NFPA 34
Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids

1995 Edition

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

IMPORTANT NOTICE ABOUT THIS DOCUMENT

NFPA codes, standards, recommended practices, and guides, of which the document contained herein is one, are developed through a consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on fire and other safety issues. While the NFPA administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in its codes and standards.

The NFPA disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this document. The NFPA also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making this document available, the NFPA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the NFPA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

The NFPA has no power, nor does it undertake, to police or enforce compliance with the contents of this document. Nor does the NFPA list, certify, test or inspect products, designs, or installations for compliance with this document. Any certification or other statement of compliance with the requirements of this document shall not be attributable to the NFPA and is solely the responsibility of the certifier or maker of the statement.

NOTICES

All questions or other communications relating to this document and all requests for information on NFPA procedures governing its codes and standards development process, including information on the procedures for requesting Formal Interpretations, for proposing Tentative Interim Amendments, and for proposing revisions to NFPA documents during regular revision cycles, should be sent to NFPA headquarters, addressed to the attention of the Secretary, Standards Council, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

Users of this document should be aware that this document may be amended from time to time through the issuance of Tentative Interim Amendments, and that an official NFPA document at any point in time consists of the current edition of the document together with any Tentative Interim Amendments then in effect. In order to determine whether this document is the current edition and whether it has been amended through the issuance of Tentative Interim Amendments, consult appropriate NFPA publications such as the *National Fire Codes*® Subscription Service, visit the NFPA website at www.nfpa.org, or contact the NFPA at the address listed above.

A statement, written or oral, that is not processed in accordance with Section 5 of the Regulations Governing Committee Projects shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

The NFPA does not take any position with respect to the validity of any patent rights asserted in connection with any items which are mentioned in or are the subject of this document, and the NFPA disclaims liability for the infringement of any patent resulting from the use of or reliance on this document. Users of this document are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Users of this document should consult applicable federal, state, and local laws and regulations. NFPA does not, by the publication of this document, intend to urge action that is not in compliance with applicable laws, and this document may not be construed as doing so.

NFPA 34

Standard for

Dipping and Coating Processes Using Flammable or Combustible Liquids

1995 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 22-25, 1995, in Denver, CO. It was issued by the Standards Council on July 21, 1995, with an effective date of August 11, 1995, and supersedes all previous editions.

This edition of NFPA 34 was approved as an American National Standard on August 11, 1995.

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 and combustible 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, 1989, and 1995.

The following are the major changes adopted in this 1995 edition of NFPA 34:

The text has been rewritten to effect editorial improvement and so that the text is more easily understood.

The text has been rearranged so that its outline parallels that in its companion document, NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*.

Improvements have been made to the technical requirements for electrical area classification (now located in Chapter 4) and for ventilation (now located in Chapter 4).

Guidance has been added for electrical area classification of open process tanks that have peripheral vapor containment.

The requirements for hardening and tempering processes have been deleted, as this subject is now covered by NFPA 86, *Standard for Ovens and Furnaces*.

Technical Committee on Finishing Processes

Edward Watson, *Chair*
Royal Insurance, GA
Rep. American Insurance Services Group, Inc.

W. H. White, *Secretary*
White Consulting Services, OH

Richard A. Bannister, R. S. Finishing Systems, ON
Constance Bayne, Liberty Mutual Insurance Co., NY
Rep. The Alliance of American Insurers
John Bloomgren, Forward Technology Industries, Inc., MN
Paul H. Dobson, Factory Mutual Research Corp., MA
Thomas G. Euson, 3S, Inc., OH
Patrick H. Franzen, Patrick H. Franzen & Assoc., OR
John Gokey, Ansul Fire Protection, WI
Rep. Fire Equipment Mfrs. Assn. Inc.
Steven J. Gunsel, M & M Protection Consultants, OH
Michael Kargl, Underwriters Laboratories Inc., IL
John Katunar, III, Industrial Risk Insurers, OH
Rep. Industrial Risk Insurers
Rick Kimbrough, Kimbrough Fire Extinguisher Co., Inc., TX
Rep. Nat'l Assn. of Fire Equipment Distributors Inc.
Jeffrey J. Kroutil, IRM Insurance, NY
Bruce McIntosh, Graco Inc., MN
Lowell Miles, Miles Fiberglass & Plastics, OR
Rep. Fiberglass Fabrication Assn.
G. Randall Nance, Superior Automatic Fire Equipment, Inc., NC
Terence P. Roche, Binks Mfg. Co., IL
Gerald J. Rosicky, General Motors Corp., MI
Rep. NFPA Industrial Fire Protection Section
Don R. Scarbrough, Nordson Corp., OH
James A. Scharfenberger, ITW Finishing Systems and Products Group, IN
John Schweitzer, SPI Composites Inst., MI
Rep. Society of the Plastics Industry Inc.

Alternates

Christopher A. Eaton, Inland Fisher Guide, LA
(Alt. to G. J. Rosicky)
Erling L. Horn, Binks Mfg. Co., CA
(Alt. to T. P. Roche)
John R. Johnson, Royal Insurance, NC
(Alt. to E. Watson)
Jane I. Lataille, Industrial Risk Insurers, CT
(Alt. to J. Katunar, III)
Donald E. Major, Factory Mutual Research Corp., MA
(Alt. to P. H. Dobson)
Gregory M. Murin, IRM Insurance, NY
(Alt. to J. J. Kroutil)
Kenneth J. Pilat, Liberty Mutual Insurance Co., FL
(Alt. to C. Bayne)
Larry L. Utterback, ITW Finishing Systems & Products Group, IN
Alt. to J. A. Scharfenberger)
Ronald C. Vaickauski, Underwriters Laboratories Inc., IL
(Alt. to M. Kargl)

Nonvoting

Michael B. Moore, U.S. Occupational Safety & Health Admin, DC
(Alt. to T. P. Smith)
Terence P. Smith, U.S. Dept. of Labor, DC

Robert P. Benedetti, NFPA Staff Liason

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in membership may have occurred. A key to classifications is found at the back of this document.

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.

Committee Scope: This Committee shall have primary responsibility for documents on safeguarding against the fire and explosion hazards associated with spray application processes, dipping processes, coating processes, and other similar processes, including glass fiber/resin fabrication processes, except for certain dipping processes that are within the scope of the Committee on Ovens and Furnaces.

Contents

NFPA 34

Standard for

Dipping and Coating Processes Using Flammable or Combustible Liquids

1995 Edition

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

A parenthetical "x," i.e., "(x)," following a defined term or the number or letter designating a paragraph indicates text that has been extracted from another document. The source document is listed in parentheses at the end of the definition or paragraph.

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 or combustible liquids depends upon the characteristics and quantities of materials used, the operations and equipment involved, and the knowledge and understanding of operating personnel. Maintaining good safety, production, and maintenance practices contributes toward minimizing the likelihood of fire or explosion.

This standard presents reasonable requirements for safety in dipping and coating processes. 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 B and Appendix C.

Chapter 1 Scope and Definitions

1-1 Scope.

1-1.1 This standard shall apply to processes in which articles or materials are passed through tanks, vats, containers, or process equipment that contain flammable or combustible liquids. Such processes include, but are not limited to, dipping, roll coating, flow coating, curtain coating, and cleaning.

1-1.2 This standard shall not apply to processes involving noncombustible liquids.

Exception: Where certain waterborne liquids that contain flammable or combustible liquids or that produce combustible residues or deposits are used, the applicable provisions of this standard shall apply.

1-1.3 This standard shall not apply to quench tanks. (*See NFPA 86, Standard for Ovens and Furnaces.*)

1-2* Purpose.

1-2.1 The purpose of this standard shall be to provide requirements for reasonable fire safety for dipping and coating processes that use flammable or combustible liquids. This standard anticipates conditions of average use. Where unusual industrial processes are involved, the authority having jurisdiction shall be permitted to require additional safeguards or modifications to the requirements of this standard, provided equivalent safety is achieved.

