flammable and Combustible Liquid Storage

201. The storage, handling and use of flammable and combustible liquids should be in accordance with nationally recognized good practice. This includes consideration of requirements such as distances to lines of adjoining property, spacing between tanks, diking and adequate vents.

NOTE: The Flammable and Combustible Liquids Code, NFPA No. 30, provides information on these subjects.

202. Tanks may be installed aboveground, underground or inside of buildings. Outside aboveground tanks are the usual practice but when space limitations do not permit storage outside and aboveground, storage may be underground or inside of buildings.

203. Tank storage inside of buildings should be permitted only in recognized storage areas at or above grade which are detached from the processing area or cut off from the processing area by construction having at least a two-hour fire resistance rating and opening should be equipped with approved fire doors. This is not intended to prevent processing equipment from containing flammable and combustible liquids or storage in such quantities as are essential to the continuity of operations.

204. Storage tanks in locations that may be flooded should be anchored, weighted with concrete or other approved solid loading material, provided with structural guides or secured by other means.

NOTE: Protection of Tanks Containing Flammable and Combustible Liquids in Locations That May Be Flooded, NFPA No. 30A, contains information on this subject.

205. Closed container storage should be in accordance with nationally recognized good practice.

NOTE: The Flammable and Combustible Liquids Code, NFPA No. 30, provides information on closed container storage.

21. Tank Car and Tank Vehicle Unloading and Loading Stations

211. Loading and unloading stations for Class I liquids should be separated from the processing area, other plant buildings and nearest line of adjoining property that may be built upon or pub-

lic thoroughfare and preferably by a clear distance of not less than 25 feet.

212. Loading and unloading structures and platforms for flammable and combustible liquids should be designed and installed in accordance with nationally recognized good practice.

NOTE: For tank car protection against static see Static Electricity, NFPA No. 77M. For tank vehicle unloading racks see the Flammable and Combustible Liquids Code, NFPA No. 30.

213. Tank cars containing flammable and combustible liquids shall be unloaded in accordance with nationally recognized good practice.

NOTE: See TC-4, Unloading Flammable Liquids from Tank Cars, published by the Manufacturing Chemists' Association.

214. Tank vehicles for flammable and combustible liquids shall be loaded and unloaded in accordance with nationally recognized good practice.

NOTE: See Tank Vehicles for Flammable and Combustible Liquids, NFPA No. 385.

22. Nitrocellulose Storage

221. The nitrocellulose storage preferably should be in a separate building or in a room cut off by construction having a fire resistance rating of at least two hours and openings should be equipped with approved fire doors. The nitrocellulose storage should be used for no other purpose. If electrical equipment is necessary in such a room or building, it should be installed in accordance with the National Electrical Code for Class I, Division 2 hazardous locations.

222. If the plant area is adequate for well detached storage, a suitable structure would be a roofed shed constructed of noncombustible material and sided on the south and west sides with the other two sides open. This would provide an adequate and well ventilated structure for the storage of barrels of nitrocellulose.

223. Nitrocellulose should be stored only in closed containers.

224. Barrels should be stored on end and, if tiered, preferably not more than two high.

225. If nitrocellulose is spilled, it should be promptly wetted with water and such material should be disposed of properly — by use if practical; if not, by burning in the open at a suitable detached location.

226. The dragging or pushing of containers on hard surfaces should be avoided because of possible frictional heat.

227. Barrels or other containers of nitrocellulose should not be opened in the main storage building but at the point of use or other location set aside for the purpose.

23. Organic Peroxides

231. In general organic peroxides should be 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 per cent solution in dimethyl phthalate) should not be exposed to temperatures above 90°F, violent decomposition may occur above 122°F, and shock sensitive crystals may be formed below 17°F.

NOTE: Further information may be found in Hazardous Chemicals Data, NFPA No. 49 and NBFU Research Report No. 11, Fire and Explosion Hazards of Organic Peroxides.

