NFPA 34

Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids

2007 Edition

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An International Codes and Standards Organization

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NFPA 34

Standard for

Dipping and Coating Processes Using Flammable or Combustible Liquids

2007 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. It was issued by the Standards Council on July 28, 2006, with an effective date of August 17, 2006, and supersedes all previous editions.

This edition of NFPA 34 was approved as an American National Standard on August 17, 2006.

Origin and Development of NFPA 34

NFPA standards on safeguarding 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 Subsequently, jurisdiction was transferred to a new Committee on Manufacturing Hazards, which, in turn, was superseded by the current Technical Committee on Finishing Processes.

The original 1913 edition was completely revised in 1921 and 1922, at which time material on hardening and tempering tanks and flow coat work was added to the original standard. Further revisions to keep the text up to date 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, 1995, 2000, 2003, and 2006.

The following major changes were adopted for the 2003 edition:

(1) The scope of the standard was extended to cover water-based coatings.
(2) The arrangement of the text was modified to comply with the *Manual of Style for NFPA Technical Committee Documents*, including the relocation of Chapter 11, Referenced Publications, to a new Chapter 2 and the addition of a new Chapter 3, Definitions, which incorporated all the definitions previously located in Chapter 1.
(3) Chapter 6 (formerly Chapter 4), Electrical and Other Sources of Ignition, was extensively revised to recognize the Zone concept of area classification. Included in those revisions were the addition of appropriate definitions and revisions of the figures illustrating the area classifications in and around dipping and coating processes.
(4) Subsection 7.6.1 (formerly 5.5.1) was revised to allow recirculation of exhaust air under certain conditions and to specify those conditions.
(5) Chapter 9 (formerly Chapter 7), Protection, was revised to correlate with Chapter 9, Protection, of NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*.
(6) Section 11.6 (formerly Section 9.6) was revised to require grounding, as well as de-energizing, of the electrostatic circuit.

The following major changes have been adopted for the 2007 edition:

(1) A number of definitions have been changed to incorporate "preferred" definitions to ensure consistent meaning and use of defined terms throughout the *National Fire Codes*. Where "preferred" definitions cannot be used for certain terms, those terms have been delimited by the phrase "For the purposes of this standard, ...".
(2) New definitions have been added for the terms *electrostatic detearing*, *peripheral vapor containment*, *secondary enclosure*, *solvent cleaning*, and *ventilation*.
(3) Requirements for hazardous location electrical utilization equipment and wiring have been further revised to correlate with NFPA 70®, *National Electrical Code®*, including appropriate Fine Print Notes from NFPA 70.
(4) New diagrams have been added to illustrate electrical area classification around open dipping and coating processes.
(5) Quantity limitations for storing flammable and combustible liquids have been changed to correlate with NFPA 30, *Flammable and Combustible Liquids Code*.

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(6) Chapter 9, Protection, has been completely rewritten to accomplish the following:
   (a) Correlate with NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
   (b) Add necessary requirements for interlocks for proper operation of fire protection systems
   (c) Require fire protection systems to be designed so that operation does not result in a spill of the flammable or combustible liquid
   (d) Require fire protection systems to discharge into the entire protected area

(7) A section on solvent distillation units (i.e., solvent recyclers) has been added.

(8) Additional changes have been made to correlate this standard with NFPA 33, *Standard for Spray Application Using Flammable and Combustible Materials*.

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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.

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Contents

Chapter 1 Administration **34**– 6
1.1 Scope **34**– 6
1.2 Purpose **34**– 6
1.3 Application **34**– 6
1.4 Retroactivity **34**– 6
1.5 Equivalency **34**– 6
1.6 Units and Formulas **34**– 6
1.7 Enforcement **34**– 6

Chapter 2 Referenced Publications **34**– 6
2.1 General **34**– 6
2.2 NFPA Publications **34**– 7
2.3 Other Publications **34**– 7
2.4 References for Extracts in Mandatory Sections **34**– 7

Chapter 3 Definitions **34**– 7
3.1 General **34**– 7
3.2 NFPA Official Definitions **34**– 7
3.3 General Definitions **34**– 7

Chapter 4 Location of Dipping and Coating Processes **34**– 8
4.1 Scope **34**– 8
4.2 Separation **34**– 8
4.3 Locations Below Grade **34**– 8
4.4 Access to Means of Egress **34**– 8
4.5 Locations in Other Occupancies **34**– 8

Chapter 5 Design and Construction of Dipping and Coating Equipment and Systems **34**– 8
5.1 Scope **34**– 8
5.2 General Requirements **34**– 8
5.3 Height Above Floor **34**– 9
5.4 Overflow Prevention **34**– 9
5.5 Liquid Level **34**– 9
5.6 Overflow Pipes **34**– 9
5.7 Bottom Drains **34**– 9
5.8 Salvage Tanks **34**– 9
5.9 Conveyor Systems **34**– 9
5.10 Control of Liquid Temperature **34**– 9

Chapter 6 Electrical and Other Sources of Ignition **34**–10
6.1 Scope **34**–10
6.2 General **34**–10
6.3 Electrical Area Classification — Class I Locations **34**–10
6.4 Areas Adjacent to Open Processes **34**–11
6.5 Areas Adjacent to Enclosed Processes **34**–12
6.6 Equipment and Containers in Ventilated Areas **34**–12
6.7 Light Fixtures **34**–12
6.8 Static Electric Discharges **34**–13

Chapter 7 Ventilation **34**–13
7.1 Scope **34**–13
7.2 General **34**–13
7.3 Performance Requirements **34**–13
7.4 Make-Up Air **34**–13
7.5 Routing of Exhaust Ducts **34**–14
7.6 Recirculation of Exhaust **34**–14
7.7 Materials of Construction **34**–14
7.8 Support of Exhaust Ducts **34**–14
7.9 Exhaust Duct Cross Section **34**–14
7.10 Exhaust Duct Access **34**–14
7.11 Exhaust Fans and Drives **34**–14
7.12 Drying Areas **34**–14

Chapter 8 Storage, Handling, and Distribution of Flammable and Combustible Liquids **34**–14
8.1 Scope **34**–14
8.2 General **34**–14
8.3 Storage in Process Areas **34**–14
8.4 Transporting Liquids **34**–15
8.5 Handling Liquids at Point of Final Use **34**–15
8.6 Liquid Piping Systems **34**–15

Chapter 9 Protection **34**–15
9.1 Scope **34**–15
9.2 General **34**–15
9.3 Automatic Fire Protection Systems **34**–15
9.4 Ventilation Systems **34**–16
9.5 Notification and Interlocks **34**–16
9.6 Automatic Fire Protection for Small Dipping Processes **34**–16
9.7 Automatic Fire Protection for Enclosed Processes and Large Processes **34**–16
9.8 Requirements for All Fire Protection Systems **34**–16
9.9 Specific Requirements for Automatic Carbon Dioxide, Dry Chemical, and Clean Agent Systems **34**–16
9.10 Specific Requirements for Water-Based Fire Protection Systems **34**–16
9.11 Portable Fire Extinguishers **34**–16

Chapter 10 Operations and Maintenance **34**–16
10.1 Scope **34**–16
10.2 General **34**–16
10.3 Waste Containers **34**–17
10.4 Inspection and Testing **34**–17
10.5 Cleaning Operations **34**–17
10.6 Smoking **34**–17

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10.7 Hot Work 34–17
10.8 Solvent Distillation Units (Solvent Recyclers) 34–17

Chapter 11 Electrostatic Detearing Apparatus 34–17
11.1 Scope 34–17
11.2 General 34–17
11.3 Requirements for Electrical System and Components 34–17
11.4 Support of Workpieces 34–17
11.5 Manual Operations 34–17
11.6 Electrical Safety Requirements 34–18
11.7 Personnel Safety 34–18
11.8 Grounding Requirements 34–18
11.9 Signs 34–18
11.10 Drip Plates and Screens 34–18

Chapter 12 Training 34–18
12.1 General 34–18

Annex A Explanatory Material 34–18

Annex B Fire Record 34–24

Annex C Illustrations of Suggested Methods of Protection 34–24

Annex D Informational References 34–27

Index 34–28

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Information on referenced publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration

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, including but not limited to dipping, roll coating, flow coating, curtain coating, and cleaning.

1.1.2 This standard shall also apply to dipping and coating processes that use water-borne, water-based, and water-reducible materials that contain flammable or combustible liquids or that produce combustible deposits or residues.

1.1.3 This standard shall not apply to dipping and coating processes that use only noncombustible liquids.

1.1.4 This standard shall not apply to dipping and coating processes that use a liquid that does not have a fire point when tested in accordance with ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup*, up to the boiling point of the liquid or up to a temperature at which the sample being tested shows an obvious physical change.

1.1.5 This standard shall not apply to electrostatic fluidized bed powder application. *(See Section 15.13 of NFPA 33, Standard for Spray Application Using Flammable or Combustible Materials.)*

1.2* Purpose.

1.2.1 The purpose of this standard shall be to provide requirements for fire safety for dipping and coating processes that use flammable or combustible liquids. Given that this standard anticipates conditions of average use, the authority having jurisdiction shall be permitted to require additional safeguards or modifications to the requirements of this standard where unusual industrial processes are involved, 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 or industrial hygiene.

1.3 Application. Chapters 4 through 10 and Chapter 12 shall apply to all dipping and coating processes. Chapter 11 shall apply only to dipping and coating processes that include electrostatic detearing systems.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 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, and safety over those prescribed by this standard.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6 Units and Formulas. The units of measurement used in this standard shall be the International System of Units, otherwise known as "SI" and "Modernized Metric System." English customary units are given in parentheses following SI units but shall be considered to be approximate conversions.

1.7 Enforcement. (Reserved)

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

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2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2007 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2005 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2005 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2007 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2007 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2002 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2003 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials,* 2007 edition.

NFPA 70, *National Electrical Code®,* 2005 edition.

NFPA 72®, National Fire Alarm Code®, 2007 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,* 2004 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2004 edition.

2.3 Other Publications.

2.3.1 AIHA Publications. American Industrial Hygiene Association, 2700 Prosperity Avenue, Suite 250, Fairfax, VA 22031.

ANSI/AIHA Z9.7, *American National Standard for the Recirculation of Air from Industrial Process Exhaust Systems*, 1998.

2.3.2 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI Z535, *Safety Signs Series IS*, 2002.

2.3.3 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME *Boiler and Pressure Vessel Code*, Section VIII, 2004.

2.3.4 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D 5, *Standard Method of Test for Penetration for Bituminous Materials*, 1997.

ASTM D 92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup*, 1998.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C,* 1999.

2.3.5 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Rd., Northbrook, IL 60062-2096.

UL 2208, *Standard for Solvent Distillation Units,* 1998.

2.3.6 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 30, *Flammable and Combustible Liquids Code,* 2003 edition.

NFPA 70, *National Electrical Code®,* 2005 edition.

NFPA 220, *Standard on Types of Building Construction,* 2006 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 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.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1* Boiling Point. The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure. [**30,** 2003]

3.3.2 Coating Processes.

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

3.3.2.2 ***Dip Coating.*** A process by which objects or materials are immersed in a liquid coating.

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

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

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3.3.3 Container. Any vessel of 450 L (119 gal) or less capacity used for transporting or storing liquids. [**30,** 2003]

3.3.3.1 ***Closed Container.*** A container as herein defined, so sealed by means of a lid or other device that neither liquid nor vapor will escape from it at ordinary temperatures. [**30,** 2003]

3.3.4 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.

3.3.5 [Electrical] Utilization Equipment. Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes. [**70,** 2005]

3.3.6 Electrostatic Detearing. A process for removing excess wet coating material, such as drips, from the bottom edge of a dipped or coated object or material by passing it through an electrostatic field.

3.3.7 Liquid. 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 of Bituminous Materials.* [**30,** 2003]

3.3.7.1 ***Combustible Liquid.*** A liquid that has a closed-cup flash point at or above 100°F (37.8°C). Combustible Liquid Classification. Combustible Liquid Class II. Any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C). Combustible Liquid Class IIIA. Any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C). Combustible Liquid Class IIIB. Any liquid that has a flash point at or above 200°F (93°C).

