

# NFPA<sup>®</sup> 33

## Standard for Spray Application Using Flammable or Combustible Materials

### 2024 Edition



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An International Codes and Standards Organization

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## NFPA® 33

### Standard for

## Spray Application Using Flammable or Combustible Materials

### 2024 Edition

This edition of NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, was prepared by the Technical Committee on Finishing Processes. It was issued by the Standards Council on December 1, 2023, with an effective date of December 21, 2023, and supersedes all previous editions.

This edition of NFPA 33 was approved as an American National Standard on December 21, 2023.

### Origin and Development of NFPA 33

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, originally titled *Standard on Paint Spraying and Spray Booths*, was initiated in 1921. The first edition was published in 1922 as part of the Standard on Dip Tanks (now NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*).

The following major changes were adopted in the 2003 edition:

- (1) Chapters were rearranged to align the standard with the NFPA *Manual of Style*. For example, all the references within the mandatory text are now listed in Chapter 2 and all the definitions are now in Chapter 3.
- (2) Chapter 6 (formerly Chapter 4) was extensively revised to recognize the Zone concept of area classification. Changes included the addition of the appropriate definitions and revision of the figures to illustrate the area classifications in and around spray areas, spray booths, spray rooms, and equipment.
- (3) Chapter 9 (formerly Chapter 7) was extensively revised to more effectively and clearly present the requirements for fire protection in spray areas.
- (4) Section 10.5 was added to provide more specific guidance on the handling of waste materials, Section 10.7 was revised to allow for the use of any suitable solvent to clean spray equipment, and Section 10.8 was added to address the hazards of solvent distillation units.
- (5) Subsection 14.3.5 (formerly 12.3.5) was revised to incorporate the Zone concept of area classification for use with limited finishing workstations.

The following major changes were adopted in the 2007 edition:

- (1) In Chapter 3, the definition of *spray area* was revised.
- (2) In Section 5.5, the allowable materials for vision and observation panels were expanded.
- (3) Section 7.7 was revised to allow for the use of fire-retardant combustible materials for ducts connected to powder coating booths.
- (4) In Chapter 8, the maximum quantities of flammable and combustible liquids were changed to correlate with changes to NFPA 30, *Flammable and Combustible Liquids Code*.
- (5) In Chapters 11, 12, and 15, subsections 11.3.6, 12.5.4, and 15.13.4 were added to designate certain highly resistive workpieces as grounded if they meet certain criteria for surface conductivity.

The following major changes were adopted in the 2011 edition:

- (1) The document scope was amended to exempt certain small quantity operations and a decision tree was added to Annex A to assist the user.
- (2) The definition of *spray area* was amended.
- (3) Chapter 6 was revised to recognize the Zone 21 and Zone 22 hazardous (classified) area classifications for combustible dusts.
- (4) Section 7.7 was amended to allow concrete as a material of construction for spray area exhaust plenums and ducts.

- (5) Section 8.2 was revised to recognize the concept of maximum allowable quantities (MAQs) and establish quantity limits based on MAQs.
- (6) Section 13.2 was revised to provide clarification for spray areas used for drying or curing at a temperature above that of the area where the spray application takes place.
- (7) Section 13.5 was added to address installations where the spray booth or spray room is directly connected to the drying/curing oven by an enclosed vestibule.
- (8) Section 17.3 was amended by replacing the requirement for an automatic sprinkler system with a requirement that resin application areas be protected in accordance with Chapter 9.
- (9) Subsection 17.5.2 was amended to replace the requirement for Division 1/Zone 1 electrical equipment with the requirement for Division 2/Zone 2.

The following major changes were adopted in the 2016 edition:

- (1) Chapter 1 was revised to include indoor and outdoor spray application processes and operations within temporary membrane enclosures.
- (2) Chapter 9 was revised to allow for the use of water mist systems and to clarify the sprinkler design area requirement.
- (3) The figure in Chapter 14 was revised to improve consistency and to clarify the electrical classification requirements in the document.
- (4) Chapter 15 was revised to incorporate the requirements for combustible dusts that are present in operations.
- (5) Chapter 18 was added to address the use of temporary membrane enclosures

The following major changes were adopted in the 2018 edition:

- (1) In Chapter 3, new or revised definitions were added for *automated spray application operations*, *basement*, *control area*, *dry particulate scrubber spray booth*, and *workstation*.
- (2) Chapter 5 was revised to address the confusion between spray rooms and spray booths.
- (3) The figures in Chapter 6 were revised to improve consistency and to clarify electrical classification requirements in the document.
- (4) Chapter 7 was revised to provide clarification on the heating of recirculated air and the manifolding of exhaust ducts.

The following major changes were adopted in the 2021 edition of the standard:

- (1) The Origin and Development for previous editions of NFPA 33 was updated to better act as a brief summary of the historical changes to the standard.
- (2) Several editorial revisions were made, including updates to extracted material. Some of these updated extracts from NFPA 30 led to revised language concerning the classification of liquids and their associated definitions. In the annex material for Chapter 6, direction was added to the applicable sections of *NFPA 70®*, *National Electrical Code®*, for the construction and installation of flexible power cords.
- (3) Several clarifications were introduced to the 2021 edition of the standard. Examples of this include requirements for the recirculation of heated air that does not apply to spray booths used for curing, language explaining why plastic bags should not be used to cover sprinklers, and how automatic fire protection is not required in small spray booths. Additionally, Chapter 9 was reorganized to provide a better flow of information.

The 2024 edition has been updated substantially in the following ways:

- (1) Vocabulary now aligns with terminology used in NFPA 30 for ignitable (flammable or combustible) liquids.
- (2) New definitions for the terms *maximum allowable quantity* and *inflatable finishing workstations* are added to Chapter 3.
- (3) New requirements added in Chapters 1 and 14 address spray finishing in inflatable finishing workstations.
- (4) Revisions in Chapter 4 and Chapter 5 align with requirements in the International Fire Code for fire rated construction and fire resistance requirements for spray rooms.
- (5) Revisions in Chapter 5 differentiate door construction requirements from walls and ceilings. Furthermore, revisions to Chapters 5 and 14 add additional test requirements for materials used in wall or ceiling assemblies.
- (6) Revisions in Chapter 8 simplify the requirements for total quantities of liquids allowed in mixing rooms based on floor area, and new requirements address how maximum allowable quantities should be determined when there are multiple mixing rooms, spray booths, and spray areas.
- (7) Revisions in Chapter 9 differentiate liquid spray operations from powder spray operations, as well as add hybrid systems (water and inert gas) to the list of available fire protection systems.
- (8) Revisions in Chapter 10 remove the term *excessive accumulation*, and new requirements allow the user to establish an appropriate accumulation threshold and cleaning schedule that manages the hazards associated with the materials they use.
- (9) New material in the annex clarifies that luminaries are designed for use in classified spaces as applicable, but the area inside luminaries is not classified, therefore the protection method around luminaries is designed to prevent flammable atmospheres from entering the device.

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## NFPA 33

## Standard for

## Spray Application Using Flammable or Combustible Materials

2024 Edition

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

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

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

## Chapter 1 Administration

## 1.1\* Scope.

**1.1.1\*** This standard shall apply to the spray application of flammable or combustible materials, as herein defined, either continuously or intermittently by any of the following methods:

- (1) Compressed air atomization
- (2) Airless or hydraulic atomization
- (3) Electrostatic application methods
- (4) Other means of atomized application

**1.1.2** This standard shall also apply to the application of flammable or combustible materials, as herein defined, either continuously or intermittently by any of the following methods:

- (1) Fluidized bed application methods
- (2) Electrostatic fluidized bed application methods
- (3) Other means of fluidized application

**1.1.3** This standard shall also apply to the spray application of 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 spray operations that use less than 1 L (33.8 fl oz) of ignitable (flammable or combustible) liquid in any 8-hour period.

**1.1.5** This standard shall apply to spray application processes or operations that are conducted indoors or outdoors within temporary membrane enclosures.

**1.1.6\*** This standard shall not apply to spray application processes or operations that are conducted outdoors.

**N 1.1.7** This standard shall apply to spray application processes and operations that are conducted outdoors within an air-inflated structure that meets the applicable requirements of Section 14.4.

**1.1.8\*** This standard shall not apply to the use of portable spraying equipment that is not used repeatedly in the same location.

**1.1.9** This standard shall not apply to the use of aerosol products in containers up to and including 1 L (33.8 oz) capacity that are not used repeatedly in the same location. (See A.1.1.8.)

**1.1.10** This standard shall not apply to the spray application of noncombustible materials.

**1.1.11** This standard shall not apply to the hazards of toxicity or to industrial health and hygiene. (See 1.2.2.)

## 1.2 Purpose.

**1.2.1** The purpose of this standard shall be to provide requirements for fire safety for spray application of flammable or combustible materials. This standard anticipates conditions of average use. Where unusual industrial processes are involved, the authority having jurisdiction shall be permitted to require additional safeguards or modifications to the requirements of this standard, provided equivalent safety is achieved.

**1.2.2\*** The purpose of this standard shall be to address only the fire and explosion hazards of spray application processes and operations. This standard shall not address toxicity and shall not address industrial health and hygiene. From the standpoint of personnel safety, it shall be recognized that the materials used in these processes could be present in concentrations that present a health hazard, even though these concentrations do not present a fire or explosion hazard.

**1.3 Application.** Chapter 4 through Chapter 10 and Chapter 19 shall apply to all spray application processes within the scope of this standard. Chapter 11 and Chapter 12 shall apply only to electrostatic spray application processes. Chapter 13 shall apply only to drying, curing, and fusion processes and operations. Chapter 14 shall apply only to miscellaneous spray operations. Chapter 15 shall apply only to powder coating application processes and operations. Chapter 16 and Chapter 17 shall apply only to multicomponent coating systems and to processes that involve the use of catalysts, such as organic peroxide formulations. Chapter 18 shall apply only to spray application processes or operations that are conducted in temporary membrane enclosures both inside and outside buildings and structures.

**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.

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

NFPA 10, *Standard for Portable Fire Extinguishers*, 2022 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2024 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2022 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2022 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2024 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2024 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2024 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2023 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2024 edition.

NFPA 70®, *National Electrical Code®*, 2023 edition.

NFPA 72®, *National Fire Alarm and Signaling Code®*, 2022 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2023 edition.

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

NFPA 101®, *Life Safety Code®*, 2024 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2023 edition.

NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, 2024 edition.

NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, 2023 edition.

NFPA 400, *Hazardous Materials Code*, 2022 edition.

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, 2024 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, 2023 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2023 edition.

NFPA 770, *Standard on Hybrid (Water and Inert Gas) Fire-Extinguishing Systems*, 2021 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2022 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2024 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/FM 4950, *Welding Pads, Welding Blankets and Welding Curtains for Hot Work Operations*, 2014.

**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, 2021.

**Δ 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*, 2020.

ASTM D56, *Standard Test Method for Flash Point by Tag Closed Cup Tester*, 2022.

ASTM D93, *Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*, 2020.

ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*, 2020a.

ASTM D3278, *Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus*, 2021.

ASTM D3828, *Standard Test Methods for Flash Point by Small Scale Closed Cup Tester*, 2016a (reapproved 2021).

ASTM D4359, *Standard Test for Determining Whether a Material is a Liquid or a Solid*, 1990 (reapproved 2019).

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2022.

ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*, 2022.

ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*, 2022.

ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*, 2022a.

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

UL 340, *Tests for Comparative Flammability of Liquids*, 2017.

UL 723, *Test for Surface Burning Characteristics of Building Materials*, 2021.

UL 900, *Air Filter Units*, 2020.

UL 2208, *Solvent Distillation Units*, 2020.

### 2.3.5 Other Publications.

*Merriam-Webster's Collegiate Dictionary*, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2020.

## 2.4 References for Extracts in Mandatory Sections.

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

NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems*, 2023 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2019 edition.

NFPA 70®, *National Electrical Code®*, 2023 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 phrases “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\* Ambient.** For the purposes of this standard, the temperature range of the air in the spray area at which a spray application process takes place.

#### 3.3.2 Area.

**3.3.2.1 Flash-Off Area.** An open or enclosed area after a spray application process where vapors are released due to exposure to ambient air or a heated atmosphere.

**3.3.2.2 Resin Application Area.** Any area in which polyester resins or gelcoats are spray applied.

**3.3.2.3\* Spray Area.** Any fully enclosed, partly enclosed, or unenclosed area in which flammable or combustible vapors, mists, residues, dusts, or deposits are present due to the operation of spray processes, including (1) any area in the direct path of a spray application process; (2) the interior of a spray booth, spray room, or limited finishing workstation, as herein defined; (3) the interior of any exhaust plenum, eliminator section, or scrubber section; (4) the interior of any exhaust duct or exhaust stack leading from a spray application process; (5) the interior of any air recirculation path up to and including recirculation particulate filters; (6) any solvent concentrator (pollution abatement) unit or solvent recovery (distillation) unit; and (7) the inside of a membrane enclosure. The following are not part of the spray area: (1) fresh air make-up units; (2) air supply ducts and air supply plenums; (3) recirculation air supply ducts downstream of recirculation particulate filters; and (4) exhaust ducts from solvent concentrator (pollution abatement) units.

**3.3.2.3.1 Outdoor Spray Area.** A spray area that is outside the confines of a building or that has a canopy or roof that does not limit the dissipation of the heat of a fire or dispersion of flammable vapors and does not restrict firefighting access and control. For the purpose of this standard, an outdoor spray area can be treated as an unenclosed spray area, as defined in 3.3.2.3.2.



**3.3.2.3.2 Unenclosed Spray Area.** Any spray area that is not confined by a limited finishing workstation, spray booth, or spray room, as herein defined.

**3.3.3 Automated Spray Application Operations.** Operations where the spray application operation is performed by mechanical or electronic devices that take the place of human labor.

**3.3.4 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]

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

**3.3.6 Chopper Gun.** A device that feeds glass fiber through a cutting unit and injects the cut glass fibers into a stream of catalyzed liquid resin that is then sprayed onto a surface.

**3.3.7 Combustible Powder.** Any finely divided solid coating material that is capable of being ignited.

**△ 3.3.8 Competent Person.** One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. [56, 2023]

**3.3.9\* Control Area.** A building or portion of a building within which hazardous materials are allowed to be stored, dispensed, used, or handled in quantities not exceeding the maximum allowable quantities (MAQ). (BLD-IND) [5000, 2021]

**3.3.10 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]

**3.3.11 Fluidized Bed.** A chamber holding powder coating material that is aerated from below to form an air-supported, expanded cloud of the powder. The object or material being coated is preheated, then immersed into the cloud.

**3.3.11.1 Electrostatic Fluidized Bed.** A chamber holding powder coating material that is aerated from below to form an air-supported, expanded cloud of the powder. The powder is electrically charged with a charge opposite to that of the object or material being coated.

**3.3.12 Inerting.** A technique by which a combustible mixture is rendered nonignitable by adding an inert gas or a noncombustible dust. [69, 2019]

**N 3.3.13\* Inflatable Finishing Workstation.** An air-inflated structure whose shape is maintained by air pressure in cells or tubes forming all or part of the enclosure of the usable area and in which the occupants are not within the pressurized area used to support the structure and confine the vapor, mist, residue, dust, or deposits that are generated by a spray application process.

**3.3.14 Limited Combustible.** See Section 4.6.

**△ 3.3.15 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 for Determining Whether a Material is a Liquid or a Solid*. [30, 2021]

**3.3.15.1 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]

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

**3.3.15.3\* Ignitable Liquid.** Any liquid or liquid mixture that has a measurable closed-cup flash point. [30, 2021]

**3.3.15.4 Liquid Class.** A uniform system of classifying ignitable liquids. (See Chapter 4.) [30, 2021]

### 3.3.16 Material.

**3.3.16.1 Limited-Combustible Material.** See Section 4.6.

**3.3.16.2 Noncombustible Material.** See Section 4.5.

**N 3.3.17\* Maximum Allowable Quantity (MAQ).** For the purposes of this code, the quantity of flammable and combustible (ignitable) liquid permitted in a control area. [30, 2021]

**3.3.18 Overspray.** Any sprayed material that is not deposited on the intended object.

**3.3.19 Readily Accessible.** For the purposes of this standard, capable of being removed or exposed without damaging the equipment or system or the building structure or finish, or not permanently enclosed.

**3.3.20\* Recirculation Particulate Filter.** A filter, or series of filters, capable of removing more than 95 percent of particles 0.3 to 10 µ in size from the airstream.

**3.3.21\* Spray Booth.** A power-ventilated enclosure for a spray application operation or process that confines and limits the escape of the material being sprayed, including vapors, mists, dusts, and residues that are produced by the spraying operation and conducts or directs these materials to an exhaust system.

**3.3.21.1 Dry Particulate Scrubber Spray Booth.** A spray booth that is equipped with a dry filtration system that uses a dry, noncombustible particulate medium to remove paint overspray particulate from the spray booth exhaust airstream.

**3.3.21.2 Dry-Type Spray Booth.** A spray booth that is not equipped with a water-washing system to remove overspray from the exhaust airstream and is equipped with one or more of the following: (1) distribution or baffle plates to promote an even flow of air through the booth or to reduce the overspray before it is pulled into the exhaust system; (2) dry media filters, either fixed or on rolls, to remove overspray from the exhaust airstream; (3) powder collection systems that capture powder overspray.

**3.3.21.3 Electrostatic Precipitator Spray Booth.** A spray booth that removes the paint particles from the exhaust air by directing the exhaust air through an electrostatic field and capturing the paint particles on grounded elements.

**3.3.21.4 High-Capacity Dry Paint Arrestor Booth.** A spray booth equipped with a dry media paint particulate overspray filtration system that utilizes discrete filtration

elements having a paint holding capacity of greater than or equal to 22.7 kg (50 lb)/ filter element.

**3.3.21.5 Water-Wash Spray Booth.** A spray booth that is equipped with a water-washing system designed to minimize the concentrations of dusts or residues entering exhaust ducts and to permit the collection of the dusts or residues.

**3.3.22\* Spray Room.** A power-ventilated fully enclosed room with a specified fire resistance rating used for spraying of flammable or combustible materials.

**3.3.23 Utilization Equipment.** Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes. [70, 2023]

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

### 3.3.25 Workstation.

**3.3.25.1\* Limited Finishing Workstation.** A power-ventilated apparatus that is capable of confining the vapors, mists, residues, dusts, or deposits that are generated by a limited spray application process. A limited finishing workstation is not a spray booth or spray room, as herein defined.

**3.3.25.2 Preparation Workstation.** A power-ventilated apparatus that is used to control the dusts and residues generated by surface preparation operations. A preparation workstation is not a limited finishing workstation, spray booth, or spray room, as herein defined.

## Chapter 4 General Requirements

**Δ 4.1\* Location of Spray Application Operations.** Spray application operations and processes shall be located in industrial or storage occupancies as defined by *NFPA 5000* and shall be confined to spray booths, spray rooms, spray areas, or temporary membrane enclosures as defined in this standard.

**Δ 4.1.1\* Locations in Other Occupancies.** Spray application operations and processes shall not be conducted in any building that is classified as an assembly, educational, day care, health care, ambulatory health care, detention/correctional, residential, mercantile, or business occupancy, unless the following requirements are met:

- (1) The spraying is located in a room that is separated both vertically and horizontally from all the surrounding areas by fire barriers having a fire resistance rating of not less than 1 hour or in a spray room (see Section 5.2).
- (2) The room is protected by an approved automatic sprinkler system designed and installed in accordance with NFPA 13.

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

### 4.3\* Basements.

**4.3.1** Spray booths, rooms, and areas in a basement shall meet the requirements of 5.1.4.

**4.3.2** Spray booths, rooms, and areas in a basement shall have an access means provided for emergency response personnel that is acceptable to the authority having jurisdiction.

**4.4 Fueled Vehicles.** Air makeup systems and spray area exhaust systems shall remain functioning when a liquefied-petroleum-gas, compressed-natural-gas, or hydrogen-fueled vehicle is present in the spray booth or spray room.

### 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) when 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 (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/m<sup>2</sup> for a 20-minute exposure, and both the following conditions are met:

- (1) The peak heat release rate shall not exceed 150 kW/m<sup>2</sup> for longer than 10 seconds.
- (2) The total heat released shall not exceed 8 MJ/m<sup>2</sup>. [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.

##### 4.7.1 Class I Liquids.

**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 40 psi (276 kPa) 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]

##### 4.7.3 Class III Liquids.

**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]

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

**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 104°F (40°C) 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 Construction and Design of Spray Areas, Spray Rooms, and Spray Booths

### 5.1\* Spray Areas.

**Δ 5.1.1** Walls and ceilings that intersect or enclose a spray area shall be both of the following:

- (1) Constructed of noncombustible or limited-combustible materials or assemblies
- (2) Securely and rigidly mounted or fastened

**5.1.1.1** The interior surfaces of the spray area shall be smooth, designed and installed to prevent pockets that can trap residues, and designed to facilitate ventilation and cleaning.

**5.1.1.2** Air intake filters that are a part of a wall, door, or ceiling assembly shall be listed in accordance with UL 900, *Air Filter Units*.

**N 5.1.1.3** Doors that are a part of a wall or ceiling assembly shall be constructed of one of the following:

- (1) Noncombustible or limited-combustible materials or assemblies
- (2) Materials or assemblies that can successfully pass Test Method 2 in NFPA 701
- (3) Materials that exhibit all of the following characteristics when tested in accordance with NFPA 286:
  - (a) During the 40 kW (136,486 Btu/hr) exposure, flames do not spread to the ceiling.
  - (b) The flame does not spread to the outer extremity of the sample on any wall or ceiling.
  - (c) Flashover, as defined in NFPA 286, does not occur.
  - (d) The peak heat release rate throughout the test does not exceed 800 kW (2,729,714 Btu/hr).
  - (e) The total smoke release throughout the test does not exceed 1000 m<sup>3</sup> (10,764 ft<sup>3</sup>).
- (4) Materials that exhibit a maximum rate of heat release of 100 kW (341,214 Btu/hr) when tested in accordance with NFPA 289 using a 20 kW (68,242 Btu/hr) ignition source



- (5) Materials that are classified as welding curtains by ANSI/FM 4950, *Welding Pads, Welding Blankets and Welding Curtains for Hot Work Operations*

**N 5.1.1.4\*** Doors that are a part of a wall or ceiling assembly shall have integral seals that minimize leakage into or out of the spray area.

