

NFPA®

34

Standard for
Dipping, Coating, and
Printing Processes
Using Flammable or
Combustible Liquids

2021



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NFPA® 34

Standard for

Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids

2021 Edition

This edition of NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*, was prepared by the Technical Committee on Finishing Processes. It was issued by the Standards Council on October 5, 2020, with an effective date of October 25, 2020, and supersedes all previous editions.

This edition of NFPA 34 was approved as an American National Standard on October 25, 2020.

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 Subsequently, jurisdiction was transferred to a new Committee on Manufacturing Hazards which, in turn, was superseded by the current Technical Committee on Finishing Processes.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 again in 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, 2006, and 2010.

The following major changes were adopted for the 2003 edition:

- (1) The scope of the standard was extended to cover water-based coatings.
- (2) Modifications to the document as a whole to comply with the *Manual of Style for NFPA Technical Committee Documents*.
- (3) Chapter 4 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 5.5.1 was revised to allow recirculation of exhaust air under certain conditions and to specify those conditions.
- (5) Chapter 7 was revised to correlate with Chapter 9 of NFPA 33.
- (6) Section 9.6 was revised to require grounding and deenergizing of the electrostatic circuit.

The following major changes were adopted for the 2007 edition:

- (1) A number of definitions were 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 were 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 were further revised to correlate with *NFPA 70®*, including appropriate Fine Print Notes from *NFPA 70*.
- (4) New diagrams were added to illustrate electrical area classification around open dipping and coating processes.
- (5) Quantity limitations for storing flammable and combustible liquids were changed to correlate with NFPA 30.
- (6) Chapter 9 was completely rewritten to accomplish the following:

- (a) Correlate with NFPA 33
- (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) was added.
- (8) Additional changes were made to correlate this standard with NFPA 33.

The following major changes were adopted in the 2011 edition:

- (1) The scope of the standard was amended to specifically address printing processes, and appropriate changes were made throughout the standard where certain provisions applied specifically to the printing process or excluded printing processes.
- (2) The scope of the standard was amended to specifically include vapor degreasing processes and to specifically exclude processes that use only Class IIIB liquids.
- (3) New definitions for printing and for certain types of printing processes were added to Chapter 3.
- (4) A new paragraph, 5.2.1.1, was added to allow coating rolls to be covered with polymeric or other combustible materials.
- (5) Section 5.3, which required the top of the coating tank to be a certain distance above the floor, was amended to apply only to tanks holding flammable or combustible liquid.
- (6) Exceptions were added to 5.9.1 and 5.9.2 to exclude sheet and web transport systems from the requirement to stop conveying systems under certain conditions.
- (7) Paragraph 5.10.1.3 was amended to prevent coating of workpieces whose surface temperature exceeds the boiling point of the coating media.
- (8) Subsection 6.2.2, which prohibited the use of certain ignition-capable equipment, was amended to apply only to areas where flammable or combustible liquid were in use.
- (9) A new Figure 6.4(e) was added to illustrate the hazardous (classified) area around a printing press for purposes of electrical area classification.
- (10) Subsection 6.4.2 was amended to describe the hazardous (classified) area associated with ink tanks and reservoirs in printing processes.
- (11) Section 6.5 on electrical area classification of enclosed processes was amended to apply only to dipping and coating processes. Printing processes are inherently open in nature.
- (12) A new subsection, 6.8.2, was added, requiring means to dissipate static electric charges from nonconductive substrates.
- (13) An exception was added to 9.5.1(4) to exclude sheet and web transport systems from the requirement to stop conveying systems under certain conditions, if stopping would cause a more hazardous situation.
- (14) A new Section 9.11 was added to address fire protection measures specific to printing processes.
- (15) Chapter 10 was amended to improve the requirements that address housekeeping, handling of liquid-impregnated rags, and waste.
- (16) Section 10.5 was completely rewritten to address use of Class I flammable liquids and Class II combustible liquids for cleaning operations.
- (17) A new Section 10.6 was added to address cleaning of combustible dusts and residues.
- (18) A new Section 10.10 was added to address solvent recovery systems.
- (19) A new annex item, A.9.3.1(3), was added to describe where carbon dioxide fire protection systems have been found useful in printing processes.

Following are some of the key changes made to the 2015 edition:

- (1) Terms and definitions were modified to be consistent with other NFPA documents and to mirror those used in NFPA 33.
- (2) Requirements were established for processes located in basements to ensure adequate egress and access for emergency response personnel.
- (3) Artwork in Chapter 6 was revised for consistent formatting and to better depict electrical classification requirements in the document.
- (4) The requirements for recirculation were revised to include the recirculation particulate filters, which are now defined in the standard.
- (5) The requirements for routing of exhaust ducts were clarified and modified to be consistent with NFPA 33.
- (6) The requirements for support of exhaust ducts were clarified and annex material was added.
- (7) The storage allowances for flammable and combustible liquids in Chapter 8 were modified to be consistent with NFPA 33 and NFPA 30 requirements.
- (8) Water mist fire protection systems meeting the requirements of NFPA 750 were added as an acceptable method of fire protection.

The following changes were made for the 2018 edition:

- (1) Chapter 1 added clarification to document application.
- (2) Chapter 3 was modified to be consistent with other NFPA documents. In addition, definition changes made to liquids and materials were consistent with other NFPA documents placing noncombustible material, limited combustible material, and classification of liquids and determination of flash points in a general requirements section. Changes to definitions are consistent with NFPA 1, NFPA 30, and *NFPA 5000*.
- (3) Chapter 4 was revised to clarify definitions and location of dipping, coating, and printing processes. Additional supporting Annex A material was provided.
- (4) Chapter 5 was revised to remove the exception and clarify construction for secondary enclosures.
- (5) Chapter 6 was revised. In addition, the figures in Chapter 6 and Annex A were revised to improve consistency and to clarify electrical classification requirements in the document.

The following revisions have been made to the 2021 edition:

- (1) The standard has been revised to align with the 2021 edition of NFPA 30 and the 2020 edition of *NFPA 70*. “Class I” has been removed from references to “Class I, Zone 0,” “Class I, Zone 1,” and “Class I, Zone 2” to match requirements in *NFPA 70*, and the term *ignitable* has been added to references of *flammable or combustible liquids* in alignment with NFPA 30.
- (2) Definitions for *flash point* and *ignitable liquid* have been extracted from NFPA 30. These terms are found in new language added to Chapter 8.
- (3) The requirements for limited-combustible materials in Chapter 4 have been expanded to include an additional option to meet these requirements based on heat release rates.

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

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall apply to dipping, roll coating, flow coating, curtain coating, printing, cleaning, and similar processes, hereinafter referred to as “coating processes” or “processes,” in which articles or materials are passed through tanks, vats, or containers, or passed over rollers, drums, or other process equipment that contain flammable or combustible liquids.

1.1.2 This standard shall also apply to cleaning processes that utilize a solvent vapor, such as vapor degreasing processes.

1.1.3 This standard shall also apply to processes that use water-borne, water-based, and water-reducible materials that contain ignitable (flammable or combustible) liquids or that produce combustible deposits or residues.

1.1.4 This standard shall not apply to processes that use only noncombustible liquids for processing and cleaning. This

standard shall also not apply to processes that use only Class IIIB [FP > 93°C (200°F)] liquids for processing or cleaning, provided the liquids or mixtures thereof maintain their Class IIIB [FP > 93°C (200°F)] liquid classification at their point of use.