1-2.2 The purpose of this standard shall be to address only the fire and explosion hazards of dipping and coating processes and operations. This standard shall not address toxicity and it shall not address industrial health and hygiene. From the standpoint of personnel safety, it must be recognized that the materials used in these processes and operations could be present in concentrations that present a health hazard, even though these concentrations do not present a fire or explosion hazard. The requirements of this standard are intended to minimize the risk of fire and explosion; they are not intended and might not be adequate to protect personnel from the toxic or negative effects from exposure to the materials used.

1-3 Applicability. Chapters 2 through 8 and Chapter 10 shall apply to all dipping and coating processes. Chapter 9 shall apply only to dipping and coating processes that include electrostatic detearing systems.

1-4 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, or safety over those prescribed by this standard, provided that technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency and the system, method, or device is approved for the intended purpose.

1-5 Retroactivity. The provisions of this standard are considered necessary to provide a reasonable level of protection from loss of life and property from fire and explosion. They reflect situations and the state-of-the-art prevalent at the time the standard was issued. Unless otherwise noted, it is not intended that the provisions of this standard be applied to facilities, equipment, structures, or installations that were existing or approved for construction or installation prior to the effective date of this standard, except in those cases where it is determined by the authority having jurisdiction that the existing situation involves a distinct hazard to life or adjacent property.

1-6 Definitions. For the purpose of this standard, the following terms shall be defined as follows.

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, 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 that is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. 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 braod manner, since jurisdictions and approved agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiciton 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, or 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 or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or department official may be the authority having jurisdiction.

Boiling Point. The temperature at which a liquid exerts a vapor pressure that is equal to the surrounding atmospheric pressure. Where an accurate boiling point is unavailable for the material in question, or for mixtures that do not have a constant boiling point, the 10 percent point of a distillation performed in accordance with ASTM D 86-82, *Standard Method of Test for Distillation of Petroleum Products*, may be used as the boiling point of the liquid.

Closed Container. A container that is sealed by means of a lid or other device so that neither liquid nor vapor can escape from it at ordinary temperatures.

Curtain Coating. A coating process by which an object or material is coated by passing it through a vertically flowing film of liquid.

Detearing. A process for rapidly removing excess wet coating material from a dipped or coated object or material by passing it through an electrostatic field.

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

(Electrical) Utilization Equipment (x). Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes. (*See NFPA 70, National Electrical Code®, Article 100.*)

Flow Coating. A coating process by which the coating liquid is discharged in an unatomized state from nozzles, slots, or other similar openings onto the object or material to be coated.

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

Liquid. (x) Any material that has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D 5, *Standard Method of Test for Penetration for Bituminous Materials.* When not otherwise identified, the term "liquid" shall mean both flammable and combustible liquids. (*See NFPA 30, Flammable and Combustible Liquids Code, Chapter 1.*)

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

Combustible liquids shall be subdivided as follows:

Class II liquid: Any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C).

Class IIIA liquid: Any liquid that has a flash point at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB liquid: Any liquid that has a flash point at or above 200°F (93°C).

(*See NFPA 30, Flammable and Combustible Liquids Code, Chapter 1.*)

Flammable Liquid. (x) A liquid having a flash point below 100°F (37.8°C) and having a vapor pressure that does not exceed 40 psia (2068 mm Hg) at 100°F (37.8°C).

Flammable liquids shall be known collectively as Class I liquids and shall be subdivided as follows:

Class IA liquid: Any liquid that has a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C).

Class IB liquid: Any liquid that has a flash point below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C).

Class IC liquid: Any liquid that has a flash point at or above 73°F (22.8°C) and below 100°F (37.8°C).

(*See NFPA 30, Flammable and Combustible Liquids Code, Chapter 1.*)

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 designated standards or has been tested and found suitable for use in a specified manner.

NOTE: 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.

Noncombustible Material (x). As applied to a material of construction, any material which, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat. Materials reported as noncombustible when tested in accordance with ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750° C*, shall be considered noncombustible by this definition. (*See NFPA 220, Standard on Types of Building Construction, Chapter 2.*)

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

Vapor Area.* Any area in the vicinity of:

(a) A dipping or coating process and its drain boards, or

(b) Associated drying or conveying equipment, or

(c) Other associated equipment that might contain a flammable vapor concentration exceeding 25 percent of the lower flammable limit (LFL) during operation or shut-down periods. (*See Chapter 5.*)

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 lower flammable limit at a distance of 1 ft (305 m) in any direction from the object.

Chapter 2 Location of Dipping and Coating Processes

2-1* Separation. Dipping and coating 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* Locations Below Grade. Dipping and coating processes shall not be located below surrounding grade level in cases where flammable vapors that are heavier (denser) than air cannot be captured and directed to the outside of the building.

2-3 Access to Means of Egress. Dipping and coating processes shall be located so that, in the event of a fire originating at the process equipment, access to means of egress will not be impaired.

2-4* Locations in Other Occupancies. Dipping and coating processes shall not be located in any building that is classified as an assembly, educational, institutional, or residential occupancy, unless they are located in a room that is separated both vertically and horizontally from all surrounding areas by construction having a fire resistance rating of not less than 2 hours and is protected by an approved automatic sprinkler system that is designed and installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

Chapter 3 Construction and Design of Dipping and Coating Equipment and Systems

3-1 General.

3-1.1 Dipping and coating equipment shall be constructed of steel, reinforced concrete, masonry, or other noncombustible material and shall be securely and rigidly supported. Supports for tanks that exceed 500 gal (1893 L) capacity or 10 ft^2 (1 m^2) of liquid surface shall have a minimum fire resistance rating of 1 hour.

3-1.2 If the dipping or coating equipment is enclosed, any panels for light fixtures or for observation shall be of heat-treated glass, wired glass, or hammered-wired glass. The panels shall be sealed to confine vapors or mists to the enclosure. Panels for light fixtures shall be separated from the fixture to prevent the surface temperature of the panel from exceeding 200°F (93°C).

3-2* Height Above Floor. The top of the dipping or coating tank shall be not less than 6 in. (152 mm) above the floor.

3-3 Overflow Prevention. To prevent the overflow of burning liquid from the dipping or coating tank should a fire in the tank actuate automatic sprinklers, one or more of the following shall be done:

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

(b) Tanks shall be equipped with automatically closing covers.

(c) Tanks shall be equipped with overflow pipes. (*See Section 3-5.*)

3-4 Liquid Level. The level of liquid in the dipping or coating tank shall be maintained not less than 6 in. (152 mm) below the top of the tank to allow effective application of extinguishing agents in the event of fire.

3-5 Overflow Pipes.

3-5.1 Dipping or coating tanks that exceed 150 gal (570 L) capacity or 10 ft^2 (1 m^2) of liquid surface shall be equipped with a properly trapped overflow pipe leading to a safe location.

3-5.2 Depending upon the area of the liquid surface and the length and pitch of pipe, overflow pipes for dipping or coating tanks that exceed 150 gal (570 L) capacity or 10 ft^2 (1 m^2) of liquid surface shall be capable of handling either the maximum rate of delivery of process liquid or the maximum rate of automatic sprinkler discharge, whichever is greater, but shall be not less than 3 in. (76 mm) in diameter.

3-5.3 Piping connections to drains and in overflow lines shall be designed to permit access for inspection and cleaning of the interior.

3-5.4 The connection of the overflow pipe to the tank shall be made not less than 6 in. (152 mm) below the top of the tank.

3-6 Bottom Drains.

3-6.1 Dipping or coating tanks that exceed 500 gal (1893 L) capacity shall be equipped with bottom drains arranged to drain the tank in the event of fire. The drains shall be both manually and automatically operable. Manual operation shall be from a safe and accessible location. Where gravity flow is impractical, automatic pumps shall be provided.

Exception No. 1: Bottom drains shall not be required for tanks that are equipped with automatic closing covers meeting the requirements of Section 7-5.

Exception No. 2: Bottom drains shall not be required if the viscosity of the liquid at normal atmospheric temperatures makes this impractical.

3-6.2* Drains shall be trapped and shall discharge to a closed, vented salvage tank or to a safe location.

3-6.3 The diameter of the bottom drain pipe or pipes shall be sized to empty the dipping or coating tank within 5 minutes, but in no case shall it be less than that 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)

3-7 Salvage Tanks.

