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NFPA 34 Dipping and Coating Processes 1989 Edition

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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

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

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

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NATIONAL FIRE PROTECTION ASSOCIATION

NFPA 34

Standard for

Dipping and Coating Processes

Using Flammable or Combustible Liquids

1989 Edition

This edition of NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*, was prepared by the Technical Committee on Finishing Processes, and acted on by the National Fire Protection Association Inc. at its Annual Meeting held May 15-18, 1989, in Washington, D.C. It was issued by the Standards Council on July 14, 1989, with an effective date of August 7, 1989, and supersedes all previous editions.

The 1989 edition of this document has been approved by the American National Standards Institute.

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

Origin and Development of NFPA 34

NFPA standards on the safeguarding of process tanks containing flammable liquids date from 1913 when standards prepared by the Committee on Explosives and Combustibles were adopted. Subsequently jurisdiction was transferred to a new Committee on Manufacturing Hazards which in turn was superseded by the present Committee on Finishing Processes.

The original 1913 edition was completely revised in 1921 and 1922 at which time hardening and tempering tanks and flow coat work were added to the original standard. Further revisions to keep the text up to date with material on various new aspects of the subject were adopted in 1922, 1926, 1936, 1940, 1946, 1952, 1957, 1959, 1963, 1966, 1971, 1974, 1979, 1982, 1987, and 1989.

The following are the major changes adopted in this 1989 edition of NFPA 34:

A corrected definition of "vapor source."

A completely rewritten Chapter 6, "Electrical and Other Sources of Ignition," including revised diagrams for area classification for electrical equipment located adjacent to dipping and coating processes.

An editorial rewrite of Chapter 8, "Protection."

It was also originally proposed to delete the requirements for hardening and tempering tanks in Section 9-1. The NFPA Standards Council directed the Committee to restore Section 9-1 until such time as the subject can be addressed in a more appropriate NFPA document.

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

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

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Standard for

Dipping and Coating Processes

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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 Chapter 11 and Appendix D.

Foreword

The safety of life and property from fire or explosion in dipping and coating processes using flammable and combustible liquids depends upon characteristics and quantities of materials used, the operations and equipment involved, and the knowledge and understanding of the personnel conducting the processes. Adherence to good safety, production, and maintenance practices contributes toward minimizing the likelihood of fire or explosion.

This standard presents requirements for establishing reasonable safety conditions in dipping and coating processes other than spray applications. An outline of the general principles useful in determining means to reduce the fire and explosion hazard incident to dipping and coating operations, together with a summary of the major requirements and illustrations of suggested arrangements, is contained in Appendix C of this standard.

Chapter 1* Scope and Definitions

1-1 Scope.

1-1.1 This standard applies to processes in which articles or materials are passed through contents of tanks, vats, or containers of flammable liquids or combustible liquids, including dipping, roll, flow, and curtain coating, finishing, treating, cleaning, and similar processes.

1-1.2 This standard does not apply to processes containing noncombustible liquids. However, certain water-type finishes may leave highly combustible residues upon evaporation of the liquid carrier, even though they involve little or no hazard in the liquid state. The provisions of this standard for minimizing the hazards of combustible residue shall be followed irrespective of the characteristics of the liquid.

1-1.3 This standard outlines practical requirements to obtain reasonable safety under average contemplated conditions. Where unusual industrial processes are involved, the authority having jurisdiction may for substantiated cause require additional safeguards or modify the requirements of this standard provided equivalent safety is thereby obtained.

1-1.4 Ovens and dryers which may be used in connection with process tanks are covered in other standards. (*See NFPA 86, Standard for Ovens and Furnaces.*)

1-2 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."

Boiling Point. The temperature at which a liquid exerts a vapor pressure of 14.7 psia (760 mm Hg). Where an accurate boiling point is unavailable for the material in question, or for mixtures that do not have a constant boiling point, for purposes of this classification the 10 percent point of a distillation performed in accordance with ASTM D86-82, *Standard Method of Test for Distillation of Petroleum Products*, may be used as the boiling point of the liquid.

Curtain Coating. The process of forming a vertically flowing film of liquid for deposition onto materials passing through the film.

Combustible Liquid. Any liquid having a flash point at or above 100 °F (37.8 °C). For further classification, see NFPA 321, *Basic Classification of Flammable and Combustible Liquids*.

Dip Tank. A tank, vat, or container of flammable or combustible liquid in which articles or materials are immersed for the purpose of coating, finishing, treating, cleaning, or similar processes.

Flammable Liquid. Any liquid having a flash point below 100 °F (37.8 °C) and having a vapor pressure not exceeding 40 psia (2068.6 mm) at 100 °F (37.8 °C).

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

(a) The flash point of a liquid having a viscosity less than 45 SUS at 100 °F (37.8 °C) and a flash point below 200 °F (93.4 °C) shall be determined in accordance with ASTM D56-87, *Standard Method of Test for Flash Point by the Tag Closed Tester.*

(b) The flash point of a liquid having a viscosity of 45 SUS or more at 100 °F (37.8 °C) or a flash point of 200 °F (93.4 °C) or higher shall be determined in accordance with ASTM D93-85, *Standard Method of Test for Flash Point by the Pensky Martens Closed Tester.*

(c) As an alternate, ASTM D3278-82, *Standard Methods of Tests for Flash Point of Liquids by Setaflash Closed Tester*, may be used for paints, enamels, lacquers, varnishes, and related products and their components having flash points between 32 °F (0 °C) and 230 °F (110 °C) and having a viscosity lower than 150 stokes at 77 °F (25 °C).

(d) As an alternate, ASTM D3828-87, *Standard Test Methods for Flash Point of Liquids by Setaflash Closed Tester*, may be used for materials other than those for which specific Setaflash Methods exist (*cf., ASTM D3278-82 for paints, enamels, lacquers, varnishes, related products and their components*).

Flow Coating. The process of discharging liquids from nozzles, slots, etc. in an unatomized state onto materials to be coated.

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

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

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

Roll Coating. The process of applying and/or impregnating materials by bringing them into contact with a roller that is coated with a liquid.

Shall. Indicates a mandatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

Vapor Area. Any area containing flammable vapor concentrations exceeding 25 percent of the lower flammable limit (LFL) in the vicinity of dipping and coating processes, drain boards or associated drying, conveying, or other equipment, during operation or shutdown periods. The authority having jurisdiction may determine the extent of the vapor area, taking into consideration the characteristics of the liquid, the degree of sustained ventilation, and the nature of the operations. (*See Chapter 3.*)

(a) A vapor area is created by the exposed surface of a liquid when the temperature of the liquid is equal to or above its flash point. Hence a liquid with a flash point of 100 °F (37.8 °C) (closed cup) may create a vapor area without the application of heat when used in a very warm atmosphere. When heat is applied to a liquid, automatic arrangements to properly limit the liquid temperature will assist in preventing the formation of a vapor area.

(b) When unenclosed dipping operations involve highly volatile liquids or large exposed surfaces, either in an open tank or on dipped materials, the vapor area may extend to all portions of the room in which the process is located. When, however, operations are provided with adequate continuous ventilation the vapor area may extend only a limited distance. (*See Chapter 3.*)

(c) The information in Chapter 5 and Appendix D of NFPA 86, *Standard for Ovens and Furnaces*, may be of assistance in determining the adequacy of ventilation necessary to prevent the formation, or limit the extent, of a vapor area under the many variable conditions encountered in the dipping and coating processes.

(d) Any vapor concentration exceeding 25 percent of that required to produce a lower flammable limit mixture is considered dangerous, and susceptible to fire or explosion. In many cases a further reduction in vapor concentration is needed to prevent a toxic effect on work personnel. An approved combustible gas indicator shall be used to establish the extent of a vapor area.

Vapor Source. The liquid exposed in the process and on the drain board. Also, any dipped or coated object from which it is possible to measure vapor concentrations exceeding 25 percent of the LFL at a distance of 1 ft (0.3 m) in any direction from the object.

Chapter 2* Location of Dipping and Coating Processes

2-1* Processes shall be separated from other operations, materials, or occupancies by location, fire walls, fire partitions, or by other means acceptable to the authority having jurisdiction.

2-2* Processes shall not be located below surrounding grade where heavy vapors cannot drain to the outside.

2-3 Process operations shall be so located that, in the event of fire originating at the equipment, freedom of egress and access will not be impaired.

2-4* Process operations shall not be located in buildings classified as assembly, educational, institutional, or residential.

Exception: In a room designed for the purpose, protected with an approved system of automatic sprinklers, and separated vertically and horizontally from such occupancies by construction consisting of wall, floor, and floor-ceiling assemblies having not less than a 2-hour fire resistance rating. Openings in interior walls to adjacent rooms or buildings shall be provided with self-closing, normally closed, listed 1½-hour (B) fire doors. The doors shall be installed in accordance with NFPA 80, Standard for Fire Doors and Windows.

Chapter 3* Ventilation

3-1 Ventilating and exhaust systems shall be installed in accordance with NFPA 91, *Standard for Blower and Exhaust Systems for Dust, Stock, and Vapor Removal,* where applicable, and shall also conform to provisions of this section.

3-2* A mechanical ventilating system shall be provided to confine the vapor area to not more than 5 ft (1½ m) from the vapor source. The ventilation system shall maintain the vapor concentration outside the vapor area at or below 25 percent of the LFL. When the physical size of a process does not allow adequate removal of vapors by mechanical ventilation alone, an enclosure shall be provided. When the dipping or coating process is automatic (without an attendant constantly on duty) the process controls shall be arranged so that dipping or coating cannot be accomplished unless the ventilating system is operating.

3-2.1 Ventilating systems where used shall be so arranged that the loss of adequate airflow shall activate an alarm and stop any automatic process.

3-3* An adequate supply of makeup air to compensate for air exhausted shall be provided. Makeup air shall be introduced to a process to provide for the efficient operation of exhaust fans and minimize the creation of dead air pockets.