232. The storage of organic peroxides should 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 should be avoided.

233. The size of the package containing the organic peroxide should 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 should be promptly cleaned up and disposed of as recommended by the supplier.

234. The hazards incident to the storage and use of organic peroxides may be materially reduced when protected by a standard automatic sprinkler system.

24. Storage of Finished Product

241. Finished products that are flammable and combustible should 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 two-hour fire-resistance rating and openings should be equipped with approved fire doors. The storage of finished products should be in closed containers or in tanks in accordance with nationally recognized good practice.

NOTE: The Flammable and Combustible Liquids Code, NFPA No. 30, provides information on such storage.

CHAPTER III. PROCESS BUILDINGS

30. General Layout and Design

301. Congestion should be avoided in planning an organic coatings manufacturing operation.

302. Research laboratories, general offices, and storage areas preferably should not be in the same building housing manufacturing operations. If these facilities are in the same building, they should be cut off from the manufacturing operations by a wall or partition having a fire-resistance rating of at least two hours and openings should be equipped with approved fire doors.

31. Construction

311. Buildings should be of fire resistive or noncombustible construction without load bearing walls and without basements or pits. The first floor should be at or above the grade to permit water drainage and vapor diffusion.

312. It is recommended that manufacturing buildings be limited to two stories in height and preferably they should be one story or one story with mezzanine.

313. Raw material and finished stock storage buildings should preferably be confined to one story in height and either detached or cut off from manufacturing buildings by construction having a fire-resistance rating of at least two hours and openings should be equipped with approved fire doors.

314. Internal partitions should be avoided because of their possible interference with ventilation and exit facilities, but where used, should be of noncombustible construction.

315. Stairway enclosures, when required, and structures housing elevators should be enclosed by walls having a fire-resistance rating of at least two hours, and be equipped with approved fire doors.

316. Each manufacturing room should have at least two exits, well separated, one of which should preferably be directly to the outside. Access to all exits should be kept clear and doors should open in the direction of travel. Door fastenings should be of the

safety release type. Supervisory management offices, change and locker rooms located in manufacturing buildings should be provided with adequate exits.

NOTE: See the Building Exits Code, NFPA No. 101.

32. Explosion Venting

321. Structures in which Class I liquids or finely divided flammable solids are processed should 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 explosion relief type.

322. Enclosures should be vented according to the nature of the materials processed and the type of structure. Larger vents are needed for materials having a rapid rate of pressure rise than for materials having a slow rate of pressure rise. 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.

323. In the selection of suitable venting, the following factors should be considered:

(a) Strength of structure or enclosure;

(b) The maximum explosion pressure and the average rate of pressure rise of the material involved;

(c) The positions of the vents with respect to the origin of the explosion;

(d) The bursting strength of the vent closure, or the minimum pressure required to open the vent closure if movable as a whole;

(e) The inertia of the vent closure.

NOTE: The Guide for Explosion Venting, NFPA No. 68, provides information on this subject.

33. Ventilation

331. Enclosed buildings in which Class I liquids are processed or handled should be ventilated at a rate of not less than one

cubic foot per minute per square foot of solid floor area. This should be accomplished by exhaust fans preferably taking suction at floor levels, and discharging to a safe location outside the building. The feasibility of natural ventilation may be investigated. Provision should be made for introduction of noncontaminated intake air in such a manner that all portions of solid floor areas will be subject to continuous uniformly distributed movement of air.

NOTE: Additional local or general ventilation may be needed for control of health hazards. Such ventilation, if provided, may be utilized for up to 75 per cent of the recommended ventilation in Section 331. Ventilation should be arranged to include all pits or other low points where flammable vapors may collect. Blower and Exhaust Systems, NFPA No. 91, provides information on this subject.

34. Heating

341. Heating in hazardous areas, if required, should be provided by indirect means. Ignition sources such as open flames, or electrical heating elements, except units approved for Class I, Group D locations, should not be used within the building.