**N 5.1.1.5** The door support structure shall be constructed of steel or other noncombustible material.

**5.1.2** The floor of the spray area shall be constructed of noncombustible material, limited-combustible material, or combustible material that is completely covered by noncombustible material.

**5.1.3** Aluminum shall not be used for structural support members, walls, or ceilings that enclose a spray area or for ventilation ductwork to or from an enclosed spray area unless otherwise permitted by 5.1.3.1.

**5.1.3.1** Aluminum shall be permitted to be used for interior components, such as platforms, spray apparatus components, and other ancillary devices.

**5.1.4\*** Enclosed spray areas shall be provided with means of egress that meet the applicable requirements of Chapter 40 of NFPA 101.

**5.2 Spray Rooms.** In addition to the requirements of Section 5.1, spray rooms shall be constructed of and separated vertically and horizontally from all the surrounding areas by fire barriers that have a fire resistance rating of not less than 1 hour.

### 5.3 Spray Booths.

**5.3.1** Spray booths shall meet the requirements of Sections 5.1 and 5.3.

**Δ 5.3.2** If walls or ceiling assemblies are constructed of sheet metal, single-skin assemblies shall be no thinner than 1.2 mm (0.0478 in.) and each sheet of double-skin assemblies shall be no thinner than 0.9 mm (0.0359 in.).

**N 5.3.3** If doors that are a part of a wall or ceiling assembly are constructed of sheet metal, the construction shall meet one of the following:

- (1) Single-skin assemblies shall be no thinner than 1.2 mm (0.0478 in.)
- (2)\* Each sheet of double-skin assemblies shall be no thinner than 0.9 mm (0.0359 in.)

**5.3.4** Structural sections of spray booths shall be permitted to be sealed with a caulk or sealant to minimize air leakage.

#### Δ 5.3.5 Powder Coating.

**5.3.5.1** Spray booths that are used exclusively for powder coating shall meet the requirements of Chapter 15.

**5.3.6** Spray application operations and processes that involve the use of finishing materials containing nitrocellulose shall be confined to water-wash spray booths as defined in this standard unless otherwise specified in 5.3.6.1.

**5.3.6.1** Spray application of finishing materials containing nitrocellulose shall be permitted in a dry-type spray booth provided that residue is removed from all baffle plates at least daily and all filters are changed at least daily.

**5.4 Conveyor Openings.** Conveyor openings that are necessary for transporting or moving work into and out of the spray area shall be as small as practical.

### 5.5 Separation from Other Operations.

**5.5.1** Spray booths shall be separated from other operations by a minimum distance of 915 mm (3 ft) or by a partition, wall, or floor/ceiling assembly having a minimum fire resistance rating of 1 hour.

**5.5.2** Multiple connected spray booths shall not be considered as "other operations" except as provided for in Section 13.3.

**5.5.3** Multiple spray booths connected by openings for moving the workpiece or that share a common wall shall not be considered as "other operations."

**5.5.4** For spray booths adjacent to rooms or equipment used for drying, curing or fusing, the separation requirements of Section 13.7 shall apply.

**5.5.5** Spray booths shall be installed so that all parts of the booth are readily accessible for cleaning.

**5.5.6** A clear space of not less than 915 mm (3 ft) shall be both of the following:

- (1) Maintained on all sides and above the spray booth
- (2) Kept free of any storage or combustible construction

**5.5.6.1** The requirement in 5.5.6 shall not prohibit locating a spray booth closer than 915 mm (3 ft) to or directly against an interior partition, wall, or floor/ceiling assembly that has a fire resistance rating of not less than 1 hour, provided the spray booth can be maintained and cleaned.

**5.5.6.2** The requirement in 5.5.6 shall not prohibit locating a spray booth closer than 915 mm (3 ft) to an exterior wall or a roof assembly, provided the wall or roof is constructed of noncombustible material and provided the spray booth can be maintained and cleaned.

### 5.6 Illumination and Observation Panels.

**5.6.1** Panels for luminaires or observation shall be of heat-treated glass, laminated glass, wired glass, or hammered-wired glass and shall be sealed to confine vapors, mists, residues, dusts, and deposits to the spray area.

**5.6.1.1** Listed spray booth assemblies that have observation panels constructed of other materials shall be permitted.

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

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

**5.7 Ventilation.** Spray areas that are equipped with ventilation distribution, baffle plates, or dry overspray collection filters shall meet the requirements of 5.7.1 through 5.7.5.

**5.7.1** Distribution plates or baffles shall be constructed of noncombustible materials and shall be readily removable or accessible for cleaning on both sides.

**5.7.2** Filters shall not be used when applying materials known to be highly susceptible to spontaneous heating or spontaneous ignition.

**5.7.3** Supports and holders for filters shall be constructed of noncombustible materials.

**5.7.4** Overspray collection filters shall be readily removable or accessible for cleaning or replacement.

**5.7.5** Filters shall not be alternately used for different types of coating materials if the combination of the materials might result in spontaneous heating or ignition. (See also Section 10.10.)

## Chapter 6 Electrical and Other Sources of Ignition

**6.1 Scope.** This chapter shall apply to electrical wiring and electrical utilization equipment that is used in the spray area or in the vicinity of the spray area. This chapter shall also apply to other sources of ignition.

### 6.2\* General.

**6.2.1** Electrical wiring and utilization equipment shall meet all applicable requirements of Articles 500, 501, 502, 505, and 516 of *NFPA 70* and all applicable requirements of this chapter.

**6.2.1.1** Powered vehicles shall meet the requirements of Section 6.10.

**6.2.1.2** Resin application operations shall meet the requirements of Chapter 17.

**6.2.2\*** 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.
- (4) A Class II, Division 1 location shall be permitted to be alternatively classified as a Zone 21 location.
- (5) A Class II, Division 2 location shall be permitted to be alternatively classified as a Zone 22 location.

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

**6.2.4** In instances of areas within the same facility classified separately, Zone 2 locations shall be permitted to abut, but not overlap, Class I, Division 2 locations. Zone 0 or Zone 1 locations shall not abut Class I, Division 1 or Division 2 locations. [70:505.7(B)]

**6.2.5\*** Open flames, spark-producing equipment or processes, and equipment whose exposed surfaces exceed the autoignition temperature of the material being sprayed shall not be located in a spray area or in any surrounding area that is classified as Division 2, Zone 2, or Zone 22.

**6.2.5.1** This requirement shall not apply to drying, curing, or fusing apparatus covered by Chapter 13.

**6.2.6\*** Any utilization equipment or apparatus that is capable of producing sparks or particles of hot metal and that is located above or adjacent to either the spray area or the surrounding Division 2, Zone 2, or Zone 22 areas shall be of the totally enclosed type or shall be constructed to prevent the escape of sparks or particles of hot metal.

### 6.3 Electrical Area Classification.

**6.3.1\* 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.

**6.3.1.1\* Class I, Division 1 Locations.** As defined in 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.

**6.3.1.2\* Class I, Division 2 Locations.** As defined in 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 liquid [FP < 37.8°C (100°F)] 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 the case of an 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.

**6.3.1.3\* Zone 0 Locations.** As defined in 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.

**6.3.1.4\* Zone 1 Locations.** As defined in 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 might 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.

**6.3.1.5 Zone 2 Locations.** As defined in 505.5(B)(3) of *NFPA 70*, a 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, it will only exist for a short period of time.
- (2) A flammable gas or a Class I liquid [FP < 37.8°C (100°F)] 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 the case of an accidental rupture or breakdown of the container or system or in the 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.6.3.1.2.)

**6.3.2 Class II Locations.** A Class II location shall be any location that might be hazardous because of the presence of a combustible dust.

**6.3.2.1\* Class II, Division 1 Locations.** As defined in 500.5(C)(1) of *NFPA 70*, a Class II, Division 1 location shall be any location where one of the following conditions exists:

- (1) Combustible dust is in the air in quantities sufficient to produce explosive or ignitable mixtures under normal operating conditions.
- (2) Mechanical failure or abnormal operation of machinery or equipment might cause an explosive or ignitable mixture of combustible dust in air and might also provide a source of ignition through simultaneous failure of electrical equipment, operation of protection devices, or from other causes.
- (3) Group E combustible dusts might be present in quantities sufficient to be hazardous.

**6.3.2.2\* Class II, Division 2 Locations.** As defined in 500.5(C)(2) of *NFPA 70*, a Class II, Division 2 location shall be a location in which one of the following conditions exists:

- (1) Combustible dust due to abnormal operations might be present in the air in quantities sufficient to produce explosive or ignitable mixtures.
- (2) Combustible dust accumulations are present but are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but could as a result of infrequent malfunctioning of handling or processing equipment become suspended in the air.
- (3) Combustible dust accumulations on, in, or in the vicinity of the electrical equipment could be sufficient to interfere with the safe dissipation of heat from electrical equipment, or could be ignitable by abnormal operation or failure of electrical equipment.

**6.3.2.3\* Zone 20.** As defined in 506.5(B)(1) of *NFPA 70*, a Zone 20 location shall be any location where one of the following conditions exists:

- (1) An ignitable concentration of combustible dust is present continuously.
- (2) An ignitable concentration of combustible dust is present for long periods of time.

**6.3.2.4\* Zone 21.** As defined in 506.5(B)(2) of *NFPA 70*, a Zone 21 location shall be any location where one of the following conditions exists:

- (1) An ignitable concentration of combustible dust is likely to exist occasionally under normal operating conditions.
- (2) An ignitable concentration of combustible dust might exist frequently because of repair or maintenance operations or because of leakage.
- (3) Equipment is operated or processes are carried on of such a nature that equipment breakdown or faulty operations could result in the release of an ignitable concentration of combustible dust and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition.
- (4) An ignitable concentration of combustible dust could be communicated from an adjacent Zone 20 location, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

**6.3.2.5\* Zone 22.** As defined in 506.5(B)(3) of *NFPA 70*, a Zone 22 location shall be any location where one of the following conditions exists:

- (1) An ignitable concentration of combustible dust is not likely to occur in normal operation, and if it does occur, will only persist for a short period.
- (2) A combustible dust is handled, processed, or used, but the dust is normally confined within closed containers or closed systems from which it can escape only as a result of the abnormal operation of the equipment with which the dust is handled, processed, or used.
- (3) An ignitable concentration of combustible dust could be communicated from an adjacent Zone 21 location, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

#### 6.4 Electrical Devices in Spray Areas.

**6.4.1** The spray area as defined in 3.3.2.3 shall be Class I, Division 1; Zone 1; Class II, Division 1; or Zone 21, whichever is applicable.

**6.4.2** Electrical wiring and utilization equipment that is located in the spray area and is not subject to deposits of combustible residues shall be suitable for Class I, Division 1; Zone 1; Class II, Division 1; or Zone 21 locations, whichever is applicable.

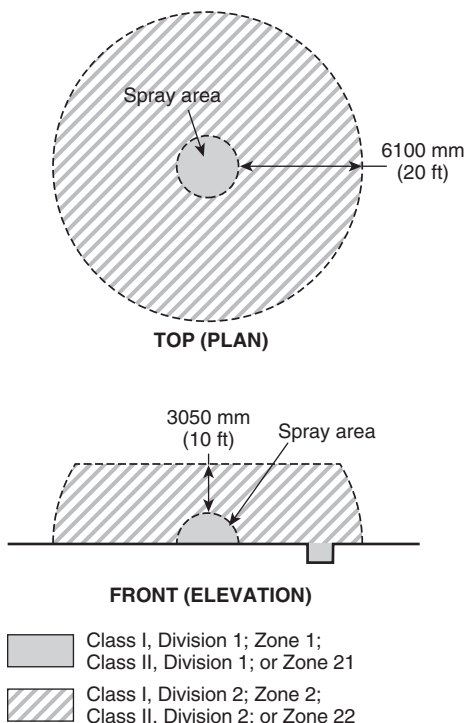
**6.4.3\*** Electrical wiring and utilization equipment that is located in the spray area and is subject to deposits of combustible residues shall be listed for such exposure and shall be suitable for Class I, Division 1; Zone 1; Class II, Division 1; or Zone 21 locations, whichever is applicable.

**6.5 Electrical Devices in Areas Adjacent to or Connected to Spray Areas.** Electrical wiring and utilization equipment located in areas adjacent to or connected to the spray area, including but not limited to vestibules and tunnels, shall be classified in accordance with 6.5.1 through 6.5.5.

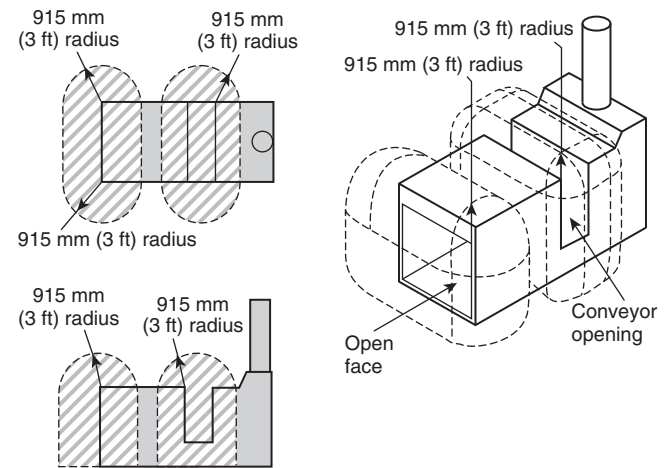
**6.5.1** Electrical wiring and utilization equipment located outside, but within 6100 mm (20 ft) horizontally and 3050 mm (10 ft) vertically, of an unenclosed spray area and not separated from the spray area by partitions extending to the boundaries of the area designated as Division 2, Zone 2; or Zone 22 in Figure 6.5.1 shall be suitable for Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable.

**6.5.2\*** If spray application operations are conducted within a closed-top, open-face, or open-front booth or room, as shown in Figure 6.5.2(a) or Figure 6.5.2(b), any electrical wiring or utilization equipment located outside the booth or room but within 915 mm (3 ft) of any opening shall be suitable for Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable.

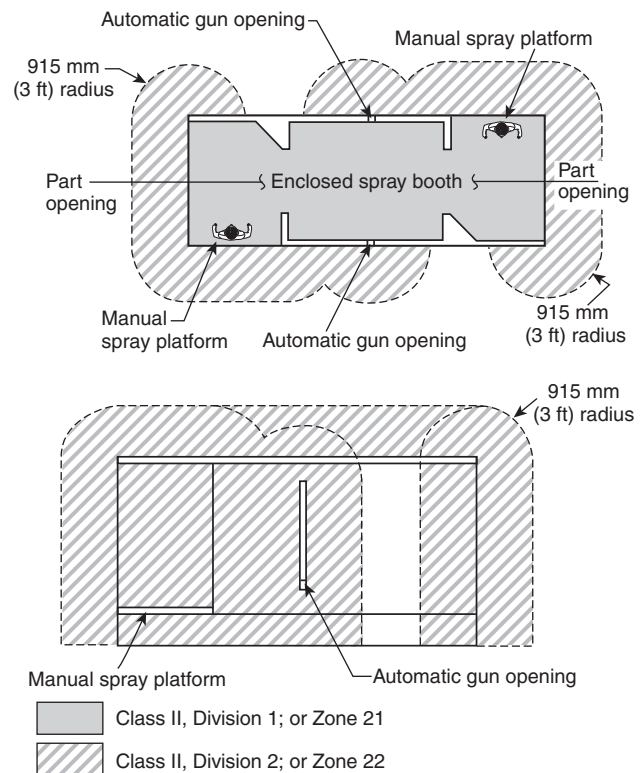
**6.5.3** If spray application operations are conducted within an open-top booth, any electrical wiring or utilization equipment located within the space 915 mm (3 ft) vertically from the top of the booth shall be suitable for Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable. In addition, any electrical wiring or utilization equipment located within 915 mm (3 ft) in all directions of openings other than the open top also shall be suitable for Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable.



**FIGURE 6.5.1** Electrical Area Classification for Unenclosed Spray Areas.



**FIGURE 6.5.2(a)** Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 Locations Adjacent to an Open-Face or Open-Front Spray Booth or Spray Room.



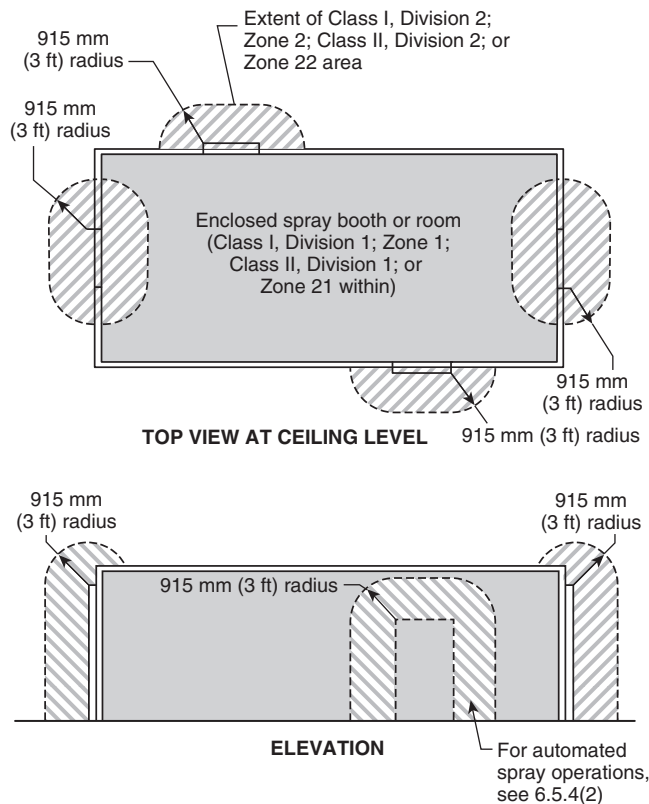
**FIGURE 6.5.2(b)** Class II, Division 1; or Zone 21 Locations Inside Powder Coating Booth and On the Manual Spray Platforms. Class II, Division 2; or Zone 22 Locations Adjacent to Automatic Gun Openings and Outer Edge of the Manual Spray Platform for Powder Coating Booth.



**▲ 6.5.4** If spray application operations are confined to an enclosed spray booth or room, electrical area classification shall be as follows:

- (1) The area within 915 mm (3 ft) of any opening shall be classified as Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable, as shown in Figure 6.5.4.
- (2)\* Where automated spray application equipment is used, the area outside the access doors shall be unclassified provided the door interlock prevents the spray application operations when the door is open.
- (3) Where exhaust air from a liquid spray operation is recirculated and all the requirements of Section 7.5 are met, both of the following shall apply:
  - (a) The interior of any path downstream of the concentration monitor up to and including the air supply plenum shall be classified as a Class I, Division 2 or Zone 2 location, whichever is applicable.
  - (b) The interior of fresh air supply ducts shall be unclassified.
- (4) Where exhaust air is not recirculated, the interior of fresh air supply ducts and fresh air supply plenums shall be unclassified.

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



**▲ FIGURE 6.5.4** Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 Locations Adjacent to an Enclosed Spray Booth or Spray Room.

**6.5.5.1** Electrical area classification shall be as follows:

- (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 6.5.5.1(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.

**6.5.5.2** Electrical wiring and utilization equipment installed in these areas shall be suitable for the location, as shown in Figure 6.5.5.2.

## 6.6 Illumination.

### 6.6.1 Luminaires — Outside Classified Areas.

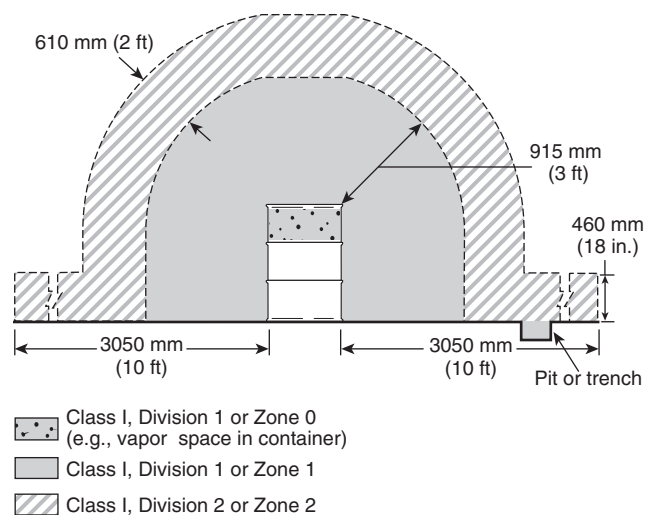
**6.6.1.1** Luminaires, like that shown in Figure 6.6.1.1, that are outside any classified area and are separated from the spray area by glass panels that meet the requirements of Section 5.6 shall not be required to be listed for use in hazardous (classified) locations.

**6.6.1.2** Such luminaires as stated in 6.6.1.1 shall be capable of being serviced from outside the spray area.

### 6.6.2 Luminaires — Location.

**6.6.2.1** Luminaires, like that shown in Figure 6.6.1.1, that are separated from the spray area by glass panels that meet the requirements of Section 5.6; 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.

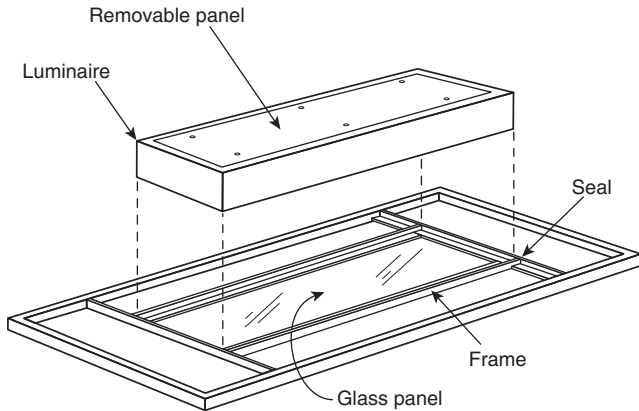
**6.6.2.2** Such luminaires as stated in 6.6.2.1 shall be serviced from outside the spray area.