3.3.7.2 ***Flammable Liquid.*** A liquid that has a closed-cup flash point that is below 100°F (37.8°C) and a maximum vapor pressure of 40 psia (2068 mm Hg) at 100°F (37.8°C). Flammable Liquid Classification. Flammable Liquid Class I. Any liquid that has a closed-cup flash point below 100°F (37.8°C) and a Reid vapor pressure not exceeding 40 psia (2068.6 mm Hg) at 100°F (37.8°C). Flammable Liquid Class IA. Any liquid that has a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C). Flammable Liquid Class IB. 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). Flammable Liquid Class IC. Any liquid that has a flash point at or above 73°F (22.8°C), but below 100°F (37.8°C).

3.3.8 Noncombustible Material. A material that, 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 that are reported as passing ASTM E 136 are considered noncombustible materials. [**220,** 2006]

3.3.9 Peripheral Vapor Containment. A system that cools the perimeter of a vapor degreaser tank near its top for the purpose of condensing a saturated vapor blanket from boiling flammable solvent.

3.3.10 Secondary Enclosure. An enclosure or guard constructed around but separate from a dipping or coating process whose purpose is other than for fire protection, confinement of a possible fire, or confinement of vapor or mists.

3.3.11 Solvent Cleaning. The removal of material from an object by a solvent using processes such as immersing, soaking, spraying, agitating, or ultrasonics.

3.3.12* Vapor Area. Any area in the vicinity of: (1) a dipping or coating process and its drainboard, (2) associated drying or conveying equipment, (3) the interior of any exhaust plenum or any exhaust duct leading from the process, (4) other associated equipment that could contain a flammable vapor concentration exceeding 25 percent of the lower flammable limit (LFL) during operation or shutdown periods.

3.3.13 Vapor Source. The liquid exposed in the process and on the drainboard. 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 305 mm (1 ft) in any direction from the object.

3.3.14 Ventilation. For the purposes of this standard, movement of air that is provided for the prevention of fire and explosion and is sufficient to prevent accumulation of vapor–air mixtures in concentrations over 25 percent of the lower flammable limit.

Chapter 4 Location of Dipping and Coating Processes

4.1 Scope. Chapter 4 shall apply to the location of dipping and coating processes in buildings and with respect to other operations or processes. This chapter shall designate acceptable and unacceptable locations for dipping and coating processes.

4.2* Separation. Dipping and coating processes shall be separated from other operations, materials, or occupancies by location, fire walls, fire partitions, or other means acceptable to the authority having jurisdiction.

4.3* Locations Below Grade. Dipping and coating processes shall not be located below the 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.

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

4.5* Locations in Other Occupancies. Dipping and coating processes shall not be located in any building that is classified as an assembly, educational, day care, health care, ambulatory health care, detention/correctional, 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 at least 2 hours and that is protected by an approved automatic sprinkler system designed and installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

Chapter 5 Design and Construction of Dipping and Coating Equipment and Systems

5.1 Scope. Chapter 5 shall apply to the design and construction of dipping and coating process equipment and systems.

5.2 General Requirements.

5.2.1 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 dipping and coating tanks that exceed either 1900 L (500 gal)

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capacity or 1 m^2 (10 ft^2) of liquid surface shall have a fire resistance rating of at least 1 hour.

5.2.2 If the dipping or coating equipment is enclosed for the purpose of confining vapors and mists, any panels for light fixtures or for observation shall be of heat-treated glass, laminated glass, wired glass, or hammered-wired glass, and the panels shall be sealed to confine vapors or mists to the enclosure.

Exception: If secondary enclosures are provided, including those installed for environmental purposes designed to capture low-level fugitive emissions, as well as those used for the purpose of any vision, panels shall not be required to meet the requirements of 5.2.2.

5.2.2.1 Panels for light fixtures shall be separated from the fixture to prevent the surface temperature of the panel from exceeding 93°C (200°F).

5.2.2.2 The panel frame and method of attachment shall be designed to not fail under fire exposure before the vision panel fails.

5.3* Height Above Floor. The top of the dipping or coating tank shall be at least 150 mm (6 in.) above the floor.

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

(1) Drainboards shall be arranged so that sprinkler discharge will not flow into the tank.
(2) Tanks shall be equipped with automatic-closing covers.
(3) Tanks shall be equipped with overflow pipes. *(See Section 5.6.)*

5.5 Liquid Level. The liquid in the dipping or coating tank shall be maintained at a level that is at least 150 mm (6 in.) below the top of the tank to allow effective application of extinguishing agents in the event of fire.

5.6 Overflow Pipes.

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

5.6.2 Depending on the area of the liquid surface and the length and pitch of pipe, overflow pipes for dipping or coating tanks that exceed 570 L (150 gal) capacity or 1 m^2 (10 ft^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. The overflow pipe shall be at least 75 mm (3 in.) in diameter.

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

5.6.4 The connection of the overflow pipe to the tank shall be made at a point that is at least 150 mm (6 in.) below the top of the tank.

5.7 Bottom Drains. Dipping or coating tanks that exceed 1900 L (500 gal) capacity shall be equipped with bottom drains arranged to drain the tank in the event of fire.

Exception No. 1: Bottom drains shall not be required for tanks that are equipped with automatic-closing covers meeting the requirements of Section 9.6.

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

5.7.1 Bottom drains shall be both manually and automatically operable. Manual operation shall be from a safe and accessible location.

5.7.2 Where gravity flow is impractical, automatic pumps shall be provided.

5.7.3 Drains shall be trapped and shall discharge to a closed, vented salvage tank *(see Section 5.8)* or to a safe location.

5.7.4 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 the pipe diameter be less than that indicated in Table 5.7.4.

Table 5.7.4 Minimum Size of Drain Pipe

Tank Capacity		Nominal Pipe Diameter	
L	gal	mm	in.
1900 to 2850	500 to 750	75	3
2851 to 3800	751 to 1000	100	4
3801 to 9500	1001 to 2500	125	5
9501 to 15,000	2501 to 4000	150	6
>15,000	>4000	200	8

5.8 Salvage Tanks.

5.8.1 Where a salvage tank is employed, a pumping arrangement shall be provided for the retrieval of the contents.

5.8.2 The salvage tank shall meet all applicable requirements of NFPA 30, *Flammable and Combustible Liquids Code.*

5.8.3 The salvage tank shall be emptied before the dipping or coating tank is refilled.

5.8.4* 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.

5.9 Conveyor Systems.

5.9.1 Conveyor systems shall be arranged to stop automatically in the event of a fire.

5.9.2 Conveyor systems shall be arranged to stop automatically if the required rate of ventilation is not maintained. *(See Section 7.3.)*

5.10 Control of Liquid Temperature.

5.10.1 Where dipping or coating liquids are heated, either directly or by the workpieces being processed, the requirements of 5.10.1.1 through 5.10.1.4 shall be met to prevent excess temperature, vapor accumulation, and possible autoignition. For the purposes of this section, *excess temperature* shall mean any temperature above which the ventilation required by Section 7.3 cannot safely confine the vapors generated. In no case shall this temperature exceed the boiling point of the liquid or a temperature that is 55°C (100°F) less than the autoignition temperature of the liquid.

5.10.1.1 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.

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5.10.1.2 Heating and cooling units for liquids shall be of an approved type and shall be controlled, serviced, and maintained in accordance with the manufacturers' instructions.

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

5.10.1.4 Heating systems shall be automatically shut down if the level of liquid in the dipping or coating tank exceeds or falls below the manufacturers' recommended operating level.

Chapter 6 Electrical and Other Sources of Ignition

6.1 Scope. Chapter 6 shall apply to electrical wiring and electrical utilization equipment that is used in or on, is attached to the dipping and coating equipment, or is in the vicinity of the dipping and coating equipment. This chapter shall also apply to other sources of ignition.

6.2 General.

6.2.1 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 6.2.1.1 and 6.2.1.2.

6.2.1.1 The extent of hazardous (classified) locations around dipping and coating processes shall be determined in accordance with Sections 6.2, 6.3, 6.4, and 6.5 of this standard and with Article 500 of NFPA 70, *National Electrical Code*.

6.2.1.2 Electrical wiring and electrical 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, 505, and 516 of NFPA 70, *National Electrical Code*.

6.2.1.3 For the purposes of this standard, the Zone system of electrical area classification shall be applied as follows:

(1) The inside of open or closed containers or vessels shall be considered a Class I, Zone 0 location.
(2) A Class I, Division 1 location shall be permitted to be alternatively classified as a Class I, Zone 1 location.
(3) A Class I, Division 2 location shall be permitted to be alternatively classified as a Class I, Zone 2 location.

6.2.1.4 For the purposes of electrical area classification, the Division system and the Zone system shall not be intermixed for any given source of release.

6.2.1.5 In accordance with 505.7(B) NFPA 70, *National Electrical Code*, where areas in the same facility are classified separately, a Class I, Zone 2 location shall be permitted to abut, but shall not overlap, a Class I, Division 2 location. A Class I, Zone 0 or Class I, Zone 1 location shall not abut a Class I, Division 1 or Class I, Division 2 location.

6.2.2* 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 that are classified as Division 2 or Zone 2.

6.2.3* Any electrical 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 or Zone 2 areas shall be of the totally enclosed type or shall be constructed to prevent the escape of sparks or particles of hot metal.

6.2.4* Electrical wiring and electrical 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 I, Zone 1 locations, whichever is applicable.

6.2.5* Electrical wiring and electrical 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 I, Zone 1 locations, whichever is applicable.

Exception: Electrostatic detearing apparatus shall meet the requirements of Chapter 11.

6.3* Electrical Area Classification — Class I Locations. A Class I location shall be any location where a flammable gas or vapor is present or might be present in the air in quantities sufficient to produce an explosive or ignitible mixture.

6.3.1* Class I, Division 1 Locations. In accordance with 500.5(B)(1) of NFPA 70, *National Electrical Code*, a Class I, Division 1 location shall be any location where one of the following conditions exists:

(1) An ignitible concentration of flammable gas or vapor can exist under normal operating conditions.
(2) An ignitible concentration of flammable gas or vapor can exist frequently because of repair or maintenance operations or because of leakage.
(3) Breakdown or faulty operation of equipment or processes might release an ignitible concentration of flammable gas or vapor and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.

6.3.2* Class I, Division 2 Locations. In accordance with 500.5(B)(2) of NFPA 70, *National Electrical Code*, a Class I, Division 2 location shall be any location where one of the following conditions exists:

(1) A flammable gas or a volatile flammable liquid is handled, processed, or used, but any flammable gas, vapor, or liquid is confined within a closed container or a closed system from which it can escape only in case of accidental rupture or breakdown of the container or system or in case of abnormal operation of the equipment.
(2) An ignitible concentration of flammable gas or vapor is normally prevented by positive mechanical ventilation but might exist because of failure or abnormal operation of the ventilating equipment.
(3) An ignitible concentration of flammable gas or vapor might occasionally be transmitted from an adjacent Class I, Division 1 location, unless such transmission is prevented by positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

6.3.3* Class I, Zone 0 Locations. In accordance with 505.5(B)(1) of NFPA 70, *National Electrical Code*, a Class I, Zone 0 location shall be any location where an ignitible concentration of flammable gas or vapor is present either continuously or for long periods of time.

6.3.4* Class I, Zone 1 Locations. In accordance with 505.5(B)(2) of NFPA 70, *National Electrical Code*, a Class I, Zone 1 location shall be any location where one of the following conditions exists:

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(1) An ignitible concentration of flammable gas or vapor is likely to exist under normal operating conditions.
(2) An ignitible concentration of flammable gas or vapor can exist frequently because of repair or maintenance operations or because of leakage.
(3) Breakdown or faulty operation of equipment or processes might release an ignitible concentration of flammable gas or vapor and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.
(4) An ignitible concentration of flammable gas or vapor might occasionally be transmitted from an adjacent Class I, Zone 0 location, unless such transmission is prevented by positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

6.3.5 Class I, Zone 2 Locations. In accordance with 505.5(B)(3) of NFPA 70, *National Electrical Code*, a Class I, Zone 2 location shall be any location where one of the following conditions exists:

(1) An ignitible concentration of a flammable gas or vapor is not likely to exist under normal operating conditions and, if an ignitible concentration does exist, will exist only for a short period of time.
(2) A flammable gas or a volatile flammable liquid is handled, processed, or used, but any flammable gas, vapor, or liquid is confined within a closed container or a closed system from which it can escape only in case of accidental rupture or breakdown of the container or system or in case of abnormal operation of the equipment.
(3) An ignitible concentration of flammable gas or vapor is normally prevented by positive mechanical ventilation but might exist because of failure or abnormal operation of the ventilating equipment.
(4) An ignitible concentration of flammable gas or vapor might occasionally be transmitted from an adjacent Class I, Zone 1 location, unless such transmission is prevented by positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided. *(See also A.6.3.2.)*

6.4 Areas Adjacent to Open Processes. Electrical wiring and electrical utilization equipment located adjacent to open dipping and coating processes shall meet the requirements of 6.4.1 through 6.4.4 and Figure 6.4(a), Figure 6.4(b), Figure 6.4(c), or Figure 6.4(d), whichever is applicable.