35. Drainage

351. Drainage facilities should be provided to direct flammable and combustible liquid leakage and fire protection water to a safe location away from the building, any other 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.

NOTE: Water Spray Systems, NFPA No. 15, provides information on this protection.

352. Emergency drainage systems may contain flammable and combustible liquids. If connected to public sewers or discharged into public waterways, they should be equipped with traps or separator tanks.

CHAPTER IV. PROCESS EQUIPMENT

40. Mills

401. The use of air pressure to discharge the contents of ball and pebble mills is not recommended. Inert gas may be used for discharging the contents by pressure. Excessive gas pressure should be avoided by providing a relief valve set to relieve at a pressure not to exceed the design pressure of the mill. As low a pressure as practical should be used.

402. A machine such as a two-roll mill or other mills operating with close clearances and which are used for the processing of flammable and heat sensitive materials, such as nitrocellulose, should 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 should be no more than that required for a batch. A manually operated water spray system with an adequate number of heads should be provided for machine protection.

403. Open mills, such as roller mills, should be provided with adequate ventilation.

41. Mixers and Mixing Tanks

411. Mixers should be of the enclosed type or, if of the open type should be provided with properly fitted covers. Such covers should be made of a spark-resistant metal or alloy, and when open should be held in an off-balance position by means of a metal cable with a fusible link which link should be located on the underside of the cover.

412. Where gravity flow is used, a shutoff valve should be installed as close as practical to the vessel and a control valve should be provided near the end of the fill pipe. A bond should be provided between the discharging vessel and the receiving container.

42. Kettles

421. Although kettles for the processing of vehicles may be open, closed kettles should be used where practical because of their greater safety.

422. Open kettles should 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 two hours. Adequate stacks or other fume disposal system should be provided to eliminate the fumes or vent them to a safe location.

423. Closed kettles involving the use of solvents are preferably heated by a heat transfer medium whose vaporizer or heat-producing equipment should be remotely located or otherwise safeguarded. If the kettles are contact heated, as with electricity, they should be designed to minimize the possibility of fire and equipped with safety devices that in case of fire can turn the process heat off, turn the cooling medium on, and inject inert gas into the vessel. Fusion (no solvent) cooks are inherently safer and may not require all the safety devices mentioned above.

424. The kettle and thin-down tank should be instrumented, controlled and interlocked so that any failure of the controls will result in a safe condition. The kettle should be provided with an excess pressure rupture disc in case the normal vent becomes inoperative. Experience has indicated that the size of such discs should be of the order of 0.05 sq. in. per gallon of capacity depending upon the process. The vent piping from the rupture disc should be of minimum length to minimize the back pressure and should discharge to a safe location. The thin-down tank should also be adequately vented.

425. Thinning or reducing operations where portable kettles are used should be performed in a well ventilated area removed from the fires and equipped with an adequate vapor removal system. Preferably the hot liquid from either a portable or set kettle should be pumped into the bottom of a closed set thinning vessel which contains the reducing solvent. This thinning vessel should be agitated and equipped with a vented condenser which should be supplied with an adequate cooling medium and be capable of handling the vapors formed. A water jacket on the thinning vessel for cooling is preferable.

43. Piping, Valves and Fittings

431. All piping, valves and fittings should be designed for the working pressures and structural stresses to which they may be subjected. They should be of steel or other material approved for the service intended. The use of cast iron valves, fittings and pipe should be avoided.

NOTE: The Flammable and Combustible Liquids Code, NFPA No. 30, provides information on these subjects.

432. Valves should be of an indicating type to show whether open or closed such as a plug or ball valve. Such valves should be mounted in a manner that vibration will close them.

433. Terminal valves on remote pumping systems should be of the "dead-man" type which will shut off both the pump and the flow of solvent.

434. Piping systems should be substantially supported and protected against physical damage caused by expansion, contraction and vibration.

435. Piping should be pitched to avoid unintentional trapping of liquids or suitable drains should be provided. Approved flexible connectors may be used where vibration exists or where frequent movement is necessary. Approved hose may be used at dispensing stations.