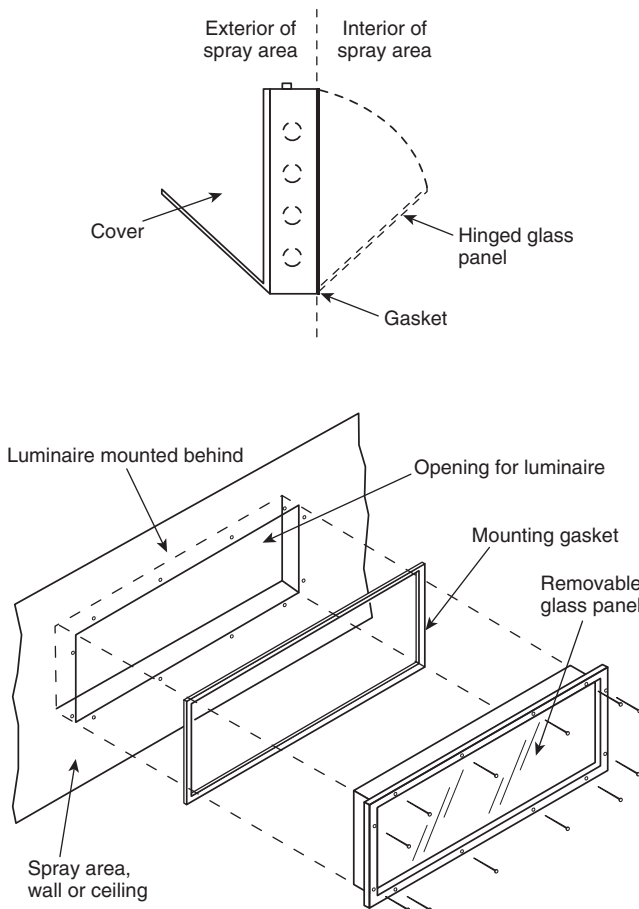
**FIGURE 6.5.5.2** Electrical Area Classification for Class I Liquid Operations Around Open Containers, Supply Containers, Waste Containers, Spray Gun Cleaners, and Solvent Distillation Units.

### 6.6.3 Luminaires — Walls or Ceilings.

**6.6.3.1** Luminaires, like that shown in Figure 6.6.3.1, that are an integral part of the walls or ceiling of a spray area shall be permitted to be separated from the spray area by glass panels that are an integral part of the luminaire.



**FIGURE 6.6.1.1** Example of a Luminaire Mounted Outside the Spray Area and Serviced from Outside the Spray Area.



**FIGURE 6.6.3.1** Examples of Luminaires That Are Integral Parts of the Spray Area and That Are Serviced from Inside the Spray Area.

**6.6.3.2** Such luminaires as stated in 6.6.3.1 shall be listed for the following:

- (1)\* Use in Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 locations, whichever is applicable
- (2) Accumulations of deposits of combustible residues

**6.6.3.3** Such luminaires as stated in 6.6.3.1 shall be permitted to be serviced from inside the spray area.

**6.6.4** Luminaires that are located inside the spray area shall meet the requirements of Section 6.4 and Section 6.7.

### Δ 6.7\* Static Electricity.

**N 6.7.1** All electrically conductive objects in the spray 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).

**N 6.7.2** The requirements of 6.7.1 shall apply to containers of coating material, wash cans, guards, hose connectors, brackets, and any other electrically conductive objects or devices in the area.

**N 6.7.3** The requirements of 6.7.1 shall apply to any personnel who enter the spray area.

**6.8\* Flexible Power Cords.** For automated equipment and robotic equipment, flexible power cords shall be permitted to be used in hazardous (classified) locations and to be connected to the fixed part of an electrical circuit provided they meet all of the following conditions:

- (1) They are listed for extra-hard usage.
- (2) They are equipped with a grounding conductor that meets the requirements of Section 400.2 of *NFPA 70*.
- (3) They are connected to terminals or conductors in an approved manner.
- (4) They are supported by a positive mechanical clamp in such a manner that enables a cord to be readily replaced and prevents strain at the cord connections within the terminal enclosure.
- (5)\* They are provided with explosionproof seals for liquid applications or dusttight seals for powder applications where cords enter junction boxes, fittings, or enclosures.
- (6) They are listed for deposits of combustible residue.

**6.9 Portable Electric Luminaires.** Portable electric luminaires used in spray areas shall meet the requirements of 6.4.3.

**6.10 Movement of Powered Vehicles.** Powered vehicles shall be listed for the electrical area classification in which they are used, and unlisted powered vehicles shall not be moved into or out of a spray area or operated in a spray area unless the spray application operation or process is stopped and the ventilation system is maintained in operation.

## Chapter 7 Ventilation

**7.1 General.** Ventilating and exhaust systems shall be designed and installed in accordance with the applicable requirements of NFPA 91 except as amended by the requirements of this chapter.

### 7.2 Performance Requirements.

**7.2.1** Each spray area shall be provided with mechanical ventilation that is capable of confining and removing vapors and mists to a safe location and confining and controlling combustible residues, dusts, and deposits.

**7.2.2** For liquid spray operations, the concentration of the vapors and mists in the exhaust stream of the ventilation system shall not exceed 25 percent of the lower flammable limit. *(See Annex B for additional guidance on determining the lower flammable limit.)*

**7.2.3** For more information on powder spray operations, see Section 15.7.

**7.2.4\*** Spray areas equipped with overspray collection filters shall have an effective means for ensuring that the performance requirements of 7.2.1 through 7.2.3 are met.

**7.2.5** Mechanical ventilation shall be kept in operation at all times while spray operations are being conducted and for a sufficient time thereafter to allow the vapors from drying coated objects or material and residues to be exhausted.

**7.2.6** Where spray operations are conducted automatically without an attendant constantly on duty, the operating controls of the spray apparatus shall be arranged so that the spray apparatus cannot function unless the exhaust fans are operating.

**7.2.7** In confined spaces where ventilation is not capable of meeting the requirements of Section 7.2, an inerting procedure shall be permitted to be used.

**7.2.8** Such procedures shall meet the applicable requirements of NFPA 69 and shall be acceptable to the authority having jurisdiction.

**7.3\* Make-Up Air.** Clean make-up air shall be provided to compensate for the air exhausted from spray operations. The intake for this make-up air shall be located so that the air exhausted from spray operations is not recirculated.

### 7.4 Routing of Exhaust Ducts.

**7.4.1** Air exhausted from liquid spray operations shall be conducted by ducts directly to the outside of the building.

**7.4.2** 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.
- (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.

**7.5\* Recirculation of Exhaust.** Air exhausted from liquid spray areas shall not be recirculated unless all of the following requirements are 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 7.5(3) shall initiate a local alarm and shall automatically shut down the spray operation 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 spray operations shall be approved by the authority having jurisdiction.
- (6)\* For occupied spray areas where a portion of the exhaust air is recirculated within the spray area, toxicity and worker exposures shall be addressed.

**7.6\* Heating of Recirculated Air.** Where air recirculated from a spray application process is heated, the following requirements shall be met:

- (1) The air heater shall be located downstream of the recirculation particulate filter and vapor concentration monitor.
- (2) The air heating system shall not include an open flame.
- (3)\* The surface temperature of the air heater shall not exceed 105°C (221°F).

**7.7\* Manifolding of Exhaust Ducts.** Individual spray booths shall be separately ducted to the building exterior except as indicated in 7.7.1 or 7.7.2.

**7.7.1** Multiple spray booths whose combined frontal area does not exceed 1.7 m<sup>2</sup> (18 ft<sup>2</sup>) shall be permitted to be manifolded if the sprayed materials used will not react and cause ignition of the residue in the ducts.

**7.7.2** Where treatment of exhaust is necessary for air pollution control or for energy conservation, ducts shall be permitted to be manifolded if all of the following conditions are met:

- (1) The sprayed materials used will not react and cause ignition of the residue in the ducts.
- (2) No finishing materials containing nitrocellulose are used.
- (3) An air-cleaning system is provided to reduce the amount of overspray carried into the duct manifold.
- (4) Automatic sprinkler protection is provided at the junction of each booth exhaust with the manifold, in addition to the protection required by Chapter 9.
- (5) The installation is approved by the authority having jurisdiction.



**7.8\* Materials of Construction.** Exhaust plenums and exhaust ducts and fasteners shall be constructed of steel, except as allowed in 7.8.1, 7.8.2, and 7.8.3.

**7.8.1** For spray booths used exclusively for powder coating, ducts shall be permitted to be constructed of fire-retardant combustible materials.

**7.8.2** 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.

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

**7.9\* Support of Exhaust Ducts.** Exhaust ducts shall be supported to prevent collapse under fire conditions.

**7.9.1** Duct supports shall be designed to carry the weight of the duct system itself, plus the anticipated weight of any residues. If sprinkler protection is provided inside the duct system, then the duct supports also shall be designed to carry the anticipated weight of any accumulation of sprinkler discharge.

**7.9.2** Hangers and supports shall be fastened to the building or to the structure to minimize vibration and stress on the duct system.

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

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

**7.9.5** The provisions of 7.9.4 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.

**7.10 Exhaust Duct Access Openings.** 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** Electric motors that drive exhaust fans shall not be placed inside any spray area unless they meet the provisions of 6.4.3.

**7.11.3** Belts shall not enter any spray area unless the belt and pulley within the spray area are completely enclosed.

**7.12\* Drying Areas.** Freshly sprayed workpieces shall be dried only in spaces that are ventilated to prevent the concentration of vapors from exceeding 25 percent of the lower flammable limit. (See also Chapter 13.)

## Chapter 8 Storage, Handling, and Distribution of Ignitable (Flammable and Combustible) Liquids

**8.1\* General.** Storage, handling, and mixing of ignitable (flammable and combustible) liquids shall meet all the applicable requirements of NFPA 30 and of this chapter.

**8.2 Storage in Process Areas.** The maximum allowable quantities (MAQs) of ignitable (flammable and combustible) liquids in each control area shall not exceed the amounts specified in Table 8.2, with additional quantities allowed in accordance with the requirements established in Section 8.3.

**Table 8.2 MAQ of Ignitable (Flammable and Combustible) Liquids per Control Area**

Liquid Classes	Quantity		Notes
	L	gal	
IA	115	30	1, 2
IB and IC	460	120	1, 2
IA, IB, IC combined	460	120	1, 2, 3
II	460	120	1, 2
IIIA	1265	330	1, 2
IIIB	50,600	13,200	1, 2

Notes:

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

(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 accumulatively.

(3) Containing not more than the maximum allowable quantity per control area of Class IA, Class IB, or Class IC liquids [FP < 100°F (37.8°C)], individually.

Source: Table 9.6.1 of NFPA 30.

### 8.3 Handling and Use.

**8.3.1** Dispensing or transfer of liquids from containers and filling of containers, including portable mixing tanks and “pressure pots,” shall be done only in a spray area with the ventilation in operation or in a mixing room.

**8.3.2** Where the quantities of liquids required or the floor area necessary to provide a suitable mixing room exceeds the limits specified in 8.3.3 through 8.3.5, the mixing room shall meet all applicable requirements of NFPA 30.

**8.3.3** Mixing rooms shall meet all of the following requirements:

- (1) Mixing rooms shall meet the construction requirements of Section 5.1.
- (2) The area of a mixing room shall not exceed 14 m<sup>2</sup> (150 ft<sup>2</sup>).
- (3) The total quantity of liquid in a mixing room shall not exceed 80 L/m<sup>2</sup> (2 gal/ft<sup>2</sup>) of floor area.
- (4) Mixing rooms shall be designed to contain a spill of the contents in the room.

- (5) Mixing rooms where ignitable (flammable or combustible) liquids at or above their flash point are being dispensed, handled, or transferred shall be provided with mechanical ventilation capable of providing air movement not less than 0.3 m<sup>3</sup>/min/m<sup>2</sup> (1 ft<sup>3</sup>/min/ft<sup>2</sup>) of floor area or 4 m<sup>3</sup>/min (150 ft<sup>3</sup>/min), whichever is greater.
- (6) Ventilation systems provided in accordance with 8.3.3(5) shall be in operation during operating hours or whenever vapors are present.
- (7) Mixing rooms shall be classified for the purposes of electrical area classification in accordance with Chapter 7 of NFPA 30.
- (8) Mixing rooms shall be provided with an approved automatic fire protection system that meets all the applicable requirements of Chapter 9.
- (9) Mixing rooms shall be provided with portable fire extinguishers located in accordance with NFPA 10.

**8.3.4** The amount of liquid permitted in a single spray area shall not exceed the lesser of 80 L/m<sup>2</sup> (2 gal/ft<sup>2</sup>) of floor area or 227 L (60 gal).

**N 8.3.5\*** The total aggregate volume of Class I, Class II, and Class IIIA liquids [FP < 200°F (93°C)] in a group of spray areas and mixing rooms shall not exceed the maximum allowable quantity of ignitable (flammable or combustible) liquids per control area in accordance with Table 8.2 and Table 8.3.5 based on the occupancy where the spray areas and mixing rooms are located.

#### 8.4 Distribution Systems — Piping.

**8.4.1\*** Piping systems that convey ignitable (flammable or combustible) liquids between storage tanks, mixing rooms (paint kitchens), and spray areas shall be composed of steel or some other material having comparable properties of resistance to heat and physical damage.

**8.4.1.1\*** Piping systems shall be properly bonded and grounded.

**8.4.1.2** Piping systems shall be in accordance with Chapter 27 of NFPA 30.

**8.4.2\*** Piping systems within the spray area shall be of steel or some other material having comparable resistance to heat and physical damage where possible.

**8.4.2.1\*** Where low melting point tubing or hose is used, a shutoff valve shall be provided on the steel pipe at the connection.

**8.4.3\*** Tubing or hose shall be inspected and maintained in accordance with Chapter 10.

**8.4.4\*** Where a pump is used to supply the liquid used in the spray application process, as well as in the cleaning process, piping, tubing, hose, and other accessories shall be designed to withstand the maximum working pressure of the pump or other means shall be provided to limit the discharge pressure of the pump.

**8.4.4.1** Where a pressure relief device is used, it shall be piped to a safe location.

#### 8.5 Distribution Systems — General.

**8.5.1** Liquids shall be transported by means of closed containers, approved safety cans, or approved portable tanks or shall be transferred by means of a piping system. Open containers shall not be used for moving or storing liquids.

**8.5.2\*** Wherever liquids are transferred from one container to another, both containers shall be effectively bonded and grounded to dissipate static electricity.

**8.5.3** Containers that supply spray nozzles shall be of the closed type or shall be provided with metal covers that are kept closed. Containers that do not rest on the floor shall have supports or shall be suspended by wire cables. Containers that supply spray nozzles by gravity flow shall not exceed 38 L (10 gal) capacity.

**8.5.4** Original shipping containers shall not be subjected to air pressure for supplying spray nozzles.

**8.5.5** Containers that are pressurized to supply spray nozzles, air storage tanks, and coolers shall comply with all applicable requirements of the ASME *Boiler and Pressure Vessel Code*, Section VIII, for construction, tests, and maintenance.

**8.5.5.1** Containers that meet the following requirements need not meet the requirements of the ASME *Boiler and Pressure Vessel Code*, Section VIII, for construction, tests, and maintenance:

- (1) Pressure containers less than 150 mm (6 in.) in diameter
- (2) Pressure containers that operate at less than a gauge pressure of 1.03 kPa (15 psi)
- (3) Siphon-type spray cups

**8.5.6** If a heater is used to heat the liquid being sprayed, it shall be low-pressure steam, low-pressure hot water, or electric.

**8.5.6.1** If electric heaters are used to heat the liquid being sprayed, the electric heater shall be approved and listed for the specific location in which it is used. (See Chapter 6.)

**N Table 8.3.5 MAQ of Liquids Per Control Area for Incidental Operations**

Liquid Class(es) <sup>#</sup>	Open Use		Use — Closed Containers	
	gal	L	gal	L
IA	10	38	30	115
IB and IC	30	115	120	460
II	30	115	120	460
IIIA	80	300	330	1,265
IIIB	3,300	12,650	13,200	50,600

<sup>#</sup>See Section 4.7 for details on the classification scheme.

Notes:

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

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

Source: Table 18.5.4 of NFPA 30.

**8.5.6.2** Heaters shall not be located in spray booths or other locations subject to the accumulation of deposits of combustible residue.

**8.5.7** Agitators, if used, shall be driven by compressed air, water, low-pressure steam, or electricity.

**8.5.7.1** If the agitators are powered by an electric motor, the motor shall meet the requirements of Chapter 6.

**8.5.8** Methods for cleaning paint circulation systems shall meet the requirements of Chapter 18 of NFPA 30.

**8.5.9** Compressed air shall be permitted to be used for cleaning paint delivery hose for individual applicators in a spray booth, provided both of the following requirements are met:

- (1) The booth ventilation is operating.
- (2) The maximum air pressure does not exceed the maximum working pressure of any component of the piping or hose system.

## Chapter 9 Protection

### 9.1\* General.

#### 9.1.1 Liquid Spray Areas.

**9.1.1.1** Spray areas, as defined in this standard, used for liquid spray operations shall be protected with an approved automatic fire protection system.

**9.1.1.2** The automatic fire protection system requirement in 9.1.1.1 shall apply to both manual and automated spray application processes.

#### 9.1.2 Mix Rooms.

**Δ 9.1.2.1** Mix rooms shall be protected with approved automatic fire protection systems.

**9.1.2.2** Mix room intake or exhaust ducts shall not require protection.

#### **Δ 9.1.3 Powder Application Areas.**

**N 9.1.3.1** Spray areas used for powder application operations shall be in accordance with Section 15.9.

**N 9.1.3.2** The automatic fire protection system requirement in 9.1.3.1 shall apply to both manual and automated powder application processes.

**Δ 9.1.4\*** Where a fire alarm system exists, the fire protection system shall be monitored in accordance with NFPA 72.

**9.1.4.1** Where a building fire alarm system is not present, actuation of fire protection systems required by this standard shall initiate an audible alarm or visual indicator.

**9.1.5** Portable fire extinguishers shall be provided and located in accordance with NFPA 10.

**9.2 Ventilation Systems.** Air make-up systems and spray area exhaust systems shall remain functioning during any fire condition.

**9.2.1\*** Where air exhausted from spray areas is recirculated, an interlock shall shut down the recirculation of air during any fire condition unless it can be demonstrated that shutdown creates a greater hazard.

**9.2.2** Where air exhausted from spray areas or nonspray areas is used to supply air to other areas, both of the following shall apply:

- (1) An interlock shall shut down the supply air.
- (2) Ductwork and dampers shall redirect the air to the outdoors in accordance with Section 7.4.

**9.2.3** Air make-up systems, spray area recirculation systems, and spray area exhaust systems shall be permitted to be shut down and dampers shall be permitted to close where the automatic fire protection system type requires that ventilation be discontinued.

### 9.3\* Coating Material Delivery Systems.

**9.3.1** Where a pump is used to supply the liquid used in the spray application process, an automatic means shall be provided to shut off the supply of liquid in the event of fire.

**9.3.2** When pressurized tanks larger than 19 L (5 gal) are used to supply the liquid used in the spray application process, an automatic means shall be provided to shut off the liquid flow at the tank outlet in the event of fire.

**9.4 Conveyors.** For operations where a workpiece is automatically conveyed through the spray area, activation of the automatic fire protection system shall automatically stop any conveyors into and out of the spray area.

**Δ 9.5 Protection Systems.** The automatic fire protection system shall be permitted to be and shall be installed in accordance with any of the following:

- (1) A water sprinkler system that meets all the applicable requirements of NFPA 13
- (2) A low expansion foam system that meets all the applicable requirements of NFPA 11
- (3) A carbon dioxide extinguishing system that meets all the applicable requirements of NFPA 12
- (4) A dry chemical extinguishing system that meets all the applicable requirements of NFPA 17
- (5) A gaseous agent extinguishing system that meets all the applicable requirements of NFPA 2001
- (6) A water mist fire protection system that meets all the applicable requirements of NFPA 750
- (7) A hybrid (water and inert gas) fire extinguishing system that meets all the applicable requirements of NFPA 770

### 9.5.1\* Automatic Sprinkler Systems.

**9.5.1.1\*** The automatic sprinkler system shall be a wet pipe system, a dry pipe system, a preaction system, or an open-head deluge system, whichever is most appropriate for the portion of the spray operation being protected.

**Δ 9.5.1.2** The automatic sprinkler system shall be designed as follows:

- (1) For spray application of styrene cross-link thermoset resin application areas, sprinklers shall be designed for Ordinary Hazard (Group 2) as defined in NFPA 13.
- (2) For powder coating operations, see Section 15.9.
- (3) For all liquid spray areas, sprinklers shall be designed for Extra Hazard (Group 2) as defined in NFPA 13.

**9.5.1.2.1** The sprinkler design area shall not be required to exceed the area of the booth or room in which spraying or resin application is conducted.

9.5.1.3\* The water supply shall be sufficient to supply all the sprinklers likely to open in any one fire incident without depleting the available water for use in hose streams.

Δ 9.5.1.3.1 Hose streams for the occupancy, in accordance with NFPA 13, shall be included in the water suppression system demands.

9.5.1.4 Where sprinklers are installed to protect spray areas and mixing rooms only, water shall be permitted to be supplied from domestic water systems, provided the domestic supply can meet the demand for the design criteria of 9.5.1.2.

9.5.1.5 The sprinkler system shall be controlled by a separate, listed indicating valve(s) that is operable from the floor level.

Δ 9.5.1.6\* **Duct Protection.** Sprinkler systems protecting stacks or ducts with widths or diameters equal to or greater than 0.25 m (10 in.) but less than 3.7 m (12 ft) shall meet all of the following requirements:

- (1) One sprinkler shall be located at the top of each vertical riser and at the midpoint of each offset. Additional sprinklers shall be spaced on 7.3 m (24 ft) centers if the rise is greater than 7.3 m (24 ft).
- (2) Horizontal exhaust ducts shall have sprinklers located on 3.7 m (12 ft) centers beginning no more than 1.7 m (6 ft) from the duct entrance.
- (3) If exhaust ducts are manifolded, a sprinkler shall be located in the manifold at the junction of each exhaust duct with the manifold.
- (4) Sprinklers shall provide a minimum flow of 114 L/min (30 gpm) per sprinkler at a minimum of 1 bar (15 psi) pressure.
- (5) Sprinklers shall be ordinary temperature rated unless required to be higher due to operating temperatures measured in the ducts, in which case the operating temperature shall be at least 28°C (50°F) above the inside temperature of the duct.
- (6)\* The system demand shall include the discharge from the hydraulically most remote adjacent sprinklers in a common 30.5 m (100 linear ft) area of duct (horizontal and/or vertical).
- (7)\* The supply line to the duct sprinklers, if taken from the ceiling sprinkler system, shall be equipped with an accessible listed control valve.