3-4 Equipment to process air exhausted for removal of contaminants shall be approved by the authority having jurisdiction.

NOTE: NFPA 86, *Standard for Ovens and Furnaces*, provides guidance for the installation of afterburners and catalytic combustion systems, which are frequently used in conjunction with dipping and coating processes.

3-5 Exhaust air shall be directed so that it will not contaminate makeup air being introduced into other areas or ventilating intakes, or directed so as to create a nuisance.

3-5.1 Exhaust air shall not be recirculated for use as makeup air for occupied spaces unless it has been decontaminated and returned to a safe acceptable composition and unless listed equipment monitors the decontaminated exhaust air stream to signal the operator and to automatically shut down the process in event of failure of the decontaminating equipment to maintain acceptable air quality standards.

3-5.2 Exhaust air shall not be recirculated for use as makeup air for unoccupied spaces unless it has been decontaminated and returned to a safe acceptable composition and unless listed equipment monitors the decontaminated exhaust air stream to signal the operator and to automatically shut down the process in the event the composition of the air exhausted from the second operation exceeds 25 percent of the LFL of the used solvents.

3-6* Individual processes shall be separately ducted to the building exterior.

Exception: Where treatment of exhaust air is necessary for air pollution or for energy conservation, ducts may be manifolded if the materials used are not likely to react and cause ignition of the residue in the duct and if:

(a) No nitrocellulose base finishing material is used.

(b) An air cleaning system reduces the amount of particulate carried into the manifolded duct.

(c) Automatic sprinkler protection is provided at the junction of each exhaust duct with the manifold in addition to protection recommended in Chapter 8.

(d) The installation is approved by the authority having jurisdiction.

3-7 Exhaust ducts shall be constructed of steel, masonry, or material of similar fire resistance; and shall be substantially supported. If dampers are installed they shall be maintained so that adequate airflow is maintained when the ventilating system is in operation.

3-8 The exhaust duct discharge point shall be not less than 6 ft (2 m) from any combustible exterior wall or roof nor shall the exhaust duct discharge in the direction of any combustible construction or unprotected opening in any noncombustible exterior wall within 25 ft (7½ m).

3-9 Exhaust ducts shall be provided with ample access doors to facilitate cleaning.

3-10 The exhaust fan rotating element shall be nonferrous or the fan shall be constructed so that a shift of the wheel or shaft will not permit two ferrous parts of the fan to rub or strike. There shall be ample clearance between the fan rotating element and fan casing to avoid a fire by friction, necessary allowance being made for ordinary expansion and loading to prevent contact between moving parts and the duct or fan housing. Fan blades shall be mounted on a shaft sufficiently heavy to maintain proper alignment even when the blades of the fan are heavily loaded, the shaft preferably to have bearings outside the duct. All bearings shall be of self-lubricating type, or lubricated from outside the duct.

3-11 Electric motors driving exhaust fans shall not be placed inside a vapor area unless of a type specifically listed for readily ignitible residues and flammable vapors.

3-12 Belts shall not enter any vapor area unless the belt and pulley within the area are completely enclosed.

3-13 Freshly processed articles shall be dried only in spaces provided with adequate ventilation to prevent the accumulation of flammable vapors. In the event adequate and reliable ventilation is not provided, such drying spaces shall be considered a vapor area.

Chapter 4* Construction of Dipping and Coating Equipment

4-1 Process equipment shall be constructed of steel, reinforced concrete, masonry, or equivalent noncombustible material and shall be securely and rigidly supported. Supports for tanks over 500 gal (1893 L) in capacity or 10 sq ft (1 sq m) in liquid surface area shall have a minimum fire resistance rating of one hour.

4-2* The top of a process tank shall be not less than 6 in. (15 cm) above the floor.

4-3 In the event of a fire in a process tank, automatic sprinkler discharge may collect in the tank and float the flaming liquid out of the tank. To avoid this occurrence one or more of the following shall be done:

(a) Drain boards shall be arranged so sprinkler discharge will not be conducted into the tank.

(b) Tanks shall be equipped with an automatically closing cover.

(c) Tanks shall be equipped with overflow pipes (*see Section 4-5*).

4-4 The level of liquid in process tanks shall be maintained not less than 6 in. (15 cm) below the top of the tank to allow effective application of extinguishing agents in the event of fire.

4-5 Overflow Pipes.

4-5.1 Process tanks of over 150 gal (570 L) in capacity, or 10 sq ft (1 sq m) in liquid surface area, shall be equipped with a properly trapped overflow pipe leading to a safe location.

4-5.2 Depending upon the area of the liquid surface and the length and pitch of pipe, overflow pipes for process tanks over 150 gal (570 L) in capacity, or 10 sq ft (1 sq m) in area, shall be capable of handling the maximum delivery of process tank liquid fill pipes, or automatic sprinkler discharge, but shall not be less than 3 in. (7.5 cm) in diameter.

4-5.3 Piping connections on drains and overflow lines shall be designed so as to permit ready access for inspection and cleaning of the interior.

4-5.4 Overflow pipes installed in process tanks shall have the elevation of their liquid entry level not less than 6 in. (15 cm) below the top of the tank.

4-6 Bottom Drains.

4-6.1 Unless the vicosity of the liquid at normal atmospheric temperatures makes this impractical or automatic covers, as described in Section 8-4, are provided, process tanks over 500 gal (1900 L) in liquid capacity shall be equipped with bottom drains arranged to both manually and automatically quickly drain the tank in the event of fire. Manual operation shall be from a safe accessible location. Where gravity flow is not practicable, automatic pumps shall be required.

4-6.2* Such drains shall be trapped and shall discharge to a closed properly vented salvage tank, or to a safe location.

4-6.3 The diameter of bottom drain pipes shall be adequate to empty the tank within five minutes, and shall not be less than indicated in the following table:

From 500 gal up to 750 gal — 3 in.
(From 1900 L up to 2850 L — 8 cm)
More than 750 gal up to 1,000 gal — 4 in.
(More than 2850 L up to 3800 L — 10 cm)
More than 1,000 gal up to 2,500 gal — 5 in.
(More than 3800 L up to 9500 L — 13 cm)
More than 2,500 gal up to 4,000 gal — 6 in.
(More than 9500 L up to 15 000 L — 15 cm)
More than 4,000 gal — 8 in.
(More than 15 000 L — 20 cm)

4-7 Salvage Tanks.

4-7.1 Where salvage tanks are employed, pumping arrangements shall be provided for the retrieval of their contents, and such tanks shall be emptied before refilling the process tanks. Salvage tanks shall conform to the applicable provisions of NFPA 30, *Flammable and Combustible Liquids Code*.

4-7.2 The capacity of salvage tanks shall be greater than the capacity of the process tank or tanks to which they are connected.

4-8 Conveyor Systems.

4-8.1 Dipping and coating processes utilizing a conveyor system shall be so arranged that, in the event of fire, the conveyor system shall automatically stop.

4-8.2 Conveyor systems shall also automatically stop if required ventilation is not in full operation. (*See also Section 3-3.*)

4-9 Temperature Control of Liquids.

4-9.1 When process tank liquids are heated, either by dipping of heated articles, or by application of heat to the liquid, controls as follows shall be provided to prevent excess temperature, vapor accumulation, and possible autoignition.

4-9.1.1 Process tanks shall be equipped with a listed manual reset excess temperature control designed to shut down the conveyor system, if any, and heating system upon reaching excess temperatures.

4-9.1.2 Heating and cooling units for liquids shall be of an approved type, and be properly controlled, serviced, and maintained.

4-9.1.3 Excess temperature shall mean any temperature above which the required ventilation, specified in Section 3-2, cannot safely handle generated vapors. In no case shall this temperature exceed the boiling point, or come within 100 °F (55 °C) below the autoignition temperature of the liquid as determined by ASTM D2155, *Test for Autoignition Temperature of Liquid Petroleum Products*.

4-9.1.4 If there is no possibility of the liquid temperature exceeding its boiling point, or coming within 100 °F (55 °C) below its autoignition temperature, then controls as specified in Section 4-9 shall not be required.

4-9.1.5 Parts shall not be dipped if their surface temperature is within 100 °F (55 °C) below the autoignition temperature of the process tank liquid.

Chapter 5* Flammable and Combustible Liquids — Storage and Handling

5-1 The storage of liquids in connection with processes shall conform to the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.

5-2* Not more than 120 gal (450 L) of Class I, Class II, and Class IIIA liquids shall be stored in a storage cabinet. Of this total, not more than 60 gal (225 L) shall be of Class I and Class II liquids. Unless approved by the authority having jurisdiction, no more than one such cabinet may be located in a process area.

5-3 The quantity of liquid that may be located outside of an inside storage room or storage cabinet, or in any one fire area of a building, shall not exceed the greater of that given in either (a), or (b), (c), (d), and (e):

(a) A supply for one day, or

(b) 25 gal (95 L) of Class IA liquids in containers,

(c) 120 gal (450 L) of Class IB, IC, Class II, or Class III liquids in containers,

(d) Two portable tanks not exceeding 660 gal (2500 L) of Class IB, IC, Class II or Class IIIA liquids, and

(e) Twenty portable tanks not exceeding 660 gal (2500 L) each of Class IIIB liquids.

5-4 Closed containers, approved portable tanks, approved safety cans, or a properly arranged system of piping shall be used for transporting flammable or combustible liquids. Open or glass containers shall not be used for transportation or storage.

5-5 Handling Liquids at Point of Final Use.

5-5.1 Class I and Class II liquids shall be kept in covered containers when not actually in use.

5-5.2 Where liquids are used or handled, except in closed containers, means shall be provided to dispose promptly and safely of leakage or spills.

5-5.3 Class I liquids shall be used only where there are no open flames or other sources of ignition within the possible path of vapor travel.