436. Piping entering equipment such as mixers and kettles should, where practical, terminate near the bottom of the equipment and be bonded to the equipment. Piping carrying materials likely to clog the piping should not terminate near the bottom of equipment but discharge against the side of the vessel.

437. Piping containing flammable and combustible liquids should be identified.

NOTE: Identification of Piping Systems, ASA A13.1, provides information on color coding. Suggested colors in ASA 13.1 are (a) Fire Protection Equipment — *red;* (b) Dangerous Materials — *yellow* (or *orange*); (c) Safe Materials — *green* (or *white, black, gray, aluminum*); (d) Protective Materials — *blue;* (e) Extra Valuable Materials — *purple.*

438. Before being placed in service, all piping should be free of leaks when tested to not less than 1½ times the working pressure or a minimum of not less than 5 psig at the highest point in the system. Tests shall continue for a minimum of 30 minutes.

44. Transfer of Flammable and Combustible Liquids

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

442. The transfer of large quantities of flammable and combustible liquids should be through piping by means of pumps. Except as required in process equipment, gravity flow should not be used.

443. The use of compressed air as a transferring or displacement medium should be prohibited.

444. Pumps should be selected for the flammable and combustible liquid used, the working pressures and the structural stresses to which they may be subjected.

445. Where solvents are pumped from storage to points of use, approved switches should be provided in the processing areas and at the pumps to shut down the pumps in case of fire.

446. The dispensing of Class I solvents from drums should preferably be by means of an approved drum pump. However, gravity dispensing from drums is permitted when an approved self-closing faucet for flammable and combustible solvents is used.

447. Containers should be covered when being transported from one place to another. Drums after being emptied should be properly closed.

448. The use of trenches, tunnels, stair or elevator towers for flammable and combustible liquid piping should be avoided. If trenches are necessary or unavoidable, they should be covered with perforated plates or grating trench covers. Trenches should be filled with sand or bulkheaded at frequent intervals.

NOTE: See Figure 6 of Water Spray Systems for Fire Protection, NFPA No. 15, for use of perforated plates and grating trench covers.

45. Filling Operations

451. In multistory operations filling is generally performed on the first floor with the main processing done in set or portable tanks on the second floor. If the organic coating is discharged by gravity in this operation, the pipe should be equipped with two shutoff valves and a third heat-actuated valve should be considered.

452. In single story operations, the filling is preferably performed in an area separated from the main processing area by a wall having a fire-resistance rating of at least two hours and all openings should be equipped with approved fire doors.

453. Empty and filled containers should be stored outside the filling area to reduce congestion, improve housekeeping and reduce the flammable material in the area.

46. Raw Materials in Process Areas

461. The amount of nitrocellulose brought into the operating area should not exceed that required for a shift. The retaining

ring holding the barrel cover in place should be removed by the use of a suitable spark-resistant wrench, and if necessary to fork or scoop the material out of a barrel, spark-resistant tools should be used. Any nitrocellulose which may be spilled on the floor or elsewhere should be promptly swept up, put into a pail of water, and removed at the end of the day or shift and disposed of properly; by use if practical; if not, by burning in the open at a suitable detached location.

462. Organic peroxides brought into the operating area should be in the original shipping container and should not exceed the quantity required for a shift. When in the operating area the peroxide should not be placed in locations exposed to ignition sources, heat or mechanical shocks.

47. Electrical Equipment

471. All electrical wiring and equipment within storage or processing areas or within a reasonable distance of such areas should be installed and maintained in accordance with nationally recognized good practice.

NOTE: Chapter 5 of the National Electrical Code, NFPA No. 70, provides information regarding such installations.

472. Where Class I liquids are exposed to the air, the design of equipment and ventilation of buildings should be such as to limit the Class I, Division 1 locations to pits, the interior of equipment and the "immediate vicinity" of pumps or equipment locations such as dispensing stations, 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 20 feet horizontally in all directions and vertically from the floor to a level 6 feet above the highest point of vapor liberation.