6.4.1 Electrical wiring and electrical utilization equipment located in any sump, pit, or belowgrade channel that is within 7620 mm (25 ft) horizontally of a vapor source, as defined by this standard, shall be suitable for Class I, Division 1 or Class I, Zone 1 locations. If the sump, pit, or channel extends beyond 7620 mm (25 ft) of the vapor source, it shall be provided with a vapor stop, or it shall be classified as Class I, Division 1 or Class I, Zone 1 for its entire length.

6.4.2 Electrical wiring and electrical utilization equipment located within 1525 mm (5 ft) of a vapor source shall be suitable for Class I, Division 1 or Class I, Zone 1 locations. The area inside the dip tank shall be classified as Class I, Division 1 or Class I, Zone 0, whichever is applicable.

6.4.3 Electrical wiring and electrical utilization equipment located within 915 mm (3 ft) of the Class I, Division 1 or Class I, Zone 1 location described in 6.4.2 shall be suitable for Class I, Division 2 or Class I, Zone 2 locations, whichever is applicable.

6.4.4 The space 915 mm (3 ft) above the floor and extending 6100 mm (20 ft) horizontally in all directions from the Class I, Division 1 or Class I, Zone 1 location described in 6.4.3 shall be classified as Class I, Division 2 or Class I, Zone 2, and electrical wiring and electrical utilization equipment located within this space shall be suitable for Class I, Division 2 or Class I, Zone 2 locations, whichever is applicable.

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 0.5 m^2 (5 ft^2), the contents of the tank do not exceed 19 L (5 gal), and the vapor concentration during operating and shutdown periods does not exceed 25 percent of the lower flammable limit.

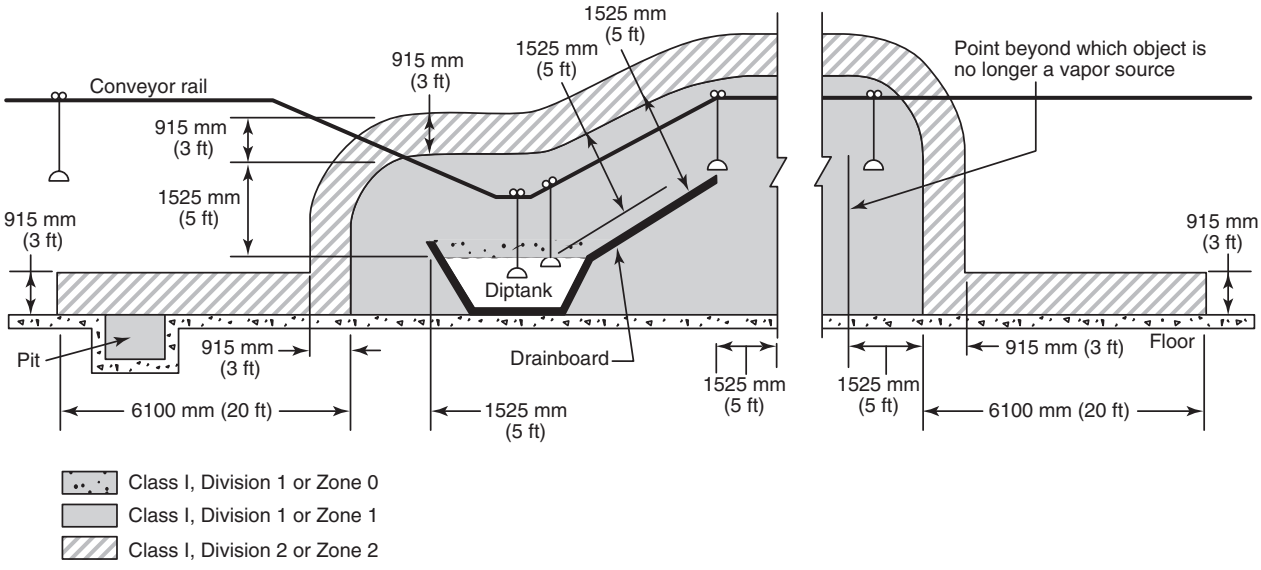
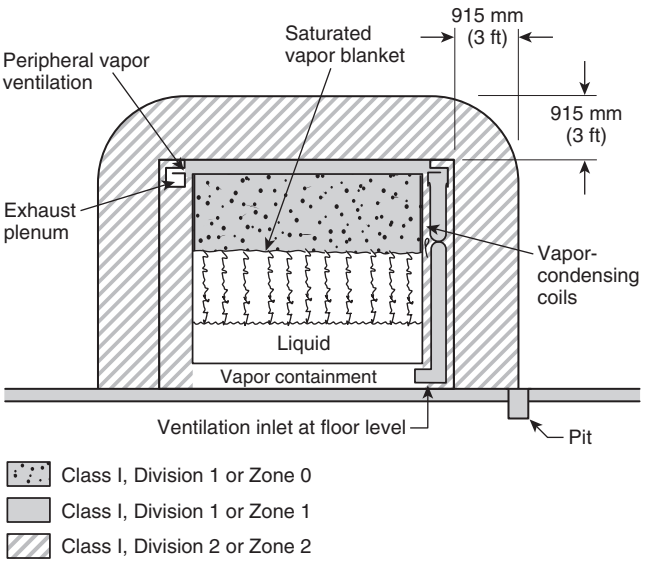


FIGURE 6.4(a) Electrical Area Classification for Open Dipping and Coating Processes Without Vapor Containment or Ventilation.

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Definitions

Freeboard: The distance from the maximum solvent or coating material level to the top of the tank

Freeboard ratio: The freeboard height divided by the smaller of the interior length or interior width of the tank

FIGURE 6.4(b) Electrical Area Classification for Open Dipping and Coating Process with Peripheral Vapor Containment and Ventilation — Vapors Confined to Process Equipment.

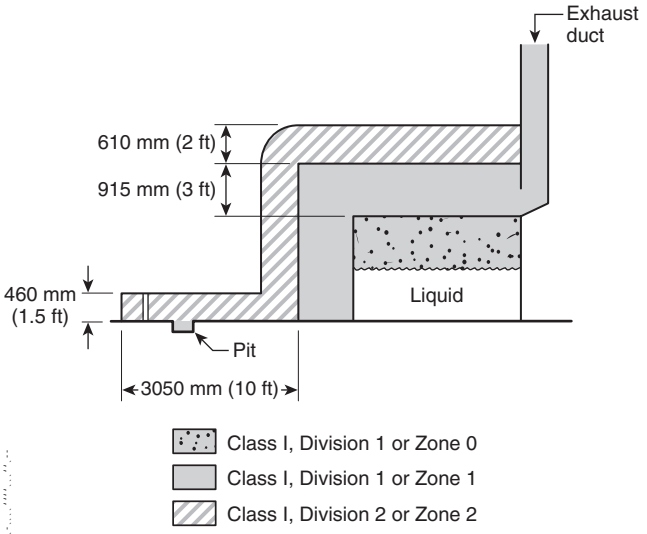


FIGURE 6.4(c) Electrical Area Classification for Open Dipping and Coating Process with Partial Peripheral Vapor Containment and Ventilation — Vapor NOT Confined to Process Equipment.

6.5 Areas Adjacent to Enclosed Processes. Areas adjacent to enclosed dipping and coating processes shall be classified in accordance with 6.5.1, 6.5.2, and Figure 6.5.

6.5.1 The interior of any enclosed dipping or coating process or apparatus shall be a Class I, Division 1 or Class I, Zone 1 location, and electrical wiring and electrical utilization equipment located within this space shall be suitable for Class I, Division 1 or Class I, Zone 1 locations, whichever is applicable. The area inside the dip tank shall be classified as Class I, Division 1 or Class I, Zone 0, whichever is applicable.

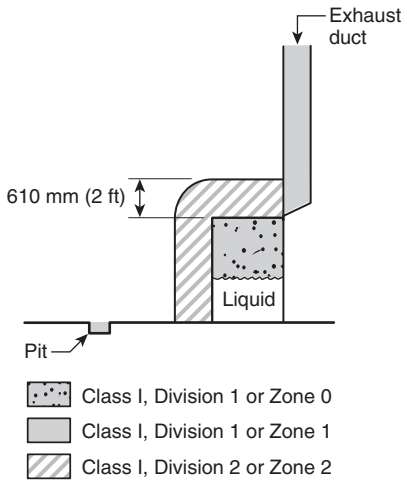


FIGURE 6.4(d) Electrical Area Classification for Open Dipping and Coating Process with Partial Peripheral Vapor Containment and Ventilation — Vapors Confined to Process Equipment.

6.5.2 The space within 915 mm (3 ft) 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 or Class I, Zone 2, and electrical wiring and electrical utilization equipment located within this space shall be suitable for Class I, Division 2 locations or Class I, Zone 2, whichever is applicable.

6.5.3 All other spaces adjacent to an enclosed dipping or coating process or apparatus shall be classified as nonhazardous for purposes of electrical installations.

6.6 Equipment and Containers in Ventilated Areas.

6.6.1 Open containers, supply containers, waste containers, and solvent distillation units that contain Class I liquids shall be located in areas ventilated in accordance with applicable requirements of Chapter 7.

6.6.2 Areas within and around such containers, solvent distillation units, and similar apparatus shall be classified in accordance with Figure 6.6.2 and with the following:

(1) The area within 915 mm (3 ft) in all directions from any such container or equipment and extending to the floor or grade level shall be classified as Class I, Division 1 or Class I, Zone 1, whichever is applicable.
(2) The area extending 610 mm (2 ft) beyond the Division 1 or Zone 1 location shall be classified as Class I, Division 2 or Class I, Zone 2, whichever is applicable.
(3) The area extending 1525 mm (5 ft) horizontally beyond the area described in 6.6.2(2) up to a height of 460 mm (18 in.) above the floor or grade level shall be classified as Class I, Division 2 or Class I, Zone 2, whichever is applicable.
(4) The area inside any tank or container shall be classified as Class I, Division 1 or Class I, Zone 0, whichever is applicable.

6.7 Light Fixtures.

6.7.1 Light fixtures that are attached to the walls or ceilings of a process enclosure but are outside any classified area and

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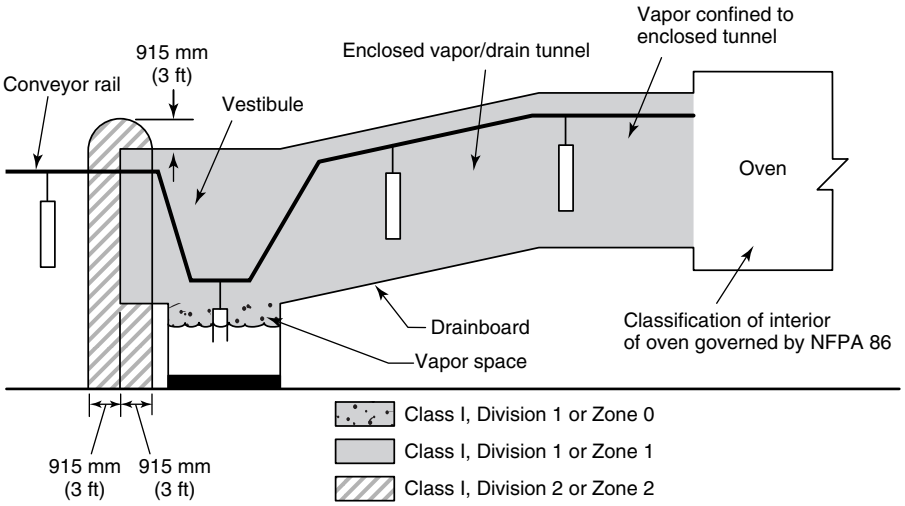


FIGURE 6.5 Electrical Area Classification Around Enclosed Dipping and Coating Processes.