5-5.4 Class I and Class II liquids shall be drawn from or transferred into process tanks, containers, or portable tanks within a building only from original shipping containers with a capacity of 5 gal (18.9 L) or less; from safety cans; through a closed piping system; from a portable tank or container by means of a device drawing through an opening in the top of the tank or container; or by gravity through a listed self-closing valve or self-closing faucet.

5-5.5 Transferring liquids by means of pressurizing the container with air is prohibited. Transferring liquids by pressure of inert gas is permitted only if controls, including pressure relief devices, are provided to limit the pressure so it cannot exceed the design pressure of the vessel, tank, or container.

5-5.6* Class I liquids shall not be dispensed into metal containers or process tanks unless the nozzle or fill pipe is in electrical contact with the container or process tank. This can be accomplished by maintaining metallic contact during filling, by a bond wire between them, or by other conductive path having an electrical resistance not greater than 10^6 ohms.

5-6 Liquids Piping Systems.

5-6.1 Equipment such as piping, pumps, and meters used for transferring liquids shall be approved for the process liquids used.

5-6.2* When a tank is filled from the top, the free end of the fill pipe shall be within 6 in. (15 cm) of the bottom of the tank. Anti-siphoning protection shall be provided for fill lines having connections below liquid-level and which are not permanently piped to the supply system. Where Class I liquids are handled, the tank and fill pipe shall have a metallic bond wire permanently electrically connected to the fill pipe. In addition, for Class I liquids, the tank, piping system, and storage tank shall be bonded and grounded.

5-6.3 When a pump is used to fill a tank, automatic means shall be provided to prevent system pressures that exceed the design working pressure of all system components.

5-6.4 Process tanks shall be provided with a limit device to prevent overfilling tanks.

5-6.5 Process pumps shall be interlocked with fire detection or automatic fire extinguishing systems to shut down the pump in case of fire.

Chapter 6* Electrical and Other Sources of Ignition

6-1 For areas involving processes where flammable liquids are utilized or where combustible liquids are utilized at temperatures at or above their flash points, the following shall apply:

(a) Hazardous (classified) locations shall be as defined in Article 500 of NFPA 70, *National Electrical Code.*

(b) Electrical equipment and wiring shall be suitable for the location in which they are installed and shall be installed according to the requirements of Articles 501, 502, and 516 of NFPA 70, *National Electrical Code.*

(c) The extent of such locations shall be as defined below.

6-2 Areas adjacent to open coating and dipping processes shall be classified according to 6-2.1 through 6-2.4 and Figure 6-1(a).

Exception: Electrostatic apparatus specifically permitted by Section 9-2.

6-2.1 Pits within 25 ft (7.5 m) horizontally of the vapor source shall be classed as Class I, Division 1. If pits extend beyond 25 ft (7.5 m) of the vapor source, a vapor stop shall be provided or the entire pit shall be classed as Class I, Division 1.

6-2.2 From the vapor source, a radial distance of 5 ft (1.5 m) shall be classed as Class I, Division 1.

6-2.3 The 3 ft (1 m) space surrounding the Class I, Division 1 location, as defined in 6-2.2, shall be classed as Class I, Division 2.

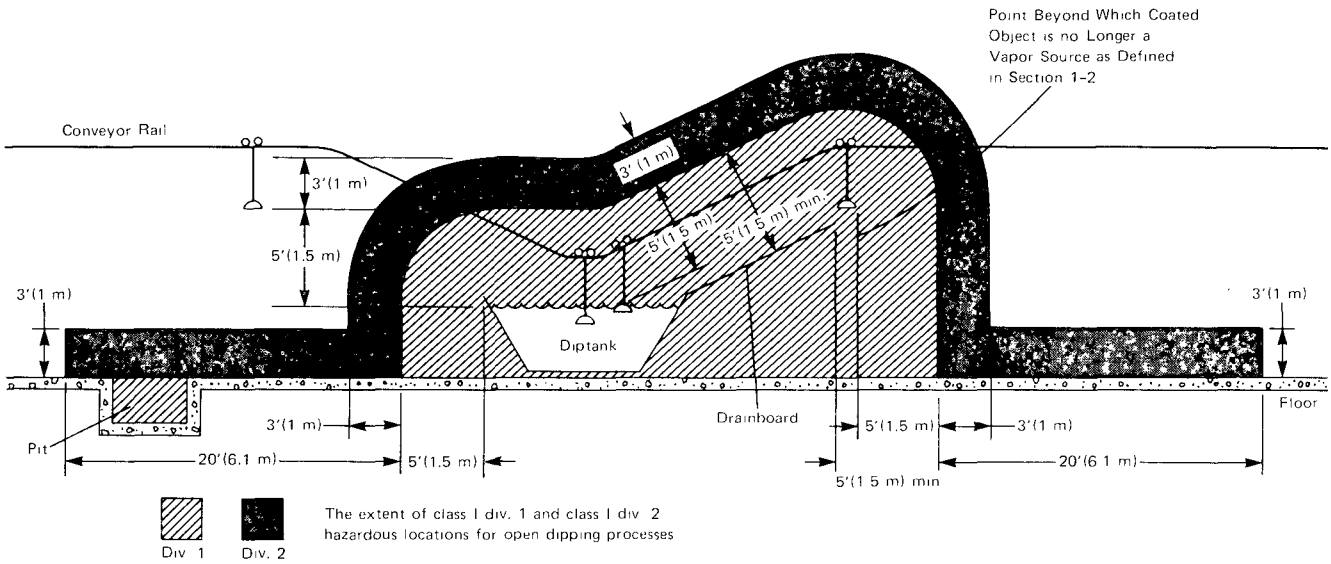


Figure 6-1(a).

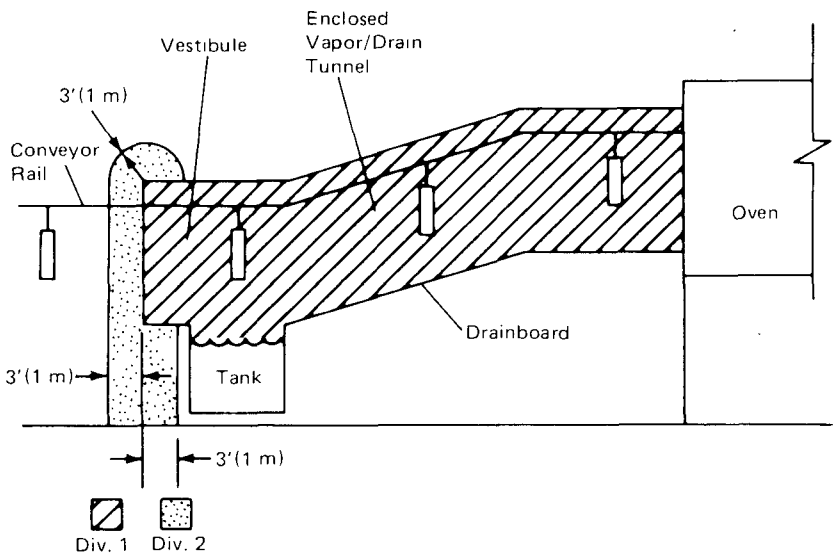


Figure 6-1(b) The extent of Class I, Division 1 and Division 2 locations in enclosed coating processes.

6-2.4 The space 3 ft (1 m) above the floor and extending 20 ft (6 m) horizontally in all directions from the Class I, Division 1 location shall be classed as Class I, Division 2.

Exception: This area need not be considered a hazardous (classified) area when the vapor source area is 5 sq ft (0.46 sq m) or less, and when the contents of the open tank, trough, or container do not exceed 5 gal (18.9 L). In addition, the vapor concentrations during operating and shutdown periods shall not exceed 25 percent of the LFL outside the Class I location specified in 6-2.2.

6-3 Areas adjacent to enclosed coating and dipping processes shall be classified according to 6-3.1 and 6-3.2 and Figure 6-1(b).

6-3.1 The interior of any enclosed process shall be classed as Class I, Division 1.

6-3.2 The space adjacent to the enclosed process shall be considered nonclassified for purposes of electrical installation.

Exception: The space within 3 ft (1 m) in all directions from any opening in the enclosure shall be classed as Class I, Division 2.

6-4* There shall be no open flames, spark-producing devices, or heated surfaces having a temperature sufficient to ignite vapors or residue in any area as defined in Section 6-2. Further, there shall be no equipment or operations that may produce sparks or particles of hot metal located above or adjacent to classified areas unless means are provided to prevent them from entering these areas.

6-5* Unless specifically listed for locations containing both deposits of combustible residues and flammable vapors, there shall be no electrical equipment in the vicinity of process tanks, or associated drain boards or drying operations, which are subject to splashing or dripping of process tank liquids. However, wiring in rigid conduit or in threaded boxes or fittings containing no taps, splices, or terminal connection is permitted.

6-6 All metal parts of process equiment, exhaust ducts, and piping systems conveying flammable or combustible liquids shall be properly electrically grounded in an effective and permanent manner.

Chapter 7* Operations and Maintenance

7-1* Areas in the vicinity of dipping and coating operations shall be kept free from accumulations of deposits of combustible residues and unnecessary combustible materials. Combustible coverings (thin paper, plastic, etc.) and strippable coatings may be used to facilitate cleaning operations in dipping and coating areas. If residue accumulates to excess in work areas, ducts, duct discharge points, or other adjacent areas, then all dipping and coating operations shall be discontinued until conditions are corrected.

7-2* Approved waste containers shall be provided wherever rags or waste are impregnated with flammable or combustible material, and all such rags or waste deposited therein immediately after use. The contents of the waste cans shall be properly disposed of at least once daily or at the end of each shift.

7-3* Periodic inspections or tests shall be made of all process tank facilities including covers, overflow pipe inlets, outlets, and discharges, bottom drains and valves, electrical wiring and equipment, grounding and bonding connections, ventilating facilities, and all extinguishing equipment. Any defects found shall be promptly corrected. Inspections shall be conducted at least monthly.