1.1.5 This standard shall not apply to processes that use a liquid that does not have a fire point when tested in accordance with ASTM D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*, up to the boiling point of the liquid or up to a temperature at which the sample being tested shows an obvious physical change.

1.1.6 This standard shall not apply to fluidized bed powder application. (See Chapter 15 of NFPA 33.)

1.2* Purpose.

1.2.1 The purpose of this standard shall be to provide requirements for fire safety for dipping, coating, and printing processes that use ignitable (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, coating, and printing 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 processes within the scope of this standard. 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.

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

NFPA 10, *Standard for Portable Fire Extinguishers*, 2018 edition.
NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2021 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2021 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2019 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2017 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2021 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2021 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2021 edition.

NFPA 70®, *National Electrical Code®*, 2020 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2019 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2019 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids*, 2020 edition.

NFPA 101®, *Life Safety Code®*, 2021 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2018 edition.

NFPA 654, *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*, 2020 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2019 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2021 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2021 edition.

2.3 Other Publications.

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

ANSI Z535, *Safety Signs Series IS*, 2011.

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

Boiler and Pressure Vessel Code, Section VIII, 2019.

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

ASTM D5/D5M, *Standard Test Method for Penetration of Bituminous Materials*, 2013.

ASTM D56, *Standard Test Method for Flash Point by Tag Closed Cup Tester*, 2016a.

ASTM D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester*, 2018.

ASTM D93, *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*, 2018.

ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*, 2015a.

ASTM D3278, *Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus*, 1996, reapproved 2011.

ASTM D3828, *Standard Test Methods for Flash Point by Small Scale Closed Cup Tester*, 2016a.

ASTM D4359, *Standard Test Method for Determining Whether a Material is a Liquid or a Solid*, 1990, reapproved 2012.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2019.

ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*, 2019a.

ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*, 2018.

ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*, 2017.

2.3.4 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 723, *Test for Surface Burning Characteristics of Building Materials*, 2018.

UL 2208, *Solvent Distillation Units*, 2010, revised 2015.

2.3.5 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*, 2021 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2021 edition.

NFPA 70®, *National Electrical Code®*, 2020 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2021 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. An NFPA Standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase “standards development process” or “standards development activities,” the term “standards” includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Basement. For the purposes of this standard, a story of a building or structure having one-half or more of its height below ground level and to which access for firefighting purposes is restricted. [30, 2021]

3.3.2* Boiling Point. (BP) The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure. [30, 2021]

3.3.3 Coating Processes.

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

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

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

3.3.3.4 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.

3.3.4 Container. A vessel of 450 L (119 gal) or less capacity used for transporting or storing liquids, excluding intermediate bulk containers. [30, 2021]

3.3.4.1 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, 2021]

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

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 Flash Point (FP). The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in Section 4.8. [30, 2021]

3.3.8 Liquid (Physical State). Any material that (1) has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D5/D5M, *Standard Test Method for Penetration of Bituminous Materials*, or (2) is a viscous substance for which a specific melting point cannot be determined but that is determined to be a liquid in accordance with ASTM D4359, *Standard Test Method for Determining Whether a Material is a Liquid or a Solid*. [30, 2021]

3.3.8.1 Combustible Liquid. An ignitable liquid that is classified as a Class II or Class III liquid. (See 4.7.2 and 4.7.3.) [30, 2021]

3.3.8.2 Flammable Liquid. An ignitable liquid that is classified as a Class I liquid. (See 4.7.1.) [30, 2021]

3.3.8.3* Ignitable Liquid. Any liquid or liquid mixture that has a measurable fire point. [30, 2021]

3.3.9 Material.

3.3.9.1 Flammable or Combustible Material. Any material, including its residue, that is used in the spray application process and also meets the definition of a combustible liquid (see 3.3.8.1) or a flammable liquid (see 3.3.8.2).

3.3.9.2 Limited-Combustible Material. See Section 4.6.

3.3.9.3 Noncombustible Material. See Section 4.5.

3.3.10 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.

3.3.11* Printing. The art of transferring an image from a plate, block, or other device onto a substrate using inks or dyes, including, but not limited to, flexography, gravure, lithography, screen, digital, and UV methods.

3.3.12* Recirculation Particulate Filter. A filter, or series of filters, capable of removing more than 95 percent of particles

0.3 to 10 μ (1.2×10^{-5} in. to 3.9×10^{-4} in.) in size from the airstream.

3.3.13 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.

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

3.3.15 Utilization Equipment. Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes. [70:100]

3.3.16* Vapor Area. Any area that could contain a flammable vapor concentration exceeding 25 percent of the lower flammable limit (LFL) during operation or shutdown periods.

3.3.17 Vapor Source. Any source 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 or material.

3.3.18 Ventilation. The changing of air within a compartment by natural or mechanical means.

Chapter 4 General Requirements

4.1* Location of Dipping, Coating, and Printing Processes. Processes shall be located in industrial occupancies as defined by NFPA 5000.

4.1.1* Industrial Occupancies. Areas in which dipping, coating, or printing operations are conducted shall be protected with approved automatic sprinkler systems that are designed and installed in accordance with the requirements of NFPA 13.

4.1.2* Locations in Other Occupancies. Processes shall not be located in any building that is classified as an assembly, an educational, a day care, a health care, an ambulatory health care, a detention/correctional, a residential, a mercantile, a business, or a storage occupancy, unless the following requirements are met:

- (1) The process area is separated both vertically and horizontally from all surrounding areas by construction having a fire resistance rating of at least 2 hours.
- (2) The process area is protected by an approved automatic sprinkler system designed and installed in accordance with NFPA 13.

4.2* Separation. Processes shall be separated from other operations, materials, or occupancies by location, fire walls, and horizontal assemblies in accordance with NFPA 5000 or other means acceptable to the authority having jurisdiction.

4.3* Basements. Processes shall not be located in a basement unless all the following requirements are met:

- (1) A means of egress is provided that meets the requirements of Chapter 40 of NFPA 101.
- (2) An access means is provided for emergency response personnel.

4.3.1 Processes utilizing combustible liquids in basements shall be captured and directed to the outside of the building or control equipment.

4.4 Access to Means of Egress. Processes shall be located so that, in the event of a fire originating at or within the process equipment, access to means of egress is in accordance with NFPA 101.

4.5 Noncombustible Material.

4.5.1 A material that complies with any one of the following shall be considered a noncombustible material:

- (1)* The material, 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.
- (2) The material is reported as passing ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*.
- (3) The material is reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with the test method and procedure in ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*. [5000:7.1.4.1.1]

4.5.2 Where the term *limited-combustible* is used in this standard, it shall also include the term *noncombustible*. [5000:7.1.4.1.2]

4.6 Limited-Combustible Material. A material shall be considered a limited-combustible material where one of the following is met:

- (1) The conditions of 4.6.1 and 4.6.2, and the conditions of either 4.6.3 or 4.6.4, shall be met.
- (2) The conditions of 4.6.5 shall be met. [5000:7.1.4.2]

4.6.1 The material does not comply with the requirements for a noncombustible material in accordance with Section 4.5. [5000:7.1.4.2.1]

4.6.2 The material, in the form in which it is used, exhibits a potential heat value not exceeding 8141 kJ/kg (3500 Btu/lb) where tested in accordance with NFPA 259. [5000:7.1.4.2.2]

4.6.3 The material shall have a structural base of noncombustible material with a surfacing not exceeding a thickness of 3.2 mm ($\frac{1}{8}$ in.) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or UL 723, *Test for Surface Burning Characteristics of Building Materials*. [5000:7.1.4.2.3]

4.6.4 The material shall be composed of materials that in the form and thickness used neither exhibit a flame spread index greater than 25 nor exhibit evidence of continued progressive combustion when tested in accordance with ASTM E84 or UL 723 and are of such composition that all surfaces that would be exposed by cutting through the material on any plane would neither exhibit a flame spread index greater than 25 nor exhibit evidence of continued progressive combustion when tested in accordance with ASTM E84 or UL 723. [5000:7.1.4.2.4]

4.6.5 Materials shall be considered limited-combustible materials where tested in accordance with ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*,

at an incident heat flux of 75 kW/m² for a 20-minute exposure, and both the following conditions are met:

- (1) The peak heat release rate shall not exceed 150 kW/m² for longer than 10 seconds.
- (2) The total heat released shall not exceed 8 MJ/m². [5000:7.1.4.2.5]

4.6.6 Where the term *limited-combustible* is used in this standard, it shall also include the term *noncombustible*. [5000:7.1.4.2.6]

▲ 4.7 Classification Scheme.