3-7.1 Where a salvage tank is employed, a pumping arrangement shall be provided for the retrieval of the contents. The salvage tank shall be emptied before the dipping or coating tank is refilled. The salvage tank shall meet all applicable requirements of NFPA 30, *Flammable and Combustible Liquids Code*.

3-7.2 The capacity of the salvage tank or tanks shall be greater than the capacity of the dipping or coating tank or tanks to which they are connected.

3-8 Conveyor Systems.

3-8.1 Conveyor systems shall be arranged to stop automatically in the event of a fire.

3-8.2 Conveyor systems shall be arranged to stop automatically if the required rate of ventilation is not maintained. (*See also Section 5-2.*)

3-9 Control of Liquid Temperature.

3-9.1 Where dipping or coating liquids are heated, either directly or by the workpieces being processed, the controls described in 3-9.2 through 3-9.2.3 shall be provided to prevent excess temperature, vapor accumulation, and possible autoignition.

3-9.2 For the purpose of this subsection, excess temperature shall mean any temperature above which the ventilation required by Section 5-2 cannot safely confine the vapors generated. In no case shall this temperature exceed the boiling point of the liquid or a temperature that is 100°F (55°C) less than the autoignition temperature of the liquid.

3-9.2.1 The dipping or coating tank shall be equipped with a listed, manual reset, high temperature limit control designed to shut down the conveyor system, if any, and the heating system, if excess temperatures are reached.

3-9.2.2 Heating and cooling units for liquids shall be of an approved type and shall be properly controlled, serviced, and maintained.

3-9.2.3 Workpieces shall not be dipped or coated if their surface temperature exceeds a temperature that is 100°F (55°C) less than the autoignition temperature of the liquid.

3-9.3 Heating systems shall be automatically shut down if the level of liquid in the dipping or coating tank exceeds or falls below a safe level.

Chapter 4 Electrical and Other Sources of Ignition

4-1 General.

4-1.1 Dipping and coating process areas where Class I liquids are used or where Class II or Class III liquids are used at temperatures at or above their flash points shall meet the requirements of 4-1.1.1 and 4-1.1.2.

4-1.1.1 The extent of hazardous (classified) locations shall be determined in accordance with Sections 4-2, 4-3, and 4-4 of this standard and with Article 500 of NFPA 70, *National Electrical Code*.

4-1.1.2 Electrical wiring and utilization equipment shall be suitable for the location in which they are installed and shall be installed in accordance with the applicable requirements of this chapter and with the applicable requirements of Articles 500, 501, 502, and 516 of NFPA 70, *National Electrical Code*.

4-1.2* Open flames, spark-producing equipment or processes, and equipment whose exposed surfaces exceed the autoignition temperature of the dipping or coating liquid shall not be located in the dipping or coating process area or in surrounding areas classified as Division 2.

4-1.3* Any utilization equipment or apparatus that is capable of producing sparks or particles of hot metal and is located above or adjacent to either the dipping or coating process area or the surrounding Division 2 areas shall be of the totally enclosed type or shall be constructed to prevent the escape of sparks or particles of hot metal.

4-1.4 Electrical wiring and utilization equipment that is located in the process area and is not subject to deposits of combustible residues shall be suitable for Class I, Division 1 or Class II, Division 1 locations, whichever is applicable. (*See NFPA 70, National Electrical Code.*)

4-1.5 Electrical wiring and utilization equipment that is located in the process area and is subject to deposits of combustible residues shall be listed for such exposure and shall be suitable for Class I, Division 1 or Class II, Division 1 locations, whichever is applicable. (*See NFPA 70, National Electrical Code.*)

Exception: Electrostatic detearing apparatus shall meet the requirements of Chapter 9.

4-2 Areas Adjacent to Open Processes. Electrical wiring and utilization equipment located adjacent to open processes shall meet the requirements of 4-2.1 through 4-2.4 and Figures 4-2(a) and 4-2(b), whichever is applicable.

4-2.1 Electrical wiring and utilization equipment located in any sump, pit, or below-grade channel that is within 25 ft (7625 mm) horizontally of a vapor source shall be suitable for Class I, Division 1 locations. If the sump, pit, or channel extends beyond 25 ft (7625 mm) of the vapor source, it shall be provided with a vapor stop or it shall be classified as Class I, Division 1 for its entire length.

4-2.2 Electrical wiring and utilization equipment located within 5 ft (1525 mm) of a vapor source shall be suitable for Class I, Division 1 locations.

4-2.3 Electrical wiring and utilization equipment located within 3 ft (915 mm) of the Class I, Division 1 location described in 4-2.2 shall be suitable for Class I, Division 2 locations.

4-2.4 The space 3 ft (915 mm) above the floor and extending 20 ft (6100 mm) horizontally in all directions from the Class I, Division 2 location described in 4-2.3 shall be classified as Class I, Division 2, and electrical wiring and utilization equipment located within this space shall be suitable for Class I, Division 2 locations.

Exception: This space shall be permitted to be nonclassified for purposes of electrical installations if the surface area of the vapor source does not exceed 5 ft^2 (0.46 m^2), the contents of the tank do not exceed 5 gal (19 L), and the vapor concentration during operating and shutdown periods does not exceed 25 percent of the lower flammable limit.

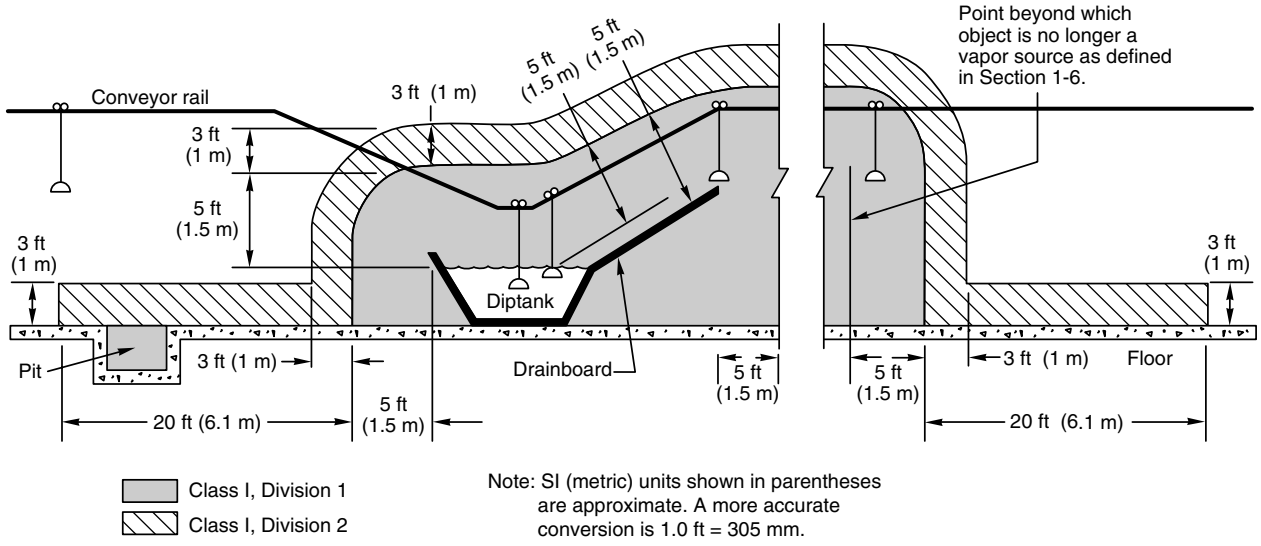

Figure 4-2(a) Electrical area classification for open processes without vapor containment or ventilation.