7-4* Residue accumulations on drain boards and pans shall be kept to a minimum by periodic cleaning.

7-5* Scrapers or other tools used for cleaning purposes shall be of nonsparking materials.

7-6 Cleaning operations shall be conducted with ventilating equipment in operation.

7-7 Solvents used for cleaning of dipping and coating operations shall have flash points above 100 °F (37.8 °C) or not less than that of dipping and coating materials normally used in the process.

7-8 "No Smoking" signs shall be conspicuously posted in the vicinity of dipping and coating processes.

7-9 When maintenance operations involve the use of welding, burning, or grinding equipment, such operations shall be performed under the supervision of a designated suitably trained individual, with proper prior precautions, and adequate fire and emergency equipment present.

Chapter 8* Protection

8-1* Areas in which processes are conducted shall be protected with an automatic sprinkler system where required by the authority having jurisdiction. In the event of a fire in a process tank, automatic sprinkler discharge may collect in the tank and float the flaming liquid out of the tank. To avoid this occurrence one or more of the following shall be done:

(a) Drain boards shall be arranged so sprinkler discharge will not be conducted into the tank.

(b) Tanks shall be equipped with automatically closing covers. (*See Section 8-4.*)

(c) Tanks shall be equipped with overflow pipes. (*See Section 4-5.*)

8-2 Areas in the vicinity of dipping and coating processes shall be provided with portable fire extinguishers suitable for flammable and combustible liquid fires, and conforming to NFPA 10, *Portable Fire Extinguishers.*

8-3 Protection systems shall be automatic and may be any of the following:

8-3.1 A water spray extinguishing system. Water is generally effective on liquids having a flash point above 140 °F (60 °C).

The system installation shall conform to NFPA 15, *Water Spray Fixed Systems.*

8-3.2 A foam extinguishing system. The foam used shall take into account characteristics of the process (freeboard in process tank), the coating (its effect on foam formation and the possibility of producing boilover frothing), use of wetting agents in the coating (they may prevent foam formation), and the effect of other extinguishing agents on the foam blanket (water spray may be used to protect hoods and ducts).

The system installation shall conform to NFPA 11, *Standard for Low Expansion Foam and Combined Agent Systems.*

8-3.3 A carbon dioxide system. The system installation shall conform to NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems.*

8-3.4 A dry chemical extinguishing system. The system installation shall conform to NFPA 17, *Standard for Dry Chemical Extinguishing Systems.*

8-3.5 A halogenated agent extinguishing system. The system installation shall conform to NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, or NFPA 12B, *Standard on Halon 1211 Fire Extinguishing Systems.*

8-3.6 A sprinkler system for tanks containing liquids having a flash point above 200 °F (95 °C), and for associated process hazards. The system installation shall conform to NFPA 13, *Standard for the Installation of Sprinkler Systems.*

8-3.7 A sprinkler system for tanks equipped with a tank cover arranged to close automatically in the event of fire. The system installation shall conform to NFPA 13, *Standard for Installation of Sprinkler Systems.*

8-4* Automatic closing process tank covers or special extinguishing systems shall be provided for open tanks under 150 gal (570 L) capacity or 10 sq ft (1 sq m) in liquid surface area. Automatic closing process tank covers shall be actuated by approved automatic devices and shall also be arranged for manual operation.

8-4.1 Covers shall be substantially constructed of noncombustible materials. Covers shall overlap the sides of the tank by at least 1 in. (2.5 cm) and have a recess or flange extending downward around the tank when it is closed.

8-4.2 Chains or wire ropes shall be used to support the cover or the operating mechanism. All pulleys, catches, and other fasteners shall be metal and shall be attached to noncombustible mountings.

8-4.3 Covers shall be kept closed when the process is not in operation.

8-4.4 Where drain boards return drippings to the tank, special means shall be provided to permit the cover to close tightly and prevent water from sprinklers or other sources from draining into the process tank.

8-5* Protection systems shall be provided for process tanks over 150 gal (570 L) capacity or over 10 sq ft (1 sq m) in liquid surface area. The systems shall be designed to protect the following areas:

(a) The tank, drain board, freshly coated objects, hoods, and ducts.

(b) For flow coaters the system shall protect open tanks, vapor drying tunnels, and ducts. Pumps circulating the coating material shall be interlocked to automatically shut off in the event of fire.

(c) For curtain and roll coaters or similar processes the system shall protect the coated object and open troughs or tanks containing coating materials. Pumps circulating the coating material shall be interlocked to automatically shut off in the event of fire.

Chapter 9* Special Process Tank Applications

9-1 Hardening and Tempering Tanks.

9-1.1 The heat treatment of metals may involve their cooling by immersion in combustible liquids. Localized overheating of the surface of the liquid at the point of the immersion or heating of the entire contents of a tank above its flash point can result in serious fire. The heated parts shall be transferred into the oil rapidly and with a continuous motion so that this localized overheating of the liquid surface will not occur. Except as modified in this chapter and except for Chapters 3 and 6, all of the preceding chapters are applicable. (*Recommendations for integral quench tanks are covered in NFPA 86C, Standard for Industrial Furnaces Using a Special Processing Atmosphere.*)

9-1.2 Tanks shall be located as far as practicable from furnaces and shall not be located on or near combustible floors. Combustible stock and other combustible materials shall not be stored in the vicinity of dipping and coating processes.

9-1.3 Tanks shall be provided with a noncombustible hood and vent or other equally effective means, to facilitate removal of vapors from the process and to prevent condensate from forming on roof structures. All such vent ducts shall be treated as flues and be kept well away from combustible roofs or materials. Hoods and ducts shall be protected with an approved automatic extinguishing system and shall be so located as to not interfere with fire protection facilities for the process tank.

9-1.4 Tanks shall be so designed that the maximum work load is incapable of raising the temperature of the cooling medium to within 50 °F (28 °C) below its flash point.

9-1.5 Tanks shall be equipped with an excess temperature limit switch arranged to sound an alarm when the temperature of the quenching medium reaches within 50 °F (28 °C) below the flash point. Limit switches shall also shut down conveying equipment supplying work to the tank provided such action does not increase the hazard.

9-1.6 Air under pressure shall not be used to fill or to agitate oil in tanks.

9-1.7 Drain facilities from bottom of tank may be combined with the oil circulating system or arranged independently to drain the oil to a safe location. Unless the viscosity of the liquid at normal atmospheric temperatures makes this impractical, tanks over 500 gal (1900 L) in liquid capacity shall be equipped with bottom drains arranged to drain the tank quickly, both manually and automatically, in the event of fire. Manual operation shall be from a safely accessible location. Where gravity flow is not practicable, automatic pumps shall be required. Such drain facilities shall be trapped and shall discharge to a closed, properly vented salvage tank or to a safe location outside. The provisions of this section do not apply to integral quench furnaces covered by NFPA 86C, *Industrial Furnaces Using a Special Processing Atmosphere.*

9-2 Electrostatic Apparatus.

9-2.1 Electrostatic detearing equipment shall conform to Chapters 1 through 8 of this standard (except as hereinafter modified), and shall also conform to the requirements of this chapter.

9-2.2 Electrostatic apparatus and devices used in connection with paint detearing operations shall be of approved types.

9-2.3 Transformers, high voltage supplies, control apparatus, and all other electrical portions of the equipment, with the exception of high voltage grids and their connections, shall be located outside the vapor area defined in Chapter 1 or shall conform to the requirements of Chapter 6.

9-2.4 Electrodes shall be of substantial construction, rigidly supported in permanent locations, and effectively insulated from ground. Insulators shall be nonporous.

9-2.5 High voltage leads to electrodes shall be effectively and permanently supported on suitable insulators, and shall be effectively guarded against accidental contact or grounding.

9-2.6 A safe distance shall be maintained between goods being deteared and electrodes or conductors of at least twice the sparking distance. A suitable sign indicating this safe distance shall be conspicuously posted near the assembly.

9-2.7* Goods being deteared by this process shall be supported on conveyors or hangers. The conveyor shall be so arranged as to assure that the parts being deteared are electrically connected to ground, with a resistance of 1 megohm, or less, and to maintain the distance required by 9-2.6 between the goods and the electrodes at all times. Goods shall be supported to prevent swinging or movement that would reduce the distance to less than that required.

9-2.8 This process shall not be used where goods being deteared are manipulated by hand.

9-2.9 Electrostatic apparatus shall be equipped with automatic means that will rapidly deenergize the high voltage elements and signal the operator under any of the following conditions:

(a) Stoppage of ventilating fans or failure of ventilating equipment from any cause.

(b) Stoppage of the conveyor carrying goods through the high voltage field.

(c) Occurrence of a ground or excessive current leakage at any point on the high voltage system.

(d) Reduction of clearance below that specified in 9-2.6.

(e) Deenergizing the primary of the power supply.

9-3 Safeguards such as adequate booths, fencing, railings, or other means shall be so placed about the equipment or incorporated therein that they, either by their location or character or both, assure that a safe isolation of the process is maintained from plant storage or personnel.

9-4* All electrically conductive objects in the area, except those objects required by the process to be at high voltage, shall be adequately grounded. This requirement shall apply to paint containers, wash cans, guards, and any other electrically conductive objects or devices in the area. The equipment shall carry a prominent, permanently installed warning regarding the necessity for this grounding feature.

9-5 Signs designating the process zone as dangerous as regards fire and accident shall be conspicuously posted.

9-6 All insulators shall be kept clean and dry.

9-7 Drip plates and screens subject to paint deposits shall be removable and shall be taken to a safe place for cleaning.

Chapter 10* Training

10-1 All personnel involved in processes shall be instructed in the potential hazards to safety and health; the operational, maintenance, and emergency procedures required; and the importance of constant operator awareness.