9.5.1.6.1 Stacks and exhaust ducts shall be provided with a means for the inspection and maintenance of sprinklers.

Δ 9.5.1.6.2 Sprinkler systems protecting stacks and ducts that are subject to freezing shall be of a nonfreezing type or a manually controlled open-head system.

Δ 9.5.1.7 Sprinklers shall be protected against overspray residue either by location or covering, so that they will operate quickly in the event of fire.

Δ 9.5.1.7.1\* Sprinklers shall be permitted to be covered by either clear, cellulose-based bags having a thickness of 0.08 mm (0.003 in.) or less or by thin paper bags.

Δ 9.5.1.7.2 The coverings permitted in 9.5.1.7.1 shall be replaced frequently so that heavy deposits of residue do not accumulate on them.

9.5.1.7.3 Sprinklers that have been painted or coated by overspray or residues shall be replaced with new sprinklers.

9.5.2\* **Automatic Carbon Dioxide, Dry Chemical, Clean Agent, Water Mist, and Hybrid (Water and Inert Gas) Systems.** The fire protection system shall be capable of discharging its contents into the entire protected area simultaneously, including the exhaust plenum and exhaust ductwork.

## 9.6 Specific Process Protection.

### 9.6.1\* Automated Spray Application Operations.

Δ 9.6.1.1 **Interlock.** For automated spray application operations, activation of the automatic fire protection system shall automatically accomplish all of the following:

- (1) Activate a local alarm in the vicinity of the spraying operation
- (2) Transmit an alarm signal to the facility's fire alarm system if such a system is provided
- (3) Shut down all spray application operations

9.6.1.2 The requirements of 9.6.1.1 shall not apply to operations where the supply of ignitable (flammable or combustible) liquids is located within the spray area and does not exceed 18.9 L (5 gal).

Δ 9.6.1.3 For automated spray application operations, the additional requirements of 9.6.2 for automated liquid electrostatic spray application equipment shall also apply.

9.6.1.4 **Emergency Shutdown.** For automated spray application operations, one or more manual emergency system shutdown stations shall be installed to serve each spray area in accordance with the following requirements:

- (1) When activated, the stations shall accomplish at least the functions listed in Section 9.3, Section 9.4, and 9.6.1.1.
- (2) At least one such station shall be within ready access of operating personnel.
- (3) If access to the station required in 9.6.1.4(2) is likely to involve exposure to danger, an additional station shall be located adjacent to an exit from the area.

### 9.6.2\* Protection for Automated Liquid Electrostatic Spray Application Equipment.

Δ 9.6.2.1 Automated liquid electrostatic spray application equipment, both listed and unlisted, shall be further protected by listed optical flame detection installed and supervised in accordance with NFPA 72.

Δ 9.6.2.1.1 The optical flame detection shall, in the event of ignition, react to the presence of flame within one-half (0.5) second and shall accomplish all of the following:

- (1) Meet all the requirements of 9.6.1.1
- (2) Disconnect power to the high-voltage elements in the spray area and de-energize the system
- (3) Stop any conveyors into and out of the spray area

Δ 9.6.2.2 Automated liquid electrostatic spray application equipment that is unlisted shall be protected further by the following:

- (1) In addition to meeting the requirements in 9.6.2.1, the optical flame detection system shall also activate one of the following over each zone in which fire has been detected:
  - (a) An open head deluge system designed to discharge a minimum density of 24.4 mm/min (0.6 gpm/ft<sup>2</sup>)
  - (b) A carbon dioxide extinguishing system
  - (c) A dry chemical extinguishing system



- (d) A gaseous agent extinguishing system
- (e) A water mist fire protection system
- (2) Manual activation stations shall be installed and meet all of the following requirements:
  - (a) At least one such station shall be within ready access of operating personnel.
  - (b) If access to this station is likely to involve exposure to danger, an additional station shall be located adjacent to an exit from the area.
  - (c) These devices shall activate the fire protection system as specified in 9.6.2.2(1) and satisfy the requirements of 9.6.1.1 and 9.6.2.2(1).
- (3) A wet pipe sprinkler system shall also be provided throughout the spray booth and shall meet all the applicable requirements of NFPA 13 for Extra Hazard (Group 2) occupancies.
- (4) Automatic electrostatic equipment enclosures inside the booth systems shall be protected with an approved automatic fire protection system. Activation of this system shall automatically accomplish the requirements of 9.6.1.1 and 9.6.2.2(1).

### 9.6.3 Protection for Dry Particulate Scrubber.

**9.6.3.1** The use of dry particulate scrubbers shall be permitted provided that both of the following conditions are met:

- (1) The virgin powder used for paint particulate scrubbing is noncombustible.
- (2) The concentration of paint solids collected and mixed in the powder scrubbing material is maintained such that the mixture remains noncombustible.

**9.6.3.2** The dry particulate scrubber chambers shall be protected by an approved automatic fire protection system.

**9.6.3.2.1** The automatic fire protection system shall be installed in accordance with any of the protection systems described in 9.5.

**9.6.3.3** Access for inspection and cleaning of sprinklers shall be provided.

**9.6.3.4\*** Areas subject to buildup of overspray residues where protection is permanently obstructed shall be protected by approved fire protection systems.

**9.6.3.4.1** Areas subject to buildup of overspray residues shall be cleaned to minimize the fuel loading.

**9.6.3.5** The scrubber shall be designed to direct the flow from the fire extinguishing system to an approved location or shall be designed to contain a minimum of 20 minutes of flow.

**9.6.3.6** In addition to the requirements of 9.6.1.1, activation of the automatic fire protection system shall automatically accomplish all of the following:

- (1) Shut down the operation of the dry particulate scrubbing system.

- (2)\* Automatically stop the air recirculation.

### 9.7 Protection for Electrostatic Precipitator Scrubber.

**9.7.1** The use of high-voltage electrostatic precipitator type scrubbers shall be permitted provided they meet the applicable requirements on Chapter 11.

**9.7.2** High voltage electrostatic precipitators shall be protected by an approved automatic fire protection system.

**9.7.2.1\*** Activation of the fire protection system shall be by an approved automatic detection system.

**9.7.3\*** Areas subject to buildup of overspray residues where protection is permanently obstructed shall be protected by approved fire protection systems.

**9.7.3.1** Areas subject to buildup of overspray residues shall be cleaned to minimize the fuel loading.

**9.7.4** The scrubber shall be designed to direct the flow from the fire-extinguishing system to an approved location or shall be designed to contain 20 minutes of flow.

**9.7.5** In addition to the requirements of 9.6.1.1, activation of the automatic fire protection system shall automatically accomplish all of the following:

- (1) Meet the requirement of 11.3.8(3)
- (2) Meet the requirement of 11.3.8(4)
- (3)\* Automatically stop the air recirculation

**9.7.6** The high-voltage power supplies shall be capable of monitoring current draw and shutting down or reducing voltage to prevent the generation of an electrostatic discharge.

### 9.8 Protection for High-Capacity Dry Paint Arrestor.

**9.8.1** The filtration media shall be protected by an approved automatic fire protection system in accordance with Section 9.5.

**9.8.2** If the filter itself is made from combustible material, the filter shall be housed in a noncombustible enclosure.

**9.8.2.1** The enclosure housing the filters shall be closed during spraying operations.

**9.8.2.2** The enclosure shall be protected by an approved automatic fire protection system in accordance with Section 9.5.

**9.8.2.3** The filters and enclosure shall be designed so as to prevent overspray residues from accumulating on the inside of the enclosure.

**9.8.3\*** Areas subject to buildup of overspray residues where protection is permanently obstructed shall be protected by approved fire protection systems.

**9.8.4\*** In addition to the requirements of 9.6.1.1, activation of the automatic fire protection system shall automatically stop air recirculation.

## Chapter 10 Operations and Maintenance

**10.1\* General.** Maintenance procedures shall be established to ensure that all spray application apparatus and processes are operated and maintained in accordance with the manufacturers' specifications and the requirements of this standard. Maintenance shall be the responsibility of the users of the apparatus and processes.

**10.1.1\*** Spray application operations shall not be conducted outside predetermined spray areas.

**10.1.2** Inspection of extinguishing systems shall be conducted to ensure that the performance of the extinguishing system components will not be affected by overspray and residues.

### 10.2 Inspection, Testing, and Maintenance.

**10.2.1** Safety devices such as detection, monitoring, actuation, interlock, and annunciation shall be maintained in accordance with the manufacturer's instructions.

**10.2.2** It shall be the responsibility of the equipment manufacturer to provide instructions for inspection, testing, and maintenance.

**10.2.3** It shall be the responsibility of the user to establish, schedule, and enforce the frequency and extent of the inspection, testing, and maintenance program, as well as the corrective action to be taken.

**10.2.4** All safety devices shall be tested for function at least annually.

**10.2.5** Safety device testing shall be documented.

**10.2.6** Calibration of equipment used to monitor the concentration of vapors shall be performed as follows:

- (1) In accordance with the manufacturer's instructions
- (2) At least annually

**10.2.7** As part of record retention, records of inspection, testing, and maintenance activities shall be retained for a period of 3 years.

### 10.3\* Combustible Residues.

**10.3.1** A cleaning threshold and schedule shall be established by the user for the removal of combustible residues from the spray area, as defined in this standard, based upon the characteristics of the material and the rate of accumulation.

**10.3.2** If accumulated combustible residue in booths, duct or duct discharge points, or other spray areas exceeds the threshold established in 10.3.1, all spraying operations shall be discontinued until conditions have been corrected.

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

**10.3.3.1** Where 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.

**10.4 High-Pressure Hose Lines.** High-pressure hose lines that convey ignitable (flammable or combustible) coating material in airless spray application operations shall be inspected daily and shall be repaired or replaced as necessary. Hose lines and equipment shall be located so that, in the event of a leak or

rupture, coating material will not be discharged into any space containing a source of ignition.

### 10.5 Maintenance Procedures.

**10.5.1** Overspray collectors shall be inspected daily and clogged filters shall be discarded and replaced. Maintenance procedures shall be established to ensure that overspray collector filters are replaced before restriction to airflow is reduced below the minimum established by Section 7.2.

**10.5.2** At the close of the day's operation, all discarded overspray collector filters, residue scrapings, and debris contaminated with residue shall be removed immediately to a designated storage location, placed in a noncombustible container with a tight-fitting lid, or placed in a water-filled metal container.

### 10.6\* Waste Containers.

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

**10.6.2** Waste containers for 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 6.5.5.

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

**10.6.4** Waste containers for Class I [FP < 37.8°C (100°F)] liquids shall be handled and stored in accordance with Chapter 8.

**10.7 Clothing.** Employees' clothing contaminated with sprayed material shall not be left on the premises overnight unless kept in metal lockers.

### 10.8 Cleaning Operations.

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

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

**10.8.3 Location.** Cleaning operations using ignitable (flammable or combustible) liquids shall be conducted inside a spray area with operating ventilating equipment or in ventilated areas that meet the requirements of Chapter 7. Such areas shall also meet the electrical area classification requirements of 6.5.5.

**10.8.4\* Equipment.** Equipment using ignitable (flammable or combustible) liquids shall meet the requirements of 6.5.5 and shall be bonded and grounded.

**10.8.5 Manual Cleaning.** Individual manual cleaning operations shall be limited to not more than 4 L (1 gal) of ignitable (flammable or combustible) liquid for each cleaning operator.

**10.8.6 Liquid Storage.** Ignitable (flammable or combustible) liquids shall be handled and stored in accordance with Chapter 8. Containers used for handling, storing, or recovering

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

## 10.9 Solvent Distillation Units (Solvent Recyclers).

### 10.9.1 Scope.

Δ 10.9.1.1 This section shall apply to solvent distillation units having distillation chambers or still pots that do not exceed 227 L (60 gal) nominal capacity and are used to recycle Class I, Class II, or Class IIIA liquids [FP < 93°C (200°F)]. [30:19.6.1.1]

10.9.1.2 This section shall not apply to research, testing, or experimental processes; to distillation processes carried out in petroleum refineries, chemical plants, or distilleries; or to distillation equipment used in dry cleaning operations. [30:19.6.1.2]

10.9.2 **Equipment.** Solvent distillation units shall be approved or shall be listed in accordance with UL 2208, *Solvent Distillation Units*. [30:19.6.2]

10.9.3 **Solvents.** Solvent distillation units shall only be used to distill liquids for which they have been investigated and that are listed on the unit's marking or contained within the manufacturer's literature. [30:19.6.3]

10.9.3.1 Unstable or reactive liquids or materials shall not be processed unless they have been specifically listed on the system's markings or contained within the manufacturer's literature. [30:19.6.3.1]

### 10.9.4 Location.

10.9.4.1 Solvent distillation units shall be located and operated in locations in accordance with their approval or listing. [30:19.6.4.1]

10.9.4.2 Solvent distillation units shall not be used in basements. [30:19.6.4.2]

10.9.4.3 Solvent distillation units shall be located away from potential sources of ignition, as indicated on the unit's marking. [30:19.6.4.3]

10.9.5 **Liquid Storage.** Distilled liquids and liquids awaiting distillation shall be stored in accordance with NFPA 30. [30:19.6.5]

10.10\* **Spontaneous Ignition Hazards.** The same spray booth shall not be alternately used for different types of coating materials if the combination of the materials is conducive to spontaneous ignition, unless all deposits of the first-used coating material are removed from the booth and exhaust ducts prior to spraying with the second coating material.

10.11\* **Chlorinated Solvents.** Coating materials containing chlorinated solvents shall not be used with spray application apparatus or fluid-handling equipment if the chlorinated solvent will come into contact with aluminum within a piping system, pump, enclosed container, or any enclosure that is capable of being pressurized by the potential reaction. This shall apply even if the container or system has been constructed with pressure relief devices.

10.12 **Smoking.** Signs stating NO SMOKING OR OPEN FLAMES in large letters on contrasting color background shall be conspicuously posted at all spray areas and paint storage rooms.

10.13\* **Hot Work.** Welding, cutting, and other spark-producing operations shall not be permitted in or adjacent to spray areas 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 precautions have been taken and will be followed until the job is completed.

## Chapter 11 Automated Electrostatic Spray Equipment

11.1 **Scope.** This chapter shall apply to any equipment using electrostatically charged elements for the atomization, charging, or precipitation of flammable and combustible materials for coatings on articles or for other purposes in which the charging or atomizing device is attached to a mechanical support or manipulator, including robotic devices. This chapter shall not apply to devices that are held or manipulated by hand.

### 11.2 General.

11.2.1 The installation and use of automated electrostatic spray application apparatus shall comply with the requirements of this chapter and also shall comply with the applicable requirements of all other chapters.

11.2.2 Where robot programming procedures involve manual manipulation of the robot arm while spraying with the high-voltage components energized, the provisions of Section 12.5 also shall apply.

11.3 **Automated Electrostatic Systems.** All automated electrostatic equipment systems shall comply with the requirements of 11.3.1 through 11.3.11.

11.3.1 Transformers, high-voltage supplies, control apparatus, and all other electrical portions of the equipment shall be located outside the spray area, as defined in 3.3.2.3, except as provided in 11.3.1.1 or 11.3.1.2.

11.3.1.1 Equipment that meets the requirements given in Chapter 6 shall be permitted to be located in the spray area.

11.3.1.2 High-voltage grids, electrodes, electrostatic atomizing heads, integral power supplies, and their connections shall be permitted to be located in the spray area.

11.3.2 Electrodes and electrostatic atomizing heads shall be insulated from ground. Electrodes and electrostatic atomizing heads that are permanently attached to their bases, supports, reciprocators, or robots shall be deemed to comply with this requirement.

11.3.3 High-voltage cables shall be insulated and protected from mechanical damage and exposure to destructive chemicals.

11.3.4\* All electrically conductive objects in the spray 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 1 megohm (10<sup>6</sup> ohms). This requirement shall apply to containers of coating material, wash cans, guards, hose connectors, brackets, and any other electrically conductive objects or devices in the area. This requirement shall also apply to any personnel who enter the spray area.

11.3.5 Conductive objects or material being coated shall be electrically connected to ground with a resistance of not more



than 1 megohm ( $10^6$  ohms). Areas of contact shall be sharp points or knife edges, where possible, and those areas of contact shall be protected from overspray, where practical.

**11.3.6** Highly resistive objects (i.e., surface conductivity between  $10^8$  and  $10^{11}$  ohms per square) that exhibit a surface voltage below 2500 volts, as measured using a nonloading kilovoltmeter and when subjected to coronal current not less than that expected in the application process, shall be considered adequately grounded.

**11.3.7** Objects or material transported by a conveyor shall be maintained in electrical contact with the conveyor or other grounding contacts. Hooks and hangers shall be cleaned regularly to ensure grounding.

**11.3.8\*** Electrostatic apparatus shall be equipped with automatic means to de-energize under any one of the following conditions:

- (1) Shutdown of ventilating fans or failure of ventilating equipment from any cause
- (2) Stopping of the conveyor carrying objects or material through the high-voltage field unless stopping is required by the spray process
- (3) De-energizing the primary voltage input to the power supply
- (4) Occurrence of excessive current leakage at any point on the high-voltage system

**11.3.9** Safeguards such as booths, fencing, railings, interlocks, or other means shall be placed about the equipment or incorporated therein so that they, either by their location or character or both, ensure that a safe separation of the process is maintained.

**11.3.10** Signs shall be conspicuously posted for the following purposes:

- (1) To designate the process zone as dangerous with regard to fire and accident
- (2) To identify the grounding requirements for all electrically conductive objects in the spray area, including persons
- (3) To restrict access to qualified personnel only

**11.3.11** All insulators shall be kept clean and dry.

**11.4 Incendive Equipment.** Spray equipment that is not considered to be nonincendive shall comply with 11.4.1 and 11.4.2.

**11.4.1** Conveyors, hangers, and application equipment shall be arranged so that a minimum separation of at least twice the sparking distance is maintained between the workpiece or material being sprayed and the electrodes, electrostatic atomizing heads, or charged conductors. Warnings defining this safe distance shall be provided.

**11.4.2\*** The high-voltage elements shall be automatically de-energized rapidly enough to prevent an arc in the event the clearance between the objects or material being coated and the electrodes or electrostatic atomizing heads falls below that specified in 11.4.1.

**11.5 Listing and Approval of Equipment.** Spray equipment shall be listed or shall meet the requirements of 11.5.1 or 11.5.2.

**11.5.1** Spray equipment that was installed prior to December 31, 1997, shall be listed or approved.

**11.5.2** This requirement shall not apply to automatic electrostatic spray equipment protected in accordance with 9.5.2 or 9.6.2.

## Chapter 12 Handheld Electrostatic Spray Equipment

**12.1 Scope.** This chapter shall apply to any equipment using electrostatically charged elements for the atomization, charging, and/or precipitation of flammable and combustible materials for coatings on articles or for other purposes in which the charging or atomizing device is handheld and manipulated during the spraying operation.

**12.2 General.** The installation and use of handheld electrostatic spray application apparatus shall comply with the requirements of this chapter and also shall comply with the applicable requirements of all other chapters.

**12.3 Handheld Apparatus.** Handheld electrostatic spray apparatus and devices shall be listed. The high-voltage circuits shall be designed so that they cannot produce a spark capable of igniting the most hazardous vapor-air mixture or powder-air mixture likely to be encountered and so that they cannot result in an ignition hazard upon coming into contact with a grounded object under all normal operating conditions.

**12.3.1** The electrostatically charged exposed elements of the hand gun shall be capable of being energized only by an actuator that also controls the coating material supply.

**12.3.2** Where the liquid coating material is electrically energized, precautions shall be taken to prevent electric shock.

**12.4 Electrical Components.** Transformers, high-voltage supplies, control apparatus, and all other electrical portions of the equipment, with the exception of the hand gun itself and its connections to the power supply, shall be located outside the spray area or shall otherwise meet the requirements of Chapter 6.

### 12.5 Grounding.

**12.5.1\*** The handle of the spray gun shall be electrically connected to ground by a conductive material. It shall be constructed so that the operator, in normal operating position, is in electrical contact with the grounded handle by a resistance of not more than  $10^6$  ohms (1 megohm) to prevent buildup of a static charge on the operator's body. Signs indicating the necessity for grounding persons entering the spray area shall be conspicuously posted.

**12.5.2** All electrically conductive objects in the spray 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 1 megohm ( $10^6$  ohms). This requirement shall apply to containers of coating material, wash cans, guards, hose connectors, brackets, and any other electrically conductive objects or devices in the area. This requirement also shall apply to any personnel who enter the area.

**12.5.3** Conductive objects or material being coated shall be electrically connected to ground with a resistance of not more than  $10^6$  ohms (1 megohm). Areas of contact shall be sharp points or knife edges, where possible, and those areas of contact shall be protected from overspray, where practical.

**12.5.4** Highly resistive objects (i.e., surface conductivity between  $10^8$  and  $10^{11}$  ohms per square) that exhibit a surface

voltage below 2500 volts, as measured using a nonloading kilovoltmeter and when subjected to coronal current not less than that expected in the application process, shall be considered adequately grounded.

**12.5.5** Objects or material transported by a conveyor shall be maintained in electrical contact with the conveyor or other grounding contacts. Hooks and hangers shall be cleaned to ensure grounding.

## Chapter 13 Drying, Curing, and Fusion Processes

**13.1 General.** Drying, curing, or fusing apparatus used in connection with spray application of ignitable (flammable and combustible) liquids or combustible materials shall meet all the applicable requirements of NFPA 86.

**13.2 Spray Booths and Spray Rooms Used for Ambient Air Drying.** If a spray booth or spray room is also used for air-drying, curing, or fusing operations and the air temperature therein is not elevated above ambient conditions, the ventilation system shall maintain the concentration of any vapors in the exhaust stream below 25 percent of the lower flammable limit. If the temperature in the spray area is elevated for the purpose of accelerating the drying or curing process, then the requirements of Section 13.3 shall apply.