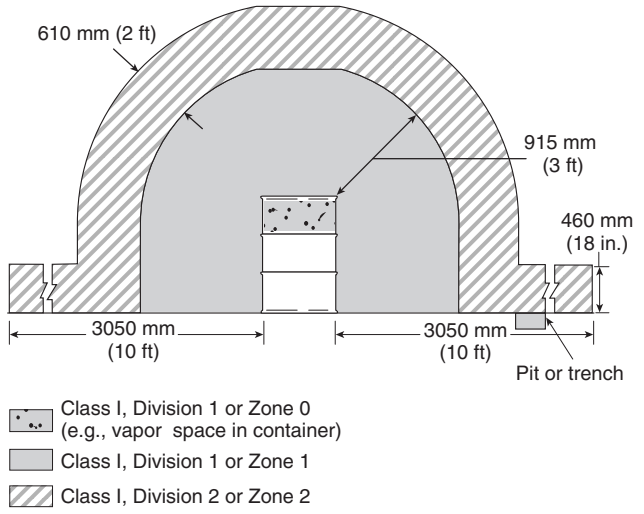


FIGURE 6.6.2 Electrical Area Classification Around an Open Container in a Ventilated Area.

are separated from the process area by glass panels that meet the requirements of 5.2.2 shall be suitable for use in ordinary hazard (general purpose) locations. Such fixtures shall be serviced from outside the enclosure.

6.7.2 Light fixtures that are attached to the walls or ceilings of a process enclosure, are located within the Class I, Division 2 or Class I, Zone 2 location, and are separated from the process area by glass panels that meet the requirements of 5.2.2 shall be suitable for use in that location. Such fixtures shall be serviced from outside the enclosure.

6.8* Static Electric Discharges. 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.

Chapter 7 Ventilation

7.1 Scope. Chapter 7 shall apply to ventilation systems provided for the purpose of capturing and removing flammable and combustible vapors from dipping and coating processes.

7.2 General. Ventilating and exhaust systems shall be installed in accordance with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, where applicable, and also shall meet the requirements of this chapter.

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

7.3.1 Where the process does not allow adequate removal of vapors by mechanical ventilation alone, an enclosure shall be provided and the ventilation shall be capable of confining all vapors to the enclosure.

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

7.3.3 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 area no longer constitutes a vapor source.

7.3.4 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.

7.4* 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.

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7.5* Routing of Exhaust Ducts.

7.5.1 Exhaust ducts shall follow the most direct route to the point of discharge but shall not penetrate a fire wall.

7.5.2 The exhaust discharge shall be directed away from any fresh air intakes, and the discharge point shall be at least 1830 mm (6 ft) from any exterior wall or roof.

7.5.3 Exhaust ducts shall not discharge in the direction of any combustible construction that is within 7620 mm (25 ft) of the discharge point.

7.5.4 Exhaust ducts shall not discharge in the direction of any unprotected opening in any noncombustible or limited-combustible construction that is within 7620 mm (25 ft) of the discharge point.

7.6 Recirculation of Exhaust.

7.6.1 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 requirements have been met:

(1) Solid particulates shall have been removed from the recirculated air.
(2) The concentration of vapors in the exhaust airstream shall not exceed 25 percent of the lower flammable limit.
(3) Listed equipment shall be used to monitor the concentration of vapors in all exhaust airstreams.
(4) 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.
(5) Equipment installed to process and remove contaminants from the air exhausted from dipping or coating processes shall be approved by the authority having jurisdiction.

7.6.2* The provisions in 7.6.1 shall not prohibit the use of recirculated air to occupied spaces. In such cases, however, other requirements addressing toxicity and permissible exposure limits shall apply. *(See ANSI/AIHA Z9.7, American National Standard for the Recirculation of Air from Industrial Process Exhaust Systems.)*

7.7 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.

7.8 Support of Exhaust Ducts. Exhaust ducts shall be supported to prevent collapse under fire conditions.

7.8.1 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, the duct supports also shall be designed to carry the anticipated weight of any accumulation of sprinkler discharge.

7.8.2 Loads shall not be placed on or transmitted to equipment connected to the duct system.

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

7.8.4 Hangers and supports shall be designed to allow for expansion and contraction.

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

7.9 Exhaust Duct Cross Section. Exhaust ducts shall be permitted to be round, rectangular, or any other suitable shape.

7.10 Exhaust Duct Access. Exhaust ducts shall be provided with doors, panels, or other means to facilitate inspection, maintenance, cleaning, and access to fire protection devices.

7.11 Exhaust Fans and Drives.

7.11.1 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 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.

7.11.2 All bearings shall be of the self-lubricating type or shall be lubricated from a point outside the duct or fan housing.

7.11.3 Electric motors that drive exhaust fans shall not be placed inside any duct or fan housing unless they meet the provisions of 6.2.4 and 6.2.5.

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

7.12 Drying Areas.

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

7.12.2* If removed from the dipping or coating process area, workpieces 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 8 Storage, Handling, and Distribution of Flammable and Combustible Liquids

8.1 Scope. Chapter 8 shall apply to the storage, handling, and distribution of flammable and combustible liquids that are used in dipping and coating processes.

8.2* General.

8.2.1 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.

8.2.2 Open or glass containers shall not be used for transportation or storage of liquids.

8.3 Storage in Process Areas.

8.3.1 The volume of Class I, Class II, and Class IIIA liquids stored in a storage cabinet shall not exceed 454 L (120 gal).

8.3.2 Storage cabinets shall be listed or shall be designed and constructed to meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.

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8.3.3 The total aggregate volume of Class I, Class II, and Class IIIA liquids in storage cabinets in a single fire area shall not exceed 1350 L (360 gal).

8.3.4 In an industrial occupancy, additional storage cabinets shall be permitted to be located in the same fire area, if a minimum separation of 30 m (100 ft) is maintained between each group and the total aggregate volume of each group does not exceed 1350 L (360 gal).

8.3.5 In an industrial occupancy that is protected by an automatic sprinkler system designed and installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, the total aggregate volume of Class I, Class II, and Class IIIA liquids in storage cabinets stored in a single group shall be permitted to be increased to 2700 L (720 gal).

8.3.6 Storage in the Vicinity of Process Areas. The quantity of liquid located in the vicinity of the dipping or coating process area but outside a storage cabinet, an inside storage room, a cutoff room or attached building, or other specific process area that is cutoff by at least a 2-hour fire-rated separation from the dipping or coating process area, shall not exceed the quantity given in either 8.3.6(1) or 8.3.6(2), whichever is greater:

(1) A supply for one day
(2) 95 L (25 gal) of Class IA liquids in containers, plus 450 L (120 gal) of Class IB, Class IC, Class II, or Class III liquids in containers, plus two portable tanks each not exceeding 2500 L (660 gal) of Class IB, Class IC, Class II, or Class IIIA liquids, plus 20 portable tanks each not exceeding 2500 L (660 gal) of Class IIIB liquids

8.4 Transporting Liquids. Liquids shall be transported from their storage area to the process area only in closed shipping containers, approved portable tanks and intermediate bulk containers, approved safety cans, or a piping system.

8.5 Handling Liquids at Point of Final Use.

8.5.1 Class I and Class II liquids shall be kept in closed original shipping containers, metal containers, metal or portable tanks, or metal intermediate bulk containers when not in use.

8.5.2 Where liquids are used or handled, means shall be provided to clean and dispose of leaks or spills in a prompt and safe manner.

8.5.3 Class I and Class II liquids shall be transferred between their original shipping containers and process tanks, containers, or portable tanks within a building only by means of the following:

(1) Containers with a capacity of 19 L (5 gal) or less
(2) Approved safety cans
(3) Through a closed piping system
(4) From a portable tank or container by means of an approved pump device drawing through an opening in the top of the tank or container
(5) By gravity through a listed self-closing valve or self-closing faucet

8.5.4 Transferring liquids by means of pressurizing the container with air shall be prohibited. Transferring liquids by pressure of inert gas shall be permitted, provided that the containers that are pressurized comply with all applicable requirements of the ASME *Boiler and Pressure Vessel Code*, Section VIII, for construction, test, and maintenance.

8.5.5 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).

8.5.6* If a heater is used to heat liquids, the heater shall be low pressure steam, low pressure hot water, or electric.

8.5.6.1 If the heating system is electric, it shall be approved and listed for the specific location in which it is used. *(See Chapter 6.)*

8.5.6.2 Heaters shall not be subject to accumulation of residue.

8.5.6.3 If used, agitators shall be driven by compressed air, water, low pressure steam, or electricity. If powered by an electric motor, the motor shall meet the requirements of Chapter 6.

8.6 Liquid Piping Systems.

8.6.1 Piping systems that convey flammable or combustible liquids between storage tanks, mixing rooms, and dipping and coating areas shall be of steel or other material having comparable properties of resistance to heat and physical damage. Piping systems shall be properly bonded and grounded.

8.6.2* Where a tank is filled from the top, the free end of the fill pipe shall be within 150 mm (6 in.) of the bottom of the tank. 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.

8.6.3 Protection against siphoning shall be provided for fill lines having connections below liquid-level that are not permanently piped to the supply system.

8.6.4 Where a pump is used to supply liquid to a dipping or coating process, the piping, tubing, hose, and other accessories shall be designed to withstand the maximum working pressure of the pump, or means shall be provided to limit the discharge pressure of the pump.

8.6.5 Process tanks shall be provided with a limit device to prevent overfilling tanks.

8.6.6 Process pumps shall be interlocked with fire detection or automatic fire-extinguishing systems for the process to shut down the pumps in case of fire.

Chapter 9 Protection

9.1 Scope. Chapter 9 shall apply to fire protection equipment and systems provided for dipping and coating processes.

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

9.3 Automatic Fire Protection Systems.

9.3.1 Dipping and coating processes shall be protected with any of the following approved automatic fire protection systems:

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

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(2) A foam extinguishing system that meets the requirements of NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam (See also 9.3.2.)*
(3) A carbon dioxide system that meets the requirements of NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
(4) A dry chemical extinguishing system that meets the requirements of NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
(5) A gaseous agent extinguishing system that meets the requirements of NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*
(6) For tanks containing liquids having flash points above 93°C (200°F) and for associated process hazards, a sprinkler system that meets the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*
(7) For tanks equipped with a tank cover arranged to close automatically in the event of fire, a sprinkler system that meets the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*

9.3.2 If a foam extinguishing system is used, hoods and ducts shall be protected by other approved fire protection systems.

9.4 Ventilation Systems. Ventilation and exhaust systems for dipping and coating process areas shall not be interlocked with the fire alarm system and shall remain functional and operable during any fire alarm condition.

Exception: Where the type of fire-extinguishing system used requires that ventilation be discontinued, air make-up and exhaust systems shall be permitted to be shut down and dampers shall be permitted to close.

9.5 Notification and Interlocks.

9.5.1 Activation of an automatic fire protection system shall automatically accomplish all of the following:

(1) Activate a local alarm in the area of the process
(2) Transmit an alarm signal to the facility's fire alarm system, if such a system is provided
(3) Shut down all coating material delivery and recirculation systems
(4) Stop the process, including but not limited to conveyors, rolls, and webs
(5) Open bottom drains of tanks, if bottom drains are provided

9.5.2 The fire alarm and fire protection system shall be supervised in accordance with *NFPA 72, National Fire Alarm Code.*

9.6* Automatic Fire Protection for Small Dipping Processes. Automatic-closing process tank covers or fire protection systems that meet the requirements of Section 9.3 shall be provided for open tanks that do not exceed 570 L (150 gal) capacity or that do not exceed 1 m^2(10 ft^2) of liquid surface area.