10-2 Personnel required to handle or use flammable or combustible liquids shall be instructed in the safe handling, storage, and use of these materials, as well as the emergency procedures that may be required.

10-3* All personnel required to enter or to work within confined or enclosed spaces shall be instructed as to the nature of the hazard involved, the necessary precautions to be taken, and in the use of protective and emergency equipment required.

10-4 All personnel shall be instructed in the proper use, maintenance, and storage of all emergency, safety, or personal protective equipment that they may be required to use in their normal work performance.

10-5 Some appropriate form of documentation shall be employed to record the type and date of training provided to each individual involved in these processes.

Chapter 11 Referenced Publications

11-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference shall be the current edition as of the date of the NFPA issuance of this document.

11-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 10-1988, *Standard for Portable Fire Extinguishers*

NFPA 11-1988, *Standard for Low Expansion Foam and Combined Agent Systems*

NFPA 12-1989, *Standard on Carbon Dioxide Extinguishing Systems*

NFPA 12A-1989, *Standard on Halon 1301 Fire Extinguishing Systems*

NFPA 12B-1985, *Standard on Halon 1211 Fire Extinguishing Systems*

NFPA 13-1989, *Standard for the Installation of Sprinkler Systems*

NFPA 15-1985, *Standard for Water Spray Fixed Systems for Fire Protection*

NFPA 17-1985, *Standard for Dry Chemical Extinguishing Systems*

NFPA 30-1987, *Flammable and Combustible Liquids Code*

NFPA 70-1990, *National Electrical Code*

NFPA 80-1986, *Standard for Fire Doors and Windows*

NFPA 86-1985, *Standard for Ovens and Furnaces*

NFPA 86C-1987, *Standard for Industrial Furnaces Using a Special Processing Atmosphere*

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

NFPA 321-1987, *Standard on Basic Classification of Flammable and Combustible Liquids.*

11-1.2 ASTM Publications. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

ASTM D56-87, *Standard Method of Test for Flash Point by the Tag Closed Tester*

ASTM D86-82, *Standard Method of Test for Distillation of Petroleum Products*

ASTM D93-85, *Standard Method of Test for Flash Point by the Pensky Martens Closed Tester*

ASTM D2155-69, *Test for Autoignition Temperature of Liquid Petroleum Products*

ASTM D3278-82, *Standard Methods of Tests for Flash Point of Liquids by Setaflash Closed Tester*

ASTM D3828-87, *Standard Test Methods for Flash Point of Liquids by Setaflash Closed Tester.*

Appendix A General Principles

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

The following Appendix material is provided to explain basic principles and give loss experience.

A-1 Scope and Definitions — General.

The safety of life and property from fire or explosion as a result of dipping and coating processes varies depending on the arrangement and operation of a particular installation.

The principal hazards of these processes are fire and explosion hazards from large quantities of exposed flammable liquids.

A fire, if not quickly controlled, can open sprinklers over a large area and may seriously damage building structural members. Enclosed processes, if not properly ventilated, present an explosion hazard which may result in release of coating material or cause structural damage.

The fire hazard can be reduced by any one of several protection systems. The systems generally fall into two categories: (1) a protection system designed specifically for the tank, i.e., a dry chemical system, an automatic closing cover, etc.; (2) an area protection system such as an automatic sprinkler system for the room where the process is located. In some cases a combination of these systems may be required. Protection should be chosen based on the design of the process and properties of the coating used.

The fire or explosion hazard can be reduced by providing adequate mechanical ventilation.

The elimination of all sources of ignition in areas where flammable or combustible liquids or combustible residues are present is essential to safe operation.

Fire spread to other property, exposure of personnel, and possibility of damage to goods in process or other equipment should be considered in location of processes and installation of protection systems. This consideration should be made, regardless of size of the process.

A-2 Location of Dipping and Coating Processes — General.

Fires in dipping and coating areas develop rapidly, generating large quantities of heat and smoke. Therefore, facilities should be located so that there is adequate egress for all personnel and access for fire fighting operations.

Where dipping and coating operations are located on upper floors of buildings, they should not be located immediately over concentrations of damageable goods, and provisions should be made for the waterproofing and drainage of the floor of the process area.

Floors should be arranged to drain to a safe location. Properly designed and guarded drains or scuppers of sufficient number and size to dispose of all surplus water likely to be discharged by automatic sprinklers over the waterproof area should be provided.

A-2-1 Process Location. Location of dipping and coating processes depends, among many considerations, upon the quantities of flammable and combustible liquids

used, the process arrangement, the personnel exposure, the construction of the building, and the surrounding exposures.

In factories conducting extensive dipping and coating operations, it is desirable that the process be confined by one of the following methods (in the order of descending preference):

(a) Detached building or building cutoff from other plant buildings by fire walls.

(b) Area in a building cutoff by fire walls or fire-resistive partitions.

(c) Area in a building cutoff by fire curtains.

(d) Isolation by safe distance.

The adaptation of assembly lines or conveyor systems to dipping and coating processes may present some additional problems of fire hazard segregation. If conveyor systems extend to or from a detached building, a sprinklered, noncombustible, connecting passageway may be advisable. If conveyor systems go through floors, the floor openings should be surrounded by deep draft curtains on the ceiling beneath and may be provided with automatically controlled high velocity spray nozzles arranged to set up a counter draft. If conveyor systems pierce fire walls, it is difficult to arrange automatic fire doors to protect the openings in a practical and reliable manner. In some instances, such openings have been provided with noncombustible tunnels extending on each side of the fire wall with tunnels protected by specially designed automatic spray or sprinkler systems.

In sprinklered buildings, rooms of extensive area having process operations should be provided with noncombustible draft curtains, extending downward from ceilings as far as practical, but not less than 18 in. (46 cm). Such curtains aid in preventing the opening of sprinklers outside the area enclosed by curtains and tend to confine the discharge of water to the immediate area of the fire.

A-2-2 Basement Areas. Dipping and coating operations involving flammable or combustible liquids should not be located in any basement area. The reason for this is threefold:

(a) Lack of egress.

(b) Lack of fire department access.

(c) Possibility for extensive structural damage should an explosion caused by accumulations of vapors occur.

A-2-4 Buildings of Public Assembly. Processes should be separated from areas of public assembly; educational, institutional, or residential occupancies. The use of proper cutoff between hazards and exposures depends on many factors. Where the risk to exposure is high, the authority having jurisdiction may require protection in excess of the indicated 2-hour fire resistance rating with 1½-hour Class B doors. Class B doors are predominately used for vertical openings, but are acceptable for use in 2-hour-rated fire partitions. Where the exposure hazard is considered high enough, some occupancies may require a wall with a fire resistance rating of at least 4 hours with automatic fire doors of a Class A rating.

A-3 Ventilation.

A-3-2 Exhaust Ventilation. Adequate mechanical ventilation can be used to confine and remove flammable mists or vapors and combustible materials from both open surface and enclosed processes.

Both the LFL (Lower Flammability Limit) and the TLV (Threshold Limit Value) must be considered when the process is a manually operated system. When the process is an automatic (conveyorized) system, the LFL will generally govern ventilation rates.

LFL Determination. Paints, varnishes, lacquers, and other coating materials may contain volatile flammable solvents. In addition, such solvents may be added as "thinners." Such solvents, when exposed to the atmosphere, give off vapors that mix with the surrounding air and, if the concentration of these vapors reaches as much as approximately one percent, at the same time a spark or other source of ignition is present, a fire or explosion may occur. Processes using only combustible liquids with relatively high flash points, although less likely to produce a flammable atmosphere than those using low flash point flammable liquids, may result in mists capable of propagating a flame similar to combustible solids in dust explosions.

Theoretical considerations may assist in hazard evaluation in some instances. Vapor pressure, temperature, and exposed liquid surface area are the primary considerations in determining evaporation rate. The ventilation rate may be based on the fact that 1 liquid gal (3.8 L) of the average flammable solvent will occupy approximately 23 cu ft (0.6 m^3) when evaporated at average room temperature. Therefore, if 1 gal (3.8 L) of liquid solvent is completely evaporated and thoroughly mixed with the surrounding air of an enclosure, the enclosure must have a volume of more than 2,300 cu ft (65 m^3) to avoid a flammable mixture if the lower limit of the flammable range of the solvent is 1 percent in air. This is a conservative number; almost all of the solvents used in processes have a LFL higher than 1 percent. Vapors from most flammable solvents are heavier than air and small quantities of vapor may form a flammable mixture in low unventilated spaces in the vicinity of, or even remote from, the point of evaporation. For these reasons, a safety factor of 4 to 1 has been traditionally used and the ventilation requirement rounded off to 10,000 cu ft per gal (74.5 m^3/L) evaporated.

Adequate mechanical ventilation throughout all areas where flammable vapors or mists may be present is essential to prevent the formation of flammable mixtures. The volume of air movement necessary will obviously vary with the arrangement of the processes.

Exhaust hoods can be used to control unmanned tanks, but are not often recommended where people are involved in a process. Hoods can be of the canopy type with or without side enclosures. The lower the canopy and the more complete the enclosure, the better the exhaust system. Canopy hoods should extend laterally over the equipment as far as practical.

Capture velocities as low as 100 cfm per sq ft (31 m^3/min per m^2) of tank surface area may be considered when the hood is located at the rear of the tank and does not extend over the surface.

Peripheral exhaust should be utilized on open surface tanks where overhead operations preclude the use of an enclosed canopy hood. Slots should be designed for approximately 2,000 fpm (610 m/min) velocity. The peripheral

duct should be tapered to allow for solvent drainage, and if the length of lateral ductwork exceeds 5 ft (1.5 m), splitters should be considered. A combination of pressure and peripheral exhaust ducts should be considered for tanks in excess of 5 ft (1.5 m) in length. The quantity of air exhausted should approximate 100 to 150 cfm per sq ft (46 to 77 m^3/min per m^2) of tank surface area and the pressure slot should be designed for approximately 1,000 to 2,000 fpm (305 to 610 m/min) velocity.