N 4.7.1 Class I Liquids.

N 4.7.1.1 A liquid with a closed-cup flash point below 37.8°C (100°F) shall be designated as a Class I liquid (i.e., flammable liquid), as determined by the test procedures and apparatus set forth in Section 4.8 and a Reid vapor pressure that does not exceed an absolute pressure of 276 kPa (40 psi) at 37.8°C (100°F), as determined by ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*. [30:4.2.1.1]

▲ 4.7.1.2 Class I liquids shall be further subclassified in accordance with the following:

- (1) *Class IA Liquid.* A liquid that has a flash point below 22.8°C (73°F) and a boiling point below 37.8°C (100°F).
- (2) *Class IB Liquid.* A liquid that has a flash point below 22.8°C (73°F) and a boiling point at or above 37.8°C (100°F).
- (3) *Class IC Liquid.* A liquid that has a flash point at or above 22.8°C (73°F), but below 37.8°C (100°F). [30:4.2.1.2]

▲ 4.7.2 Class II Liquids. A liquid with a closed-cup flash point at or above 37.8°C (100°F) but below 60°C (140°F) shall be designated as a Class II liquid (i.e., combustible liquid), as determined by the test procedures and apparatus set forth in Section 4.8. [30:4.2.2]

N 4.7.3 Class III Liquids.

N 4.7.3.1 A liquid with a closed-cup flash point at or above 60°C (140°F) shall be designated as a Class III liquid (i.e., combustible liquid), as determined by the test procedures and apparatus set forth in Section 4.8. [30:4.2.3.1]

N 4.7.3.2 Class III liquids shall be further subclassified in accordance with the following:

- (1) *Class IIIA Liquid.* A liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C).
- (2) *Class IIIB Liquid.* A liquid that has a flash point at or above 200°F (93°C). [30:4.2.3.2]

4.8 Determination of Flash Point (FP). The flash point of a liquid shall be determined according to the methods specified in 4.8.1 through 4.8.4. [30:4.4]

4.8.1 Except as specified in 4.8.1.1, the flash point of a liquid having a viscosity below 5.5 centiStokes at 40°C (104°F) or below 9.5 centiStokes at 25°C (77°F) shall be determined in accordance with ASTM D56, *Standard Test Method for Flash Point by Tag Closed Cup Tester*. [30:4.4.1]

▲ 4.8.1.1 Cut-back asphalts, liquids that tend to form a surface film, and liquids that contain suspended solids shall not be tested in accordance with ASTM D56, *Standard Test Method for*

Flash Point by Tag Closed Cup Tester, even if they otherwise meet the viscosity criteria. [30:4.4.1.1]

N 4.8.1.2 Such liquids as stated in 4.8.1.1 shall be tested in accordance with 4.8.2. [30:4.4.1.2]

4.8.2 The flash point of a liquid having a viscosity of 5.5 centiStokes or more at 40°C (104°F) or 9.5 centiStokes or more at 25°C (77°F) or a flash point of 93.4°C (200°F) or higher shall be determined in accordance with ASTM D93, *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*. [30:4.4.2]

4.8.3 As an alternative, ASTM D3278, *Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus*, shall be permitted to be used for paints, enamels, lacquers, varnishes, and related products and their components that have flash points between 0°C (32°F) and 110°C (230°F) and viscosities below 150 Stokes at 25°C (77°F). [30:4.4.3]

4.8.4 As an alternative, ASTM D3828, *Standard Test Methods for Flash Point by Small Scale Closed Cup Tester*, shall be permitted to be used for materials other than those for which ASTM D3278, *Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus*, is specifically required. [30:4.4.4]

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

5.1 Scope. Chapter 5 shall apply to the design and construction of 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) capacity or 1 m² (10 ft²) of liquid surface shall have a fire resistance rating of at least 1 hour.

5.2.1.1 Rolls shall be permitted to be covered with polymeric or other combustible materials.

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.

5.2.2.1 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 constructed with other materials shall be permitted.

▲ 5.2.2.2 Panels shall be separated from the luminaire to prevent the surface temperature of the panel from exceeding 105°C (221°F).

5.2.2.3 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 any tank that holds ignitable (flammable or combustible) liquids shall be at least 150 mm (6 in.) above the floor.

5.4 Overflow Prevention. To prevent the overflow of burning liquid from a 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) The tank shall be equipped with automatic-closing covers.
- (3) The tank shall be equipped with overflow pipes. (See Section 5.6.)

5.5 Liquid Level. The liquid in any 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 m² (10 ft²) 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 m² (10 ft²) 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 9.5.

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.

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.

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

5.8.3 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.

Exception: This requirement shall not apply to web or sheet transport systems.

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

Exception: This requirement shall not apply to web or sheet transport systems in printing processes where stopping the movement of the substrate can result in a more hazardous condition.

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.

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 the boiling point of the liquid or a temperature that is 55°C (100°F) less than the autoignition temperature of the liquid.

5.10.1.4 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, or is attached to the dipping, coating, or printing equipment, or is in the vicinity of such equipment. This chapter shall also apply to other sources of ignition.

6.2 General.

6.2.1 Process areas where Class I [FP < 37.8°C (100°F)] liquids are used, or where Class II or Class III [FP ≥ 37.8°C (100°F)] 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 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*.

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*.

▲ **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 Zone 0 location.
- (2) A Class I, Division 1 location shall be permitted to be alternatively classified as a Zone 1 location.
- (3) A Class I, Division 2 location shall be permitted to be alternatively classified as a 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) of *NFPA 70* where areas in the same facility are classified separately, a Zone 2 location shall be permitted to abut, but shall not overlap, a Class I, Division 2 location. A Zone 0 or 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 ignitable (flammable or combustible) liquid being used shall not be located in the 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 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 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 comply with one of the following requirements:

- (1) Electrical wiring and electrical utilization equipment that is not part of electrostatic detearing apparatus shall be listed for such exposure and shall be suitable for Class I, Division 1 or Zone 1 locations, whichever is applicable.
- (2) 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 ignitable mixture.

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

- (1) An ignitable concentration of flammable gas or vapor can exist under normal operating conditions.
- (2) An ignitable 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 ignitable 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*, a Class I, Division 2 location shall be any location where one of the following conditions exists:

- (1) A flammable gas or a Class I [FP < 37.8°C (100°F)] 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 ignitable 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 ignitable 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* Zone 0 Locations.** In accordance with 505.5(B)(1) of *NFPA 70*, a Zone 0 location shall be any location where an ignitable concentration of flammable gas or vapor is present either continuously or for long periods of time.