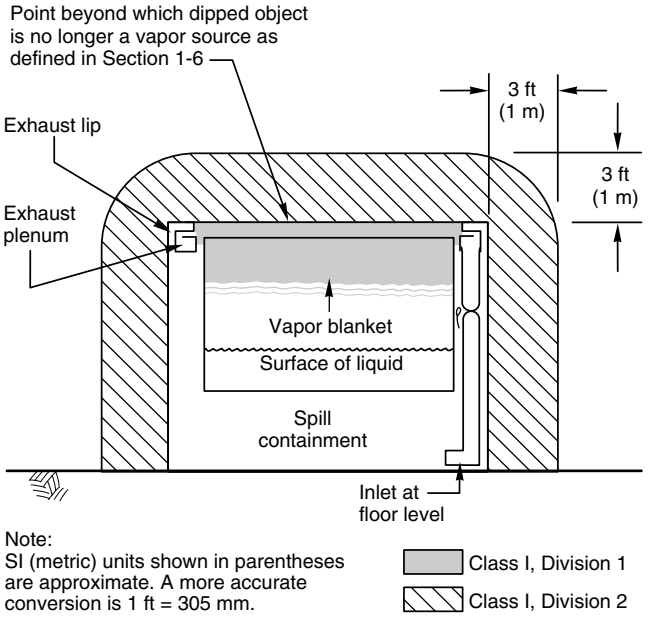

Figure 4-2(b) Electrical area classification for open processes with peripheral vapor containment and ventilation.

4-3 Areas Adjacent to Enclosed Processes. Areas adjacent to enclosed processes shall be classified in accordance with 4-3.1, 4-3.2, and Figure 4-3.

4-3.1 The interior of any enclosed dipping or coating process or apparatus shall be a Class I, Division 1 location, and electrical wiring and utilization equipment located within this space shall be suitable for Class I, Division 1 locations.

4-3.2 The space adjacent to an enclosed dipping or coating process or apparatus shall be considered to be nonclassified for purposes of electrical installation.

Exception: The space within 3 ft (915 mm) in all directions from any opening in the enclosure and extending to the floor or grade level shall be classified as Class I, Division 2, and electrical wiring and utilization equipment located within this space shall be suitable for Class I, Division 2 locations.

4-4 Equipment and Containers in Adequately Ventilated Areas. Where dipping or coating equipment and supply containers are located in an adequately ventilated area that is adjacent to the process area, but outside of a storage room or mixing room, the area within 3 ft (915 mm) in all directions from any open container or equipment and extending to the floor or grade level shall be classified as Class I, Division 1. The area extending 2 ft (610 mm) beyond the Division 1 location shall be classified as Class I, Division 2. In addition, the area within 10 ft (3050 mm) horizontally of the perimeter of such open container or equipment, up to a height of 18 in. (458 mm) above the floor or grade level, shall be classified as Class I, Division 2. Electrical wiring and utilization equipment installed in these areas shall be suitable for the location. (*See Figure 4-4 for an example.*)

4-5 Light Fixtures.

4-5.1 Light fixtures that are attached to the walls or ceilings of a process enclosure, but are outside of any classified area and are separated from the process area by glass panels that meet the requirements of 3-1.2 shall be suitable for use in ordinary hazard (general purpose) locations. Such fixtures shall be serviced from outside the enclosure.

4-5.2 Light fixtures that are attached to the walls or ceilings of a process enclosure, are located within the Class I, Division 2 location, and are separated from the process area by glass panels that meet the requirements of 3-1.2 shall be suitable for use in that location. Such fixtures shall be serviced from outside the enclosure.

4-6 Static Electric Sparks. In order to prevent sparks from the accumulation of static electricity, all persons and all electrically-conductive objects, including any metal parts of the process equipment or apparatus, containers of material, exhaust ducts, and piping systems that convey flammable or combustible liquids, shall be electrically grounded. (NFPA 77,

Recommended Practice on Static Electricity, contains information about grounding for static electric charge.)

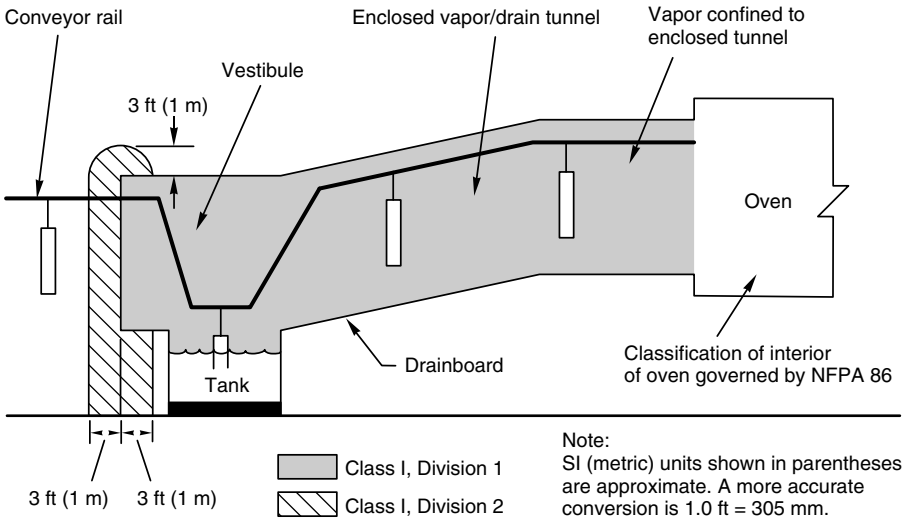

Figure 4-3 Electrical area classification around enclosed processes.

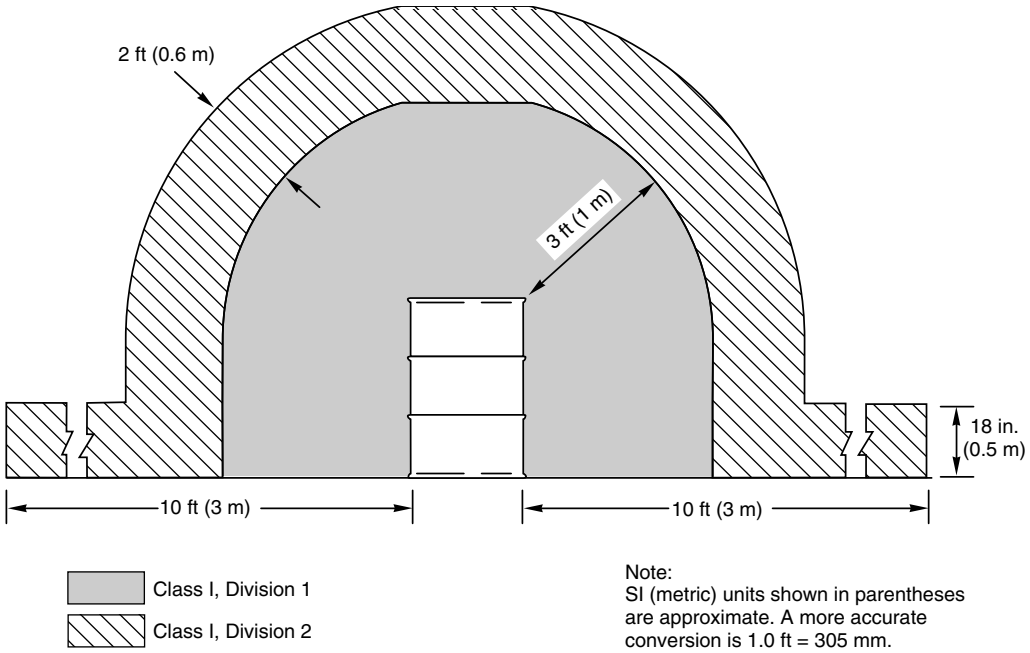

Figure 4-4 Electrical area classification around an open container.

Chapter 5 Ventilation

5-1 General. Ventilating and exhaust systems shall be installed in accordance with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Materials*, where applicable, and also shall meet the requirements of this chapter.

5-2* Performance Requirements. Dipping and coating process areas shall be provided with mechanical ventilation that is capable of confining the vapor area to not more than 5 ft (1525 mm) from the vapor source and removing the vapors to a safe location. The concentration of the vapors in the exhaust stream of the ventilation system shall not exceed 25 percent of the lower flammable limit.

5-2.1 Where the physical size of a process does not allow adequate removal of vapors by mechanical ventilation alone, a properly designed enclosure shall be provided and the ventilation shall be capable of confining all vapors to the enclosure.

5-2.2 Controls shall be provided to automatically shut down the dipping or coating process and sound an alarm if the ventilating system fails.