Open drain boards should be ventilated at a rate approximately 50 cfm per sq ft (23 m^3/min per m^2) of drain board area.

Cleaning tanks that contain solutions of combustible materials may also represent toxic hazards. Ventilation rates can generally be reduced for cleaning tanks and may be as low as 50 cfm per sq ft (23 m^3/min per m^2) of tank surface area with slot velocities as low as 1,000 ft per min (305 m/min).

Any heated tank will require a separate mechanical ventilation system where there are products of combustion.

One source for information on recommended capture and slot velocities, ductwork design, ventilation rates, and hood design is *Industrial Ventilation - A Manual of Recommended Practice,* published by the Committee on Industrial Ventilation, P.O. Box 16153, Lansing, Michigan 48901.

Additional Ventilation. Other operations producing flammable vapors should be provided with independent mechanical ventilation.

Smoke Removal. Provisions for removal of smoke from process areas under fire conditions should be included in the ventilation and protection scheme.

A-3-3 Makeup Air. Since the air exhausted from processes is normally contaminated and can only be recirculated under rigidly controlled conditions, consideration should be given to the heating of incoming air in cold weather. An efficient and satisfactory method of heating rooms containing processes is to strategically locate air intakes so as to provide a uniform sweep of air throughout the entire room toward exhaust fans and provide the air intake with a safe heating arrangement. Makeup or replacement air may be obtained from the outside by air replacement systems or from other plant areas. As a general rule, when the total volume of these areas is less than 20 times the capacity of all exhaust fans, an air replacement system should be considered.

With the many variables which may be encountered in heating and ventilating systems, it is generally advisable to engage the services of a qualified ventilating engineer to obtain a safe and efficient installation.

A-3-6 Exhaust Systems. Exhaust systems should be individually ducted to the outside. Where treatment of exhaust is necessary to satisfy EPA requirements or where energy conservation measures are used, this may not be practical. Manifolding exhaust ducts increases the fire hazard. A fire starting in one process may spread through the exhaust system and involve other processes. Heat exchangers are sometimes used to preheat the exhaust before it enters an incinerator. This may result in spontaneous ignition of residue accumulations on heat exchange surfaces.

A-4 Construction of Dipping and Coating Equipment.

A-4-2 The purpose of this requirement is to prevent water flow from the floor into the tank, as well as the overflow of tank contents during fire fighting operations.

A-4-6.2 Salvage tank capacity should be at least 125 percent of the volume of the process tank. Influent pipe should be terminated at the bottom of the salvage tank to prevent refloating low specific gravity combustible liquids. Tank vents should be installed to relieve filling pressures.

A-5 Flammable and Combustible Liquids — Storage and Handling.

A-5-2 Storage Cabinets. The provisions of this section are more restrictive than NFPA 30 regarding the number of storage cabinets permitted. Review by the authority having jurisdiction, based on operational needs, may indicate that the number of cabinets can be increased to the number permitted by NFPA 30.

A-5-5.6 NFPA 77, *Recommended Practice on Static Electricity,* provides information on static protection.

A-5-6.2 Filling Process Tanks. The purpose of having the fill pipe close to the bottom of the process tank is to minimize the generation of static electricity within liquids having a static accumulating tendency. The hazard involves liquids that evolve flammable vapors at normal temperatures; that is, Class I liquids. It should be recognized that even though liquid splashing is minimized and the bonding procedure is used, it is still possible for a static discharge to occur on the liquid surface, from surface to tank, or from surface to fill pipe, and cause ignition.

A-6 Electrical and Other Sources of Ignition.

A-6-4 Source of Ignition Other than Electrical. Areas surrounding dipping and coating operations must be kept free of ignition sources such as open flames or spark-producing equipment. The ignition sources will be well beyond the area containing flammable vapor air mixtures during normal operation. This is recommended because an upset in the process (failure of ventilation system) may result in the spread of residues or flammable vapor air mixtures well beyond the area anticipated during normal operation.

A-6-5 Electrical Equipment Subject to Residue Accumulations. Some residues may be ignited at very low temperatures; therefore, additional consideration must be given to operating temperatures of equipment subject to residue deposits. Many deposits may be ignited at temperatures produced by low pressure steam pipes or by incandescent light globes, even those of the explosion-proof type. Deposits on the surface of the electrical equipment will also change the heat transfer characteristics, and may increase the operating temperature of the equipment.

A-7 Operations and Maintenance — General. The inherent characteristics of the materials used in dipping and coating processes emphasize the fact that supervision of operations, maintenance of equipment, and routine cleaning are essential to reasonable safety. Properly designed equipment can do much to lessen, but cannot eliminate, this necessity.

A-7-1 Control of Residue. When dipping or coating articles, some process liquid does not deposit directly on the article or return to the process tank, but deposits on adjacent surfaces as residue material. Much of this residue is highly combustible, igniting at very low temperatures, and it may ignite spontaneously, resulting in fast spreading fires. To limit the duration and intensity of fires, the accumulations of residue must be prevented and controlled as much as practical. Dipping and coating operations must be restricted to locations designed and equipped for the purpose, and then only with proper operation and effective maintenance and housekeeping.

A-7-2 Disposal. Many fires have originated from the spontaneous ignition of fabric and waste impregnated with coating materials. When dipped or coated articles are rubbed with rags or waste is cleaned up, all rags and waste material must be immediately placed in approved waste containers and removed from the premises at least daily or at the close of each shift. When employees change clothes on plant premises, soiled clothing should be kept in metal lockers provided in a separate dressing room.

Many residue scrapings, used filter media, and process room refuse are highly susceptible to spontaneous ignition, hence they must be carried to a safe, well-detached location and properly disposed of daily. Nitrocellulose residues should not be burned in boilers as the gases of decomposition may cause an explosion.

A-7-3 Self-Inspection. Periodic inspection by a competent and reliable individual should be made to determine that all sprinkler control valves are open, fire extinguishers are properly charged and in place, fire suppression and alarm systems are charged and in operable condition, electric motors and fan bearings are not overheating, fan blades are in alignment, electric wiring is properly overcurrent protected, guards and globes on lighting fixtures are clean and in place, overflow and drain systems are in proper operating condition, cleanliness is being maintained, and all operating and safety instructions are being observed.

If repairs or changes are to be made to equipment, care should be taken to see that all residue deposits are removed and the area kept wetted down with water beforehand in order to avoid a fire. During such repairs, no dipping or coating operations are to be conducted, all flammable and combustible liquids and portable combustible materials should be removed from the vicinity, and suitable fire extinguishers kept readily available.

The use of welding or cutting torches should be under the supervision of a suitably trained person familiar with the hazards involved.

A-7-4 Cleaning. The areas adjacent to dipping and coating processes, exhaust fans and ducts, conveyor systems, etc., must be cleaned regularly to avoid the accumulation of residues. Either process operators should be allowed ample time for this cleaning, or a special maintenance crew should be provided for this purpose. If equipment is so designed that, during cleanup, hose streams or fixed water nozzles may be used in ducts and process areas without water damage to building and contents, cleaning operations are greatly facilitated. Many plants have found that by coating the interiors of process areas and enclosures with a suitable water soluble material immediately after cleaning, adhesive residues may be removed with the use of water streams. Other materials such as plastics, which can be readily peeled off the interior of the process areas and equipment, may also be used to facilitate cleaning of the residue.

Exhaust ducts or stacks should not be entered for cleaning or repairs unless they are free from flammable vapors and have been thoroughly wetted down.

A-7-5 Cleaning Tools. Cleaning operations themselves may be the source of fires, hence should be intelligently conducted. If cleaning is done by scraping, only nonferrous scrapers, spuds, or similar tools should be used. Steel tools may cause sparks.

A-8 Protection.

A-8-1 Automatic Sprinkler Protection. Automatic sprinkler systems are highly effective in controlling the spread of fire and protecting the building and nearby occupancies from heat damage. Processes should only be located in buildings completely protected by an automatic sprinkler system. If located in unsprinklered buildings, sprinklers should be installed to protect processes where practical. Because of the rapid spread and intensity of fires, the available water should be ample to supply all sprinkler heads likely to open in one fire area without depleting the available water for anticipated hose streams. Noncombustible draft curtains may be used to limit the number of sprinklers that may open.

The proper drainage of the large volume of water frequently necessary to extinguish fires in processes often presents considerable difficulty. Use of water over processes delivered at a high enough rate for extinguishment requires adequate preplanning for the removal of water contaminated with solvents to a safe location. This is especially true for processes in multiple story buildings. It may be necessary to provide waterproofing and drainage of the floor so that extensive water damage does not occur on the floor below.

Sprinklers will extinguish fires in combustible residue deposits and in liquids with flash points in excess of 200 °F (93.3 °C). They will control fires in liquids with flash points under 200 °F (93.3 °C), i.e., the building will be protected from heat of the fire and, if the tank is equipped with overflow drains, the fire will be confined to the tank. The sprinkler system should be designed to deliver the density indicated in Table A-8-1. The area of application as indicated in the table is a maximum and can be reduced to either the area of the room if the process is in a cutoff room, or protection may be extended 20 ft (6 m) beyond the process in all directions.

The following table gives recommended sprinkler densities and area of coverage for coating operations involving flammable and combustible liquids:

Table A-8-1

Sprinkler Densities and Area Protection for Processes Relative to Flash Point of Liquids Used.