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

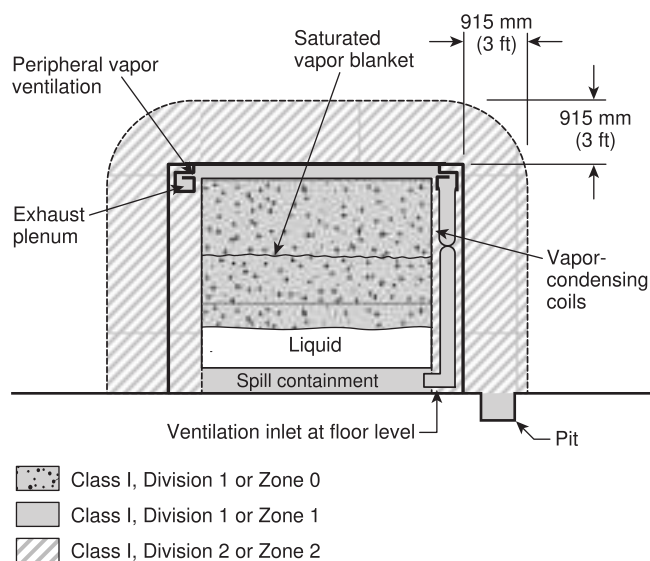
- (1) An ignitable concentration of flammable gas or vapor is likely to exist under normal operating conditions.
- (2) An ignitable concentration of flammable gas or vapor can exist frequently because of repair or maintenance operations or because of leakage.
- (3) Breakdown or faulty operation of equipment or processes might release an ignitable 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 ignitable concentration of flammable gas or vapor might occasionally be transmitted from an adjacent 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*, a Class I, Zone 2 location shall be any location where one of the following conditions exists:

- (1) An ignitable concentration of a flammable gas or vapor is not likely to exist under normal operating conditions and, if an ignitable concentration does exist, will exist only for a short period of time.
- (2) A flammable gas or a Class I [FP < 37.8°C (100°F)] 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 ignitable 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 ignitable concentration of flammable gas or vapor might occasionally be transmitted from an adjacent 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 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.



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 Processes with Peripheral Vapor Containment and Ventilation — Vapors Confined to Process Equipment.

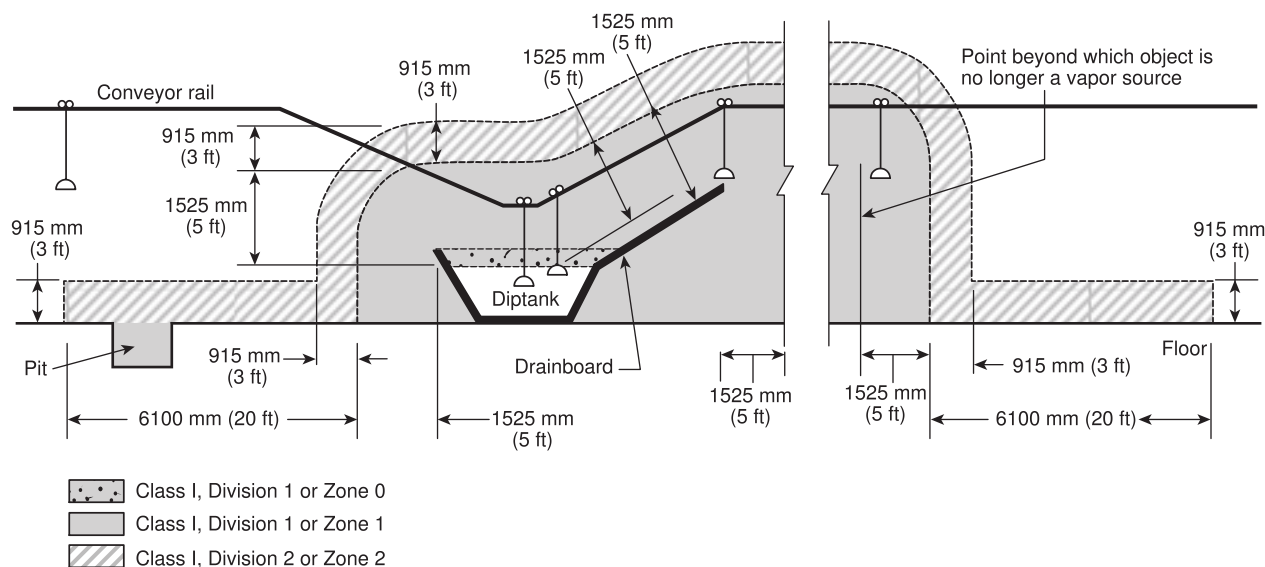


FIGURE 6.4(a) Electrical Area Classification for Open Dipping and Coating Processes Without Vapor Containment or Ventilation.