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

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

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

9.6.4 Covers shall be kept closed when the process is not in operation.

9.6.5 Where drainboards 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.

9.7* Automatic Fire Protection for Enclosed Processes and Large Processes. An automatic fire protection system, installed in accordance with Section 9.3, shall be provided for processes not covered by Section 9.6, such as:

(1) Enclosed processes
(2) Large open tanks
(3) Roll coating operations
(4) Curtain or flow coating operations
(5) Flammable solvent cleaning operations

9.7.1 The system shall be designed to protect the following areas:

(1) For dip tanks: the tank, its drainboard, freshly coated workpieces above the drainboard, and exhaust ducts
(2) For curtain and flow coaters: open troughs and tanks, canopies or hoods, vapor drying tunnels, and exhaust ducts
(3) For roll coaters and similar processes: open troughs and tanks, coating and transfer rolls, the web, and open containers of coating materials
(4) For vapor degreasers using flammable liquids: the tank and any areas within the unit that can have solvent accumulation

9.7.2* The extinguishing system shall be designed to simultaneously discharge into the entire protected area, as described in 9.7.1(1) through 9.7.1(3).

9.8 Requirements for All Fire Protection Systems. Fire protection systems shall be designed and installed so as to minimize splashing of the solvent or coating materials.

9.9 Specific Requirements for Automatic Carbon Dioxide, Dry Chemical, and Clean Agent Systems. The fire protection systems shall be capable of discharging their agents into the entire protected area simultaneously.

9.10 Specific Requirements for Water-Based Fire Protection Systems. Water-based fire protection systems shall be designed to allow drainage of water without raising the level of the coating material to the overflow level.

9.11 Portable Fire Extinguishers. Portable fire extinguishers shall be provided and located in accordance with NFPA 10, *Standard for Portable Fire Extinguishers.*

Chapter 10 Operations and Maintenance

10.1 Scope. Chapter 10 shall apply to operation and maintenance of dipping and coating processes.

10.2* General.

10.2.1 Areas in the vicinity of dipping and coating operations, especially drainboards and drip pans, shall be cleaned on a regular basis to minimize the accumulation of combustible residues and unnecessary combustible materials.

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10.2.2 Combustible coverings (thin paper, plastic, and so forth) and strippable coatings shall be permitted to be used to facilitate cleaning operations in dipping and coating areas.

10.2.3 If excess residue accumulates in work areas, ducts, duct discharge points, or other adjacent areas, then all dipping and coating operations shall be discontinued until conditions are corrected.

10.3* Waste Containers.

10.3.1 Approved waste containers shall be provided wherever rags or waste are impregnated with flammable or combustible material, and all such rags or waste shall be deposited therein immediately after use. The contents of waste containers shall be placed in a designated storage location.

10.3.2 Waste containers containing flammable liquids shall be located in ventilated areas that meet the requirements of Chapter 7. Such areas shall also meet the electrical area classification requirements of Section 6.6.

10.3.3* Waste containers for flammable liquids shall be constructed of conductive materials and shall be bonded and grounded.

10.3.4 Flammable liquids waste containers shall be handled and stored in accordance with Chapter 8.

10.4* Inspection and Testing. Inspections and tests of all process tanks, including covers, overflow pipe inlets, overflow outlets and discharges, bottom drains, pumps and valves, electrical wiring and utilization equipment, bonding and grounding connections, ventilation systems, and all extinguishing equipment, shall be made monthly. Any defects found shall be corrected.

10.5 Cleaning Operations. Cleaning operations shall be conducted with ventilating equipment in operation.

10.5.1 Solvents used for cleaning of dipping and coating equipment shall have flash points above 37.8°C (100°F) or at least equal to that of the dipping or coating materials normally used in the process.

10.6 Smoking. Signs stating NO SMOKING OR OPEN FLAMES and meeting the requirements of ANSI Z535, *Safety Signs Series IS*, shall be conspicuously posted at all dipping and coating areas and paint storage rooms.

10.7* Hot Work. Welding, cutting, and other spark-producing operations shall not be permitted in or adjacent to dipping or coating operations until a written permit authorizing such work has been issued. The permit shall be issued by a person in authority following his or her inspection of the area to ensure that proper precautions have been taken and will be followed until the job is completed.

10.8 Solvent Distillation Units (Solvent Recyclers).

10.8.1 Scope. This section shall apply to solvent distillation units having distillation chambers or still pots that do not exceed 227 L (60 gal) capacity and are used to recycle Class I, Class II, and Class IIIA liquids.

10.8.2 Equipment. Solvent distillation units shall be approved or shall be listed in accordance with UL 2208, *Standard for Solvent Distillation Units*.

10.8.3 Solvents. Solvent distillation units shall only be used to distill liquids for which they have been investigated and which are indicated on the unit's marking or instruction manual. Unstable or reactive liquids or materials shall not be processed unless they have been specifically indicated on the system's markings or in the instruction manual.

10.8.4 Location. Solvent distillation units shall only be used in locations in accordance with their approval or listing. They shall not be used in basements. They shall be located away from potential sources of ignition, as indicated on the unit's marking.

10.8.5 Liquid Storage. Distilled liquids and liquids awaiting distillation shall be stored in accordance with Chapter 8.

Chapter 11 Electrostatic Detearing Apparatus

11.1 Scope. Chapter 11 shall apply to any dipping or coating process that incorporates electrostatic detearing systems to remove excess coating material.

11.2 General.

11.2.1 Electrostatic detearing equipment shall meet the requirements of Chapter 1 through Chapter 10, except as hereinafter modified, and shall also meet the requirements of this chapter.

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

11.3 Requirements for Electrical System and Components.

11.3.1 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 3.3.12 or shall meet the requirements of Chapter 6.

11.3.2 Electrodes shall be supported and shall be insulated from ground.

11.3.3 High voltage leads to electrodes shall be supported on insulators and shall be guarded against accidental contact or grounding. Insulators shall be kept clean and dry.

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

11.4 Support of Workpieces.

11.4.1 Workpieces or material being deteared shall be supported on conveyors or hangers.

11.4.2* The conveyor shall be arranged to ensure that the workpieces or material being deteared is electrically connected to ground with a resistance of not more than 10^6 ohms (1 megohm) and that the distance required by 11.3.4 is maintained between the workpiece or material and the electrodes at all times.

11.4.3 Workpieces or material being deteared shall be supported to prevent swinging or movement that would reduce the distance to less than that required.

11.5 Manual Operations. Electrostatic detearing shall not be used where the workpieces or material being deteared is manipulated by hand.

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

(1) Stopping of ventilating fans or failure of ventilating equipment from any cause
(2) Stopping of the conveyor carrying the objects or material through the high voltage field
(3) Occurrence of a ground fault or excessive current leakage at any point on the high voltage system
(4) Reduction of clearances to below that specified in 11.3.4
(5) De-energizing of the primary side of the power supply

11.7 Personnel Safety. Safeguards such as enclosures, fencing, railings, or other means shall be placed about the equipment or incorporated therein to ensure that isolation of the process is maintained from plant storage or personnel.

11.8* 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).

11.8.1 This requirement shall apply to paint containers, wash cans, guards, and any other electrically conductive objects or devices in the area.

11.8.2 This requirement also shall apply to any personnel in the process area.

11.8.3 The equipment shall carry a prominent, permanently installed warning regarding the necessity for this grounding feature.

11.9 Signs. Signs that designate the process zone as dangerous in regard to fire and accident and that meet the requirements of ANSI Z535, *Safety Signs Series IS*, shall be conspicuously posted.

11.10 Drip Plates and Screens. Drip plates and screens subject to deposits of coating material shall be cleaned regularly to prevent excess accumulation of residues.

Chapter 12 Training

12.1* General. All personnel involved in dipping or coating processes covered by this standard shall be instructed in the safety and health hazards; the operational, maintenance, and emergency procedures required; and the importance of constant operator awareness.

12.1.1 Personnel required to handle or use flammable or combustible materials shall be instructed in the handling, storage, and use of the materials, as well as the emergency procedures that might be required.

12.1.2* 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 the use of protective and emergency equipment required.

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

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

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex 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 depends on the arrangement and operation of the particular installation. The principal hazards of these processes are fire and explosion due to the large quantities of exposed flammable liquids. If not quickly controlled, a fire can open sprinklers over a large area and might seriously damage building structural members. If not properly ventilated, enclosed processes 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 the following two categories:

(1) A fire protection system designed specifically for the process, which for dip tanks can also include an automatic-closing cover
(2) A fire protection system, such as an automatic sprinkler system, for the area in which 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 the properties of the coating.

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 possible damage to goods in process or other equipment should be considered in location of processes and installation of protection systems, regardless of the size of the process.

A.1.2.2 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, but not 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 toxic or negative health effects from exposure to the materials used.

A.3.2.1 Approved. 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 that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire preven-

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tion 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 departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations 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.

A.3.3.1 Boiling Point. For purposes of defining the boiling point, atmospheric pressure is considered to be 1.0 bar (14.7 psia). For mixtures that do not have a constant boiling point, the 20 percent evaporated point of a distillation performed in accordance with ASTM D 86, *Standard Method of Test for Distillation of Petroleum Products*, is considered the boiling point.

A.3.3.12 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 37.8°C (100°F) (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. However, when operations are provided with adequate continuous ventilation, the vapor area might extend only a limited distance. *(See Chapter 7.)*

The information in Chapter 7 of this publication and in Chapter 9 and associated annex material of NFPA 86, *Standard for Ovens and Furnaces*, can be of assistance in determining the adequacy of ventilation necessary to prevent the formation or to 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.4.2 The location of dipping and coating processes depends on considerations such as the quantities of flammable and combustible liquids used, the process arrangement, personnel exposure, the construction of the building, and surrounding exposures.

In facilities conducting extensive dipping and coating operations, the process should be confined by one of the following methods (in order of preference):

(1) Detached building or building cut off from other plant buildings by fire walls
(2) Area in a building cut off by fire walls or fire-resistive partitions
(3) Area in a building cut off by fire curtains
(4) Isolation by safe distance

The adaptation of assembly lines or conveyor systems to dipping and coating processes can present 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 counterdraft. 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 at least 450 mm (18 in.). Such curtains aid in preventing the activation 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.4.3 Dipping and coating operations involving flammable or combustible liquids should not be located in any basement area for the following reasons:

(1) Lack of egress
(2) Lack of access by emergency response personnel
(3) The possibility for extensive structural damage should an explosion occur because of accumulations of vapors

A.4.5 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.5.3 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.5.8.4 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.6.2.2 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, and so forth.

A.6.2.3 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 that might become dangerous due to accident or

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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.6.2.4 See NFPA 70, *National Electrical Code*.

A.6.2.5 See NFPA 70, *National Electrical Code*.

A.6.3 See NFPA 70, *National Electrical Code*.