473. All locations not covered by Paragraph 472 where Class I liquids are handled should be Class I, Division 2. If the flash point of the liquid processed is higher than ambient temperature and at least 100°F, ordinary electrical equipment is satisfactory though care should be used in locating electrical apparatus to prevent hot metal from falling into open processing equipment.

NOTE: The accidental release of heated flammable and combustible liquids or unheated Class I liquid may, if sufficient quantities are involved, generate vapors to the extent that the entire building and possibly a zone surrounding it must be considered a Class I, Division 2 location.

474. Where the provisions of Paragraph 471 would require the installation of explosion-proof switch gear, ordinary electrical equipment, including switch gear, may be used if located in a nonhazardous area or installed in a room which is maintained under positive pressure with respect to the hazardous area. Air or other media for pressurization shall be taken from a location where entrainment of flammable vapor is improbable.

48. Static Electricity

481. All equipment such as tanks, machinery and piping, where an ignitible mixture may be present should be bonded and connected to a ground. The bond or ground or both should be physically applied or should be inherently present by the nature of the installation. For static purposes, this electrically conductive path should not have a resistance of more than one million ohms.

NOTE: Static Electricity, NFPA No. 77M, provides information on this subject.

482. Electrically isolated sections of metallic piping or equipment should be bonded to the other portions of the system or grounded to prevent external ignition hazards.

483. Bonding need not be required when loading or unloading tank cars and tank vehicles through closed connections. When loading or unloading through open connections the tank vehicle should be grounded and bonded to the receiving system.

NOTE: The Flammable and Combustible Liquids Code, NFPA No. 30, provides information on static and stray current protection.

484. When a flammable mixture is transferred from one portable container to another a bond should be provided between the two containers.

485. A bond or ground should be composed of suitable conductive materials having adequate mechanical strength, corrosion resistance and flexibility for the service intended. No. 8 or 10 AWG wire is about the minimum size which should be used. Conductors may be insulated or uninsulated. Permanent connections may be made with pressure type clamps, by brazing, welding or other suitable means. Temporary connections may be made with battery type clamps, by magnetic or other special clamps.

486. Where the special hazards of a particular operation make it desirable, an approved conductive floor is recommended to drain away static developed by personnel or portable equipment. The floor should be nonsparking, have a resistivity not in excess of one million ohms and be installed by an approved contractor. A regular and frequent floor cleaning schedule should be established to keep the floor free of films of insulating materials.

487. Humidification can be used to reduce accumulations of static electricity. In some cases localized humidification, by directing a steam jet on the critical areas, may provide satisfactory results without humidification of the whole room.

488. Ordinary rubber or leather flat belts generate static. This static generation can be minimized by making the belt conductive by applying a special type of belt dressing. Such coatings should be renewed frequently to be considered practical or reliable. Grounded metal "combs" with the sharp points placed close to the side of the belt where it leaves the pulley can also be used effectively to drain away static charges. Conductive rubber belting is available and should be used, where practical, when belts are required.

NOTE: Static Electricity, NFPA No. 77M, provides information on this subject.

49. Lightning Protection

491. High masonry stacks and chimneys should be provided with approved lightning protection.

492. Where needed, approved lightning protection should be provided for buildings, structures and equipment.

493. Steel framing of buildings should be grounded with resistance of not more than five ohms.

NOTE: The Lightning Code, NFPA No. 78, provides information on this subject.

CHAPTER V. FIRE PREVENTION AND PROTECTION

50. Sprinkler Systems

501. Important manufacturing and storage buildings should be protected by a sprinkler system installed in conformance with the Standard for the Installation of Sprinkler Systems, NFPA No. 13, or a water spray system installed in conformance with the Standard for Water Spray Systems, NFPA No. 15.

502. In sections where large quantities of flammable and combustible liquids may be involved or where flammable vapor may be present, the sprinkler system should be wet pipe, pre-action or deluge type.