Flash Point °F	A.S. Temp. Rating °F	Density gpm/sq ft	Area of Coverage sq ft
Below 20°F (including nitrocellulose lacquer)	286 160	0.3 0.3	6,000 8,000
20°F to 200°F or heated combustible liquids	286 160	0.3 0.3	4,000 6,000
Over 200°F	286 160	0.25 0.25	4,000 6,000

Flash Point °C	A.S. Temp. Rating °C	Density L/min/m²	Area of Coverage (m²)
Below -7°C (including nitrocellulose lacquer)	141 72	12 12	560 740
-7°C to 94°C or heated combustible liquids	141 72	12 12	370 560
Over 94°C	141 72	10 10	370 560

A-8-4 Tank Protection. Loss experience indicates that the size of a tank in a coating process may not necessarily be an indication of hazard. The average reported loss in tanks under 50 gal (190 L) in capacity is often greater than those over 1,000 gal (3800 L) capacity. This is generally because the hazard in large tanks is recognized and protection provided. Protection has therefore been recommended for all tanks regardless of size.

A-8-5 Protection Systems. Fires in large process tanks [150 gal (570 L) and over] usually require complete automatic extinguishment. Protection systems should be designed to cover all liquid surfaces, wetted surfaces, and surfaces exposed to combustible residue. Prior to selecting a protection system, a review should be made and the following features considered:

(a) Is it effective on the hazard?

(b) Is it the best agent to use under the circumstances in regard to safety, cleanup, and contamination?

(c) Is the importance of the process such that it requires redundant protection?

(d) Is it hazardous to personnel?

Where processes are protected by carbon dioxide and Halon, if the fire is not quickly extinguished, it may reignite when agent concentration dissipates. Dry chemical and foam agents may delay reignition if the foam and dry chemical layer remains in place. However, discharge from hose streams or other portable extinguishing equipment may take off the foam or dry chemical blanket and result in reignition of the liquid surface. Ignition sources must be eliminated to prevent reignition regardless of the agent employed.

A-9 Special Process Tank Applications.

A-9-2.7 Grounding of Parts Being Deteared. Ungrounded parts can, if they are near high voltage electrodes, become electrically charged. In this condition, they constitute an energy source capable of producing an incendive spark when approached by a grounded object or person. This condition can be avoided if the electrical resistance between the part and ground is 1 megohm or less. Further detailed information on this subject may be found in NFPA 77, *Static Electricity*.

A-9-4 Grounding of Other Objects. The grounding requirements for parts being deteared (*see A-9-2.7*) apply, for the same reasons, to all other conductive objects (including personnel) that are in the vicinity of the high voltage electrodes.

A-10 Training — General. The safety of a dipping and coating process depends on the employees who operate it and the knowledge and understanding they have of the process and equipment involved. It therefore is important to maintain an effective and ongoing training program for all employees involved in such work. New employees must be effectively trained before being assigned to a job. After the initial training, employees must receive periodic retraining to assure their knowledge and understanding of normal process procedures as well as emergency procedures or changes in procedures. Safe work habits must be developed. They do not occur naturally.

All training must be provided by qualified personnel, knowledgeable in process and operations involved. Appropriate training must be provided for all employees involved in or affected by dipping and coating processes. This includes but is not limited to operating, supervisory, housekeeping, and maintenance personnel.

A-10-3 Confined Space Entry. Any work requiring entry of employees into confined spaces should be conducted in accordance with a written procedure, rigidly followed. This procedure should include, but not be limited to:

(a) Analysis of confined space atmosphere for flammable, combustible, toxic, or oxygen deficient conditions.

(b) Rescue, fire, and emergency procedures.

(c) Locking and tagging procedures for all power and process hazard sources.

(d) Ventilation.

(e) Personal protective equipment.

(f) Proper tools and electrical equipment.

(g) Written entry authorization by a qualified responsible individual.

Appendix B Fire Record

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

Many fires in dipping and coating processes can be prevented by following the provisions outlined in this standard. When a fire occurs, the provisions of this standard help to minimize loss to property and interruption to production.

Fires in dipping operations are more frequent than in other types of coating operations. However, many of the causes of ignition and the deficiencies that make for serious damage to property and extended interruptions to production in process tanks also apply to roll, flow, and curtain coating.

Loss experience has shown that the size of the tank may not be a factor in process tank losses. The average damage to property and interruption to production are often as high in tanks under 50 gal (190 L) as in tanks exceeding 1,000 gal (3800 L) in capacity. This may be due to the fact that little consideration is given to where a small tank is placed and to what protection is provided. For large tanks, protection and/or isolation from main plant areas is generally provided.

Most process tank losses involve coatings with flash points under 100 °F (37.8 °C). Ignition occurs in either the vapor space above the liquid surface or in deposits of residue on the drain board or near the tank. The most common ignition source is electrical equipment not suitable for use in a process tank area. The most common deficiency leading to a large loss is lack of or failure of the protection system.

The following are the four most common sources of ignition:

Ignition Sources.

(a) Electrical Equipment — Ignition occurs most frequently from failure of electrical equipment in the area or by bringing electrical equipment not rated for use in a Class I, Division 1 area into the vapor area.

(b) Maintenance Operations — It is generally well recognized that flammable liquid vapors can be readily ignited by sparks from cutting, welding, and drilling operations. Few losses have been reported involving the exposed liquid surface of the tank. Most losses have occurred in areas where residue has accumulated near the tank or in the exhaust duct. When the residue was ignited, flame spread back to the tank.

(c) Static Electricity — Ignition occurs usually when transferring liquids from one container to another or in processes without adequate bonding and grounding.

(d) Smoking — Carelessly discarding smoking materials or matches has been another common ignition source.

Contributing Factors.

Process tank fires have varied from a "typical" fire confined to the tank and drain board and extinguished in several minutes by plant personnel or the public fire department, to a fire that has burned "out of control" for a long period of time with resultant damage to property and a long period in which production has been interrupted.

The following are three factors that have contributed to large losses either alone or in combination:

(a) Lack of protection, incomplete protection, or failure of a protection system to function properly. Incomplete protection such as failure to provide protection inside an enclosure or under a ventilation hood over a process tank may allow the fire to burn in the tank shielded from overhead sprinklers. This may open automatic sprinklers a distance from the tank causing water damage to adjacent equipment and stock in process.

Dry chemical, foam protection, and carbon dioxide systems have been the most common special protection systems used. If properly designed and maintained, they can rapidly extinguish a process tank fire. The following are the most common reasons for failure:

1. Lack of maintenance of the system.
2. System not designed to cover all wetted surfaces.
3. Failure of the detection system to respond or the relays to actuate the system automatically.
4. The intensity of heat rapid enough so that manual pull stations could not be reached.

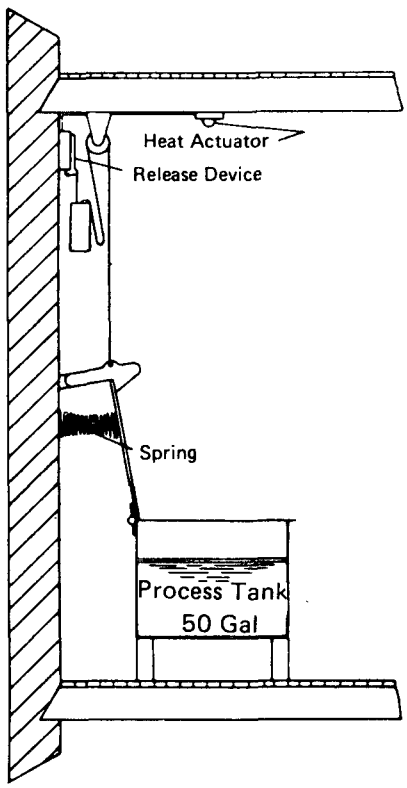
(b) Spread of coating material out of tank. This has generally occurred either because the tank was not equipped with overflow drains or because of discharge of portable extinguishing equipment directly onto the tank surface from close range. Coating material discharged onto the floor increases the fire area and exposes tank supports to heat from the fire.

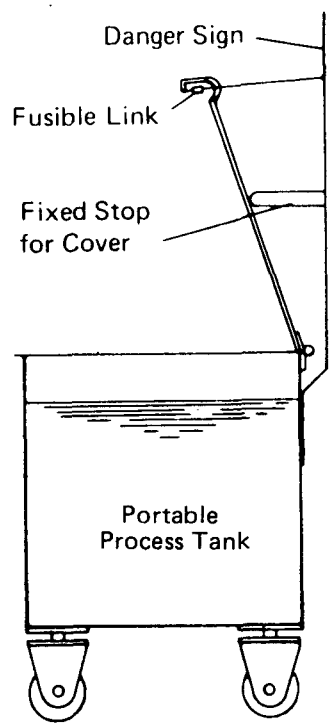
(c) Lack of adequate cutoffs. This has occurred when nearby material (for example, goods in process or equipment) is susceptible to heat, smoke, and water damage and where the tank has not been adequately cutoff. In one case, the process tank operation was located close to a computer room without adequate cutoffs. In other cases, tanks were located on upper floors of multi-story buildings with board on joist floors. Water from hose streams and sprinklers wet down goods in process and finished goods on floors below.

Appendix C Illustrations of Suggested Arrangements

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

NOTE: The following illustrations represent only general principles of process tank arrangements and are not intended to cover detail design. Alternate arrangements accomplishing the same objectives are equally effective.