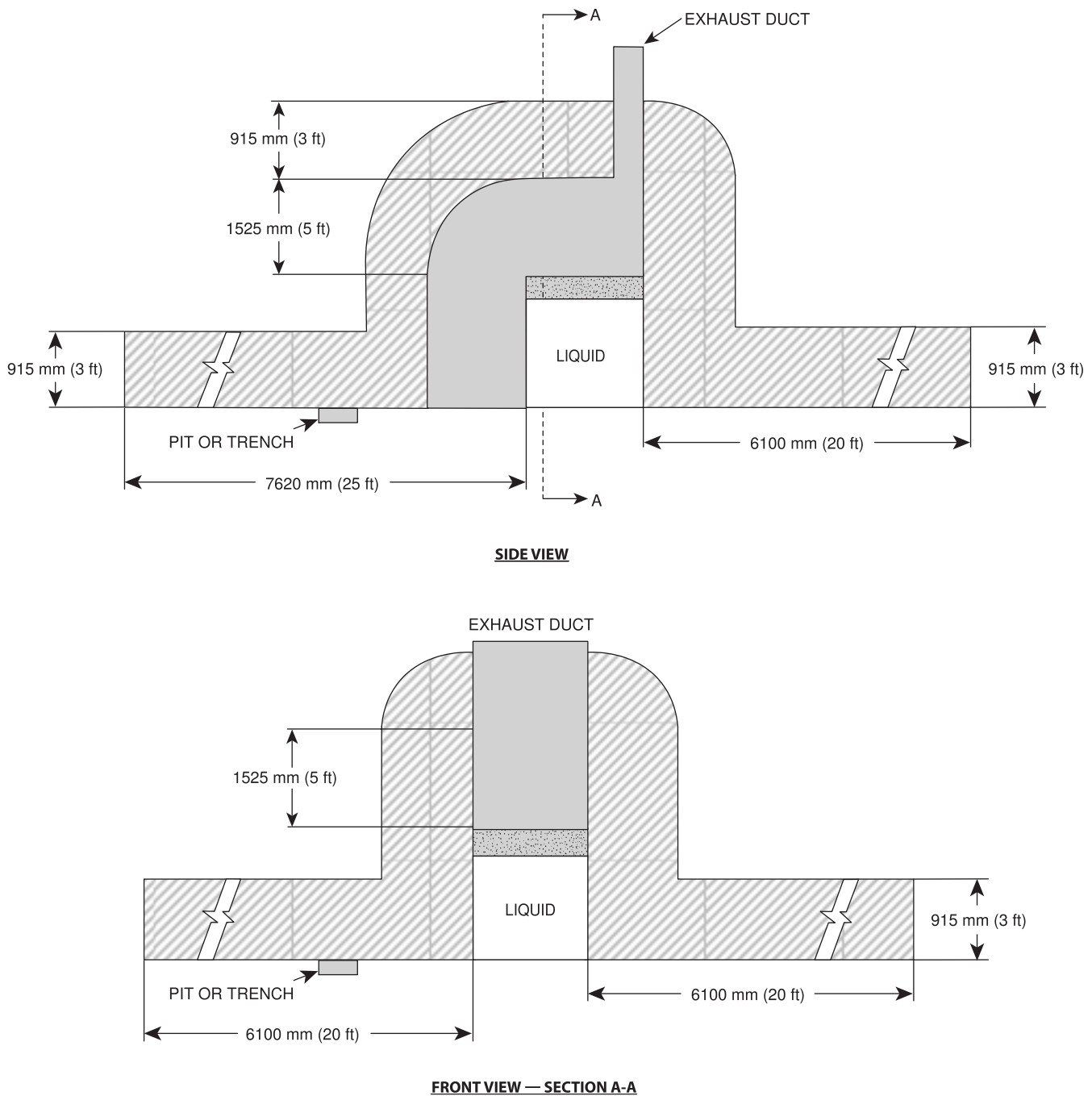


FIGURE 6.4(c) Electrical Area Classification for Open Dipping and Coating Processes with Partial Peripheral Vapor Containment and Ventilation — Vapors NOT Confined to Process Equipment.

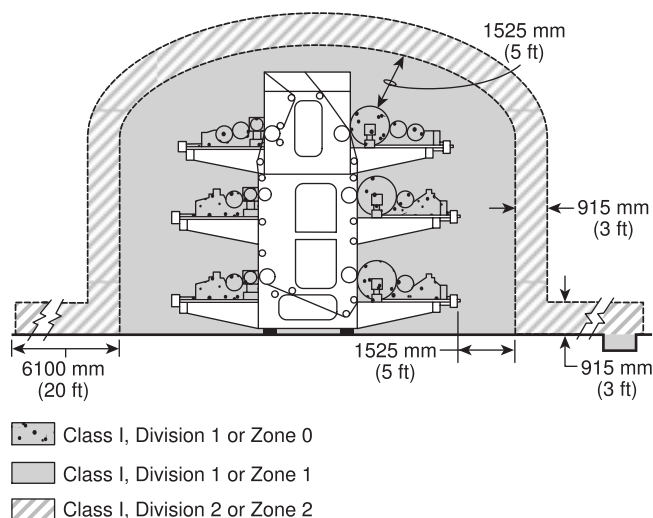


FIGURE 6.4(d) Electrical Area Classification for a Typical Printing Process.

▲ **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 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 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 Zone 1 locations. The space inside a dip tank, ink fountain, ink reservoir, or ink tank shall be classified as Class I, Division 1 or 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

Zone 1 location described in 6.4.2 shall be suitable for Class I, Division 2 or 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 Zone 1 location described in 6.4.3 shall be classified as Class I, Division 2 or Zone 2, and electrical wiring and electrical utilization equipment located within this space shall be suitable for Class I, Division 2 or Zone 2 locations, whichever is applicable.

6.4.4.1 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 m² (5 ft²), the contents of the dip tank, ink fountain, ink reservoir, or ink 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.

6.5 Areas Adjacent to Enclosed Dipping and Coating 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 Zone 1 location, and electrical wiring and electrical utilization equipment located within this space shall be suitable for Class I, Division 1 or Zone 1 locations, whichever is applicable. The area inside the dip tank shall be classified as Class I, Division 1 or Zone 0, whichever is applicable.

▲ **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 Zone 2, and electrical wiring and electrical utilization equipment located within this space shall be suitable for Class I, Division 2 locations or Zone 2 locations, 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.

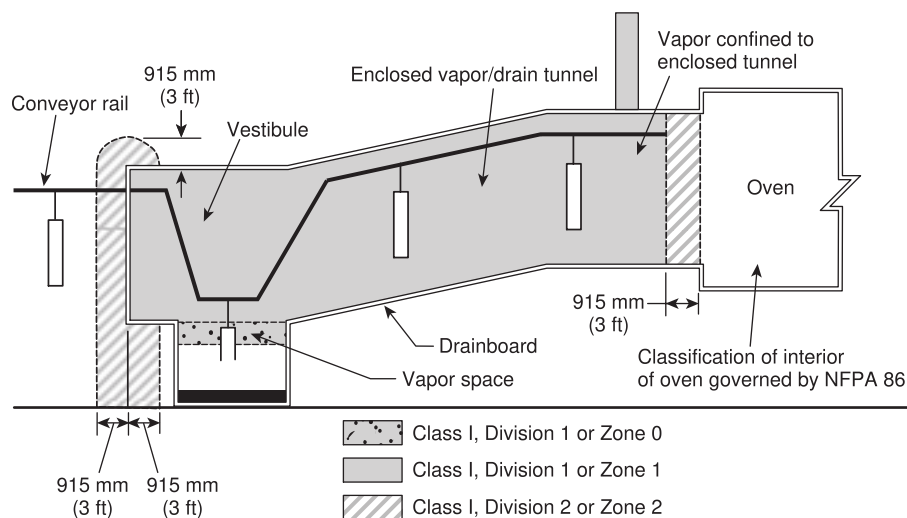


FIGURE 6.5 Electrical Area Classification Around Enclosed Dipping and Coating Processes.

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 [FP < 37.8°C (100°F)] liquids shall be located in areas ventilated in accordance with applicable requirements of Chapter 7.

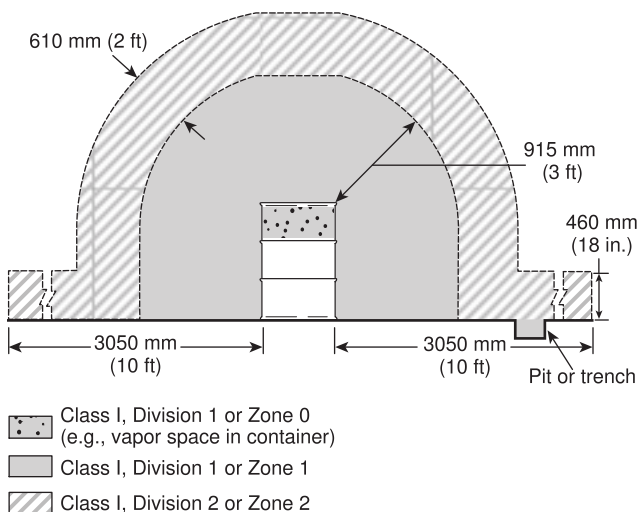
▲ **6.6.2** Areas within and around such containers, solvent distillation units, and similar apparatus shall be classified in accordance with Figure 6.6.2 and with the following:

- (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 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 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 Zone 2, whichever is applicable.
- (4) The area inside any tank or container shall be classified as Class I, Division 1 or Zone 0, whichever is applicable.

6.7 Luminaires.

6.7.1 Luminaires that are attached to the walls or ceiling of a process enclosure but are outside any classified area and are separated from the process area by glass panels that meet the requirements of 5.2.2 shall not be required to be suitable for use in unclassified locations. Such fixtures shall be serviced and listed for use in hazardous (classified) locations. Such luminaires shall be capable of being serviced from outside the enclosure.

6.7.2 Luminaires that are separated from the process enclosure by glass panels that meet the requirements of 5.2.2; and that are located within a Class I, Division 2; a Zone 2; a Class II, Division 2; or a Zone 22 location shall be listed for such locations. Such luminaires shall be serviced from outside the enclosure.