5-2.3 Mechanical ventilation shall be kept in operation at all times while dipping or coating processes are being conducted and for a sufficient time thereafter to allow vapors to be exhausted until the vapor area no longer constitutes a vapor source. Where dipping or coating processes are conducted automatically without an attendant constantly on duty, the operating controls of the apparatus shall be arranged so that the apparatus cannot function unless the exhaust fans are operating.

5-3* Make-up Air. An adequate supply of clean make-up air shall be provided to compensate for the air exhausted from dipping or coating processes. The intake for this make-up air shall be located so that the air exhausted from dipping or coating processes is not recirculated.

5-4* Routing of Exhaust Ducts. Exhaust ducts shall follow the most direct route to the point of discharge, but shall not penetrate a fire wall. The exhaust discharge shall be directed away from any fresh air intakes and the discharge point shall be at least 6 ft (1830 mm) from any exterior wall or roof. Exhaust ducts shall not discharge in the direction of any combustible construction that is within 25 ft (7625 mm) of the discharge point. Exhaust ducts shall not discharge in the direction of any unprotected opening in any noncombustible or limited-combustible construction that is within 25 ft (7625 mm) of the discharge point.

5-5 Recirculation of Exhaust.

5-5.1 Air exhausted from dipping or coating processes shall not be recirculated.

Exception: Air exhausted from a dipping or coating process shall be permitted to be recirculated as make-up air for an unmanned dipping or coating process or cascaded to subsequent unmanned dipping or coating processes, provided all of the following conditions have been met:

(a) Solid particulates shall have been removed from the recirculated air.

(b) The concentration of vapors in the exhaust airstream shall not exceed 25 percent of the lower flammable limit.

(c) Listed equipment shall be used to monitor the concentration of vapors in all exhaust airstreams.

(d) An alarm shall be sounded and the dipping or coating process shall be automatically shut down, if the concentration of any vapor in the exhaust airstream exceeds 25 percent of the lower flammable limit.

(e) Equipment installed to process and remove contaminants from the air exhausted from dipping or coating processes shall be approved by the authority having jurisdiction.

5-5.2* These provisions shall not disallow the use of recirculated air to occupied spaces. However, other requirements addressing the toxicity and the permissible exposure limits shall also apply.

5-6 Materials of Construction. Exhaust ducts and fasteners shall be constructed of steel.

Exception: Other materials of construction shall be permitted to be used in cases where the conveyed materials are not compatible with steel.

5-7 Support of Exhaust Ducts. Exhaust ducts shall be supported to prevent collapse under fire conditions.

5-7.1 Duct supports shall be designed to carry the weight of the duct system itself, plus the anticipated weight of any residues. If sprinkler protection is provided inside the duct system, then the duct supports also shall be designed to carry the anticipated weight of any accumulation of sprinkler discharge. Loads shall not be placed on or transmitted to equipment connected to the duct system.

5-7.2 Hangers and supports shall be securely fastened to the building or to the structure to avoid vibration and stress on the duct system.

5-7.3 Hangers and supports shall be designed to allow for expansion and contraction.

5-7.4 Exhaust ducts shall not use building walls, floors, ceilings, or roofs as component parts.

5-8 Exhaust Duct Cross-Section. Exhaust ducts shall be permitted to be round, rectangular, or any other suitable shape. They shall be provided with doors, panels, or other means to facilitate inspection, maintenance, cleaning, and access to fire protection devices.

5-9 Exhaust Fans and Drives.

5-9.1 The rotating element of the exhaust fan shall be nonferrous or the fan shall be constructed so that a shift of the impeller or shaft will not permit two ferrous parts of the fan to rub or strike. There shall be ample clearance between the rotating element and fan casing to avoid a fire by friction, necessary allowances being made for ordinary expansion and loading, and to prevent contact between moving parts and the duct or fan housing. Fan blades shall be mounted on a shaft that is sufficiently heavy to maintain proper alignment even when the blades of the fan are heavily loaded. All bearings shall be of the self-lubricating type or shall be lubricated from a point outside the duct and preferably shall be located outside the duct or fan housing.

5-9.2 Electric motors that drive exhaust fans shall not be placed inside any duct or fan housing unless they meet the provisions of 4-1.4 and 4-1.5.

5-9.3 Belts shall not enter any duct or fan housing unless the belt and pulley are completely enclosed.

5-10 Drying Areas.

5-10.1 Freshly dipped or coated objects or materials shall be dried only in spaces that are ventilated to prevent the concentration of vapors from exceeding 25 percent of the lower flammable limit.

5-10.2* If removed from the dipping or coating process area, objects or material shall be dried only in areas that are ventilated to prevent the concentration of vapors from exceeding 25 percent of the lower flammable limit.

Chapter 6 Storage, Handling, and Distribution of Flammable and Combustible Liquids

6-1* General. Storage, handling, and mixing of flammable and combustible liquids shall meet all applicable requirements of NFPA 30, *Flammable and Combustible Liquids Code*. Storage, handling, and mixing of flammable and combustible liquids at process areas also shall meet the requirements of this chapter.

6-2 Storage Cabinets. There shall be not more than three approved flammable liquid storage cabinets in any single process area without the approval of the authority having jurisdiction. Storage cabinets shall be listed or shall be designed and constructed to meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*. Any single cabinet shall contain not more than 120 gal (454 L) of Class I, Class II, or Class IIIA liquids, of which not more than 60 gal (227 L) shall be Class I and Class II liquids.

6-3 Storage in Vicinity of Process Areas. The quantity of liquid located in the vicinity of the dipping or coating process area but outside of a storage cabinet, an inside storage room, a cut-off room or attached building, or other specific process area that is cut off by at least a 2-hour fire-rated separation from the dipping or coating process area shall not exceed the quantity given in either (a) or (b), whichever is greater:

(a) A supply for one day, or

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

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

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

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

6-4 Transporting Liquids. Closed containers, approved portable tanks, approved safety cans, or a properly arranged piping system shall be used for transporting flammable or combustible liquids from the storage area to the process area. Open or glass containers shall not be used for transportation or storage.

6-5 Handling Liquids at Point of Final Use.

6-5.1 Class I and Class II liquids shall be kept in closed containers or portable tanks when not actually in use.

6-5.2 Where liquids are used or handled, except in closed containers, means shall be provided to clean and dispose of leaks or spills in a prompt and safe manner.

6-5.3 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.

6-5.4 Class I and Class II liquids shall only be transferred between their original shipping containers and process tanks, containers, or portable tanks within a building by means of containers with a capacity of 5 gal (19 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.

6-5.5 Transferring liquids by means of pressurizing the container with air shall be prohibited. Transferring liquids by pressure of inert gas shall be permitted only if controls, including pressure relief devices, are provided to limit the pressure so that it cannot exceed the design pressure of the vessel, tank, or container.

6-5.6* 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 shall be accomplished by maintaining metallic contact during filling, by a bond wire, or by any other conductive path having an electrical resistance not greater than 10^6 ohms (1 megohm).

6-6 Liquid Piping Systems.

6-6.1 Equipment used for transferring liquids, such as piping, pumps, and meters, shall be approved for the process liquids used.

6-6.2* Where a tank is filled from the top, the free end of the fill pipe shall be within 6 in. (152 mm) of the bottom of the tank. Anti-siphoning protection shall be provided for fill lines having connections below liquid-level, 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 connected to the fill pipe. In addition, for Class I liquids, the tank, piping system, and storage tank shall be bonded and grounded.

6-6.3 Where 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.

6-6.4 Process tanks shall be provided with a limit device to prevent overfilling tanks.

6-6.5 Process pumps shall be interlocked with fire detection or automatic fire extinguishing systems to shut down the pump in case of fire.

Chapter 7 Protection

7-1* General. Where required by the authority having jurisdiction, areas in which dipping or coating operations are conducted shall be protected with an approved automatic sprinkler system. The system shall be designed and installed in accordance with the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*.