### 13.3\* Spray Booths and Spray Rooms Used for Drying at Elevated Temperatures.

**13.3.1** Spray booths or spray rooms used for batch-type spray application operations, including automobile refinishing operations, shall be permitted to be used alternately for drying, curing, or fusing operations, provided they meet all applicable requirements of this standard and the requirements of NFPA 86 as well as the requirements of 13.3.1.1 through 13.3.1.6.

**13.3.1.1** The interior surfaces (especially the floor) of the spray area shall be cleaned regularly to minimize the accumulation of deposits of combustible residues.

#### 13.3.1.2 Temperature Limit Switches.

**13.3.1.2.1** A high-temperature-limit switch shall be provided to automatically shut off the heat source if the discharge temperature of the air heater exceeds the maximum discharge air temperature allowed by the standard under which the heater is listed or 105°C (221°F), whichever is less.

**13.3.1.2.2\*** The temperature-sensing element of the high-temperature-limit switch shall be located where recommended by the manufacturer of the air heater or the designer of the system.

**13.3.1.3** Any containers of ignitable (flammable or combustible) liquids shall be removed from the booth before the drying apparatus is energized.

**13.3.1.4** Where a spray booth or spray room is used for drying, curing, or fusing operations, the interlocks specified in 13.3.1.4.1 and 13.3.1.4.2 shall be provided.

**13.3.1.4.1** Spraying apparatus, drying apparatus, and the ventilating system shall be equipped with interlocks arranged so that the spraying apparatus cannot be operated when drying apparatus is in operation or is energized.

**13.3.1.4.2\*** Where industrial air heaters are used to elevate the air temperature for drying, curing, or fusing operations, means shall be provided to deter entry into the spray booth or spray room during the drying, curing, or fusing operation and interlocks shall be provided to shut down the drying, curing, or fusing operation if entry is made.

**13.3.1.5\*** Explosion control shall not be required for a spray booth or spray room that is alternately used for drying, curing, or fusing, if all of the following conditions exist:

- (1) The spray booth or spray room is used for batch-type spray application operations only.
- (2) The air heater is not within the recirculated air path.
- (3) The ventilation system complies with the applicable requirements of NFPA 86.

#### 13.3.1.6 Fuel Tanks.

**13.3.1.6.1** Fuel tanks containing fuel other than gasoline or diesel fuel shall be removed from any vehicle brought into the spray area.

**13.3.1.6.2** Where fuel tanks containing liquefied petroleum gas or compressed natural gas remain attached to the vehicle brought into the spray area the requirements of Section 13.4 shall apply.

### 13.4 Liquefied-Petroleum-Gas, Compressed-Natural-Gas, or Hydrogen-Fueled Vehicles.

**13.4.1\*** Fuel tanks shall be defueled to reduce the volume of fuel that could escape during a failure of the fuel system.

**13.4.2** The high-temperature-limit switch required by 13.3.1.2 shall shut off the drying apparatus if the air temperature in the spray booth exceeds the maximum discharge air temperature allowed by the standard under which the heater is listed, or if 105°C (221°F) or the maximum temperature that the fuel system can be exposed to is reached, whichever is less.

**13.4.3** Listed equipment shall be used to detect the escape of fuel from the fuel tanks.

#### 13.4.4 Alarm.

**13.4.4.1** The equipment specified in 13.4.3 shall initiate a local alarm.

**13.4.4.2** The alarm specified in 13.4.4.1 shall automatically shut down the drying, curing, or fusing operation if the concentration of fuel gas in the spray area exceeds 10 percent of the lower flammable limit.

### 13.5 Radiant Drying Apparatus.

**13.5.1** Radiant drying apparatus that is permanently attached to the walls, ceiling, or partitions of the spray area shall be listed for exposure to flammable or combustible vapors, mists, dusts, residues, or deposits.

**13.5.2** Radiant drying, curing, or fusion apparatus that is permanently attached to the structure of a spray booth and is movable, but suitable only for use in an Ordinary Hazard (general-purpose) location, that is, not suitable for a hazardous (classified) location as defined in *NFPA 70*, shall be permitted to be used provided the following conditions apply:

- (1) The apparatus can be moved into a pressurized enclosure that meets the requirements for Type X pressurizing, as specified in NFPA 496.

- (2) Interlocks are provided to prevent both of the following:
- (a) Use of the spray application equipment unless the drying, curing, or fusion apparatus has been moved into the pressurized enclosure and the enclosure has been purged and pressurized in accordance with NFPA 496
  - (b) Actuation of the drying, curing, or fusion apparatus when it is located in the enclosure

**13.5.3** Radiant drying, curing, or fusion apparatus that is permanently attached to the structure of a spray booth and is pendent-mounted or employs the use of a track or similar system, but is suitable only for use in an Ordinary Hazard (general-purpose) location, that is, not suitable for a hazardous (classified) location as defined in *NFPA 70*, shall be permitted to be used, provided that all requirements of 13.5.2 have been met.

**13.5.3.1** Pendent-mounted apparatus shall be arranged to allow the apparatus, its power cord, and its pendent-mount system to be moved into a pressurized enclosure that meets the requirements for Type X pressurizing, as specified in NFPA 496.

**13.5.3.2** Track-mounted systems shall meet the requirements for Type X pressurizing, as specified in NFPA 496.

### 13.6 Flash-Off Areas.

**13.6.1** The electrical area classification extending into a flash-off area shall meet the requirements for openings specified in 6.5.4.

**13.6.2** Flash-off areas that are heated above ambient temperatures to accelerate release of vapors shall meet the requirements of NFPA 86. If the flash-off area is adjacent to or connected to a spray booth or spray room then the requirements of Section 13.7 shall apply.

**13.6.3** Open or enclosed, unheated flash-off areas shall be ventilated in accordance with Section 7.12.

**13.6.4** Open flash-off areas shall be protected in accordance with the requirements of the occupancy in which they are located.

**13.6.5** Enclosed flash-off areas shall be provided with an approved automatic fire protection system.

### 13.7 Spray Booths or Spray Rooms Adjacent to or Connected to Rooms or Equipment Used for Drying, Curing, or Fusing.

**13.7.1** Interconnecting doors and related interlocks shall meet the requirements of NFPA 86. An interlock shall be provided to prevent spray application operations when the interconnecting doors are open.

**13.7.2\*** Where an interconnecting door is not used, a 915 mm (3 ft) minimum pressurized vestibule shall be provided for separation. This vestibule shall be ventilated in accordance with Section 7.12. Airflow into the vestibule shall be proven and interlocked so that loss of ventilation or airflow shuts down the spray application equipment or the heating equipment. Airflow into the connected spray booth or spray room shall be capable of confining vapors and mists to the spray booth or spray room.

**13.7.3** A high-temperature-limit switch shall be provided to automatically shut off the drying apparatus if the air temperature in the spray area exceeds 105°C (221°F).

**13.8\* Ventilation.** Fusion apparatus shall be ventilated at a rate that maintains the concentration of ignitable vapors in the area at or below 25 percent of the lower flammable limit.

**13.9 Warning Signs.** Drying, curing, or fusing apparatus shall be affixed with a permanently attached, prominently located warning sign indicating that ventilation shall be maintained during the drying, curing, or fusing period and that spraying shall not be conducted in the vicinity in such manner as to deposit residue on the apparatus.

## Chapter 14 Miscellaneous Spray Operations

### 14.1 Vehicle Undercoating and Body Lining.

**14.1.1** Spray undercoating or spray body lining of vehicles that is conducted in an area that has adequate natural or mechanical ventilation shall be exempt from the provisions of this standard, if all the requirements of 14.1.1.1 through 14.1.1.4 are met.

**14.1.1.1** There shall be no open flames or spark-producing equipment within 6100 mm (20 ft) of the spray operation while the spray operation is being conducted.

**14.1.1.2** There shall be no drying, curing, or fusion apparatus in use within 6100 mm (20 ft) of the spray operation while the spray operation is being conducted.

**14.1.1.3** Any solvent used for cleaning procedures shall have a flash point not less than 37.8°C (100°F).

**14.1.1.4** The coating or lining materials used shall meet one of the following criteria:

- (1) Be no more hazardous than UL Class 30-40 when tested in accordance with UL 340, *Tests for Comparative Flammability of Liquids*
- (2) Not contain any solvent or component that has a flash point below 37.8°C (100°F)
- (3) Consist only of Class IIIB [FP ≥ 93°C (200°F)] liquids and not include any organic peroxide catalyst

**Δ 14.1.2** Spray undercoating operations or spray body lining of vehicles that do not meet the requirements of Section 14.1 shall meet all the applicable requirements of this standard pertaining to spray finishing operations.

**14.2 Preparation Workstations.** If spray finishing operations are performed at or in a preparation workstation, the preparation workstation shall be considered an unenclosed spray area and shall meet all requirements of an unenclosed spray area.

**14.2.1** A preparation workstation that is designed and operated in accordance with Section 14.3 shall be considered a limited finishing workstation and not an unenclosed spray area.

### 14.3 Limited Finishing Workstations.

**14.3.1** A limited finishing workstation shall be designed and operated in accordance with the requirements of 14.3.2 through 14.3.10.

**Δ 14.3.2** A limited finishing workstation shall be designed and constructed in accordance with the requirements of 14.3.2.1 through 14.3.2.4.

**N 14.3.2.1** A limited finishing workstation shall have a dedicated make-up air supply and air supply plenum.

**N 14.3.2.2** A limited finishing workstation shall be enclosed by one of the following:

- (1) Curtains or partitions that are noncombustible or limited-combustible
- (2) Curtains or partitions that can successfully pass Test Method 2 in NFPA 701
- (3) Curtains or partitions that exhibit all of the following characteristics when tested in accordance with NFPA 286:
  - (a) During the 40 kW (136,486 Btu/hr) exposure, flames do not spread to the ceiling.
  - (b) The flame does not spread to the outer extremity of the sample on any wall or ceiling.
  - (c) Flashover, as defined in NFPA 286, does not occur.
  - (d) The peak heat release rate throughout the test does not exceed 800 kW (2,729,714 Btu/hr).
  - (e) The total smoke release throughout the test does not exceed 1000 m<sup>2</sup> (10,764 ft<sup>2</sup>).
- (4) Curtains or partitions that exhibit a maximum rate of heat release of 100 kW (341,214 Btu/hr) when tested in accordance with NFPA 289 using a 20 kW (68,242 Btu/hr) ignition source
- (5) Curtains or partitions that are classified as welding curtains by ANSI/FM 4950, *Welding Pads, Welding Blankets and Welding Curtains for Hot Work Operations*

**N 14.3.2.3** A limited finishing workstation shall have a dedicated mechanical exhaust and filtration system.

**N 14.3.2.4\*** A limited finishing workstation shall have an approved automatic extinguishing system installed that meets the requirements of Chapter 9.

**14.3.3** The amount of material sprayed in a limited finishing workstation shall not exceed 3.8 L (1 gal) in any 8-hour period.

**14.3.4** The limited finishing workstation shall meet all applicable requirements of Chapter 4 through Chapter 10 and Chapter 19 of this standard.

**14.3.5** Curtains or partitions shall be fully closed during any spray application operations.

**14.3.6** The area inside the curtains or partitions shall be considered a Class I, Division 1; Zone 1; Class II, Division 1; or Zone 21 hazardous (classified) location, as defined by Article 500 of NFPA 70.

**14.3.6.1** A Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 hazardous (classified) location, as applicable, shall extend 915 mm (3 ft) both horizontally and vertically beyond the volume enclosed by the outside surface of the curtains or partitions as shown in Figure 14.3.6.1.

**14.3.6.2** For the purposes of this subsection, *interlocked* shall mean that the spray application equipment cannot be operated unless the exhaust ventilation system is operating and functioning properly and spray application is automatically stopped if the exhaust ventilation system fails.

**14.3.7** Any limited finishing workstation used for spray application operations shall not be used for any operation that is capable of producing sparks or particles of hot metal or for operations that involve open flames or electrical utilization equipment capable of producing sparks or particles of hot metal.

**14.3.8** Drying, curing, or fusion apparatus shall be permitted to be used in a limited finishing workstation if they meet the requirements of Chapter 13 and the requirements of 14.3.8.1 through 14.3.8.3.

**14.3.8.1** Where industrial air heaters are used to elevate the air temperature for drying, curing, or fusing operations, a high-limit switch shall be provided to automatically shut off the drying apparatus if the air temperature in the limited finishing workstation exceeds the maximum discharge-air temperature allowed by the standard that the heater is listed to or 105°C (221°F), whichever is less.

**14.3.8.2\*** A means shall be provided to show that the limited finishing workstation is in the drying or curing mode of operation and that it is to be unoccupied.

**14.3.8.3** Any containers of ignitable (flammable or combustible) liquids shall be removed from the limited finishing workstation before the drying apparatus is energized.

**14.3.9** Portable spot-drying, curing, or fusion apparatus shall be permitted to be used in a limited finishing workstation, provided that it is not located within the hazardous (classified) location defined in 14.3.5 when spray application operations are being conducted.

**14.3.10** Recirculation of exhaust air shall be permitted only if all provisions of Section 7.5 are met.

## **N 14.4 Inflatable Finishing Workstations.**

### **N 14.4.1 General.**

**N 14.4.1.1** An inflatable finishing workstation shall be designed and operated in accordance with the requirements of 14.4.2 through 14.4.9 and the applicable requirements of NFPA 5000.

**N 14.4.1.2\*** An inflatable finishing workstation shall not be used for processes in which combustible dry powders are applied or combustible dust is created in hazardous quantities.

**N 14.4.1.3** Electrostatic spray application equipment shall not be used in an inflatable finishing workstation.

### **N 14.4.2 Location.**

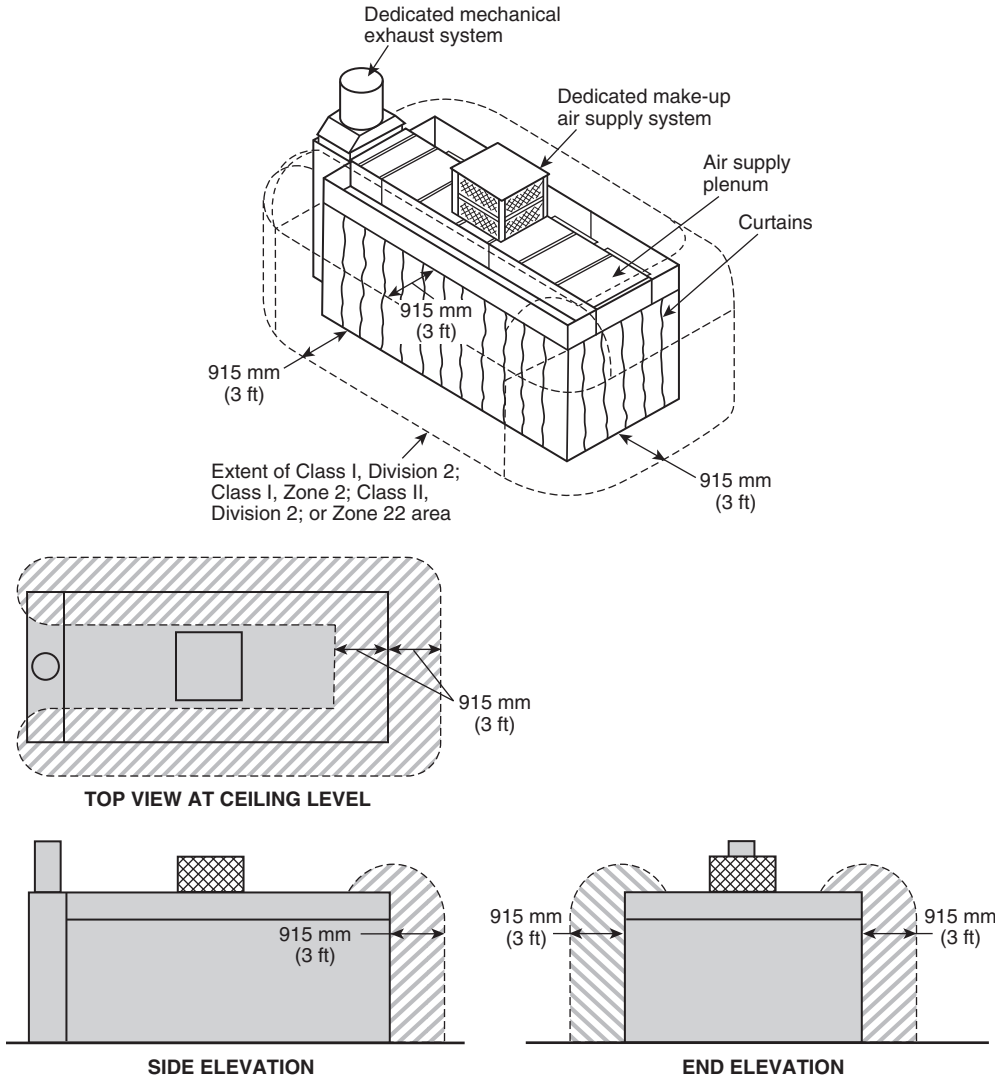
**N 14.4.2.1** An inflatable finishing workstation shall be used outdoors.

**N 14.4.2.2\*** The location of an inflatable finishing workstation shall meet the following conditions:

- (1) Be a minimum distance of 6100 mm (20 ft) from any permanent or temporary structures with blank, fire-resistant masonry walls or those equivalent to 1-hour fire rated construction
- (2) Be a minimum distance of 6100 mm (20 ft) from a public way
- (3) Be a minimum distance of 15,250 mm (50 ft) from any permanent or temporary structures with combustible walls or those not meeting the requirements of 14.4.2.2(1) or where there are unprotected openings in the walls meeting the requirements of 14.4.2.2(1) within 15,250 mm (50 ft)

**N 14.4.2.3** An inflatable finishing workstation shall not block emergency vehicle access to adjacent structures.





**FIGURE 14.3.6.1 Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 Locations Adjacent to a Limited Finishing Workstation.**

#### **N 14.4.3 Construction and Design.**

**N 14.4.3.1** An inflatable finishing workstation, including the floor, shall be constructed of one of the following:

- (1) Materials or assemblies that are noncombustible or limited-combustible
- (2) Materials or assemblies that can successfully pass Test Method 2 in NFPA 701
- (3) Materials or assemblies that exhibit a maximum rate of heat release of 100 kW (341,214 Btu/hr) when tested in accordance with NFPA 289 using a 20 kW (68,242 Btu/hr) ignition source
- (4) Materials that exhibit all of the following characteristics when tested in accordance with NFPA 286:
  - (a) During the 40 kW (136,486 Btu/hr) exposure, flames do not spread to the ceiling.
  - (b) The flame does not spread to the outer extremity of the sample on any wall or ceiling.
  - (c) Flashover, as defined in NFPA 286, does not occur.

(d) The peak heat release rate throughout the test does not exceed 800 kW (2,729,714 Btu/hr).

(e) The total smoke release throughout the test does not exceed 1000 m<sup>2</sup> (10,764 ft<sup>2</sup>).

(5) Materials that are classified as welding curtains by ANSI/FM 4950, *Welding Pads, Welding Blankets and Welding Curtains for Hot Work Operations*

**N 14.4.3.2\*** Materials that enclose the spray area shall be static dissipative.

**N 14.4.3.3\*** A means for grounding the air-inflated structure shall be provided and shall ensure the following:

- (1) To dissipate any accumulated charge, the inflatable finishing workstation shall be manufactured with a grounding connection such that no point on the structure exceeds the requirement of Section 6.7.
- (2) The installation shall connect all the designated ground connections of the inflatable finishing workstation to a suitable ground.

**N 14.4.3.4** The interior surfaces of the spray area shall be smooth, designed and installed to prevent pockets that can trap residue, and designed to facilitate ventilation and cleaning.

**N 14.4.3.5** Air intake filters that are a part of a wall or ceiling assembly shall be listed in accordance with UL 900, *Air Filter Units*.

**N 14.4.3.6\*** An inflatable finishing workstation shall be anchored against wind load during installation and operation.

**N 14.4.4 Means of Egress.** The location and number of exits shall comply with Chapter 40 of NFPA 101.

**N 14.4.4.1** An inflatable finishing workstation shall be considered to contain high-hazard contents when determining the means of egress.

**N 14.4.4.2** A minimum of two means of egress shall be provided.

#### **N 14.4.5 Ventilation.**

##### **N 14.4.5.1 Performance Requirements.**

**N 14.4.5.1.1** The inflatable finishing workstation shall be provided with mechanical ventilation capable of confining and removing vapors and mists to a safe location and capable of confining and controlling combustible residue, dust, and deposits.

**N 14.4.5.1.2** The concentration of the vapors and mists in the exhaust stream of the ventilation system shall not exceed 10 percent of the lower flammable limit.

**N 14.4.5.2\* Safety Design Data Form.** A safety design data form or a nameplate that states the operating conditions for which the enclosure was designed, built, altered, or extended shall be accessible to the operator.

**N 14.4.5.3 Routing of Exhaust.** Air exhausted from an inflatable finishing workstation shall meet the following conditions:

- (1) The exhaust discharge shall be directed away from any air intakes.
- (2)\* The exhaust discharge point shall be at least 6100 mm (20 ft) from openings into any building or other inflatable finishing workstations.
- (3) The exhaust shall not discharge in the direction of any combustible construction that is within 7.5 m (25 ft) of the exhaust duct discharge point.
- (4) The exhaust shall not discharge in the direction of any unprotected opening in any noncombustible or limited-combustible construction that is within 7.5 m (25 ft) of the exhaust duct discharge point.
- (5) The exhaust shall not discharge in the direction of any exit discharge or public way that is within 7.5 m (25 ft) of the exhaust duct discharge point.

##### **N 14.4.5.4 Supply Air.**

**N 14.4.5.4.1\*** Air for inflating the structure and for the introduction of diluted air shall be provided in accordance with Section 7.3.

**N 14.4.5.4.2** Supply air shall not be heated.

**N 14.4.5.5 Air Recirculation.** Process exhaust air shall not be recirculated.

##### **N 14.4.6\* Electrical and Other Sources of Ignition.**

**N 14.4.6.1** During spray application, the area within the inflatable finishing workstation shall be Class I, Division 1 or Zone 1.