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

6.8* Static Electric Discharges.

6.8.1 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 ignitable (flammable or combustible) liquids, shall be electrically grounded.

6.8.2* Provision shall be made to dissipate static electric charges from all nonconductive substrates in printing processes.

Chapter 7 Ventilation

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

7.2 General. Ventilating and exhaust systems shall be installed in accordance with NFPA 91 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 shall continue to operate 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. 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.

▲ **7.5* Routing of Exhaust Ducts.** Air exhausted from processes shall be conducted by ducts directly to the outside of the building. Exhaust ducts shall follow the shortest route to the point of discharge and shall meet the following conditions:

- (1) Exhaust ducts shall not penetrate a fire wall or fire barrier wall.
- (2) Exhaust discharge shall be directed away from any air intakes.
- (3) Exhaust discharge point shall be at least 1830 mm (6 ft) from any exterior wall or roof.
- (4) Exhaust discharge point shall be at least 3048 mm (10 ft) from openings into the building.

- (5) Exhaust discharge point shall be at least 3048 mm (10 ft) above adjoining grade.
- (6) Exhaust duct shall not discharge in the direction of any combustible construction that is within 7625 mm (25 ft) of the exhaust duct discharge point.
- (7) Exhaust duct shall not discharge in the direction of any unprotected opening in any noncombustible or limited-combustible construction that is within 7625 mm (25 ft) of the exhaust duct discharge point.
- (8) Exhaust duct shall not discharge in the direction of any exit discharge or public way that is within 7625 mm (25 ft) of the exhaust duct discharge point.

7.6* Recirculation of Exhaust. Air exhausted from processes shall not be recirculated unless all of the following requirements have been met:

- (1) Recirculation particulate filters as defined in this standard shall be used to remove particulates 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) The equipment specified in 7.6(3) shall initiate a local alarm and shall automatically shut down the processes if the concentration of any vapor in the exhaust airstream exceeds 25 percent of the lower flammable limit.
- (5) All equipment installed to process and remove contaminants from the air exhausted from the processes shall be approved by the authority having jurisdiction.
- (6) For occupied process areas where a portion of the exhaust air is recirculated within the process area, toxicity and worker exposures shall be addressed.

7.7 Materials of Construction. Exhaust plenums, and exhaust ducts and fasteners shall be constructed of steel, except as allowed in 7.7.1 and 7.7.2.

7.7.1 Concrete shall be permitted to be used. The interior surfaces of the concrete exhaust plenum or exhaust duct shall be smooth and sealed to facilitate cleaning.

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

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

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

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

7.8.5 The provisions of 7.8.4 shall not disallow the use of concrete exhaust plenums or exhaust ducts where some or all of the plenum or duct is part of the concrete floor.

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. Necessary allowances shall be made for ordinary expansion and loading, and to prevent contact between moving parts and the duct or fan housing. Fan blades shall be mounted on a shaft that shall maintain alignment even when the blades of the fan are heavily loaded. All bearings shall be of the self-lubricating type or shall be provided with accessible lubricating ports.

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 ignitable 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 Ignitable (Flammable and Combustible) Liquids

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

8.2* General.

8.2.1 Storage, handling, and mixing of ignitable (flammable and combustible) liquids shall meet all applicable requirements of NFPA 30. Storage, handling, and mixing of ignitable (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 [FP < 93°C (200°F)] liquids stored in a storage cabinet shall not exceed 454 L (120 gal).

Δ 8.3.2 The total aggregate volume of Class I, Class II, and Class IIIA [FP < 93°C (200°F)] liquids in a group of storage cabinets shall not exceed the maximum allowable quantity of

ignitable (flammable or combustible) liquids per control area based on the occupancy where the cabinets are located. [30:9.5.2]

8.3.3 For industrial occupancies, the total aggregate volume of Class I, Class II, and Class IIIA [FP < 93°C (200°F)] liquids in a group of storage cabinets in a single fire area shall not exceed the maximum allowable quantity (MAQ) of flammable and combustible liquids per control area for industrial occupancies as set forth in Table 8.3.3.

8.3.4 Storage cabinets shall be listed or shall be designed and constructed to meet the requirements of NFPA 30.

8.3.5 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 cut off by at least a 2-hour fire-rated separation from the dipping or coating process area, shall not exceed the quantity given in 18.5.4.1 of NFPA 30.

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 [FP < 60°C (140°F)] 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.

Table 8.3.3 Maximum Allowable Quantity of Ignitable (Flammable and Combustible) Liquids per Control Area

	Liquid Classes	Quantity		
		L	gal	Notes
Flammable liquids	IA	115	30	1,2
	IB & IC	460	120	1,2
	IA, IB, IC	460	120	1,2,3
	Combined			
Combustible liquids	II	460	120	1,2
	IIIA	1265	330	1,2

Notes:

(1) Quantities are permitted to be increased 100 percent where all liquids are stored in approved flammable liquid storage cabinets or in safety cans. Where Note 2 also applies, the increase for both notes is permitted to be applied cumulatively.

(2) Quantities are permitted to be increased 100 percent in buildings equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13. Where Note 1 also applies, the increase for both notes is permitted to be applied cumulatively.

(3) Containing not more than the maximum allowable quantity per control area of Class IA, Class IB, or Class IC flammable liquids, individually.

Source: Table 34.1.3.1 of NFPA 5000.

8.5.3 Class I and Class II [FP < 60°C (140°F)] 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 [FP < 37.8°C (100°F)] 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 10⁶ 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 be approved and listed for the specific location in which it is used.

8.6 Liquid Piping Systems.

8.6.1 Piping systems that convey ignitable (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 [FP < 37.8°C (100°F)] 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 [FP < 37.8°C (100°F)] 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 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 processes.

9.2 Automatic Fire Protection Systems.

9.2.1 Processes shall be protected with any of the following approved automatic fire protection systems:

- (1)* A water spray extinguishing system that meets all applicable requirements of NFPA 15
- (2) A foam extinguishing system that meets all applicable requirements of NFPA 11 (*See also 9.2.2.*)
- (3)* A carbon dioxide system that meets all applicable requirements of NFPA 12
- (4) A dry chemical extinguishing system that meets all applicable requirements of NFPA 17
- (5) A gaseous agent extinguishing system that meets all applicable requirements of NFPA 2001
- (6) A water mist fire protection system that meets all applicable requirements of NFPA 750
- (7) For tanks containing liquids having flash points above 93°C (200°F) and for associated process hazards, a sprinkler system that meets all applicable requirements of NFPA 13
- (8) For tanks equipped with a tank cover arranged to close automatically in the event of fire, a sprinkler system that meets all applicable requirements of NFPA 13

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

9.3 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.

9.3.1 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.

9.4 Notification and Interlocks.

9.4.1 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 web or sheet transport systems, unless stopping the movement of the substrate can result in a more hazardous condition
- (5) Open bottom drains of tanks, if bottom drains are provided
- (6) Shut down all sources of heat to the application processes

9.4.2 The fire alarm and fire protection system shall be supervised in accordance with NFPA 72.

9.5* Automatic Fire Protection for Small Dipping Processes. Automatic-closing process tank covers or fire protection systems that meet the requirements of Section 9.2 shall be provided for open tanks that do not exceed 570 L (150 gal) capacity or that do not exceed 1 m² (10 ft²) of liquid surface area.

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

9.5.2 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.

9.5.3 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.

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

9.5.5 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.