7-2 Overflow Prevention. In the event of a fire in a process tank and to prevent the overflow of flaming liquid out of the tank because of sprinkler discharge, one or more of the following shall be done:

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

(b) Tanks shall be equipped with automatically closing covers. (*See Section 7-5.*)

(c) Tanks shall be equipped with overflow pipes. (*See Section 3-5.*)

7-3 Portable Extinguishers. Areas in the vicinity of dipping and coating processes shall be provided with portable fire extinguishers that are suitable for flammable and combustible liquid fires and that meet the requirements of NFPA 10, *Standard for Portable Fire Extinguishers.*

7-4 Automatic Protection Systems. Dipping and coating processes shall be protected with an approved automatic fire extinguishing system and shall be permitted to be any of the following:

(a)*A water spray extinguishing system that meets the requirements of NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection.*

(b) A foam extinguishing system that meets the requirements of NFPA 11, *Standard for Low-Expansion Foam.* In selecting the specific foam agent to be used, the following shall be considered:

1. The characteristics of the process, for example the freeboard in the process tank.

2. The coating material and its effect on foam formation and the possibility of producing frothing.

3. The use of wetting agents in the coating that might prevent foam formation.

4. The effect of other extinguishing agents on the foam blanket.

Exception: Water spray shall be permitted to be used to protect hoods and ducts.

(c) A carbon dioxide system that meets the requirements of NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems.*

(d) A dry chemical extinguishing system that meets the requirements of NFPA 17, *Standard for Dry Chemical Extinguishing Systems.*

(e) A gaseous agent extinguishing system that meets the requirements of NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems.*

(f) A sprinkler system that meets the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, for tanks containing liquids having flash points above 200°F (93°C) and for associated process hazards.

(g) A sprinkler system that meets the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, for tanks equipped with a tank cover arranged to close automatically in the event of fire.

7-5* Protection for Small Processes. Automatic closing process tank covers or special extinguishing systems shall be provided for open tanks under 150 gal (570 L) capacity or 10 ft^2 (1 m^2) in liquid surface area.

7-5.1 Automatic closing process tank covers shall be actuated by approved automatic devices and also shall be arranged for manual operation.

7-5.2 Covers shall be substantially constructed of noncombustible materials and shall overlap the sides of the tank by at least 1 in. (25 mm) and have a recess or flange that extends downward around the tank when it is closed.

7-5.3 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.

7-5.4 Covers shall be kept closed when the process is not in operation.

7-5.5 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.

7-6* Protection for Large Processes. Protection systems shall be provided for process tanks over 150 gal (570 L) capacity or over 10 ft^2 (1 m^2) in liquid surface area. The systems shall be designed to protect the following areas:

(a) For dip tanks, the system shall protect the tank, its drain board, freshly coated objects or material, and any 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 shut off automatically in the event of fire.

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

7-6.1* The extinguishing system shall be designed to simultaneously discharge into the entire protected area, as described in 7-6(a) through (c).

Chapter 8* Operations and Maintenance

8-1* General. Areas in the vicinity of dipping and coating operations, especially drain boards and drip pans, shall be cleaned on a regular basis to minimize the accumulation of combustible residues and unnecessary combustible materials. Combustible coverings (thin paper, plastic, etc.) and strippable coatings shall be permitted to 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.

8-2* Waste Containers. Approved waste containers shall be provided for rags or waste impregnated with flammable or combustible material, and all such rags or waste shall be deposited therein immediately after use. The contents of waste cans shall be properly disposed of at least once daily or at the end of each shift.

8-3* Periodic Inspection and Testing. Periodic inspections or tests shall be made of all process tanks including covers, overflow pipe inlets, outlets and discharges, bottom drains, pumps and valves, electrical wiring and utilization equipment, grounding and bonding connections, ventilation systems, and all extinguishing equipment. Any defects found shall be

promptly corrected. Inspections shall be conducted at least monthly.

8-4 Cleaning Operations. Cleaning operations shall be conducted with ventilating equipment in operation.

8-4.1 Solvents used for cleaning of dipping and coating equipment shall have flash points above 100°F (37.8°C) or not less than that of dipping or coating materials normally used in the process.

8-5 Smoking. "NO SMOKING" signs shall be conspicuously posted in the vicinity of dipping and coating processes.

8-6 Hot Work. Where 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 9 Electrostatic Detearing Apparatus

9-1 Scope. This chapter shall apply to any dipping or coating process that incorporates electrostatic detearing systems to remove excess coating material.

9-2 General. Electrostatic detearing equipment shall meet the requirements of Chapters 1 through 8, except as hereinafter modified, and shall also meet the requirements of this chapter.

9-2.1 Electrostatic apparatus and devices used in connection with paint detearing operations shall be listed or approved.

9-3 Requirements for Electrical System and Components.

9-3.1 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 meet the requirements of Chapter 4.

9-3.2 Electrodes shall be of substantial construction, rigidly supported in permanent locations, and effectively insulated from ground. Insulators shall be nonporous.

9-3.3 High voltage leads to electrodes shall be effectively and permanently supported on suitable insulators and shall be effectively guarded against accidental contact or grounding.

9-3.4 A safe distance of at least twice the sparking distance shall be maintained between the object or material being deteared and the electrodes or conductors. A suitable sign indicating this safe distance shall be conspicuously posted near the assembly.

9-4* Support of Workpieces. Objects or material being deteared shall be supported on conveyors or hangers. The conveyor shall be arranged to ensure that the objects or material being deteared are electrically connected to ground with a resistance not exceeding 10^6 ohms (1 megohm) and that the distance required by 9-3.4 is maintained between the object or material and the electrodes at all times. Objects or material being deteared shall be supported to prevent swinging or movement that would reduce the distance to less than that required.

9-5 Manual Operations. Electrostatic detearing shall not be used where the objects or material being deteared are manipulated by hand.

9-6 Electrical Safety Requirements. Electrostatic apparatus shall be equipped with automatic means that will rapidly de-energize the high voltage elements and signal the operator under any of the following conditions:

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

(b) Stopping of the conveyor carrying the objects or material through the high voltage field.

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

(d) Reduction of clearances below that specified in 9-3.4.

(e) De-energizing of the primary side of the power supply.

9-7 Personnel Safety. Safeguards such as adequate booths, fencing, railings, or other means shall be placed about the equipment or incorporated therein so that they, either by their location or character or both, ensure that a safe isolation of the process is maintained from plant storage or personnel.

9-8* Grounding Requirements. All electrically conductive objects in the process area, except those objects required by the process to be at high voltage, shall be electrically connected to ground with a resistance of not more than 10^6 ohms (1 megohm). This requirement shall apply to paint containers, wash cans, guards, and any other electrically conductive objects or devices in the area. This requirement also shall apply to any personnel that might be in the process area. The equipment shall carry a prominent, permanently installed warning regarding the necessity for this grounding feature.

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

9-10 Insulators. All insulators shall be kept clean and dry.

9-11 Drip Plates and Screens. Drip plates and screens subject to deposits of coating material shall be removable and shall be taken to a safe place for cleaning.

Chapter 10* Training

10-1 General. All personnel involved in dipping or coating 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.

10-1.1 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 might be required.

10-1.2* 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.

10-1.3 All personnel shall be instructed in the proper use, maintenance, and storage of all emergency, safety, or personalprotective equipment that they might be required to use in their normal work performance.

10-1.4 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, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10, *Standard for Portable Fire Extinguishers*, 1994 edition.

NFPA 11, *Standard for Low-Expansion Foam*, 1994 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 1993 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1994 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 1990 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 1994 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 1993 edition.

NFPA 70, *National Electrical Code*, 1996 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 1995 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Materials*, 1995 edition.

NFPA 220, *Standard on Types of Building Construction*, 1995 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 1994 edition.

Appendix A Explanatory Material

Appendix A is not a part of the requirements of this NFPA document but is included for informational purposes only. This appendix contains explanatory material, numbered to correspond with the applicable text paragraphs.

A-1-2 The risk to life and property from fire or explosion as a result of dipping or 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 might seriously damage building structural members. Enclosed processes, if not properly ventilated, present an explosion hazard that can 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:

(a) a protection system designed specifically for the process, i.e., a dry chemical system, an automatic closing cover, etc.; and

(b) 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 might be required. Protection should be chosen based on the design of the process and properties of the coating used.