A.6.3.1 This classification usually includes the following locations:

(1) Where volatile flammable liquids are transferred from one container to another
(2) Interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable solvents are used
(3) Locations containing open tanks or vats of volatile flammable liquids
(4) Drying rooms or compartments for the evaporation of flammable solvents
(5) All other locations where ignitible concentrations of flammable vapors or gases are likely to occur in the course of normal operations [**70:**500.5(B)(1) FPN No. 1]

In some Division 1 locations, ignitible concentrations of flammable gases or vapors can be present continuously or for long periods of time. Examples include the following:

(1) The inside of vented tanks containing volatile flammable liquids
(2) Inadequately ventilated areas within spraying or coating operations using volatile flammable fluids
(3) The interior of an exhaust duct that is used to vent ignitible concentrations of vapors [**70:**500.5(B)(1) FPN No. 2]

A.6.3.2 This classification usually includes locations where volatile flammable liquids or ignitible vapors are used but that, in the judgment of the authority having jurisdiction, would become hazardous only in case of an accident or of some unusual operating condition. The quantity of flammable material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that merit consideration in determining the classification and extent of each location. [**70:**500.5(B)(2) FPN No. 1]

Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids. Depending on factors such as the quantity and size of the containers and ventilation, locations used for the storage of flammable liquids in sealed containers may be considered either hazardous (classified) or unclassified locations. See NFPA 30, *Flammable and Combustible Liquids Code*. [**70:**500.5(B)(2) FPN No. 2]

A.6.3.3 This classification includes locations inside vented tanks or vessels that contain volatile flammable liquids; inside inadequately vented spraying or coating enclosures, where volatile flammable solvents are used; inside open vessels, tanks and pits containing volatile flammable liquids; and the interior of an exhaust duct that is used to vent ignitible concentrations of vapors. [**70:**505.5(B)(1) FPN No. 2]

It is not good practice to install electrical equipment in Zone 0 locations except when the equipment is essential to the process or when other locations are not feasible. [See NFPA 70, 505.5(A) FPN No. 2.] If it is necessary to install electrical systems in a Zone 0 location, it is good practice to install intrinsically safe systems as described by NFPA 70, Article 504. [**70:**505.5(B)(1) FPN No. 3]

A.6.3.4 Normal operation is considered the situation when plant equipment is operating within its design parameters. Minor releases of flammable material may be part of normal operations. Minor releases include the releases from mechanical packings on pumps. Failures that involve repair or shutdown (such as the breakdown of pump seals and flange gaskets, and spillage caused by accidents) are not considered normal operation. [**70:**505.5(B)(2) FPN No. 1]

This classification usually includes the following locations:

(1) Where volatile flammable liquids are transferred from one container to another
(2) Areas in the vicinity of spraying and painting operations where flammable solvents are used
(3) Adequately ventilated drying rooms or compartments for evaporation of flammable solvents
(4) Inadequately ventilated pump rooms for volatile flammable liquids
(5) Other locations where ignitible concentrations of flammable vapors or gases are likely to occur in the course of normal operation but not classified Zone 0 [**70:** 505.5(B)(2) FPN No. 2]

A.6.8 The intent of this requirement is to prevent discharge of static electricity in the form of an ignition-capable spark. NFPA 77, *Recommended Practice on Static Electricity*, contains information about grounding for static electric charge.

A.7.3 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 (TLV) must be considered when the process is a manually operated system. When the process is an automatic (conveyorized) system, the lower flammable limit generally governs 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; if the concentration reaches 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, 3.8 L (1 gal) of the average solvent occupies approximately 0.65 m^3 (23 ft^3) when evaporated into vapor at average room temperature. Therefore, if 3.8 L (1 gal) 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 65 m^3 (2300 ft^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 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 those reasons, a

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safety factor of 4 to 1 has been traditionally used and the ventilation requirement rounded off to 75 m^3/L (10,000 ft^3/gal) 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 obviously varies 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 0.5 m^3/sec of air movement per m^2 (100 cfm/ft^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 10 m/sec (2000 ft/min). The peripheral duct should be tapered to allow for solvent drainage, and if the length of lateral ductwork exceeds 1525 mm (5 ft), splitters should be considered. A combination of pressure and peripheral exhaust ducts should be considered for tanks in excess of 1525 mm (5 ft) in length. The quantity of air exhausted should approximate 0.50 to 0.75 m^3/sec/m^2 (100 to 150 cfm/ft^2) of tank surface area, and the pressure slot should be designed for approximately 5 to 10 m/sec (1000 to 2000 ft/min) capture velocity.

Open drainboards should be ventilated at a rate of approximately 0.25 m^3/sec/m^2 (50 cfm/ft^2) of drainboard 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 0.25 m^3/sec/m^2 (50 cfm/ft^2) of tank surface area with slot velocities as low as 5 m/sec (1000 ft/min).

One source for information on recommended capture and slot velocities, ductwork design, ventilation rates, and hood design is the ACGIH publication *Industrial Ventilation — A Manual of Recommended Practice*.

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.7.4 All dipping and coating process areas require make-up air. Because the air exhausted from these operations is normally contaminated and can be recirculated only 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, and so forth. 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 shutoff 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, and so forth, should not exceed 1 m/sec. Higher velocities can cause excessive turbulence in the airflow 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 the following:

(1) Location of sources of heat
(2) Location of air intakes to prevent recirculation of contaminated air
(3) Equipping air intakes with appropriate screens or filters
(4) Providing automatic temperature and proportioning controls, including an independent excess temperature limit control
(5) Use of 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
(6) Use of 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
(7) In the case of direct-fired units, use of 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.7.5 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 process might result in spontaneous ignition of residue accumulations on heat exchange surfaces.

A.7.6.2 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 are 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.7.12.2 If other operations or processes outside the dipping or coating process area also can produce ignitible vapors, in addition to the drying areas, they should be provided with adequate mechanical ventilation that is independent of the ventilation system provided for the dipping or coating process.

A.8.2 For large dipping or coating operations, coatings, thinners, and solvents can be stored in the following locations:

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(1) Underground storage tanks
(2) Aboveground storage tanks
(3) Separate buildings
(4) Separate dedicated rooms within the facility

In some cases, the coating material is pumped directly to the process vessel or tank. For smaller operations, separate storage areas might not be justified, but it is desirable to minimize the fire loading in or near the process area by one or a combination of the following methods:

(1) Use of flammable liquid storage cabinets
(2) Use of a protected enclosed metal structure
(3) Use of metal containers with limitations on the quantity of material located near the process area

A.8.5.6 NFPA 77, *Recommended Practice on Static Electricity*, provides information on static protection.

A.8.6.2 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.9.2 Automatic sprinkler systems are highly effective in controlling the spread of fire and protecting a building and nearby occupancies from damage. Dipping and coating processes should 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 located. Because of the rapid spread and intensity of fires involving flammable or combustible coating materials, the water supply should be sufficient to supply all sprinklers 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 planning for the removal of water contaminated with solvents to a safe location. This is especially true for processes in a multistory building. It might be necessary to provide waterproofing and drainage of the floor so that extensive water damage does not occur on floors below.

Sprinklers can extinguish fires in deposits of combustible residue and in liquids with flash points in excess of 93°C (200°F). They can control fires in liquids with flash points under 93°C (200°F), that is, the building should be protected from the heat of a 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.9.2(a) and Table A.9.2(b). The area of application indicated in the tables 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 6100 mm (20 ft) beyond the process in all directions.

Table A.9.2(a) and Table A.9.2(b) give recommended sprinkler densities and their area of coverage for coating operations involving flammable and combustible liquids.

Table A.9.2(a) Sprinkler Densities and Area Protection for Processes Relative to Flash Point of Liquids Used (SI Units)

Flash Point (°C)	Sprinkler Temperature Rating (°C)	Density ($L/min \cdot m^2$)	Area of Coverage (m^2)
Below –7 (including nitrocellulose lacquer)	141	12	560
	72	12	740
–7 to 94 or heated combustible liquids	141	12	370
	72	12	560
Over 94	141	10	370
	72	10	560

Table A.9.2(b) Sprinkler Densities and Area Protection for Processes Relative to Flash Point of Liquids Used (U.S. Customary Units)

Flash Point (°F)	Sprinkler Temperature Rating (°F)	Density (gpm/ft^2)	Area of Coverage (ft^2)
Below 20 (including nitrocellulose lacquer)	286	0.3	6000
	160	0.3	8000
20 to 200 or heated combustible liquids	286	0.3	4000
	160	0.3	6000
Over 200	286	0.25	4000
	160	0.25	6000

A.9.3.1(1) Water is generally effective on liquids having flash points above 60°C (140°F).

A.9.6 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 190 L (50 gal) in capacity is often greater than those over 3800 L (1000 gal) capacity. This is generally because the hazard in large tanks is recognized and protection is provided. Protection has, therefore, been recommended for all tanks regardless of size.

A.9.7 Fires in large process tanks [570 L (150 gal) 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:

(1) Will the extinguishing agent be effective on the hazard?
(2) Is it the best agent to use under the circumstances in regard to safety, cleanup, and contamination?
(3) Is the importance of the process such that it requires redundant protection?
(4) 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. Note, however, that discharge from hose streams or other portable extinguishing equipment can disturb the foam

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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.9.7.2 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 drainboards, hoods, ducts, drying tunnels, and so forth, 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.10.2 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.

In the dipping or coating of 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. Proper operation, effective maintenance, and housekeeping should be maintained.

A.10.3 Many fires have originated from the spontaneous ignition of fabric and waste impregnated with coating materials. After dipped or coated articles have been rubbed with rags or waste has been 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 because the gases of decomposition could cause an explosion.

A.10.3.3 See NFPA 77, *Recommended Practice on Static Electricity*, for information on bonding and grounding.

A.10.4 Inspection by a competent and reliable individual should be made to determine the following:

(1) All sprinkler control valves are open.
(2) Fire extinguishers are properly charged and in place.
(3) Fire suppression and alarm systems are charged and in operable condition.
(4) Electric motors and fan bearings are not overheating.
(5) Fan blades are in alignment.
(6) Electric wiring has proper overcurrent protection.
(7) Guards and globes on lighting fixtures are clean and in place.
(8) Overflow and drain systems are in proper operating condition.
(9) Cleanliness is being maintained.
(10) 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 is kept wetted down with water beforehand 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 should be 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.10.7 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 wet down with water beforehand in order to avoid a fire. During such repairs, no spraying should be conducted, all flammable and combustible liquids and portable combustible material should be removed from the vicinity, and suitable fire extinguishers should be kept readily available. The use of welding or cutting torches should be prohibited except under the supervision of a competent person familiar with the fire hazards involved. See NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, for additional information.

A.11.4.2 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.11.8 The grounding requirements for parts being deteared apply for the same reasons to all other conductive objects (including personnel) that are in the vicinity of the high voltage electrodes.

A.12.1 The safety of a dipping or 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 the 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.12.1.2 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, the following:

(1) Analysis of the confined-space atmosphere for flammable, combustible, toxic, or oxygen-deficient conditions
(2) Rescue, fire, and emergency procedures
(3) Locking and tagging procedures for all power and process hazard sources
(4) Ventilation procedures
(5) Personal protective equipment to be used
(6) Proper tools and electrical equipment to be used
(7) Provision for written entry authorization by a qualified responsible individual

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Annex B Fire Record

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Overview. 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 is not necessarily a factor in process tank losses. The average damage to property and interruption to production are often as high in tanks under 190 L (50 gal) as in tanks exceeding 3800 L (1000 gal) 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 37.8°C (100°F). Ignition occurs in either the vapor space above the liquid surface or in deposits of residue on the drainboard 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.

B.2 Ignition Sources. The following are the four most common sources of ignition:

(1) *Electrical Utilization Equipment.* Ignition occurs most frequently from failure of electrical utilization equipment in the area or by the use of electrical utilization equipment that is not suitable for the location in which it is located.
(2) *Maintenance Operations.* It is generally well recognized that flammable liquid vapors can be readily ignited by sparks from cutting, welding, and drilling operations. Few losses have been reported involving the exposed liquid surface of the tank. Most losses have occurred in areas where residue has accumulated near the tank or in the exhaust duct. When the residue was ignited, flame spread back to the tank.
(3) *Static Electricity.* Ignition occurs usually when liquids are transferred from one container to another or in processes without adequate bonding and grounding.
(4) *Smoking.* Careless discarding of smoking materials or matches has been another common ignition source.

B.3 Contributing Factors. Process tank fires have varied from a "typical" fire, confined to the tank and drainboard 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.

Subsections B.3.1 through B.3.3 describe the three factors that either alone or in combination have contributed to large losses.

B.3.1 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, can 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
(4) Increase of heat intensity rapid enough that manual pull stations cannot be reached

B.3.2 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.

B.3.3 Lack of Adequate Cutoffs. This has occurred when nearby material (e.g., goods in process or equipment) is susceptible to heat, smoke, and water damage and where the tank has not been adequately cut off. 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.

Annex C Illustrations of Suggested Methods of Protection

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 Overview. Figure C.1(a) through Figure C.1(f) represent only general principles of process tank arrangements and are not intended to cover detail design. Alternative arrangements accomplishing the same objectives are equally effective.

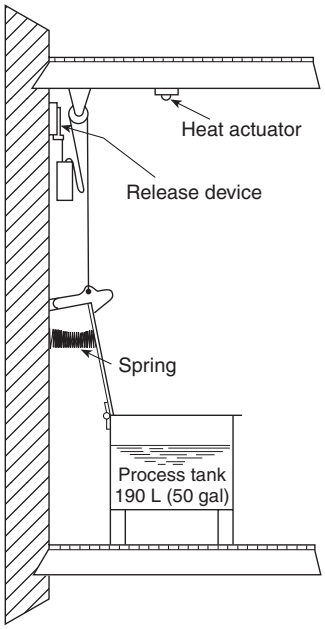


FIGURE C.1(a) A Small Process Tank with an Automatic Cover.