503. Water supply for sprinklers should be of adequate pressure and capacity for all sprinklers likely to be involved in any one fire with ample reserve for necessary hose streams.

NOTE: Although fires involving some solvents may not be extinguished by water, a liberal supply of water from sprinklers controls the flames and should keep the structure, equipment and the supports cool, thereby preventing collapses. Some sprinkler heads on a pre-action system may be left open over the most severe hazards instead of providing a separate deluge system.

504. Aboveground tanks containing flammable liquids located near buildings may be protected with manually or automatically operated water spray systems.

NOTE: Standard for Water Spray Systems, NFPA No. 15, provides additional information.

505. Adequate drainage facilities should be provided for water from sprinkler systems (see Section 35).

51. Fixed Extinguishing Systems

511. Equipment such as mixers, solvent tanks or fixed open containers may be protected by foam, inert gas or dry chemical extinguishing systems.

NOTE: For further information see Carbon Dioxide Extinguishing Systems, NFPA No. 12, and Dry Chemical Extinguishing Systems, NFPA No. 17.

512. Foam hose streams are valuable in extinguishing fires in tanks and indoor or outdoor fires in case of flammable and combustible liquid spills. Foam powder or foam liquid should be of the type suitable for specific solvent fires. Different foams may

be needed depending upon whether the solvents are or are not water miscible. A reasonable amount of foam producing materials and equipment, an adequate water supply, hose and nozzles should be provided.

NOTE: Foam Extinguishing Systems, NFPA No. 11, provides additional information.

52. Portable Fire Extinguishers

521. An adequate supply of portable fire extinguishers suitable for flammable and combustible liquid fires should be provided. If the manufacturing building covers a large area containing several large mixers, change cans and solvent measuring tanks, handling large quantities of flammable or combustible liquids, it is recommended that several large wheeled units be provided and strategically located.

NOTE: Standard for Portable Fire Extinguishers, NFPA No. 10, provides additional information.

53. Standpipe and Hose Systems

531. Standpipe and hose should be provided in important operating buildings or at other locations where a fire risk of some importance is believed to exist. The hose may be 1 inch or 1½ inch of an approved type, mounted on a reel or other suitable support and should be fitted with a spray or fog type nozzle. An applicator type of nozzle is useful as it enables an operator to more effectively fight a fire. The use of a solid stream type of nozzle or play pipe should be avoided as a stream from such a nozzle tends to spread a flammable liquid fire or stir up a dust cloud.

NOTE: For further information see the Standard for Standpipe and Hose Systems, NFPA No. 14.

54. Outside Fire Protection

541. Where good public fire protection facilities are not readily available, private fire protection facilities should be provided.

NOTE: For further information see the Standard for Outside Protection, NFPA No. 24.

55. Fire Brigade

551. A fire brigade should be organized and trained to fight fires promptly and efficiently. This may be accomplished by

conducting fire drills at periodic intervals and using the various kinds of fire-fighting equipment on hand. Manufacturers of fire-fighting equipment and local public fire departments can be of assistance with such training. Local public fire departments should also be informed of the plant fire hazards so that they may be of more effective help.

NOTE: For further information see Suggestions for the Organization, Training and Equipment of Private Fire Brigades, NFPA No. 27.

56. Personnel Training

561. Personnel should be made aware of special hazards and should be trained in proper procedures for safe operation of process, as well as emergency shut-down procedures for unusual conditions.

562. Personnel should be trained in the use of portable fire extinguishers, methods of actuating fixed special extinguishing systems, and method of notifying plant fire brigade, public fire department and emergency organization.

NOTE: This training should extend generally to all personnel and to supplement the fire brigade training covered in Section 55.

57. Fire Alarm

571. A suitable fire alarm system should be provided for promptly notifying plant personnel and the fire brigade. Where service is available, it is recommended that a public fire alarm box be provided nearby and it might be advisable to connect the plant system with the public system.