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

Spread of fire 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 the size of the process.

A-1-6 Vapor Area. 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) might 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.

When unenclosed dipping operations involve highly volatile liquids or large exposed surfaces, either in an open tank or on dipped materials, the vapor area might extend to all portions of the room where the process is located. When, however, operations are provided with adequate continuous ventilation, the vapor area might extend only a limited distance. (*See Chapter 5.*)

The information in Chapter 5 and Appendix D of NFPA 86, *Standard for Ovens and Furnaces*, can 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.

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. An approved combustible gas indicator should be used to establish the extent of a vapor area. In many cases a further reduction in vapor concentration is needed to prevent a toxic effect on personnel.

In any given situation, the authority having jurisdiction can 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.

A-2-1 The location of dipping and coating processes depends upon such considerations as: the quantities of flammable and combustible liquids used, the process arrangement, the personnel exposure, the construction of the building, and the surrounding exposures.

In facilities conducting extensive dipping and coating operations, it is desirable that the process be confined by one of the following methods (in order of 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; or

(d) Isolation by safe distance.

The adaptation of assembly lines or conveyor systems to dipping and coating processes can present some additional problems of fire hazard segregation. If conveyor systems extend to or from a detached building, a sprinklered, noncombustible, connecting passageway is advisable. If conveyor systems go through floors, the floor openings should be surrounded by deep draft curtains on the ceiling beneath and should 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 or limited-combustible tunnels extending on each side of the fire wall and the tunnels have been protected by specially designed automatic spray or sprinkler systems.

In sprinklered buildings, rooms of extensive area having process operations should be provided with noncombustible or limited-combustible 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 the curtains and tend to confine the discharge of water to the immediate area of the fire.

A-2-2 Dipping and coating operations involving flammable or combustible liquids should not be located in any basement area for the following reasons:

(a) The lack of egress.

(b) The lack of fire department access.

(c) The possibility for extensive structural damage should an explosion occur because of accumulations of vapors.

A-2-4 Processes should be separated from areas of public assembly, and from 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 might require protection beyond the indicated 2-hour fire resistance rating. Where the exposure hazard is considered to be severe, some occupancies might require a wall with a fire resistance rating of at least 4 hours and 3-hour rated automatic closing fire doors.

A-3-2 The purpose of this requirement is to prevent any water that might be on the floor from flowing into the tank and to prevent overflow of the tank contents during fire-fighting operations.

A-3-6.2 Salvage tank capacity should be at least 125 percent of the volume of the process tank. Inlet piping should terminate at the bottom of the salvage tank to prevent refloating low specific gravity flammable or combustible liquids. Tank vents should be installed to relieve filling pressures.

A-4-1.2 There should be no open flames, hot surfaces, or spark-producing equipment in any dipping or coating process area. Open flames, hot surfaces, or spark-producing equipment should not be located where they can be exposed to deposits of combustible residues. Some residues can ignite at low temperatures, such as those produced by steam pipes, light fixtures, power tools, etc.

A-4-1.3 Equipment known to produce flames, sparks, or particles of hot metal, including light fixtures, that is located adjacent to areas that are safe under normal operating conditions but which might become dangerous due to accident or careless operation, should not be installed in those areas unless the equipment is totally enclosed or separated from the area by partitions to prevent sparks or particles of hot metal from entering that area.

A-5-2 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 lower flammable limit and the Threshold Limit Value must be considered when the process is a manually operated system. When the process is an automatic (conveyorized) system, the lower flammable limit will generally govern ventilation rates.

Determination of Lower Flammable Limit. Many paints, varnishes, lacquers, and other coating materials contain volatile flammable solvents. In addition, such solvents are often added as "thinners." When exposed to the atmosphere, these solvents give off vapors that mix with the surrounding air and, if the concentration reaches as much as approximately 1 percent solvent in air, these vapors can be ignited and an explosion can 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, can result in mists capable of propagating a flame similar to combustible solids in dust explosions.

Theoretical considerations can assist in hazard evaluation in some instances. For example, 1 gal (3.8 L) of the average solvent will occupy approximately 23 ft^3 (0.65 m^3) when evaporated into vapor 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 2300 ft^3 (65 m^3) to avoid an ignitible mixture, assuming 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 dipping and coating processes have a lower flammable limit greater than 1 percent. In using such theoretical considerations, caution should be exercised to prevent erroneous conclusions. Vapors from most flammable solvents are heavier than air and small quantities of vapor can form an ignitible 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 ft^3/gal (74.5 m^3/L) evaporated.

Adequate mechanical ventilation throughout all areas where ignitible vapors or mists might be present is essential to prevent the formation of ignitible mixtures. The volume of air movement necessary will obviously vary with the arrangement of the dipping or coating process, the amount of material used in a given length of time, and the rate of evaporation of the particular solvent.

Exhaust hoods can be used to control unmanned tanks, but are not often recommended where personnel 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 more efficient the ventilation. Canopy hoods should extend laterally over the equipment as far as practical.

Ventilation rates as low as 100 cfm/ft^2 (31 m^3/min/m^2) of tank surface area can 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 a capture velocity of 2000 fpm (610 m/min). The peripheral duct should be tapered to allow for solvent drainage and, if the length of lateral ductwork exceeds 5 ft (1525 mm), splitters should be considered. A combination of pressure and peripheral exhaust ducts should be considered for tanks in excess of 5 ft (1525 mm) in length. The quantity of air exhausted should approximate 100 to 150 cfm/ft^2 (46 to 77 m^3/min/m^2) of tank surface area and the pressure slot should be designed for approximately 1000 to 2000 fpm (305 to 610 m/min) capture velocity.

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

Cleaning tanks that contain solutions of combustible materials can also represent toxic hazards. Ventilation rates can generally be reduced for cleaning tanks and can be as low as 50 cfm/ft^2 (23 m^3/min/m^2) of tank surface area with slot velocities as low as 1000 ft/min (305 m/min).

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 ignitible vapors should be provided with independent mechanical ventilation.

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

A-5-3 All dipping and coating process areas require make-up air and since the air exhausted from these operations is normally contaminated and can only be recirculated under rigidly controlled conditions, the source of the make-up air should be given careful consideration. When the capacity of the ventilating fan is low and the area where the exhaust system is located is large, sufficient make-up air can often be provided by natural infiltration of air through building walls, windows, doors, etc. In general, if the volume of the room or building where the exhaust system is located is not at least 20 times the volumetric capacity of the fans (three air changes per hour), then additional make-up air will have to be provided. Outside air should be tempered and might have to be dehumidified or chilled. Automatic controls, including a high temperature limit switch, fan interlocks, and safety shut-off valves, should be provided for safe operation.

The method of distributing the make-up air requires careful consideration. The velocity of the air through filters, etc., should not exceed 200 ft/min (61 m/min). Higher velocities can cause excessive turbulence in the air flow patterns near the dipping or coating process. This turbulence can also cause a properly designed exhaust system to fail to confine and remove vapors or to fail to confine and control residues, dusts, and deposits.

With the many variables that can 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.

The features that should be considered include:

(a) Location of sources of heat.

(b) Location of air intakes to prevent recirculation of contaminated air.

(c) Equipping air intakes with appropriate screens or filters.

(d) Automatic temperature and proportioning controls, including an independent excess temperature limit control.

(e) A safety system interlocked with the heater to automatically provide for its safe ignition and to minimize the hazards that might result from failure of its proper operating cycle, proper pressure of fuel supply, ventilation, and electrical power.

(f) An interlock between the process exhaust system and the make-up air system to ensure that both systems are operable to provide a proper balance of supply and replacement air.

(g) In the case of direct-fired units, operating controls that will ensure that concentrations of unburned fuel or products of combustion are kept to levels that will be safe for operating personnel if inhaled.

A-5-4 Exhaust systems should be individually ducted to the outside. Where treatment of exhaust is necessary to satisfy environmental regulations or where energy conservation measures are used, this might not be practical. Manifolding exhaust ducts increases the fire hazard. A fire starting in one process can spread through the exhaust system and involve other processes. Heat exchangers are sometimes used to preheat the exhaust before it enters an incinerator. This might result in spontaneous ignition of residue accumulations on heat exchange surfaces.