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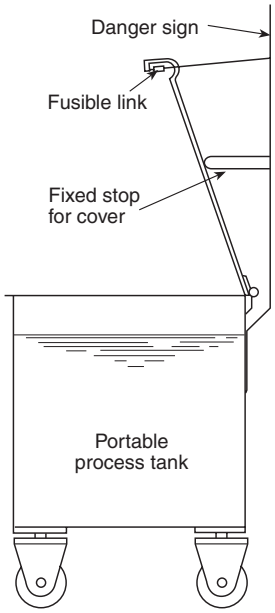


FIGURE C.1(b) A Portable Tank with an Automatic Cover.

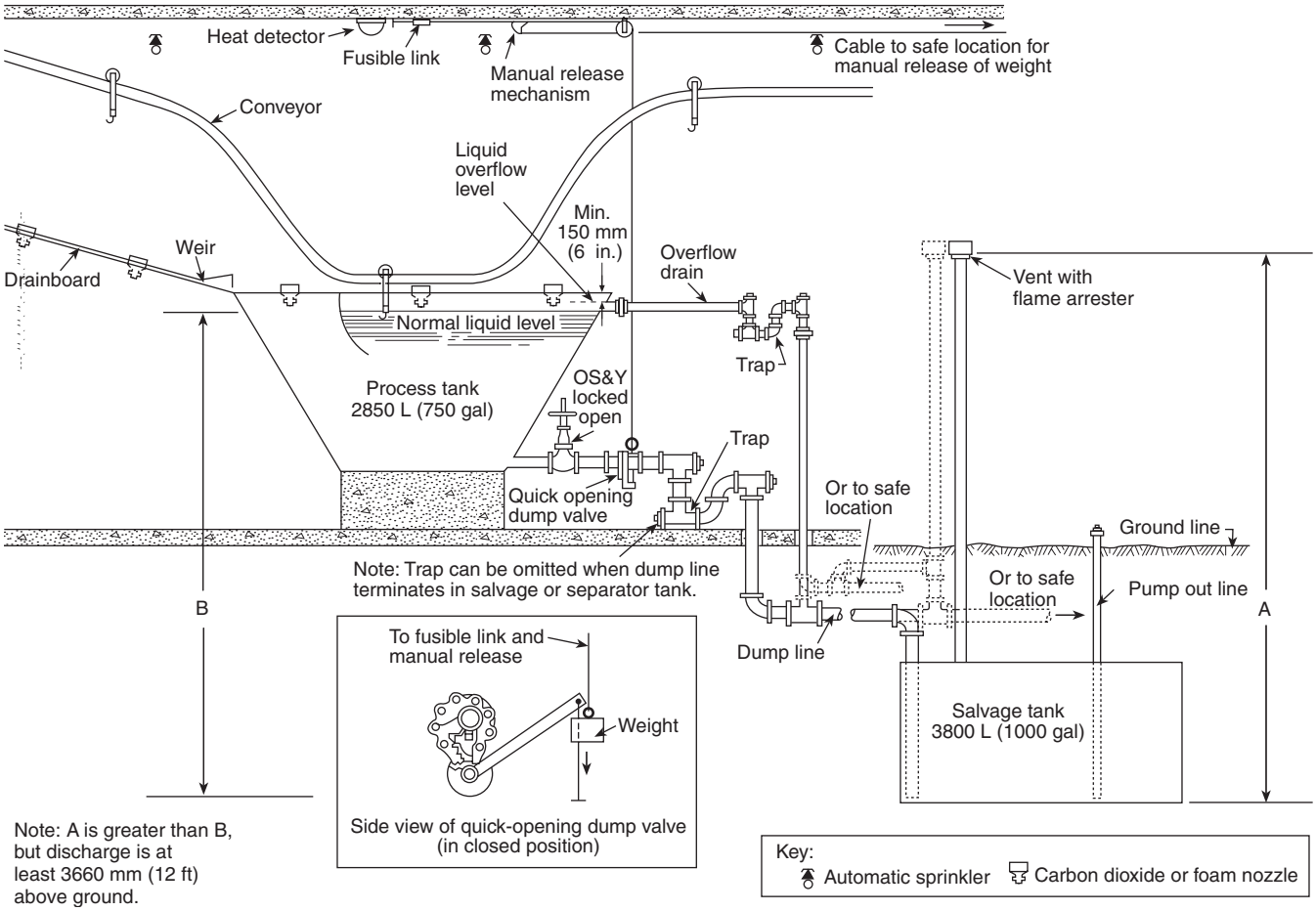


FIGURE C.1(c) Typical Process Tank Installation.

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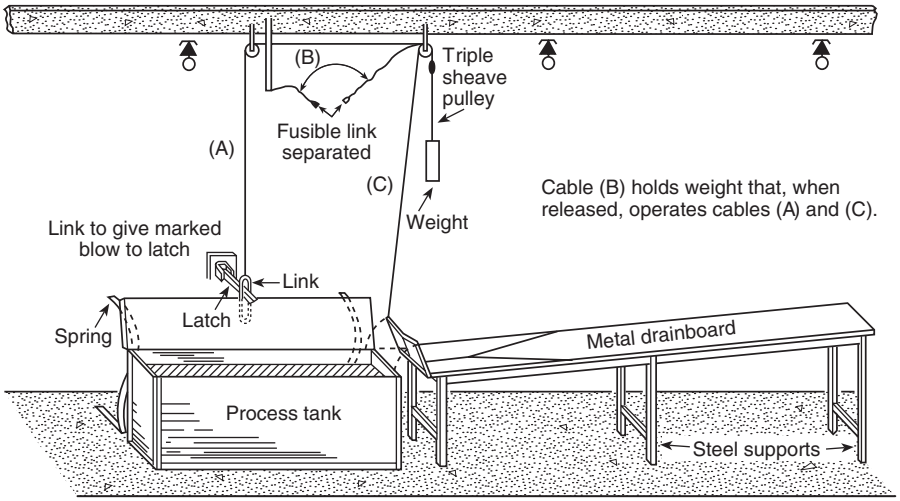


FIGURE C.1(d) Process Tank, Automatic Cover, and Drainboard, with Drainboard Arranged to Prevent Interference with Cover. The link in cable B has separated, the weight has lifted the hinged section of the drainboard, and the latch is about to operate to release the cover. [For drainboard details, see Figure C.1(e).]

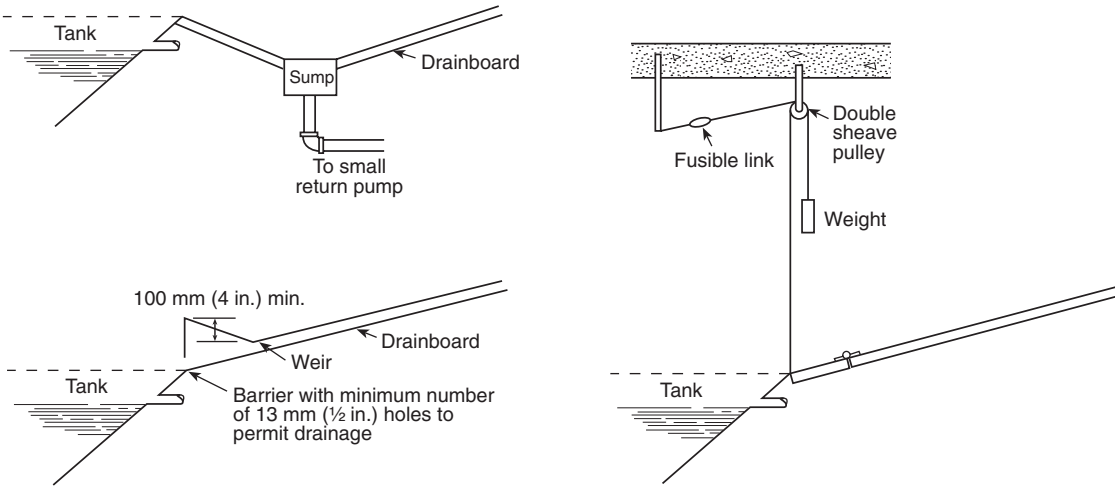


FIGURE C.1(e) Suggested Arrangements to Prevent Sprinkler Discharge onto Drainboard from Entering Tank. The two arrangements on the left are most effective for other than paint process tanks. If used for paint process tanks, drain holes and piping should be cleaned frequently to prevent clogging. The arrangement on the right is effective for paint process tanks.

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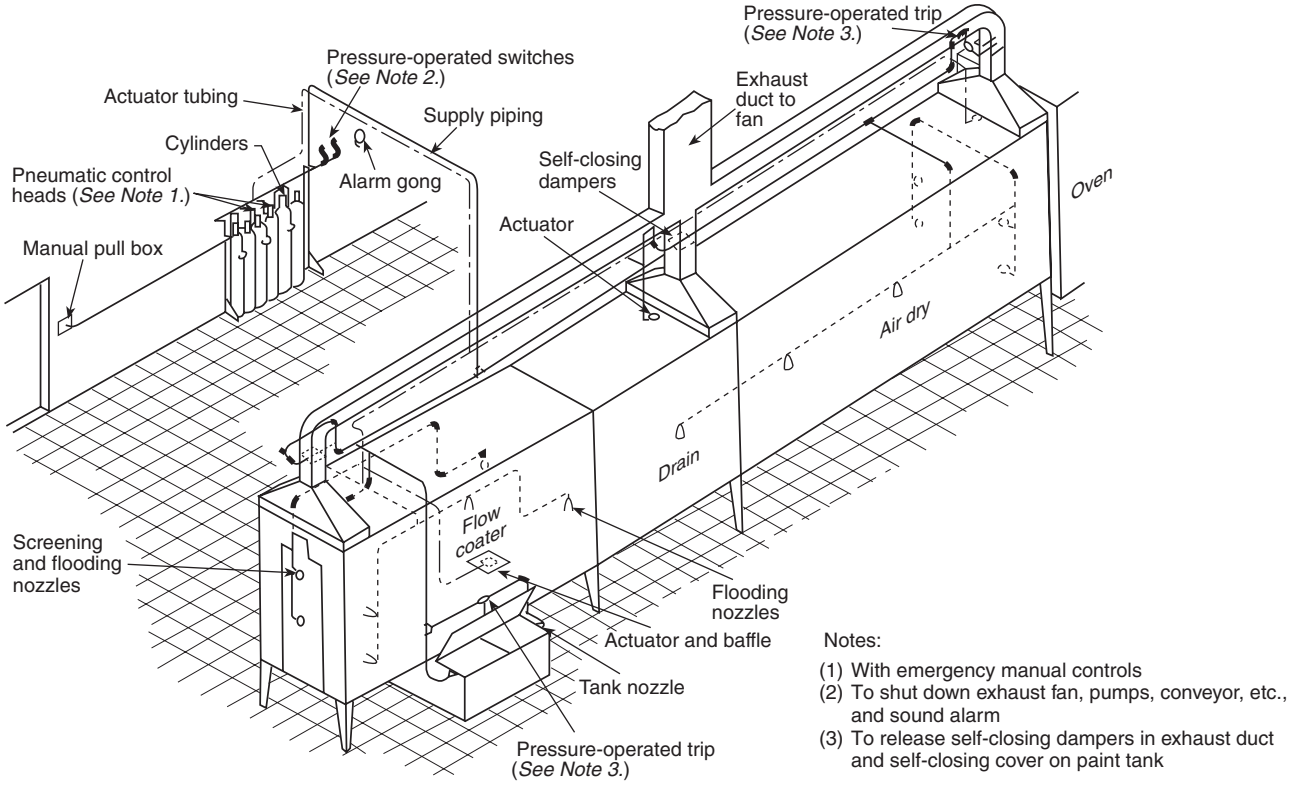


FIGURE C.1(f) Flow Coater Protected by a Typical Carbon Dioxide Total Flooding System That Can Be Either Manually or Automatically Activated.

Annex D Informational References

D.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

D.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2003 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2003 edition.