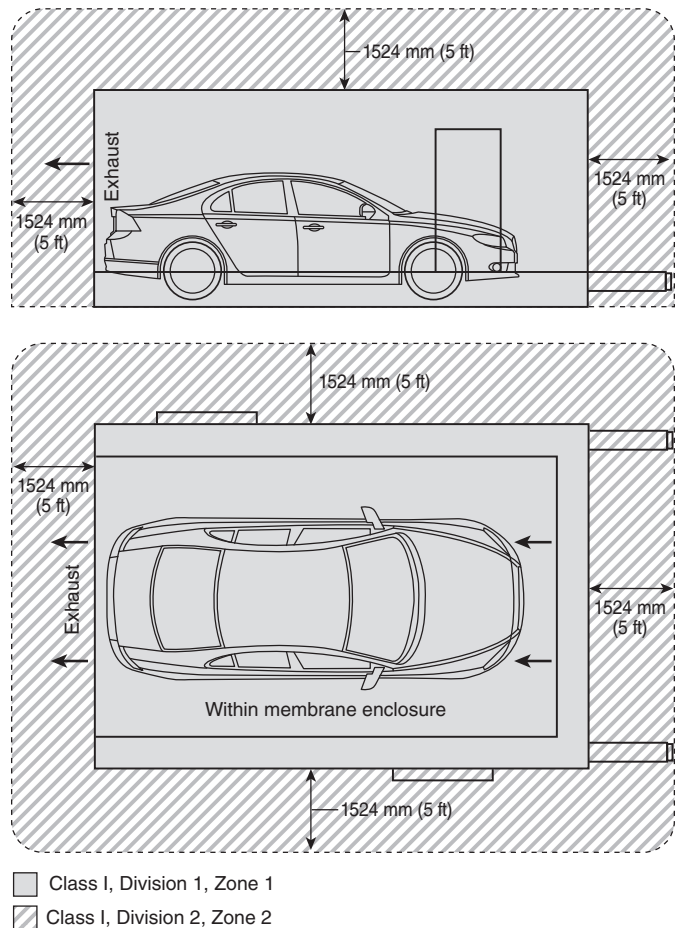
**N 14.4.6.2** During spray application, areas within 1525 mm (5 ft) of the exhaust shall be Class I, Division 1 or Zone 1.

**N 14.4.6.3** During spray application, areas between 1525 mm (5 ft) and 3050 mm (10 ft) of the exhaust shall be Class I, Division 2 or Zone 2.

**N 14.4.6.4** During spray application, the area within 1525 mm (5 ft) horizontally and vertically from the surface of the inflatable finishing workstation shall be Class I, Division 2 or Zone 2 (see Figure 14.4.6.4).

**N 14.4.6.5** Electrical wiring and electrical utilization equipment shall not be utilized within the enclosure.

**N 14.4.6.6\*** Electrical wiring and electrical utilization equipment that is used adjacent to the inflatable finishing workstation shall comply with Chapter 6.



**N FIGURE 14.4.6.4 Electrical Classifications for Inflatable Finishing Workstations.**

**N 14.4.6.7\*** All the electrically conductive objects in the spray area shall be electrically connected to ground in accordance with Section 6.7.

**N 14.4.7 Storage, Handling, and Distribution of Ignitable (Flammable and Combustible) Liquids.**

**N 14.4.7.1** Ignitable (flammable and combustible) liquids within the inflatable finishing workstation shall not exceed a total of 3.8 L (1 gal) at any time.

**N 14.4.7.2** Pressurized containers used for paint delivery shall not be larger than 3.8 L (1 gal).

**N 14.4.8 Protection.**

**N 14.4.8.1 General.** An automatic fire protection system shall not be required for an inflatable finishing workstation.

**N 14.4.8.2 Portable Fire Extinguishers.**

**N 14.4.8.2.1** Portable fire extinguishers shall be provided and located in accordance with NFPA 10.

**N 14.4.8.2.2** Portable fire extinguishers shall be rated for Extra Hazard occupancies.

**N 14.4.8.2.3** At least one portable fire extinguisher shall be located external to the inflatable finishing workstation near the exhaust side.

**N 14.4.9 Operations and Maintenance.**

**N 14.4.9.1** In addition to the requirements of this section, the inflatable finishing workstation shall comply with the applicable requirements of Chapter 10.

**N 14.4.9.2** A cleaning threshold and schedule shall be established by the user for the removal of combustible residues from all process areas of the enclosure based upon the characteristics of the material and the rate of accumulation.

**N 14.4.9.3** The manufacturer of the inflatable finishing workstation shall provide instructions for cleaning prior to the enclosure being taken down.

**N 14.4.9.4** Spray application of finishing materials containing nitrocellulose shall be permitted in an inflatable finishing workstation provided that residue is removed from all the surfaces at least daily and all the filters are changed at least daily.

## Chapter 15 Powder Coating

**15.1\* Scope.** This chapter shall apply to processes in which combustible dry powders are applied.

**Δ 15.2 General.** The installation and use of powder coating application apparatus shall comply with the requirements of this chapter and the applicable requirements of all the other chapters.

**15.3 Applicability.** Section 15.4 through Section 15.10 and Section 15.13 are general and shall apply to all methods of powder coating application. Section 15.11, Section 15.12, and Section 15.4 through Section 15.16 shall apply to the specific method indicated therein.

**15.4 Location.** Powder coating operations shall be confined to enclosures that are located in accordance with Chapter 4.

## Δ 15.5 Construction and Design of Spray Booths and Spray Rooms.

**Δ 15.5.1** Powder shall be confined by conducting coating operations within one of the following:

- (1) A completely enclosed, ventilated room of noncombustible or limited-combustible construction with smooth surfaces designed to prevent accumulation of powder and facilitate cleaning
- (2) A ventilated spray booth meeting the requirements of Section 5.1 through Section 5.7 and containing enclosed, ventilated containers (tanks, bins, etc.)

**N 15.5.2** Spray booths that are used exclusively for powder coating shall be permitted to be constructed of fire-retardant combustible materials where approved by the authority having jurisdiction.

**N 15.5.3** Listed spray booth assemblies that are constructed of other materials shall be permitted.

**Δ 15.5.4 Enclosures.** Enclosures shall either be listed for the specific application or shall be designed to resist the destructive effects of an internal deflagration.

**N 15.5.4.1\*** Any enclosure that is not so listed and is effectively tight, such as a spray booth, dust collector, powder recovery device, or other enclosure, shall be provided with one of the following:

- (1) Deflagration venting that meets the requirements of NFPA 68
- (2) A deflagration suppression system that meets the requirements of NFPA 69

**N 15.5.5** Observation panels for spray booths that are used exclusively for powder coating processes shall be permitted to be constructed of fire-resistant combustible materials.

## 15.6 Electrical and Other Sources of Ignition.

**15.6.1** Electrical utilization equipment and other sources of ignition shall meet both the requirements of Chapter 6 of this standard and Articles 500, 502, 504, and 516 of *NFPA 70*, as applicable.

**15.6.2** Where the object or material being coated is preheated, the controls shall be set so that the surface temperature of the object or material does not come within 28°C (50°F) of the autoignition temperature of the powder used.

**Δ 15.6.3\* Static Electricity.** All electrically conductive objects in the spray 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<sup>6</sup> ohms (1 megohm).

**N 15.6.3.1** This requirement shall also apply to any personnel who enter the area.

**Δ 15.7\* Ventilation and Dust Collection.** See also Annex C.

### 15.7.1 Ductwork.

**Δ 15.7.1.1\*** Where nondeposited, air-suspended powder (powder overspray) is conveyed by ductwork to a recovery system, sufficient airflow shall be provided in the ductwork to maintain the powder concentration in the ductwork at not more than 50 percent of the minimum explosible concentration (MEC) of the powder in use.



**N 15.7.1.2** If the MEC of the powder has not been established, the exhaust duct powder concentration shall be maintained below 15 g/m<sup>3</sup> (0.015 oz/ft<sup>3</sup>).

**15.7.1.3** Exhaust equipment shall bear an identification plate stating the ventilation rate for which it was designed.

**15.7.1.4** If the coating operation is conducted at an exhaust duct concentration above 50 percent of the MEC, listed explosion suppression equipment shall be provided.

**15.7.2** Air exhausted from the recovery system of a powder operation shall not be recirculated unless the concentration of particulate matter in the exhaust air has been reduced to a level that is considered safe for personnel occupational exposure and equipment continuously monitors the filtration system to signal the operator and to automatically shut down the operation in the event the filtration system fails to maintain the air in this condition.

**15.7.3** Ventilation for powder coating being applied via fluidized beds and electrostatic fluidized beds shall be designed to prevent the escape of nondeposited powder from the enclosure.

**15.7.4** The ventilation system shall confine air-suspended powder to the booth and the recovery system at all times.

#### **15.8 Storage and Handling.**

**Δ 15.8.1** Containers, including but not limited to bags, jars, boxes, totes, bins, super-sacks, hoppers, collectors, and so on, containing powder coating material shall be permitted to be stored directly adjacent to spray areas provided that the container meets all of the following requirements:

- (1) It is not actively used in the spray process
- (2) It is covered or sealed
- (3) It is labeled with the contents
- (4) It does not interfere with equipment operation

#### **15.8.2\* Housekeeping.**

**15.8.2.1** Areas around the spray area, including horizontal surfaces such as ledges, beams, pipes, hoods, and floors, shall be cleaned to prevent the accumulation of powder.

**15.8.2.2** Surfaces shall be cleaned in a manner that does not scatter powder or create dust clouds.

**15.8.2.3** Vacuum sweeping equipment, where used, shall be approved for Class II, Division 2 or Zone 22 locations.

#### **15.8.3\* Spill Cleanup.**

**15.8.3.1** All sources of ignition shall be removed from the area of a spill or accidental release of powder.

**15.8.3.2** Tools used for the cleanup shall be of a type that cannot produce a spark.

**15.8.3.3** Vacuum sweeping equipment shall be approved for Class II, Division 2 or Zone 22 locations.

**Δ 15.8.3.4\*** The use of brooms for sweeping up powder shall be done in a way that does not scatter powder or create dust clouds.

**15.8.3.5** Disposal of the spill material shall be in accordance with local, state, and federal regulations.

**Δ 15.8.3.6\*** Compressed air shall not be permitted during cleanup unless it is in a booth or vented coating area.

**15.8.3.6.1** Compressed air lines shall be conductive and grounded.

#### **15.8.4\* Powder Unloading, Bag Dumping Stations, and Pneumatic Conveying Systems.**

**15.8.4.1** Powder unloading, bag dumping stations, and pneumatic conveying systems located in, connected to, or adjacent to the spray area shall be Class II, Division 2 as defined in 6.3.2.2 or Zone 22 as defined in 6.3.2.5.

**15.8.4.2** All powder unloading, bag dumping stations, and pneumatic conveying systems shall comply with Section 6.5.

**15.8.4.3** Housekeeping shall be maintained in accordance with 15.10.1 through 15.10.5.

#### **15.8.5 Screening or Sieving Operations.**

**15.8.5.1** When a screening or sieving operation is an in-line, integral part of the powder application equipment, it shall meet the requirements of 15.14.3.

**15.8.5.2** Ventilation for screening or sieving operations shall be designed to contain and prevent the accumulation of powder outside of the operation.

#### **15.8.6\* Powder Coating Delivery and Circulation.**

**15.8.6.1\*** All bins, hoppers, and fluid beds that are actively in use in the powder application process shall be grounded and shall comply with 15.6.3 and 15.14.4.

**15.8.6.2\*** Bins, hoppers, and fluid beds shall be vented to prevent the accumulation of powder outside of the application process in accordance with 15.7.3.

**15.8.6.3** The compressed air supply shall be interlocked with the ventilation system so that the equipment cannot be operated unless ventilation is in operation.

#### **15.9\* Protection.**

**15.9.1 General.** Spray areas for manual or automated powder application processes, as defined in this standard, shall be protected with an approved automatic fire protection system.

**15.9.1.1\*** An approved automatic fire protection system shall not be required to be installed in booths when all of the following are met:

- (1) The booth size does not exceed 0.84 m<sup>2</sup> (9 ft<sup>2</sup>) with a maximum dimension of 0.91 m (3 ft) in one direction
- (2) It uses a single manual powder spray gun
- (3) A portable fire extinguisher is available within 3.05 m (10 ft)
- (4) Overspray of powder is directed toward a dust collection system

**15.9.1.2\*** The fire protection system shall be monitored in accordance with *NFPA 72* when a fire alarm system exists.

**15.9.1.2.1** Where a building fire alarm system is not present, actuation of the fire protection systems required by this standard shall initiate an audible alarm or visual indicator.

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

**15.9.2 Ventilation Systems.** Ventilation systems shall be shut down during any fire alarm condition.

**15.9.3 Coating Material Delivery System.** Where equipment is used to supply the powder for the spray application process, an automatic means shall be provided to shut off the supply of powder in the event of fire.

**15.9.4 Conveyors.** For operations where a workpiece is automatically conveyed through the spray area, activation of the automatic fire protection system shall automatically stop any conveyors into and out of the spray area.

**15.9.5 Protection Systems.** The automatic fire protection system shall be permitted to be and shall be installed in accordance with any of the following:

- (1) A water sprinkler system that meets all the applicable requirements of NFPA 13
- (2) A low expansion foam water sprinkler system that meets all the applicable requirements of NFPA 11
- (3) A carbon dioxide extinguishing system that meets all the applicable requirements of NFPA 12
- (4) A dry chemical extinguishing system that meets all the applicable requirements of NFPA 17
- (5) A gaseous agent extinguishing system that meets all the applicable requirements of NFPA 2001
- (6) A water mist fire protection system that meets all the applicable requirements of NFPA 750

**15.9.5.1\* Automatic Sprinkler Systems.**

**15.9.5.1.1\*** The automatic sprinkler system shall be a wet pipe system, a dry pipe system, a preaction system, or an open-head deluge system, whichever is most appropriate for the portion of the spray operation being protected.

**15.9.5.1.2** The automatic sprinkler system for powder coating operations shall be in accordance with the following requirements:

- (1) Sprinklers shall be designed for Ordinary Hazard (Group 2) as defined in NFPA 13.
- (2) The sprinkler design area shall not be required to exceed the area of the booth or room in which spraying is conducted.

**15.9.5.1.3** The water supply shall be sufficient to supply all the sprinklers likely to open in any one fire incident without depleting the available water for use in hose streams.

**N 15.9.5.1.3.1\*** Hose streams for the occupancy, in accordance with NFPA 13, shall be included in the water suppression system's demand.

**Δ 15.9.5.1.4** Where sprinklers are installed to protect spray areas, water shall be permitted to be supplied from domestic water systems provided the domestic supply can meet the demand for the design criteria in 15.9.5.1.2.

**15.9.5.1.5** The sprinkler system shall be controlled by a separate listed indicating valve(s) that is operable from the floor level.

**Δ 15.9.5.1.6** Sprinklers shall be protected against overspray residue either by location or covering so that they can operate quickly in event of fire.

**15.9.5.1.6.1\*** Sprinklers shall be permitted to be covered by either clear, cellulose-based bags having a thickness of 0.08 mm (0.003 in.) or less or by thin paper bags.

**15.9.5.1.6.2** The coverings permitted in 15.9.5.1.6.1 shall be replaced frequently so that heavy deposits of residue do not accumulate.

**15.9.5.1.6.3** Sprinklers that have been painted or coated by overspray or residues shall be replaced with new sprinklers.

**15.9.5.2\* Automatic Carbon Dioxide, Dry Chemical, Clean Agent, Water Mist, and Hybrid (Water and Inert Gas) Systems.** The fire protection system shall be capable of discharging its contents into the entire protected area simultaneously.

**15.9.6\* Automated Spray Application Operations.**

**Δ 15.9.6.1 Interlock.** For automated spray application operations, activation of the automatic fire protection system shall automatically accomplish all of the following:

- (1) Activate a local alarm in the vicinity of the spraying operation
- (2) Transmit an alarm signal to the facility's fire alarm system if such a system is provided
- (3) Shut down all the spray application operations

**15.9.6.2 Emergency Shutdown.** For automated spray application operations, one or more manual emergency system shutdown stations shall be installed to serve each spray area in accordance with the following requirements:

- (1) When activated, the stations shall accomplish at least the functions listed in 15.9.6 and 15.9.6.3.1.
- (2) At least one such station shall be accessible to operating personnel.
- (3) If access to the station required in 15.9.6.2(2) is likely to involve exposure to danger, an additional station shall be located adjacent to an exit from the area.

**15.9.6.3\* Protection for Automated Powder Application Equipment.**

**15.9.6.3.1** Automated powder application equipment, both listed and unlisted, shall be further protected by listed optical flame detection systems installed and supervised in accordance with NFPA 72.

**Δ 15.9.6.3.1.1** The optical flame detection system shall, in the event of ignition, react to the presence of flame within one-half (0.5) second and shall bring about all of the following:

- (1) Meet all the requirements of 15.9.6.1
- (2) Disconnect power to the high-voltage elements in the spray area and de-energize the system
- (3) Stop any conveyors into and out of the spray area
- (4) Shut off the ventilation system
- (5) Close segregation dampers in associated ductwork to interrupt airflows
- (6) Shut off application, transfer, and powder collection equipment

**Δ 15.9.6.3.2** Automated powder application equipment that is unlisted shall be further protected by the following:

- (1) In addition to meeting the requirements of 15.9.6 and 15.9.6.3.1, the optical flame detection system shall also activate the automatic fire protection system.
- (2) Automatic electrostatic equipment enclosures inside the booth shall be protected with an approved automatic fire

protection system, and activation of this system shall automatically fulfill the requirements of 15.9.6 and 15.9.6.3.1.

(3) Manual activation stations shall be installed in accordance with the following:

- (a) At least one such station shall be within ready access of operating personnel.
- (b) If access to the station required in 15.9.6.3.2(3)(a) is likely to involve exposure to danger, an additional station shall be located adjacent to an exit from the area.
- (c) The devices shall activate the fire protection system as specified in 15.9.5 for the affected automated zone, if applicable, and fulfill the requirements in 15.9.6.3.1.

**15.9.6.3.2.1** The requirements of 15.9.6.3.2 shall not apply to a closed-head wet pipe automatic sprinkler systems.

#### 15.10 Operation and Maintenance.

**15.10.1\*** The area surrounding the spray area, including horizontal surfaces such as ledges, beams, pipes, hoods, and floors, shall be maintained to prevent the accumulation of powder.

Δ **15.10.2** Surfaces outside of the spray area shall be cleaned in a manner that does not scatter powder or create dust clouds.

N **15.10.3** Vacuum sweeping equipment, where used, shall be of a type approved for use in hazardous locations.

**15.10.4** The booth exhaust shall remain on during spray area cleaning operations to confine airborne combustible dust.

**15.10.5** Means shall be provided to prevent tramp metal or spark-producing material from being introduced into the powder being deposited.

**15.10.6** Signs stating NO SMOKING OR OPEN FLAMES in large letters on contrasting color backgrounds shall be conspicuously posted at all powder coating areas and powder storage rooms.

**15.11 Automated Electrostatic Powder Spraying Equipment.** The provisions of Chapter 11 and other sections of Chapter 15 shall apply to fixed electrostatic equipment, and electrical equipment not covered therein shall comply with Section 15.6.

#### Δ 15.12 Handheld Electrostatic Powder Spraying Equipment.

N **15.12.1** The provisions of Chapter 12 and other provisions of Chapter 15 shall apply to electrostatic handheld spraying equipment where it is used in powder coating.

N **15.12.2** High-voltage circuits shall be designed so as not to produce sparks capable of igniting any powder-air mixtures likely to be encountered instead of the vapor-air mixtures.

N **15.12.3** All electrical equipment not covered in 15.12.1 and 15.12.2 shall comply with Section 15.6.

#### 15.13 Drying, Curing, and Fusing Equipment.

**15.13.1** The temperature of the object or material being coated shall be maintained at least 28°C (50°F) below the auto-ignition temperature of the powder.

**15.13.2\*** Drying, curing, and fusing equipment shall meet all the applicable requirements of NFPA 86.

#### 15.14 Electrostatic Fluid Beds.

**15.14.1** High-voltage circuits shall be designed so that any discharge produced when the charging electrodes of the bed are approached or contacted by a grounded object cannot produce a spark that is capable of igniting the most hazardous powder-air mixture.

**15.14.2** Transformers, power packs, control apparatus, and all other electrical portions of the equipment, with the exception of the charging electrodes and their connections to the power supply, shall be located outside the area classified as hazardous or otherwise meet the requirements of 15.6.1.

Δ **15.14.3** All electrically conductive objects within the powder coating 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<sup>6</sup> ohms (1 megohm).

N **15.14.3.1** This requirement shall also apply to any personnel who might enter the area.

N **15.14.3.2** The powder coating equipment shall carry a prominent, permanently installed warning regarding the necessity for grounding these objects.

**15.14.4** Highly resistive objects [i.e., surface conductivity between 10<sup>8</sup> and 10<sup>11</sup> ohms per square (10<sup>2</sup> and 10<sup>5</sup> megaohms per square)] that exhibit voltage below 2500 volts, as measured using a nonloading kilovoltmeter and when subjected to coronal current not less than that expected in the application process, shall be considered adequately grounded.

**15.14.5** Objects or material being coated shall be maintained in electrical contact [less than 10<sup>6</sup> ohms (1 megohm)] with the conveyor or other support to ensure grounding.

Δ **15.14.5.1** Hangers shall be cleaned to ensure effective contact.

N **15.14.5.2** Areas of contact shall be sharp points or knife edges where possible.

**15.14.6** The electrical equipment and compressed air supplies shall be interlocked with the ventilation system so that the equipment cannot be operated unless the ventilation fans are in operation.

**15.15 Hot Flocking.** The temperature of the object or material being coated shall be maintained at least 28°C (50°F) below the autoignition temperature of the powder.

**15.16 Fluid Bed Coating.** The temperature of the object or material being coated shall be maintained at least 28°C (50°F) below the autoignition temperature of the powder.

## Chapter 16 Organic Peroxides and Plural Component Coatings

**16.1\* Scope.** This chapter shall apply to the spray application operations that involve the use of organic peroxide formulations and other plural component coatings, not including styrene cross-linked composites manufacturing as covered in Chapter 17.

**16.2 General.** Spray application operations that involve the use of organic peroxide formulations and other plural component coatings shall be conducted in spray areas that are protected by approved automatic sprinkler systems that meet the requirements of Chapter 9.