A-5-5.2 If recirculated air is used for make-up air for occupied spaces, including dipping or coating process areas and other process areas, the requirements for decontamination and maximum allowable concentrations of solvents will be far more stringent than those required by this standard for fire and explosion prevention. Refer to appropriate occupational safety and health and industrial hygiene standards for permissible exposure limits.

A-5-10.2 If there are other operations or processes outside of the dipping or coating process area that also can produce ignitible vapors, in addition to the drying areas, these should be provided with adequate mechanical ventilation that is independent of the ventilation system provided for the dipping or coating process.

A-6-1 For large dipping or coating operations, coatings, thinners, and solvents can be stored in the following locations: underground storage tanks, aboveground storage tanks, separate buildings, or separate dedicated rooms within the facility. In some cases, the coating material is then pumped directly to the process vessel or tank. For smaller operations, separate storage areas might not be justified. However, it is desirable to minimize the fire loading in or near the process area by one or a combination of the following methods:

(a) flammable liquid storage cabinets;

(b) a protected enclosed metal structure;

(c) use of metal containers with limitations on quantity of material located near the process area.

A-6-5.6 NFPA 77, *Recommended Practice on Static Electricity*, provides information on static protection.

A-6-6.2 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 tendency for static accumulation. 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 that can cause ignition to occur on the liquid surface, from surface to tank, or from surface to fill pipe.

A-7-1 Automatic sprinkler systems are highly effective in controlling the spread of fire and protecting the building and nearby occupancies from heat damage. Dipping and coating processes should only be located in buildings that are protected throughout by an automatic sprinkler system. If such processes are located in an unsprinklered building, then sprinklers should be installed, wherever practical, to protect the area where the processes are installed. Because of the rapid spread and intensity of fires involving flammable or combustible coating materials, the water supply should be sufficient to supply all sprinkler heads that are likely to open in any one fire area without depleting the water available for anticipated hose streams. Noncombustible draft curtains should be used to limit the number of sprinklers that will open.

Drainage of the large volume of water frequently necessary to extinguish fires in such processes often presents considerable difficulty. The quantity of water necessary to effect 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 might be necessary to provide waterproofing and drainage of the floor so that extensive water damage does not occur on the floor below.

Sprinklers can extinguish fires in combustible residue deposits and in liquids with flash points in excess of 200°F (93°C). They can control fires in liquids with flash points under 200°F (93°C), i.e., the building should be protected from heat of the fire and, if the tank is equipped with overflow drains, the fire should be confined to the tank. The sprinkler system should be capable of delivering the density indicated in Table A-7-1. The area of application indicated in the table is a maximum and can be reduced to the area of the room, if the process is in a cutoff room. Alternatively, protection can be provided only over the process area itself and for 20 ft (6.1 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:

A-7-4(a) Water is generally effective on liquids having flash points above 140°F (60°C).

A-7-5 Loss experience indicates that the size of the dipping or coating tank might 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 1000 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-7-6 Fires in large process tanks [150 gal (570 L) and larger] 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:

Table A-7-1 Sprinkler Densities and Area Protection for Processes Relative to Flash Point of Liquids Used

Flash Point °F	A.S. Temp. Rating °F	Density gpm/ft²	Area of Coverage ft²
Below 20°F (including	286	0.3	6,000
nitrocellulose lacquer)	160	0.3	8,000
20°F to 200°F or heated	286	0.3	4,000
combustible liquids	160	0.3	6,000
Over 200°F	286	0.25	4,000
	160	0.25	6,000

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

(a) Will the extinguishing agent be 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) Can the agent be hazardous to personnel?

If processes are protected by dry chemical or carbon dioxide, or other gaseous agents and the fire is not quickly extinguished, it can re-ignite when agent concentration dissipates. Foam agents can delay re-ignition if the foam layer remains in place. However, discharge from hose streams or other portable extinguishing equipment can disturb the foam blanket and result in re-ignition of the liquid surface. Ignition sources should be eliminated to prevent re-ignition regardless of the agent employed.

A-7-6.1 This is typically accomplished by means of a piping network into all parts of the process area. To avoid potential flashback of an unextinguished fire, modular extinguishing units should not be used to protect processes with drain boards, hoods, ducts, drying tunnels, etc., or areas that exceed the listing of the system. They might, however, be suited for smaller processes that do fall within the limits of the listing.

A-8 The inherent characteristics of the materials used in dipping and coating processes require supervision of operations, maintenance of equipment, and routine cleaning. These are essential to reasonable safety. Properly designed equipment can do much to lessen, but cannot eliminate, this necessity.

A-8-1 When dipping or coating objects or material, some process liquid might not deposit directly on the article or return to the process tank, but instead deposit on adjacent surfaces as residue material. Much of this residue is highly combustible and can ignite at very low temperatures, sometimes spontaneously, resulting in fast-spreading fires. To limit the duration and intensity of fires, accumulations of residue should be prevented and controlled as much as practical. Dipping and coating operations should be restricted to locations designed and

equipped for the purpose, and then only with proper operation and effective maintenance and housekeeping.

A-8-2 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 should 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 should 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 could cause an explosion.

A-8-3 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 has proper overcurrent protection, 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-9-4 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 ignition-capable spark when approached by a grounded object or person. This condition can be avoided if the electrical resistance between the part and ground is 10^6 ohms (1 megohm) or less. Further detailed information on this subject can be found in NFPA 77, *Recommended Practice on Static Electricity.*

A-9-8 The grounding requirements for parts being deteared (*see A-9-4*) apply, for the same reasons, to all other conductive objects (including personnel) that are in the vicinity of the high voltage electrodes.

A-10 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 should be effectively trained before being assigned to a job. After the initial training, employees should receive periodic retraining to ensure their knowledge and understanding of normal process procedures as well as emergency procedures or changes in procedures. Safe work habits should be developed, they do not occur naturally.

All training should be provided by qualified personnel knowledgeable in process and operations involved. Appropriate training should 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-10-1.2 Any work requiring entry of employees into confined spaces should be conducted in accordance with a written procedure that is 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; and

(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 informational 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 ignition hazards and 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 might 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 1000 gal (3800 L) in capacity. This might 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 Utilization Equipment — Ignition occurs most frequently from failure of electrical utilization equipment in the area or by using electrical utilization equipment that is not suitable for the location in which it is located.

(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 res-

idue 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 interruption of production.

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 might allow the fire to burn in the tank shielded from overhead sprinklers. This can 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; and

4. The increase of heat intensity is rapid enough that manual pull stations cannot 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 multistory 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 informational 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.

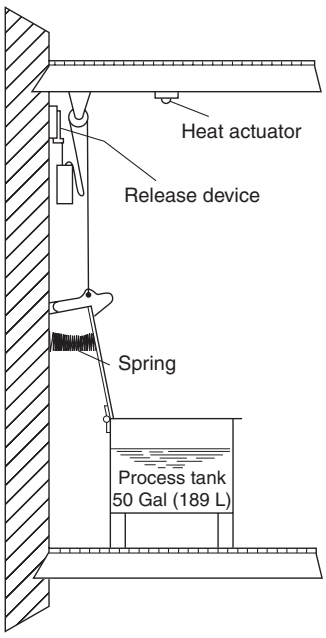

Figure C-1 A small process tank with an automatic cover.

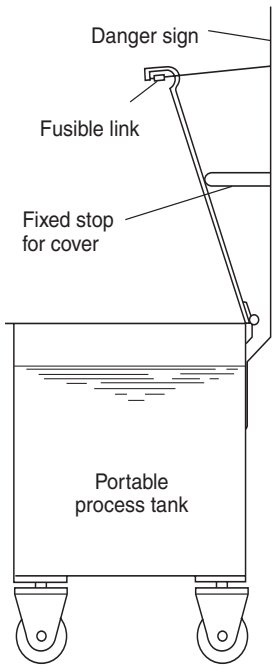

Figure C-2 A portable tank with an automatic cover.