9.6* Automatic Fire Protection for Enclosed Processes and Large Processes. An automatic fire protection system, installed in accordance with Section 9.2, shall be provided for processes not covered by Section 9.5, such as the following:

- (1) Enclosed processes
- (2) Large open tanks
- (3) Roll coating operations
- (4) Curtain or flow coating operations
- (5) Class I [FP < 37.8°C (100°F)] solvent cleaning operations

9.6.1 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 Class I [FP < 37.8°C (100°F)] liquids: the tank and any areas within the unit that can have solvent accumulation

9.6.2* The extinguishing system shall be designed to simultaneously discharge into the entire protected area, as described in 9.6.1(1) through 9.6.1(3).

9.7 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 due to discharge of the fire suppression agent.

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

9.9 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.

9.10* Automatic Fire Protection for Printing Processes. Automatic fire protection shall be provided for the following areas:

- (1) All printing process areas that contain ordinary combustibles, ignitable (flammable or combustible) liquids, or combustible construction
- (2) All printing operations areas, at the ceiling level
- (3) Areas of printing presses that are shielded from ceiling protection and where combustibles exist

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

Chapter 10 Operations and Maintenance

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

10.2* General.

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

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 process operations shall be discontinued until conditions are corrected.

10.2.4 For printing processes, good housekeeping shall be provided throughout the process area, with special attention given to presses, ducts, ink troughs, folders, and driers. Particular attention shall be given to assessing the degree of ink residue and dust accumulation in the vicinity of the press. Paper scrap, Class I [FP < 37.8°C (100°F)] liquids, and cleaning rags shall not be allowed to accumulate.

10.3* Waste Containers.

10.3.1 Rags, other absorbent materials, or waste that are impregnated with ignitable (flammable or combustible) liquids shall be deposited in approved waste containers immediately after use.

10.3.1.1 Storage beyond the immediate work shift shall be in closed metal containers.

10.3.1.2 The closed metal containers shall be placed in a designated location.

10.3.1.3 The lid of the waste container shall remain fully closed and latched when not in use.

10.3.2 Waste containers containing Class I [FP < 37.8°C (100°F)] 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 Class I [FP < 37.8°C (100°F)] liquids shall be constructed of conductive materials and shall be bonded and grounded.

10.3.4 Class I [FP < 37.8°C (100°F)] 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.

10.5.1 Scope. This section shall apply to the use of ignitable (flammable or combustible) liquids for the flushing and cleaning of equipment.

10.5.2 Liquids. Class I and Class II [FP < 60°C (140°F)] liquids used in cleaning operations shall be in original shipping containers or in listed safety containers.

10.5.3 Location. Cleaning operations using ignitable (flammable or combustible) liquids shall be conducted with ventilating equipment operating or in ventilated areas that meet the requirements of Chapter 7; such areas shall also meet the electrical area classification requirements of Section 6.6.

10.6 Combustible Dusts and Residues.

10.6.1* Equipment that produces combustible dusts, such as paper and starch, and surrounding areas shall be kept clean in accordance with 8.2.1 of NFPA 654.

10.6.2 All process areas shall be kept free of excessive accumulation of deposits of combustible residues, as specified in Section 6.1 of NFPA 654.

10.6.3 Combustible coverings (thin paper, plastic) and strippable coatings shall be permitted to be used to facilitate cleaning operations in process areas.

10.6.3.1 When plastic covering is used, it shall be of a static dissipative nature or shall have a maximum breakdown voltage of 4 kV to prevent accumulation of a hazardous static electric charge.

10.6.4 If residue accumulates to excess, all process operations shall be discontinued until conditions have been corrected.

10.7 Smoking. Signs stating NO SMOKING OR OPEN FLAMES and meeting the requirements of ANSI Z535, *Safety Signs Series IS*, shall be conspicuously posted in all process areas and in ignitable (flammable and combustible) liquids storage areas.

10.8* 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.

10.9 Solvent Distillation Units (Solvent Recyclers).

10.9.1 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 [FP < 93°C (200°F)] liquids.

▲ **10.9.2 Equipment.** Solvent distillation units shall be approved or shall be listed in accordance with UL 2208, *Solvent Distillation Units*.

10.9.3 Solvents. Solvent distillation units shall only be used to distill liquids for which they have been investigated and that 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.

10.9.4 Location. Solvent distillation units shall be used only 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.

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

10.10 Solvent Recovery Systems. Where solvent recovery systems are provided for the process or for exhaust systems, the installation shall be designed and protected in accordance with NFPA 30.

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 3.3.15 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.

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, coating, or printing processes covered by this standard shall be instructed in the safety and health hazards of the processes and the fire protection systems; the operational, maintenance, and emergency procedures required; and the importance of constant operator awareness.

12.1.1 Personnel required to handle or use ignitable (flammable or combustible) materials shall be instructed in the handling, storage, and use of the materials, as well as in 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 Records shall be maintained, recording initial and refresher training, with 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.1.1.1 Where a requirement applies to a particular process, the name of that process will be stated.

A.1.2 The risk to life and property from fire or explosion as a result of dipping, coating, or printing 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 prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or 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.3.3.2 Boiling Point (BP). For purposes of defining the boiling point, atmospheric pressure is considered to be 1.0 bar (absolute pressure of 14.7 psi). For mixtures that do not have a constant boiling point, the 20 percent evaporated point of a distillation performed in accordance with ASTM D86, *Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure*, is considered the boiling point.

A.3.3.8.3 Ignitable Liquid. Unless otherwise specified, the term *liquid* means an ignitable liquid.

The term *ignitable liquid* refers to any liquid that will burn. Class I liquids [FP < 37.8°C (100°F)], Class II and Class III liquids [FP ≥ 37.8°C (100°F)], and inflammable liquids are all ignitable liquids. [30, 2021]

A.3.3.11 Printing. Examples of the types of printing processes intended to be addressed by this standard are the following:

- (1) *Flexographic Printing.* A process of rotary letterpress using flexible plates and fast-drying inks.
- (2) *Gravure Printing (Rotogravure Printing).* A method of printing using etched plates or cylinders.
- (3) *Lithographic Printing.* A printing process in which the image to be printed is rendered on a flat surface, chiefly on sheet zinc or aluminum, and treated so that only those areas to be printed will retain ink.

A.3.3.12 Recirculation Particulate Filter. Recirculation particulate filters are intended to minimize the potential for particulate accumulation in downstream areas. The removal efficiency is based upon EPA Method 319 in 40 CFR 63, "Test Methods, Pollutant Measurement Methods from Various Waste Media, Method 319 — Determination of Filtration Efficiency for Paint Overspray Arrestors." This test method is the basis for the filters typically found in current recirculation spray booths.

A.3.3.15 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 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.4.1 Fires involving coating operations and processes can be expected to develop rapidly and to generate copious quantities of heat and smoke. In sprinklered buildings, such fires can also result in the operation of a greater-than-normal number of sprinklers.

A.4.1.1 Automatic sprinkler systems are highly effective in controlling the spread of fire and protecting a building and nearby occupancies from damage. Dipping, coating, and printing 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.4.1.1(a) and Table A.4.1.1(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.4.1.1(a) and Table A.4.1.1(b) give recommended sprinkler densities and their area of coverage for operations involving flammable and combustible liquids.

A.4.1.2 The use of proper cutoff between hazards and exposures depends on many factors. Where the exposure hazard is high or severe, the authority having jurisdiction might require protection beyond the indicated 2-hour fire resistance rating.