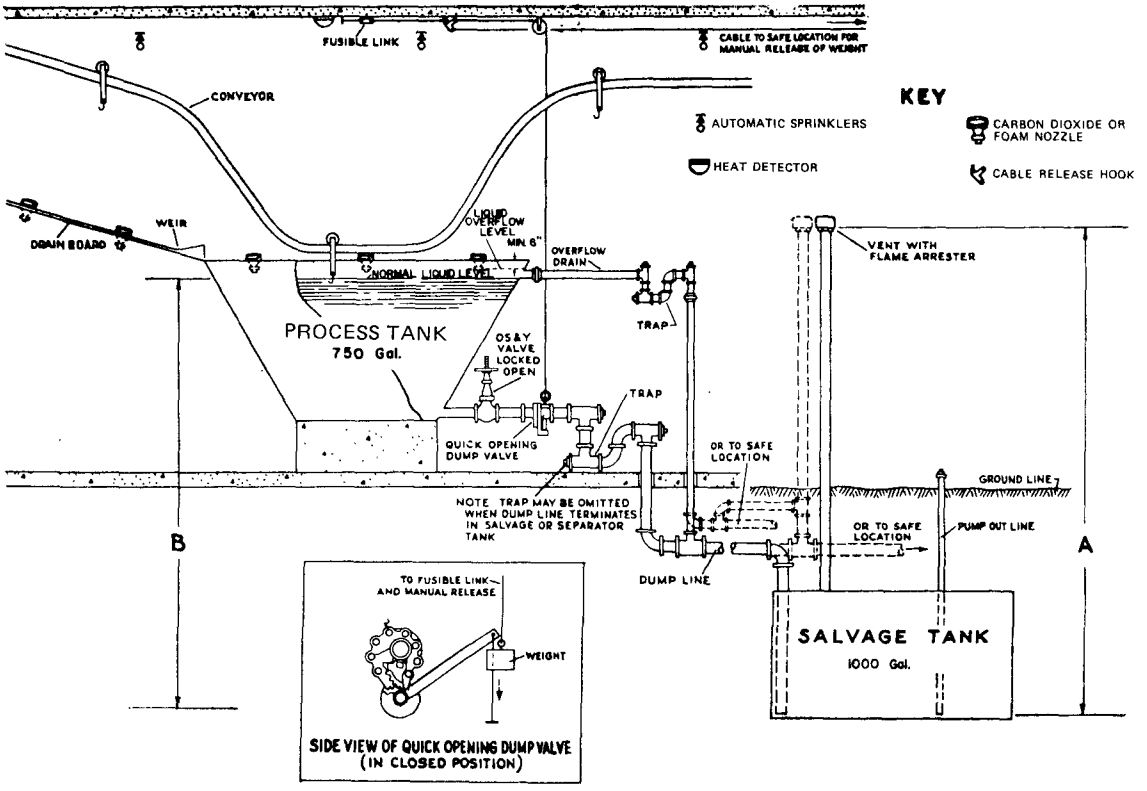




For SI units in the following figures: 1 in. = 25.4 mm; 1 gal = 3 785 L.

Figure 1 A small process tank with an automatic cover.

Figure 2 A portable tank with an automatic cover.



A greater than B but discharge point at least 12 ft (3.6 m) above ground.

Figure 3 Typical process tank installation.

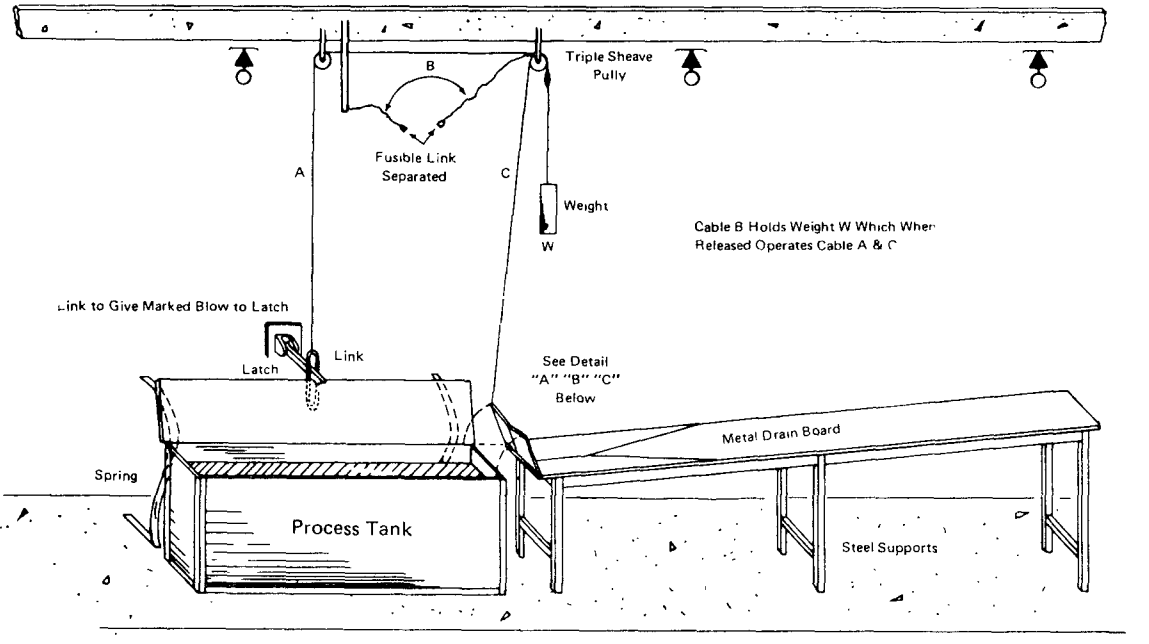


Figure 4 Process tank, automatic cover and drain board, with drain board arranged to prevent interference with cover. The link in cord "B" has separated, weight "W" has lifted,the hinged section of the drain board and the latch is about to operate to release the cover.

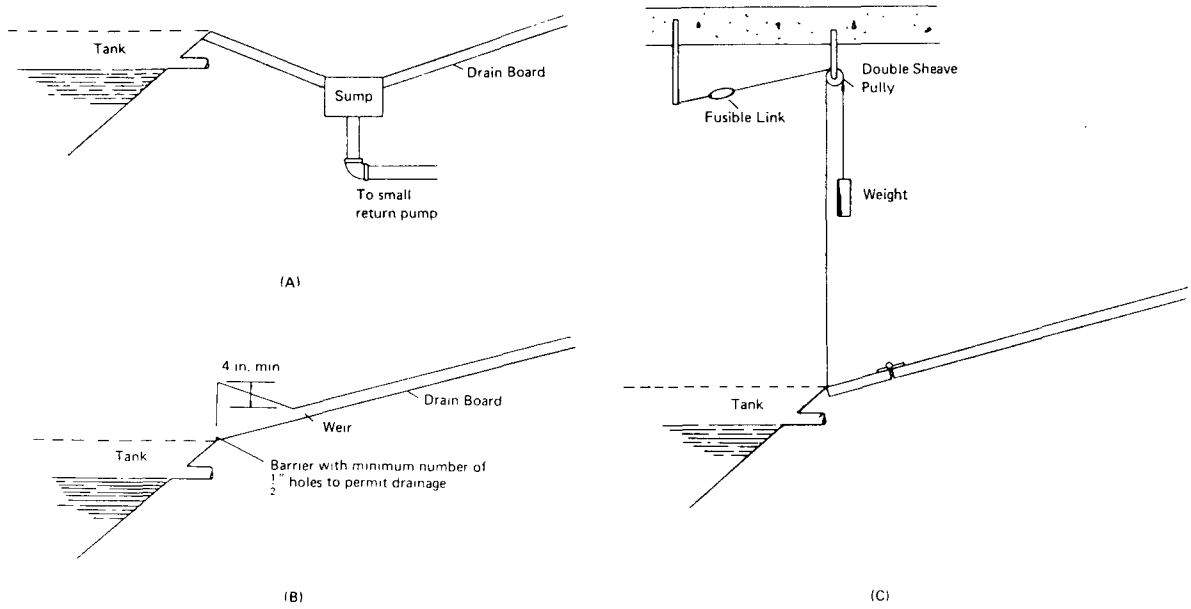
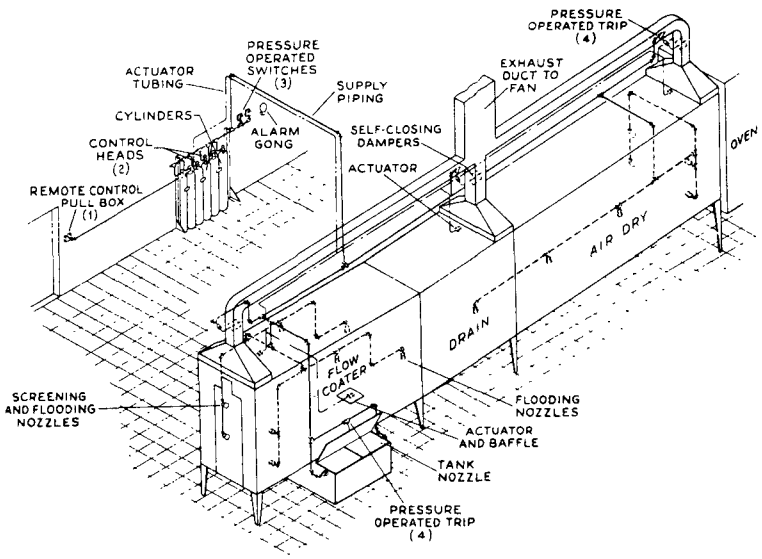


Figure 5 Suggested arrangements to prevent sprinkler discharge onto drain board from entering tank. A and B are most effective for other than paint process tanks. If used for paint process tanks drain holes and piping should be cleaned frequently to prevent clogging. C is effective for paint process tanks.



Notes to Fig. 6

1. Normal manual pull-box control and cable
2. Pneumatic control heads with emergency manual controls
3. Pressure-operated switches to shut down exhaust fan, pumps, conveyor, etc., and sound alarm
4. Pressure-operated trips to release self-closing dampers in exhaust duct and self-closing cover on paint tank

Figure 6 Flow coater protected by a typical carbon dioxide total flooding system which can be either manually or automatically activated.

Appendix D Referenced Publications

D-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

D-1.1 NFPA Publication. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 77-1988, *Recommended Practice on Static Electricity.*

D-1.2 Other Publication.

Industrial Ventilation — A Manual of Recommended Practice, Committee on Industrial Ventilation, P.O. Box 16153, Lansing, MI 48901.

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