**16.3 Prevention of Contamination.** Measures shall be taken to prevent the contamination of organic peroxide formulations with any foreign substance. Only spray guns and related handling equipment that are specifically manufactured for use with organic peroxide formulations shall be used. Separate fluid-handling equipment shall be used for the resin and for the catalyst, and they shall not be interchanged.

**16.3.1** The wetted portions of equipment and apparatus that handle organic peroxide formulations shall be constructed of stainless steel (300 series), polyethylene, Teflon®, or other materials that are specifically recommended for the application.

**16.3.2\*** Measures shall be taken to prevent contamination of organic peroxide formulations with dusts or overspray residues resulting from the sanding or spray application of finishing materials.

**16.3.3** Spills of organic peroxide formulations shall be promptly removed so there are no residues. Spilled material shall be permitted to be absorbed by use of a noncombustible absorbent, which is then disposed of promptly in accordance with the manufacturer's recommendations.

**16.4 Storage of Organic Peroxides.** Organic peroxide formulations shall be stored in accordance with the requirements of NFPA 400 and with the manufacturers' recommendations.

**16.5 Handling of Organic Peroxides.** Measures shall be taken to prevent handling of organic peroxide formulations to avoid shock and friction, which can cause decomposition and violent reaction.

**16.6\* Mixing of Organic Peroxides with Promoters.** Organic peroxide formulations shall not be mixed directly with any cobalt compounds or other promoters or accelerators, due to the possibility of violent decomposition or explosion. To minimize the possibility of such accidental mixing, these materials shall not be stored adjacent to each other.

**16.7 Smoking.** Smoking shall be prohibited, NO SMOKING signs shall be prominently displayed, and only nonsparking tools shall be used in any area where organic peroxide formulations are stored, mixed, or applied.

**16.8 Trained Personnel.** Only designated personnel trained to use and handle organic peroxide formulations shall be permitted to use these materials.

**16.9 Material Safety Data Sheets.** Where organic peroxide formulations are used, the material safety data sheet (MSDS) or its equivalent shall be consulted.

## Chapter 17 Styrene Cross-Linked Composites Manufacturing (Glass Fiber-Reinforced Plastics)

**17.1\* Scope.** This chapter shall apply to manufacturing processes involving spray application of styrene cross-linked thermoset resins (commonly known as glass fiber-reinforced plastics) for hand lay-up or spray fabrication methods, that is, resin application areas, and where the processes do not produce vapors that exceed 25 percent of the lower flammable limit.

**17.2 Resin Application Equipment.** The equipment and apparatus for spray application of the resin shall be installed and used in accordance with the requirements of Chapter 16 and Chapter 17.

**17.3\* Fire Protection.** Resin application areas shall be protected in accordance with Chapter 9.

**17.4 Resin Storage.** The quantity of ignitable (flammable and combustible) liquids located in the vicinity of resin application areas outside an inside storage room or storage cabinet in any one process area shall not exceed the greater of any of the following:

- (1) A supply for one day
- (2) The sum of 95 L (25 gal) of Class IA [FP < 22.8°C (73°F) and BP < 37.8°C (100°F)] liquids in containers and 454 L (120 gal) of Class IB, IC, II, or III [any flash point and BP > 37.8°C (100°F)] liquids in containers
- (3) One approved portable tank not exceeding 2500 L (660 gal) of Class IB, IC, II, or III [any flash point and BP > 37.8°C (100°F)] liquids

### 17.5 Electrical and Other Hazards.

**17.5.1** Electrical wiring and utilization equipment located in resin application areas that is not subject to deposits of combustible residues shall be installed in accordance with the requirements of NFPA 70 for Ordinary Hazard locations.

**17.5.2** Electrical wiring and utilization equipment located in resin application areas that is subject to deposits of combustible residues shall be listed for such exposure and shall be suitable for Class I, Division 2 or Zone 2 locations, if applicable as defined in 6.3.1.2.

**17.5.3\*** All metal parts of resin application areas, exhaust ducts, ventilation fans, spray application equipment, workpieces or containers that receive the spray stream, and piping that conveys ignitable (flammable or combustible) liquids shall be electrically grounded.

**17.5.4** Space heating appliances or other hot surfaces in resin application areas shall not be located where deposits or residues accumulate.

### 17.6 Ventilation.

**17.6.1** Mechanical ventilation shall be designed and installed throughout the resin application area in accordance with the requirements of Chapter 7.

**17.6.1.1** Buildings that are not enclosed for at least three-quarters of their perimeter shall not be required to meet this requirement.



**17.6.2** Local ventilation shall be provided where personnel are under or inside of the workpiece being fabricated.

### 17.7 Use and Handling.

**17.7.1** The storage and use of organic peroxide formulations shall meet the requirements of Chapter 16.

### 17.7.2 Containers.

**17.7.2.1** Excess catalyzed resin, while still in the liquid state, shall be drained into a steel container of no more than 208 L (55 gal) capacity.

**17.7.2.2** The container shall conform to all of the following:

- (1) Be located in an area with sprinklers if inside the building
- (2) Be allowed to be no more than 75 percent full
- (3) Kept covered (but not sealed) except when adding or mixing material

**17.7.3** In areas where chopper guns are used, paper, polyethylene film, or similar material shall be provided to cover the exposed surfaces of the walls and floor to allow the buildup of overchop to be removed.

**17.7.3.1** Accumulated overchop shall be disposed of when it has reached an average thickness of 50 mm (2 in.).

**17.7.3.2** Used paper, polyethylene film, or similar material shall be placed in a noncombustible container and disposed of when removed from the facility.

## Chapter 18 Spray Application Operations in Membrane Enclosures

**18.1\* Scope.** This chapter shall apply to spray application operations and processes for coating the exterior of a workpiece conducted in membrane enclosures.

### 18.2 Limitations.

**18.2.1** Spray application operations and processes within the enclosure shall only be permitted at a fixed location, for the workpiece for which the enclosure was erected, but which can involve multiple coats for a single workpiece.

**18.2.2** Membrane enclosures shall be erected for 180 days or less.

**18.2.3** Membrane material shall not be reused for any other spray application operations.

**18.2.4** Other operations shall not take place within an enclosure while the spray application operation is in progress.

**18.2.5\*** Operations conducted within the enclosure other than spray applications shall meet the fire and safety requirements for those operations.

**18.2.6** Spray application operations for parts removed from the workpiece shall be conducted in accordance with applicable requirements of this standard.

### 18.3 Membrane Material.

**18.3.1** Material used for membrane enclosures shall be constructed of one of the following:

- (1) Noncombustible or limited-combustible materials or assemblies

(2) Materials or assemblies that can successfully pass Test Method 2 in NFPA 701

(3) Materials that exhibit all of the following characteristics when tested in accordance with NFPA 286:

- (a) During the 40 kW (136,486 Btu/hr) exposure, flames do not spread to the ceiling.
- (b) The flame does not spread to the outer extremity of the sample on any wall or ceiling.
- (c) Flashover, as defined in NFPA 286, does not occur.
- (d) The peak heat release rate throughout the test does not exceed 800 kW (2,729,714 Btu/hr).
- (e) The total smoke release throughout the test does not exceed 1000 m<sup>2</sup> (10,764 ft<sup>2</sup>).

(4) Materials that exhibit a maximum rate of heat release of 100 kW (341,214 Btu/hr) when tested in accordance with NFPA 289 using a 20 kW (68,242 Btu/hr) ignition source

(5) Materials that are classified as welding curtains by ANSI/FM 4950, *Welding Pads, Welding Blankets and Welding Curtains for Hot Work Operations*

**18.3.2** Testing shall have been performed by an independent test laboratory.

### 18.4 Protection.

#### 18.4.1 Portable Fire Extinguishers.

**18.4.1.1** Portable fire extinguishers shall be installed, inspected, and maintained in accordance with NFPA 10.

**18.4.1.2** The minimum size of all extinguishers shall be 4A:80B:C.

#### 18.4.2 Enclosures Outside of Buildings.

**18.4.2.1** The spray area shall be separated from permanent structures by a minimum of 4.6 m (15 ft).

**18.4.2.2** The spray area shall not block emergency vehicle access to adjacent buildings.

**18.4.3 Enclosures Inside of Buildings.** The requirements of 18.4.3.1 through 18.4.3.2.2 shall apply to membrane enclosures used inside a building.

#### 18.4.3.1 Automatic Sprinkler Systems.

**Δ 18.4.3.1.1** Buildings in which membrane enclosures are installed shall be provided with automatic sprinkler systems in accordance with 9.5.1.

**18.4.3.1.2\*** The automatic sprinkler system shall be designed for extra hazard (Group 2) occupancies as defined in NFPA 13.

**18.4.3.1.3\*** Sprinkler installations in areas using membrane materials shall comply with all design and installations rules outlined in NFPA 13.

**18.4.3.1.4\*** Buildings in which membrane enclosures are installed shall be provided with a Class III standpipe system in accordance with NFPA 14.

**18.4.3.1.5** Pre-engineered extinguishing systems shall not be utilized for fire protection unless specifically listed for use in membrane enclosures.

#### 18.4.3.2\* Drop-Out Ceiling.

**Δ 18.4.3.2.1** Other than material in a vertical plane, the membrane material shall be both of the following:

- (1) Listed for installation beneath sprinklers

- (2) Installed to meet the requirements in NFPA 13 for drop-out ceilings and ceiling materials

**18.4.3.2.2** Where a listed membrane material is used, it shall be considered a drop-out ceiling in NFPA 13 and follow the applicable requirements for those assemblies.

### 18.5 Personnel Inside the Enclosure.

**18.5.1** During the spray process, only personnel required for the process shall be allowed inside the membrane enclosure, vessel, or workpiece.

**18.5.2** Travel distance to an exit from within a membrane enclosure shall comply with Table 40.2.6 in NFPA 101 for general industrial occupancies.

### 18.6 Electrical and Other Sources of Ignition.

**18.6.1 Electrical Wiring and Utilization Equipment.** Electrical wiring and utilization equipment used in membrane enclosures during spray painting shall comply with Chapter 6 except as amended in 18.6.1.1 through 18.6.1.6.

**18.6.1.1** The spray area shall consist of the area within the membrane enclosure.

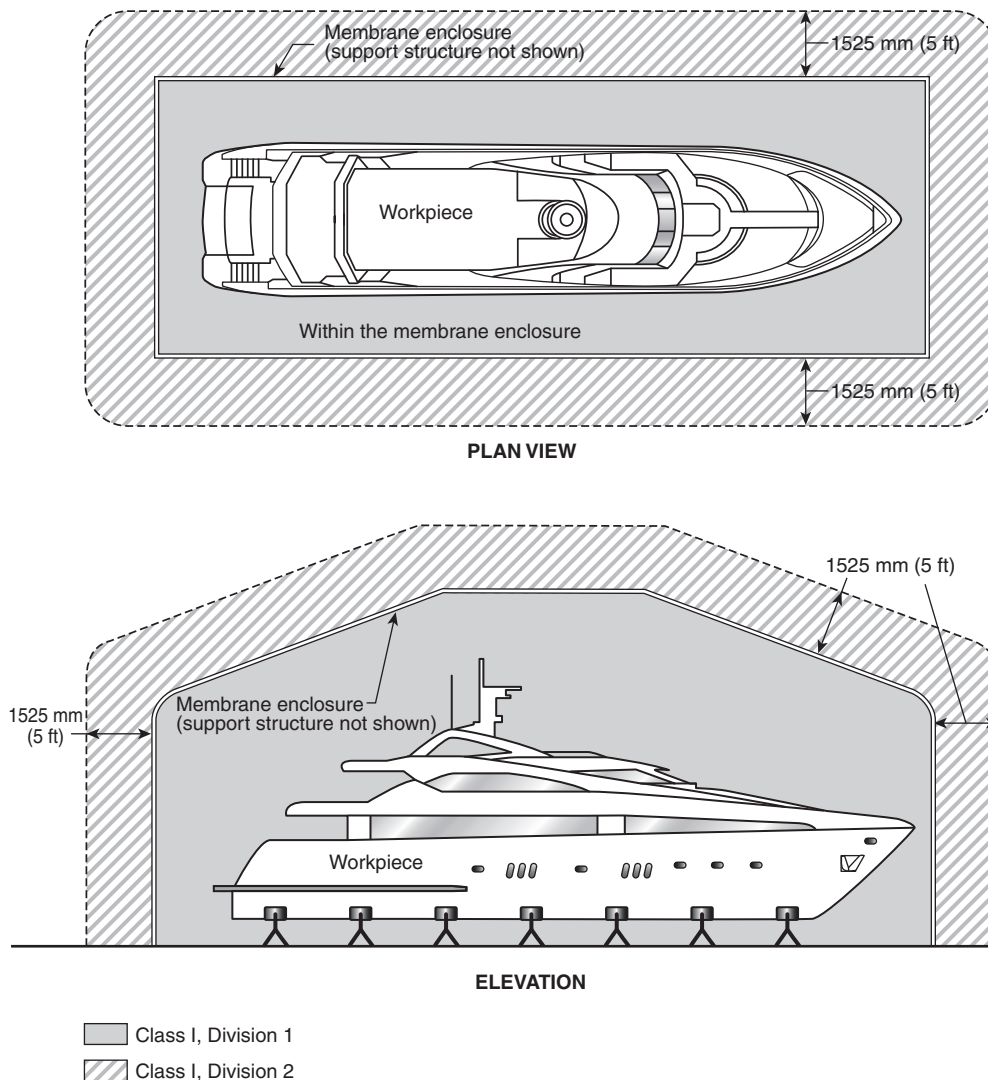
**18.6.1.2** The spray area shall be considered a Class I, Division 1 area, as shown in Figure 18.6.1.2

**18.6.1.3** A 1.5 m (5 ft) zone outside of the membrane enclosure shall be considered Class I, Division 2, as shown in Figure 18.6.1.2.

**18.6.1.4** All lighting, electrical power cords, and any related equipment within the membrane enclosure shall be in accordance with 6.4.3.

**18.6.1.5** All lighting, electrical power cords, and any related equipment within the 1.5 m (5 ft) distance horizontally from the exterior of the membrane enclosure shall be listed for Class I Division 2 as defined by NFPA 70 when used during spray paint operations.

**18.6.1.6** All power to the workpiece shall be disconnected during spray painting.



**FIGURE 18.6.1.2 Electrical Classifications for Outdoor Membrane Enclosures.**

## 18.6.2 Prohibitions.

**18.6.2.1** No hot work, welding, grinding, or cutting shall take place in the spray area while it is permitted for spray painting per Section 18.10.

**18.6.2.2** No vehicles, ordinary combustibles, portable buildings, or container storage shall be located in the 1.5 m (5 ft) Class I, Division 2; Zone 2 area during spray operations.

**18.6.2.3** No smoking or open flames shall be allowed in the paint spray area, including the membrane enclosure, while it is permitted for spray painting per Section 18.10.

**18.6.2.4** Hot work adjacent to designated spray painting operations in membrane enclosures shall be performed only when authorized by the competent person designated for spray painting.

## 18.6.3 Grounding.

**18.6.3.1\*** Workpieces shall be grounded.

**18.6.3.2** Scaffolding shall be bonded to the workpiece and grounded to an appropriate grounding rod or other approved method consistent with requirements referenced in 6.2.1.

**18.6.3.3** Spray paint equipment shall be grounded.

## 18.7 Ventilation.

### 18.7.1 Mechanical Ventilation.

**18.7.1.1** Each membrane enclosure shall be provided with mechanical ventilation consistent with requirements in Section 5.7 and Chapter 7, except as amended by the requirements of this chapter.

**18.7.1.2\*** The ventilation system shall be designed and installed to ensure that the enclosure is maintained at a pressure that is negative relative to the surrounding environs.

**18.7.2\*** The concentration of the vapors and mists in the exhaust stream of the ventilation system during spray operations and ambient air drying operations shall not exceed 10 percent of the lower flammable limit.

**18.7.2.1** Equipment used to monitor the concentration of solvent vapors shall be calibrated for the solvents used according to the recommendations of the monitoring equipment manufacturer.

**18.7.2.2** The calibration frequency required by 18.7.2.1 shall be per the manufacturer's recommendations.

**18.7.2.3** All spray operations within the membrane enclosure shall cease operations when the concentration of the vapors and mists in the exhaust stream of the ventilation system reaches or exceeds 10 percent of the lower flammable limit.

### 18.7.2.4 Interlocks.

**18.7.2.4.1** An interlock shall be provided so that the spray apparatus is automatically stopped if the ventilation system fails to maintain the concentration of the vapors and mists in the exhaust stream below 10 percent of the lower flammable limit.

**18.7.2.4.2** Where interlocks cannot be effectively provided for ventilation equipment that uses plant air, large air storage tanks, or equipment that cannot be instantly shut off, an audible alarm upon loss of ventilation that will alert all spray paint

operators shall be permitted with approval of the authority having jurisdiction.

**18.7.3** Exhaust air shall be taken from one or more points within 300 mm (12 in.) of the floor of the enclosure.

**18.7.4** A supply of clean make-up air shall be provided per the requirements of Section 7.3.

**18.7.5\*** The location of both the exhaust and make-up air openings shall be arranged to provide air movement throughout the enclosure and across all portions of the floor to prevent accumulation of flammable vapors.

**18.7.6** Ventilation equipment containing overspray collection filters shall follow the requirements of 7.2.4.

**18.7.7** Air exhausted from the membrane enclosure shall not be recirculated.

**18.7.8** Routing of exhaust shall comply with Section 7.4.

### 18.7.9 Drying.

**18.7.9.1** Membrane enclosures used for the spray application of ignitable (flammable or combustible) liquids or combustible materials shall not be used for drying, curing, or fusing operations at elevated temperature.

**18.7.9.2** Freshly sprayed workpieces shall be dried only in spaces that are ventilated to prevent the concentration of vapors from exceeding 10 percent of the lower flammable limit.

## 18.8 Recordkeeping.

**18.8.1** Any contractor supplying exhaust equipment for painting and coating work within membrane enclosures shall provide documentation that the equipment complies with Chapter 7 requirements.

**18.8.2** All equipment shall bear a permanent unique number or other designation to identify equipment in use.

### 18.8.3 Records.

**18.8.3.1** Records of approved equipment shall be kept on file for 12 months.

**18.8.3.2** Records shall be in the form of a memorandum stating the equipment number; the owner of the equipment; and the lease of the equipment, if any, and state that the owner has accepted the equipment for use at the facility.

**18.8.4** Installers shall provide documentation that the membrane material has met the requirements of 18.3.1 to the owner before installation.

**18.8.5** Records shall be made available to the AHJ or any inspecting authority upon request.

## 18.9 Storage and Handling of Ignitable (Flammable and Combustible) Liquids.

**18.9.1 Coating Material Handling.** Ignitable (flammable and combustible) paints, coatings, and cleaning agents for equipment within the membrane enclosure and its 1.5 m (5 ft) Class I, Division 2 and Class I, Zone 2 area shall not exceed 37.9 L (10 gal) total at any time.

### 18.9.2 Mixing and Storage.

**18.9.2.1** All mixing and storage shall be done outside the membrane enclosure area.

**18.9.2.2** Where mixing and storage operations are located inside buildings, they shall be protected in accordance with Chapter 8.

### 18.10 Facilities Compliance Permitting.

#### 18.10.1\* Issuance.

**18.10.1.1** Permits for spray painting shall be issued for each spray paint activity on a daily basis.

**18.10.1.2** Paint spray permit records shall be kept for 12 months for review by the AHJ.

**18.10.2** Competent persons shall perform all spray paint permitting for membrane enclosures.

**18.10.3** Spray painting shall not be performed in any membrane enclosure until a paint spray permit is signed by a competent person and posted at the entrance to the enclosure. (See example in Figure A.18.10.1.)

**18.10.4** The competent person shall have the authority to stop the spray painting operation if any equipment malfunctions, if combustible gas detection readings exceed 10 percent of LFL readings, or if any spray operations are deemed unsafe by the competent person.

**18.10.5** No spray paint operations shall take place without permitting by a competent person present at all times that spray painting is in progress.

**18.10.6** Combustible gas testing shall be performed by the competent person prior to the start of spray painting, during spray painting operations, and 10 minutes after the ventilation has been shut down.

**18.10.6.1** Equipment used to monitor the concentration of solvent vapors shall be calibrated for the solvents used.

**18.10.6.2** The calibration frequency shall be per the manufacturer's recommendations.

**18.10.7** The competent person shall inspect all electrical connections within the membrane enclosure as a part of permitting.

**18.10.8** The competent person shall ensure that energized electrical equipment is in compliance with the requirements in Section 18.6.

#### 18.10.9 Interlocks.

**18.10.9.1** The competent person shall ensure that ventilation exhaust equipment and paint spray compressors are interlocked.

**18.10.9.2** For spray painting within membrane enclosures, *interlocked* shall mean that the spray application equipment cannot be operated unless the exhaust ventilation system is operating and functioning properly and spray application is automatically stopped if the exhaust ventilation system fails.

## Chapter 19 Training

**19.1\* General.** All personnel involved in the spray application processes covered by this standard shall be instructed in the following:

- (1) Potential safety and health hazards
- (2) Operational, maintenance, and emergency procedures required
- (3) Importance of constant operator awareness

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

**19.1.2\*** 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.

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

**19.1.4** Documentation shall be employed to record the type and date of training provided to each individual involved in these processes.

## Annex A Explanatory Material

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

**A.1.1** The risk to life and property because of the fire and explosion hazards of spray application of flammable and combustible materials varies depending on the arrangement and operation of the particular process and on the nature of the material being sprayed. The principal hazards addressed in this standard are those of the materials being sprayed: flammable and combustible liquids and combustible powders, as well as their vapors, mists, and dusts, and the highly combustible deposits and residues that result from their use. Properly designed, constructed, and ventilated spray areas are able to confine and control combustible residues, dusts, or deposits and to remove vapors and mists from the spray area and discharge them to a safe location, thus reducing the likelihood of fire or explosion. Likewise, accumulations of overspray residues, some of which are not only highly combustible but also subject to spontaneous ignition, can be controlled.

The control of sources of ignition in spray areas and in areas where flammable and combustible liquids or powders are handled, together with constant supervision and maintenance, is essential to safe spray application operations. The human element requires careful consideration of the location of spray application operations and the installation of fire extinguishing systems so that the potential for spread of fire to other property and damage to property by extinguishing agent discharge is reduced.