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

Coating operations that incorporate assembly lines or conveyor systems can present additional fire hazard segregation concerns. If conveyor systems extend between separate buildings, a sprinklered, noncombustible, connecting passageway is advisable. If conveyor systems pass through floors, the openings should be surrounded by deep [greater than 460 mm (18 in.)] draft curtains on the underside of the floor deck and should be provided with automatic high-velocity spray nozzles arranged to create a counterdraft. If conveyor systems pierce fire walls or

Table A.4.1.1(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·m ²)	Area of Coverage (m ²)
Below -7 (including nitrocellulose lacquer)	141	12	560
	72	12	740
-7 to 94 or heated	141	12	370
combustible liquids	72	12	560
Over 94	141	10	370
	72	10	560

Table A.4.1.1(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	286	0.3	4000
combustible liquids	160	0.3	6000
Over 200	286	0.25	4000
	160	0.25	6000

fire barrier walls, it is most desirable to provide a short gap in the conveyor to allow automatic fire doors to close. Interlocks might be necessary to stop conveyors moving toward the fire walls and clear the conveyors moving away from the fire walls in order to prevent fire doors from dropping on conveyed materials, and thereby preventing complete closure. Another option is to provide a noncombustible or limited-combustible, sprinkler protected tunnel on both sides of the opening.

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.). The draft 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. Additional consideration might be given to the use of heat and smoke vents to aid in fire control.

A.4.3 Processes 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

Note that other requirements, such as NFPA 30's prohibition of Class I liquids in basements, are still applicable. The requirements of Section 4.3 are not intended to override or reduce any stricter code requirements as adopted by the authorities having jurisdiction.

The walls and doors of the process area can impact the existing egress paths in any building area, particularly a basement level or upper story where egress pathways are limited. Chapter 40 of NFPA 101 references the egress requirements.

A means of access for emergency response personnel is required for search and rescue efforts. It is also required for manual firefighting efforts to control and extinguish a fire involving process equipment. The large variety of equipment and types of coating operations in existence increase the likelihood of fires in concealed spaces or flash fires involving a large area within the occupied floor. These can be especially difficult to address in belowgrade areas.

In some cases, emergency response access can be provided by grade level access to areas that are partly below grade (*see 3.3.1, Basement*).

A.4.5.1(1) Examples of such materials include steel, concrete, masonry, and glass.

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 firefighting 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 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.

A.6.2.5 See NFPA 70.

A.6.3 See NFPA 70.

A.6.3.1 This classification usually includes the following locations:

- (1) Where volatile flammable liquids or liquefied flammable gases 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 ignitable concentrations of flammable vapors or gases are likely to occur in the course of normal operations

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

- (1) The inside of inadequately vented enclosures containing instruments normally venting flammable gases or vapors to the interior of the enclosure
- (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 ignitable concentrations of vapors

A.6.3.2 This classification usually includes locations where volatile flammable liquids or flammable gases or 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) Informational Note No. 1]

Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids or gases. Depending on factors such as the quantity and size of the containers and ventilation, locations used for the storage of flammable liquids or liquefied or compressed gases in sealed containers may be considered either hazardous (classified) or unclassified locations. See NFPA 30-2018, *Flammable and Combustible Liquids Code*, and NFPA 58-2017, *Liquefied Petroleum Gas Code*. [70:500.5(B)(2) Informational Note 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; between the inner and outer roof sections of a floating roof tank containing volatile flammable liquids; inside open vessels, tanks, and pits containing volatile flammable liquids; the interior of an exhaust duct that is used to vent ignitable concentrations of gases or vapors; and inside inadequately ventilated enclosures that contain normally venting instruments utilizing or analyzing flammable fluids and venting to the inside of the enclosures. [70:505.5(B)(1) Informational Note 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 *Informational Note 2 to 505.5(A) of NFPA 70*.] 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 *Article 504 of NFPA 70*.

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 shut-down (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) Informational Note 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 ignitable concentrations of flammable vapors or gases are likely to occur in the course of normal operation but not classified Zone 0

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 contains information about grounding for static electric charge.

A.6.8.2 See Section 10.2 of NFPA 77 for recommendations specific to printing processes.

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 m³ (23 ft³) 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 m³ (2300 ft³) to avoid an ignitable 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 ignitable mixture in low, unventilated spaces in the vicinity of, or even remote from, the point of evaporation. For those reasons, a safety factor of 4 to 1 has been traditionally used and the ventilation requirement rounded off to 75 m³/L (10,000 ft³/gal) evaporated.

Adequate mechanical ventilation throughout all areas where ignitable vapors or mists might be present is essential to prevent the formation of ignitable 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 m³/sec of air movement/m² (100 cfm/ft²) 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 m³/sec/m² (100 to 150 cfm/ft²) 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 m³/sec/m² (50 cfm/ft²) 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 m³/sec/m² (50 cfm/ft²) 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 for Design*.

Additional Ventilation. Other operations producing ignitable 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 (3.3 ft/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 If recirculated air is used for make-up air for occupied spaces, including spray areas, spray booths, spray rooms, 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. One such standard is *ASSP Z9.7, Recirculation of Air from Industrial Process Exhaust Systems*.

▲ A.7.8 The designer of the exhaust ducts and fasteners should refer to appropriate design guides, such as *ANSI/SMACNA 005, Round Industrial Duct Construction Standards*, and *ANSI/SMACNA 002, Rectangular Industrial Duct Construction Standards*, published by the Sheet Metal and Air Conditioning Contractors' National Association.

A.7.12.2 If other operations or processes outside the dipping or coating process area also can produce ignitable 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:

- (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.8.5.5 NFPA 77 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.9.2.1(1) Water is generally effective on liquids having flash points above 60°C (140°F).

A.9.2.1(3) Fixed, automatic carbon dioxide systems historically have been provided to protect the following:

- (1) Flexograph presses and rotogravure presses using Class I and Class II inks, with nozzles arranged to protect printing heads, ink reservoirs, and other areas likely to contain flammable liquid-based inks
- (2) Presses using flammable liquid-based inks having shielded spaces where automatic sprinkler installation is impractical

Consideration should be given to providing a connected reserve for high-pressure carbon dioxide systems and sufficient

agent for two complete discharge cycles for low-pressure carbon dioxide systems.

A.9.5 Loss experience indicates that the size of the process 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.9.6 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 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.9.6.2 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.9.10 Particular attention should be given to areas beneath platforms and beneath press units, such as reel areas of newspaper plants, where fire can result in extensive damage to press supporting members and to the press itself. Consideration should be given to providing protection for steel plating and structural members surrounding the press at operating floor level, if they are subject to deposits of combustible ink on the underside.

A.10.2 The inherent characteristics of the materials used in dipping, coating, and printing 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, coating, or printing 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. 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 material, workpieces, or equipment have been rubbed with rags or after waste has been cleaned up, all rags and waste material should be immediately placed in approved waste containers. Due to the frequency of fires in waste containers with improperly closed lids, consideration should be given to not placing the waste containers near exits. When employees change clothes on plant premises, soiled clothing should be kept in metal lockers provided in a separate dressing room.

Many residue scrapings and process room refuse are highly susceptible to spontaneous ignition. They should be taken to an approved location. Nitrocellulose residues should not be burned in boilers because the gases of decomposition could cause an explosion.

A.10.3.3 See NFPA 77 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.10.6.1 For manual cleaning, vacuuming is the preferred method.

A.10.8 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 for additional information.

A.11.4.2 If they are near high voltage electrodes, ungrounded parts can 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.

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, coating, and printing 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

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.