NFPA 70, *National Electrical Code®*, 2005 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2007 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2007 edition.

D.1.2 Other Publications.

D.1.2.1 ACGIH Publications. American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240.

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Index

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-A-

Air, make-up ..... *see* Make-up air
Alarms 9.5
Application of standard ..... 1.1.1 to 1.1.5, 1.3
Approved (definition) 3.2.1, A.3.2.1
Assembly occupancies, location in 4.5, A.4.5
Authority having jurisdiction (AHJ) (definition) 3.2.2, A.3.2.2

-B-

Below grade level locations 4.3, 6.4.1, A.4.3
Boiling point (definition) 3.3.1, A.3.3.1
Bonding, electrical 8.5.5, 8.6.2, 10.3.3, 10.4, A.8.6.2, A.10.3.3, B.2

-C-

Cabinets, flammable/combustible liquids storage 8.3, A.8.2
Carbon dioxide extinguishing system ..... 8.3.1(3), 9.9, B.3.1
Cleaning operations 10.5, A.10.4
Closed containers ..... *see* Containers
Coating ..... *see also* Curtain coating; Flow coating; Roll coating
Dip coating (definition) ..... 3.3.3.2; *see also* Dip tanks
Coating processes ..... *see* Curtain coating; Dip coating; Flow coating; Roll coating
Coating tanks ..... *see* Dip tanks
Combustible liquids ..... *see* Liquids
Confined spaces, entry to 12.1.2
Construction
Of equipment and systems ..... Chap. 5
Of exhaust ducts 7.7
Containers
Closed containers 8.4, 8.5.1
Definition 3.3.3.1
Definition 3.3.3
Intermediate bulk containers 8.4, 8.5.1
Transferring liquids from/to ..... 8.5.3 to 8.5.6, A.6.3.1, A.8.5.6
Ventilated areas, open, supply, or waste containers of flammable liquids located in 6.6
Conveyor systems ..... 5.9, 9.5, 11.4, 11.6(2), A.11.4.2
Covers, tank ..... 9.3.1(7), 9.6, 10.4, A.9.6
Curtain coating ..... 9.7.1(2), 9.8(4)
Definition 3.3.2.1

-D-

Day care occupancies, location in 4.5, A.4.5
Definitions ..... Chap. 3
Design of equipment and systems ..... Chap. 5
Detearing (definition) 3.3.4
Detearing apparatus, electrostatic ..... Chap. 11
Detention and correctional occupancies, location in 4.5, A.4.5
Dip coating (definition) ..... 3.3.2.2; *see also* Dip tanks
Dip tanks
Arrangements, illustrations of ..... Annex C
Bottom drains 5.7
Covers ..... 9.3.1(7), 9.6, 10.4, A.9.6
Definition 3.3.4
Electrical area classification, Class I location A.6.3.1, A.6.3.3
Filling ..... 8.6.2 to 8.6.6, A.8.6.2
Fire protection systems ..... Chap. 9
Fires in ..... Annex B
Height above floor 5.3, A.5.3
Inspection and testing 10.4, A.10.4
Liquid level
Maximum 5.5
Overflow control ..... 5.4 to 5.6, 8.6.5
Liquid temperature, control of 5.10
Supports for 5.2.1
Transfer of liquids to ..... 8.5.3 to 8.5.6, 8.6.2 to 8.6.6, A.8.5.6, A.8.6.2
Drains, bottom 5.7, 9.5, 10.4, A.10.4
Drip plates and screens 11.10
Dry chemical extinguishing systems ..... 9.3.1(4), B.3.1
Drying areas 7.12, A.6.3.1, A.6.3.4, A.7.12.2
Ducts, exhaust
Access 7.10
Construction materials 7.7
Cross-section of 7.9
Electrical area classification, Class I location A.6.3.1
Fire protection systems 9.3.2
Maintenance B.2
Routing of 7.5, A.7.5
Support of 7.8

-E-

Educational occupancies, location in 4.5, A.4.5
Egress, means of 4.4
Electrical area classification 6.3, A.6.3
Electrical utilization equipment ..... Chap. 6, B.1, B.2; *see also* Static electricity
Definition 3.3.5
Electrostatic detearing apparatus 11.3, 11.6
Inspection and testing 10.4, A.10.4
Electrostatic detearing (definition) 3.3.6
Electrostatic detearing apparatus ..... Chap. 11
Enclosed processes
Electrical installations in areas adjacent to 6.5
Fire protection 9.7, A.9.7
Light fixtures in 5.2.2, 6.7
Personnel, training of 12.1.2
Ventilation 7.3.1
Equivalency to standard 1.5
Exhaust systems ..... *see* Ventilation
Extinguishers, portable fire 9.11, A.10.4, A.10.7

-F-

Fans, exhaust ..... 7.11, 11.6(1)
Fire protection ..... Chap. 9, Annex B
Dip tank liquid level for 5.5
Inspection and testing 10.4, A.10.4
Notification and interlocks 9.5
Process pumps 8.6.6
Fire record ..... Annex B
Flammable gas, Class I locations 6.3, A.6.3
Flammable liquids ..... *see* Liquids
Flow coating ..... 9.7(4), 9.7.1(2)
Definition 3.3.2.3
Foam extinguishing systems ..... 9.3.1(2), 9.3.2, B.3.1

-G-

Gas, flammable, Class I locations 6.3, A.6.3
Gaseous agent extinguishing systems ..... 9.3.1(5)
Grade level, locations below 4.3, 6.4.1, A.4.3
Grounding 6.8, 10.3.3, 10.4, 11.4.2, 11.6, 11.8, A.6.8, A.10.3.3, A.11.4.2, A.11.8, B.2

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-H-

Health care occupancies, location in 4.5, A.4.5
Heater, liquid 8.5.6
Heating and ventilating system A.7.3
Hoods 9.3.2, A.7.3
Hot surfaces 6.2.2, A.6.2.2
Hot work 10.7, A.10.4, A.10.7, B.2

-I-

Ignition sources ..... Chap. 6, 10.3, 10.8.4, A.10.3, B.2
Industrial occupancies, storage cabinets in ..... 8.3.3 to 8.3.5
Inspections 10.4, A.10.4
Institutional occupancies, location in 4.5, A.4.5
Interlocks 9.5, A.7.3
Intermediate bulk containers 8.4, 8.5.1

-L-

Labeled (definition) 3.2.3
Large processes, fire protection for 9.7, A.9.7
Light fixtures 5.2.2, 6.7
Liquids
Cleaning solvents 10.5.1
Combustible liquids (definition) 3.3.7.1
Definition 3.3.7
Flammable liquids (definition) 3.3.7.2
Handling at point of final use 8.5, A.8.5.6
Piping systems 8.5.3, 8.5.6.3, 8.7
Repairs, removal during A.10.4, A.10.7
Solvent distillation units 6.6, 10.8.3, 10.8.5
Storage and handling ..... Chap. 8
Temperature, control of 5.10
Transporting of 8.4
Ventilated areas for containers or solvent distillation units containing Class I liquids 6.6
Waste containers containing ..... 10.3.2 to 10.3.4, A.10.3.3
Listed (definition) 3.2.4, A.3.2.4
Location of dipping and coating processes ..... Chap. 4

-M-

Maintenance ..... Chap. 10, 11.10, B.2
Make-up air ..... 7.4, 9.4 Ex., A.7.4
Means of egress 4.4
Measurement, units of 1.6

-N-

Noncombustible material (definition) 3.3.8

-O-

Open flames 6.2.2, A.6.2.2
Open processes, electrical installations in areas adjacent to 6.4
Operations ..... Chap. 10

-P-

Peripheral vapor containment (definition) 3.3.9
Personnel
Safety 11.7
Training ..... Chap. 12
Pipes and piping
Drain 5.7.4
Flammable and combustible liquids 8.4, 8.5.3, 8.5.6.3, 8.6
Overflow 5.6, 10.4, A.10.4
Sprinkler system A.9.7.2
Portable storage tanks 8.4, 8.5.1
Process areas, flammable/combustible liquids storage in 8.3
Process tanks ..... *see* Dip tanks
Protection ..... Chap. 9
Suggested methods of ..... Annex C
Pumps 8.6.4, 8.6.6, 10.4, A.6.3.4, A.10.4
Purpose of standard 1.2, A.1.2

-R-

Recirculation, of exhaust air 7.6, A.7.6.2
References ..... Chap. 2, Annex D
Repairs A.10.4, A.10.7
Residential occupancies, location in 4.5, A.4.5
Residue
Control of 10.2.1, 10.2.3, A.10.2, A.10.3, A.10.4, A.10.7, B.2
Electrical wiring and equipment, deposits on 6.2.5, A.6.2.5
Retroactivity of standard 1.4
Roll coating ..... 9.5, 9.7(3), 9.7.1(3)
Definition 3.3.2.4

-S-

Safety cans 8.4, 8.5.3
Salvage tanks 5.7.3, 5.8, A.5.8.4
Scope of standard 1.1
Secondary enclosure (definition) 3.3.10
Separation, of dipping and coating processes ... 4.2, 4.5, A.4.2, A.4.5
SI units 1.6
Small processes, fire protection for 9.6, A.9.6
Smoking 10.6, B.2
Solvent cleaning 10.5.1
Definition 3.3.11
Solvent distillation units 6.6, 10.8
Spark-producing equipment 6.2.2, 6.2.3, A.6.2.2, A.6.2.3
Spontaneous ignition A.10.3
Sprinkler systems ..... 4.5, 9.2, 9.3.1(6), 9.3.1(7), 9.9, 10.4, A.4.5, A.9.2, A.10.4, B.3.1
Standard (definition) 3.2.5
Static electricity ..... 6.8, A.6.8, B.2; *see also* Bonding, electrical
Storage of flammable and combustible liquids ..... Chap. 8, 10.8.5

-T-

Tanks
Dip ..... *see* Dip tanks
Fill pipes 8.5.5, 8.6.2, A.8.6.2
Fire protection systems ..... Chap. 9
Portable storage 8.4, 8.5.1
Salvage 5.7.3, 5.8, A.5.8.4
Testing, of tanks 10.4, A.10.4
Training ..... Chap. 12

-U-

Units of measurement 1.6
Utilization equipment, electrical ..... *see* Electrical utilization equipment

-V-

Vapor area 7.3, 7.12.2, A.6.3.1, A.7.3, A.7.12.1
Class I locations 6.3, A.6.3
Definition 3.3.12, A.3.3.12
Vapor source ..... 6.4.1 to 6.4.4, 7.3, A.7.3
Definition 3.3.13
Ventilation ..... Chap. 7, 11.6(1); *see also* Ducts, exhaust
Cleaning operations 10.5
Definition 3.3.14
Drying areas 7.12, A.7.12.2
Electrical classification of area based on 6.6.2
Fans and drives ..... 7.11, 11.6(1)
Fire alarm systems, interlocks with 9.4
Flammable liquids, containers or solvent distillation units containing 6.6
Inspection and testing 10.4, A.10.4
Recirculation of exhaust 7.6
Vision panels 5.2.2

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-W-

Warning signs
Electrostatic detearing apparatus 11.9
Smoking prohibition 10.6
Waste containers 6.6, 10.3, A.10.3
Water spray extinguishing systems ..... 9.3.1(1), 9.9, A.9.3.1(1)
Wiring .... 6.2.1.2, 6.2.4, 6.2.5, 10.4, A.6.2.4, A.6.2.5; *see also* Electrical utilization equipment

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Step 1: Call for Proposals

- Proposed new Document or new edition of an existing Document is entered into one of two yearly revision cycles, and a Call for Proposals is published.

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- Committee meets to act on Proposals, to develop its own Proposals, and to prepare its Report.
- Committee votes by written ballot on Proposals. If two-thirds approve, Report goes forward. Lacking two-thirds approval, Report returns to Committee.
- Report on Proposals (ROP) is published for public review and comment.

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- Committee meets to act on Public Comments to develop its own Comments, and to prepare its report.
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Revise definition of effective ground-fault current path to read:

3.3.78 Effective Ground-Fault Current Path. An intentionally constructed, permanent, low impedance electrically conductive path designed and intended to carry ~~underground~~ electric fault current ~~conditions~~ from the point of a ground fault on a wiring system to the electrical supply source.

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