NOTE: For further information see Standard for the Installation, Maintenance and Use of Proprietary and Auxiliary Protective Signaling Systems, NFPA No. 72, or the Standard for Local Protective Signaling Systems (No. 72A).

58. Maintenance of Fire Protection Equipment

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

CHAPTER VI. MAINTENANCE

60. Cleaning Tanks or Vessels

601. The cleaning of tanks or vessels which have contained flammable and combustible liquids should only be done under the supervision of persons who understand the fire and explosion potential, assisted by skilled workmen 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 61.

NOTE: Standard Procedures for Cleaning or Safeguarding Small Tanks and Containers, NFPA No. 327, provides detailed information on the procedures to be followed for the various methods of cleaning or safeguarding a tank or vessel.

602. Prior to initiating the cleaning procedures, the following steps should be taken:

6021. Empty the tanks, vessels, piping and traps of all materials. All such material should be removed to a safe location.

6022. Disconnect, plug or blank off all piping and other connections to other facilities.

6023. If a vessel is fitted with power-driven internal equipment, the power source should be disconnected completely when not used with cleaning solutions; that is, the motor disconnect switch should be padlocked in the off position and the key of the padlock should remain in the possession of the man doing the work.

603. The removal of residues and the cleaning of the tanks or vessels may be accomplished by one of the following methods:

6031. 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 waste water should be to a safe location.

6032. 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 should be worn to protect against possible injury to the eyes or skin. Tanks which have contained reactive or unstable materials should 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 should be added at a controlled rate to cold water. When using a proprietary cleaning solution, the manufacturer's instructions should be followed. The drainage of the solution should be to a safe location.

6033. A suitable flammable solvent agitated in the interior of a closed vessel to be cleaned may be used safely providing the vapor space is inerted by the use of 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 vapor is applied to the vessel. The direct discharge from a carbon dioxide fire extinguisher will produce electrostatic sparks that could cause ignition. The carbon dioxide or nitrogen piping should be bonded to the vessel into which the gas is to be discharged. The cleaning solvent and residue should be drained to a closed container or waste tank.

6034. 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 should be to a safe location. Air movers should 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 should be taken to insure that the air mover is bonded to the equipment in order to minimize the hazard of ignition by static electricity.

NOTE: 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.

6035. The vapor freeing may be accomplished by the introduction of steam into the equipment. Steam supply lines should be bonded to the equipment. Precautions should be used to guard against static discharge by escaping steam. The rate of supply of steam should be sufficient to exceed the rate of condensation so that the equipment is heated close to the boiling point of water. The equipment should be steamed long enough to vaporize the residues from all portions. After the steaming the procedures outlined in Paragraph 604 should be followed when hot work is to be performed. Any unbonded conductive object should be removed or bonded to the equipment.

604. To insure a safe condition, tests for flammable vapors with a combustible gas indicator or other approved means should 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 should be stopped immediately when the presence of solvent vapor is indicated. The source of the vapor should be located and removed and the procedure outlined above should be followed before such work is recommenced.

605. 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 Section 603 may be followed.

61. Hot Work and Tank Entry Permits

611. When necessary to make repairs involving "hot work," the work should be authorized by the responsible individual in charge before the work is started.

NOTE: See Appendix for a suggested safety work permit.

612. When necessary to enter a tank, pit, manhole or other confined spaces, such entry should be authorized by the responsible individual in charge.

NOTE: See Appendix for a suggested safety tank entry permit.

62. Industrial Trucks and Hand Trucks

621. Power operated industrial trucks that are approved and designated as EX, should 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).

NOTE: Reference should be made to the National Electrical Code, NFPA No. 70, for additional information on the interpretation of the electrical classifications referred to herein and to Standard for Industrial Trucks, NFPA No. 505, for an explanation of the designations of industrial trucks.

622. Power operated industrial trucks that are approved and designated as EX, or EE should be used in areas where Class I liquids and their vapors are normally confined 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).