**A.1.1.1** Refer to Figure A.1.1.1 for assistance in determining whether NFPA 33 applies to a particular spray application process.



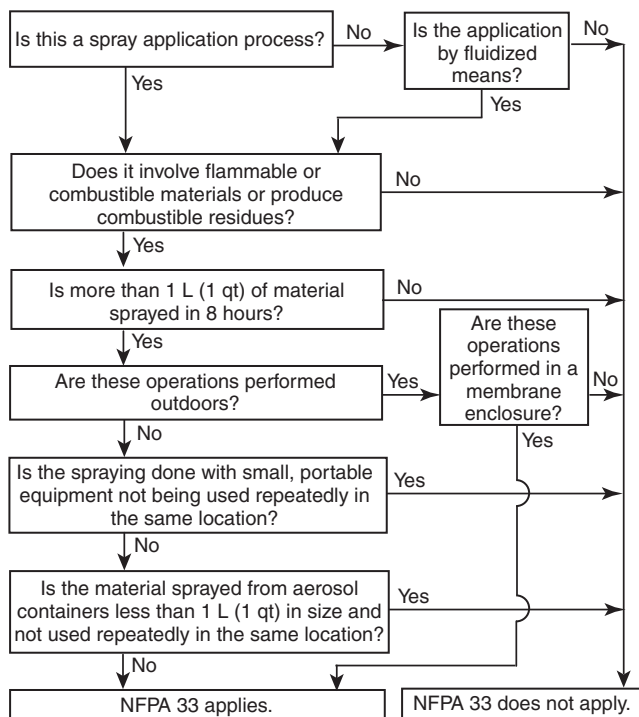


FIGURE A.1.1.1 Decision Tree — Does NFPA 33 Apply?

**A.1.1.4** There are many industrial applications that involve routine use of small quantities of flammable or combustible liquids (e.g., coatings, lubricants, adhesives) on a regular or periodic basis. An example would be touch-up of manufactured articles using aerosol containers or small, portable spray application equipment. The intent of this provision is to allow such use without having to comply with the requirements of NFPA 33.

**A.1.1.6** This standard does not cover spray application operations that are conducted outdoors on buildings, bridges, tanks, or similar structures. These situations occur only occasionally for any given structure and overspray deposits are not likely to present a hazardous condition. Also, the space where there might be an ignitable vapor air or dust air mixture is very limited due to atmospheric dilution.

**A.1.1.8** The occasional use of portable spray equipment or aerosol spray containers is not likely to result in hazardous accumulations of overspray. Therefore, such operations are not within the scope of this standard. The following safeguards, however, should be observed:

- (1) Adequate ventilation should be provided at all times, particularly where spray application is conducted in relatively small rooms or enclosures.
- (2) Spray application should not be conducted in the vicinity of open flames or other sources of ignition. Either the spray operation should be relocated or the source of ignition should be removed or turned off.
- (3) Containers of coating materials, thinners, or other hazardous materials should be kept tightly closed when not actually being used.
- (4) Oily or coating-laden rags or waste should be disposed of promptly and in a safe manner at the end of each day's operations, due to the potential for spontaneous ignition.

- (5) The same fundamental rules for area cleanliness and housekeeping that are required for industrial spray application operations should be observed.

**A.1.2.2** The requirements of this standard are intended to minimize the risk of fire and explosion; they are not intended and might not be adequate to protect personnel from the toxic or negative effects from exposure to the materials used.

**Δ 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 or procedures, equipment, or materials, the "authority having jurisdiction" may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The "authority having jurisdiction" may also refer to the listings or labeling practices of an organization 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 standards in a broad manner because 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.3.3.1 Ambient.** Most lower explosive limit (LEL) (also known as "lower flammable limit" or "LFL") values are reported at 25°C (77°F), although several are given at 100°C (212°F). The LEL value decreases at higher temperatures, so it is necessary that the LEL value for the particular solvent be corrected for the operating temperature of the spray booth or spray room when operating above 25°C (77°F). See 12.6.8.3 of NFPA 86 for calculation of the correction factor. Note that NFPA 86 uses the term *lower flammable limit (LFL)*.

**A.3.3.2.3 Spray Area.** This definition identifies the areas in which vapors, residue, and combustible powders might exist, either in suspension or on surfaces, as a result of the normal operation of the equipment. The presence of these materials requires various protection measures as identified later in this standard, such as the installation of fire suppression systems.

For the purpose of this standard, the authority having jurisdiction can define the limits of the spray area in any specific case. The spray area in the vicinity of spray application opera-

tions will necessarily vary with the design and arrangement of the equipment and with the method of operation. Where spray application operations are strictly confined to predetermined spaces that are provided with adequate and reliable ventilation, such as a properly designed and constructed spray booth, the spray area ordinarily will not extend beyond this space. When spray application operations are *not* confined to an adequately ventilated space, then the spray area might extend throughout the room or building area where the spraying is conducted.

The following areas are typically not considered part of the spray area:

- (1) Fresh air make-up units
- (2) Air supply ducts and air supply plenums
- (3) Recirculation air supply ducts downstream of recirculation particulate filters
- (4) Exhaust ducts from solvent concentrator (i.e., pollution abatement) units

Spray booth recirculation systems contain a recirculation particulate filter, or series of filters, that have a minimum removal efficiency intended to minimize the potential for particulate accumulation in downstream areas. The reduction of particulates downstream of these filters reduces the hazards that are found in spray areas.

**A.3.3.9 Control Area.** For a typical spray paint operation, this could include a process area within which spraying, mixing, and other ancillary activities might occur.

**N A.3.3.13 Inflatable Finishing Workstation.** An inflatable finishing workstation is not a spray booth, spray room, or limited finishing workstation as defined in this standard.

**A.3.3.15.3 Ignitable Liquid.** Unless otherwise specified, the term *liquid* means an ignitable liquid.

The term *ignitable liquid* refers to any liquid that has a measurable closed-cup flash point. 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]

**N A.3.3.17 Maximum Allowable Quantity (MAQ).** Quantities of flammable and combustible (ignitable) liquids are permitted to exceed the MAQs when they are located in an area that complies with Protection Levels 2 and 3 in accordance with NFPA 30 and with the building code. [30, 2021]

**A.3.3.20 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.3.3.21 Spray Booth.** Spray booths are manufactured in a variety of forms, including automotive refinishing, downdraft, open-face, traveling, tunnel, and updraft booths. This definition is not intended to limit the term *spray booth* to any particular design. The entire spray booth is part of the spray area. A spray booth is not a spray room.

**A.3.3.22 Spray Room.** The entire spray room is considered part of the spray area. A spray booth is not a spray room.

**A.3.3.25.1 Limited Finishing Workstation.** A limited finishing workstation is a power-ventilated apparatus that meets all the requirements found in Section 14.3 of this standard but does not meet the requirements of a spray booth or spray room as herein defined.

**A.4.1** Fires involving spray application 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. Operations and equipment should be arranged and located so that there is adequate egress for personnel and adequate access for firefighting operations. Where spray application operations are extensive, they should be located in a separate building or in an area that is separated by fire-rated construction from all other operations or storage.

**A.4.1.1** 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 1-hour fire resistance rating.

**A.4.2** Spray application operations that incorporate assembly lines or conveyor systems present special problems. 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 pass through fire walls or 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.

Rooms that house spray application operations should be separated from other occupancies or operations by construction that meets the requirements of Chapter 5 of this standard.

In sprinklered buildings where spray application operations occupy one portion of an open area, the spray application operations should be surrounded by noncombustible or limited-combustible draft curtains extending downward at least 460 mm (18 in.) from the ceiling, but deeper if practical. 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.

Sprinkler discharge should be drained to the outside of the building, to an internal drain system, or to some other suitable location. Properly designed and installed floor drains and scuppers of sufficient number and size to handle expected sprinkler discharge should be provided. Where spray application operations are located on an upper floor, they should not be located directly above goods or equipment that are subject to water damage. In addition, the floor should be made watertight and means should be provided to drain sprinkler discharge directly from the area.

**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 booth or spray area can impact the existing egress paths in any building area, particularly a basement level or upper story where egress pathways are limited. Subsection 5.1.4 references the egress requirements in Chapter 40 of NFPA 101. Because spray operations present a higher hazard than is typical in most nonindustrial areas, this is a minimal standard approach.

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. 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 3.3.4, Basement*).

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

**A.5.1** Spray booths can be of a wide variety of shapes and sizes to accommodate the various industrial uses of spray application. Without the use of a spray booth, the spray area, as defined in 3.3.2.3, can constitute a considerable area, with all the requirements for a spray area then becoming applicable. It is important that only equipment suitable for specific purposes be utilized in connection with the handling and application of ignitable (flammable or combustible) liquids or powders.

**N A.5.1.1.4** The purpose of a door is to provide continuation of the walls or ceilings that provide containment.

**N A.5.1.4** For the purposes of determining means of egress components, due to the additional features required of an enclosed spray area, the contents of an enclosed spray area can be considered ordinary hazard contents as classified in NFPA 101.

**N A.5.3.3(2)** The outer skin of a double-skin assembly can be less than 0.9 mm (0.0359 in.) if the inner skin is no thinner than 1.2 mm (0.0478 in.)

**A.6.2** Because of the requirements for special safeguards, electrostatic apparatus; drying, curing, and fusing apparatus; and vehicle undercoating and body lining operations are covered in other chapters of this standard.

**Δ A.6.2.2** In the Division system, areas are classified as either Division 1 or Division 2 depending on whether flammable gases or vapors are always present or likely to be present (Division 1) or whether flammable gases or vapors are not normally present (Division 2). The Zone system identifies hazardous

locations as Zone 0, Zone 1, or Zone 2 depending on whether the flammable atmosphere will always be present (Zone 0), is likely to be present (Zone 1), or is not normally present (Zone 2). The Zone system is based on International Electrotechnical Commission (IEC) standards and was incorporated into NFPA 70 in 1996.

**A.6.2.5** There should be no open flames, hot surfaces, or spark-producing equipment in the spray area or in any area where they might be exposed to combustible residues. Open flames or spark-producing equipment should not be located where they can be exposed to deposits of combustible residues. Some residues can be ignited at low temperatures, such as those produced by steam pipes, incandescent luminaires, and power tools. In powder coating applications, the temperature of the object or material being coated should be maintained at least 28°C (50°F) below the autoignition temperature of the powder.

**A.6.2.6** Areas that are above or adjacent to spray areas and where materials are located, stored, mixed, or processed should be ventilated. Equipment that is known to produce flame, sparks, or particles of hot metal, including luminaires, that are adjacent to areas that are safe under normal operating conditions but which can become dangerous due to accident or careless operation should not be installed in such areas unless the equipment is totally enclosed or is separated from the area by partitions that will prevent the sparks or particles from entering the area.

**A.6.3.1** See NFPA 70.

**Δ A.6.3.1.1** This classification usually includes the following locations:

- (1) Where Class I [FP < 100°F (37.8°C)] 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 Class I [FP < 100°F (37.8°C)] liquids
- (4) Drying rooms or compartments for the evaporation of flammable solvents
- (5) All other locations where flammable concentrations of vapors or gases are likely to occur in the course of normal operations

In some Division 1 locations, flammable concentrations of 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 that normally vent flammable gases or vapors to the interior of the enclosure
- (2) Inadequately ventilated areas within spraying or coating operations using volatile flammable [Class I [FP < 100°F (37.8°C)] fluids
- (3) The interior of an exhaust duct that is used to vent flammable concentrations of vapors

**Δ A.6.3.1.2** 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]

See NFPA 30, *Flammable and Combustible Liquids Code*, and NFPA 58, *Liquefied Petroleum Gas Code*. Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even if 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 might be considered either hazardous (classified) or unclassified locations. [70:500.5(B)(2) Informational Note No. 2]

**Δ A.6.3.1.3** This classification includes locations inside vented tanks or vessels that contain Class I [FP < 100°F (37.8°C)] liquids; inside inadequately vented spraying or coating enclosures where Class I [FP < 100°F (37.8°C)] solvents are used; inside open vessels, tanks, and pits containing Class I [FP < 100°F (37.8°C)] liquids; and the interior of exhaust ducts that are used to vent flammable concentrations of vapors.

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

**Δ A.6.3.1.4** Normal operation is considered the situation when plant equipment is operating within its design parameters. Minor releases of Class I [FP < 100°F (37.8°C)] might be part of normal operations. Minor releases include the releases from mechanical packings on pumps. Failures that involve repair or shutdown (such as the breakdown of pump seals and flange gaskets and spillage caused by accidents) are not considered normal operation.

This classification usually includes locations where Class I [FP < 100°F (37.8°C)] liquids are transferred from one container to another; areas in the vicinity of spraying and painting operations where Class I [FP < 100°F (37.8°C)] solvents are used; adequately ventilated drying rooms or compartments for evaporation of Class I [FP < 100°F (37.8°C)] solvents; inadequately ventilated pump rooms for Class I [FP < 100°F (37.8°C)] liquids; and other locations where flammable concentrations of flammable vapors or gases are likely to occur in the course of normal operation but are not classified Zone 0.

**A.6.3.2.1** Dusts containing magnesium or aluminum are particularly hazardous, and the use of extreme precaution is necessary to avoid ignition and explosion. [70:500.5(C)(1) Informational Note]

**A.6.3.2.2** The quantity of combustible dust that may be present and the adequacy of dust removal systems are factors that merit consideration in determining the classification and may result in an unclassified area. [70:500.5(C)(2) Informational Note No. 1]

Where products such as seed are handled in a manner that produces low quantities of dust, the amount of dust deposited may not warrant classification. [70:500.5(C)(2) Informational Note No. 2]

**Δ A.6.3.2.3** As a guide to classification of Zone 20 locations, refer to ANSI/ISA 60079-10-2 (12.10.05)-2013, *Explosive Atmospheres — Part 10-2: Classification of areas — Combustible dust atmospheres*.

Zone 20 classification includes locations inside dust containment systems; hoppers, silos, etc., cyclones and filters, dust transport systems, except some parts of belt and chain conveyors, etc.; blenders, mills, dryers, bagging equipment, etc.

**Δ A.6.3.2.4** This classification usually includes the following:

- (1) Locations outside dust containment and in the immediate vicinity of access doors subject to frequent removal or opening for operation purposes when internal combustible mixtures are present
- (2) Locations outside dust containment in the proximity of filling and emptying points, feed belts, sampling points, truck dump stations, belt dump over points, and so on, where no measures are employed to prevent the formation of combustible mixtures
- (3) Locations outside dust containment where dust accumulates and where, due to process operations, the dust layer is likely to be disturbed and form combustible mixtures
- (4) Locations inside dust containment where explosive dust clouds are likely to occur (but neither continuously, nor for long periods, nor frequently) for example, silos (if filled and/or emptied only occasionally) and the dirty side of filters if large self-cleaning intervals are occurring [70:506.5(B)(2) Informational Note No. 2]

See also A.6.3.2.3.

**Δ A.6.3.2.5** Zone 22 locations usually include the following:

- (1) Outlets from bag filter vents (in the event of a malfunction, there can be emission of combustible mixtures)
- (2) Locations near equipment that has to be opened at infrequent intervals or equipment that from experience can easily form leaks where, due to pressure above atmospheric, dust will blow out
- (3) Pneumatic equipment, flexible connections that can become damaged
- (4) Storage locations for bags containing dusty product, (failure of bags can occur during handling, causing dust leakage)
- (5) Locations where controllable dust layers are formed that are likely to be raised into explosive dust-air mixtures

Only if the layer is removed by cleaning before hazardous dust-air mixtures can be formed is the area designated unclassified. [70:506.5(B)(3) Informational Note No. 2]

Protective measures to reduce the formation of explosive dust-air mixtures can often result in a Zone 21 location being classified as a Zone 22 location, or possibly unclassified. Such measures include local exhaust ventilation. [70:506.5(B)(3) Informational Note No. 3]

See also A.6.3.2.3.

**A.6.4.3** Equipment that is both listed for accumulation of deposits of combustible residues and listed for Class I, Division 1; Zone 1; Class II, Division 1; or Zone 21 locations can be installed in the spray area. (See NFPA 70.)

**N A.6.5.2** A luminaire as described in 6.6.3.1 is not considered an opening and, therefore, the interior of the luminaire is not



a Class I, Division 2; Zone 2; Class I, Division 2; or Zone 22 location, whichever is applicable.

**A.6.5.4(2)** Access doors into a spray area that must be closed to allow normal automated spray application operations to occur should not be considered an opening. The door should be considered a maintenance access and never open while a hazardous condition exists in the booth. Therefore, the area outside the door/maintenance access should be considered unclassified.

**A.6.5.5** Supply containers include paint pressure pots, paint pressure tanks, and any container with attached pumping equipment.

**■ A.6.6.3.2(1)** The interior of the luminaire is not a Class I, Division 2; Zone 2; Class II, Division 2; or Zone 22 location, whichever is applicable. The luminaire is required to be listed for use in the appropriate location as the listed assembly is an integral part of the wall or ceiling that encloses a spray area.

**A.6.7** During operation of any electrostatic equipment, electrically conductive isolated objects within the process area are influenced by the process and can become charged to voltages that result in spark discharges capable of igniting flammable or combustible substances. Objects commonly involved in such incidents include workpieces on conveyor racks that have fouled contact points; solvent containers or tools placed on nonconducting paint residues, cardboard, or wooden rests; spray booth components such as loose floor grates; and human beings insulated from ground by rubber footwear, paint residue accumulations on floors, and gloves.

Even in spray painting environments where there is no electrostatic equipment in operation but where sticky, electrically nonconductive paint residues have accumulated on the floor, a significant hazard is associated with static electrification of human bodies that results from walking across such a floor. As few as two or three steps can produce sufficient voltage on the body of a worker to create an incendive spark when he or she approaches a grounded object. If this spark occurs in a flammable vapor such as is found surrounding a solvent container or a freshly painted object, a fire results. See NFPA 77 for additional information.

**A.6.8** See Article 400 of NFPA 70, which covers general requirements, applications, and construction specifications for flexible cords and flexible cables.

**A.6.8(5)** See Article 500 of NFPA 70, which covers the requirements for electrical and electronic equipment and wiring for all the voltages in Class I, Divisions 1 and 2; Class II, Divisions 1 and 2; and Class III, Divisions 1 and 2 locations where fire or explosion hazards might exist due to flammable gases, ignitable (flammable or combustible) liquid-produced vapors, combustible dust, or ignitable fibers/flyings.

**A.7.2.4** Acceptable means to comply with 7.2.4 include, but are not limited to, visible gauges, audible alarms, approved interlocks, and effective inspection programs.

**A.7.3** All spray areas require make-up air, and since the air exhausted from spray application 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 often can 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 equal to at least 20 times the volumetric capacity of the fans (three air changes per hour), then additional make-up air should be provided. Outside air should be tempered and might have to be dehumidified or chilled for proper operation of the spray application apparatus. 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. If the velocities and distribution of air through baffles, filters, and registers have not been carefully designed, the spray application operation can be inefficient. The velocity of the air through filters, and so forth, should not exceed 60 m/min (200 ft/min). Higher velocities can disrupt spray application operations due to turbulent airflow in the vicinity of the spray apparatus. 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.

In some heating arrangements, forced make-up or replacement air directly compensating for the contaminated air exhausted from spray application operations is used in place of or to augment general area heating and ventilation.

With the many variables that can be encountered in heating and ventilating systems, it generally is 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 to comply with Chapter 6
- (2) Locating air intakes to prevent recalculation of contaminated air, and equipping air intakes with appropriate screens or filters
- (3) Automatic temperature and proportioning controls, including an independent excess temperature limit control
- (4) 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
- (5) An interlock between the spray booth exhaust system and the make-up air system to ensure that both systems are operable and provide a proper balance of supply and replacement air
- (6) In the case of direct-fired units, operating controls that ensure that concentrations of unburned fuel or products of combustion, if inhaled, are kept to levels that are safe for operating personnel

**A.7.5** If air exhausted from the spray area is permitted to be recirculated, as provided for in Section 7.5, it is critical for effective monitoring that sensors be protected from obstruction and contamination. See NFPA 72 for recommended maintenance and calibration procedures.

**A.7.5(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.7.6** This requirement does not apply to spray booths that are alternately used for drying, curing, or fusing processes. See Chapter 13 for the requirements that address these processes.

**A.7.6(3)** If air exhausted from the spray area is permitted to be recirculated, as provided for in Section 7.5, indirect heaters are allowed to be located within the recirculated air path as long as the surface temperature of the indirect heater does not exceed 105°C (221°F). This temperature limit addresses the hazards associated with the possible accumulation of combustible residue on the heater surface in the event of a failure of the filter system during spray application operations.

**A.7.7** Exhaust systems should be individually ducted to the outside of the building. Where treatment of the exhaust airstream is necessary to satisfy environmental regulations or where energy conservation measures are used, this might not be practical, and manifolding of the exhaust ducts might be necessary. It should be understood that manifolding of exhaust ducts increases the fire hazard. A fire starting in one booth can spread through the exhaust system and involve other spray areas. Heat exchangers, which are sometimes used to preheat exhaust air before it enters an incinerator, are subject to fires from the spontaneous ignition of residue that collects on heat exchanger surfaces.

**A.7.8** For ducts for powder coating systems, the strength of the materials of construction should be considered, since the duct might have to contain the pressure of a deflagration. (See NFPA 68.)

**A.7.9** The designer of the exhaust ducts and fasteners should refer to appropriate design guides, such as the ANSI/SMACNA 005, *Round Industrial Duct Construction Standards* and the ANSI/SMACNA 002, *Rectangular Industrial Duct Construction Standards*, published by the Sheet Metal and Air Conditioning Contractors National Association.

**A.7.12** If there are other operations that give off ignitable vapors in the vicinity of a spray application operation, they should be provided with independent mechanical ventilation.

**A.8.1** For large spray operations, coatings, thinners, and solvents can be stored in one of the following locations:

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

In some cases, liquids are pumped to a mixing room or paint kitchen, where they are mixed and then pumped to the spray area. For smaller operations, separate storage and mixing areas might not be justified. However, it is desirable to minimize the fire loading in or near the spray area by one or a combination of the following methods:

- (1) Flammable liquid storage cabinets
- (2) A protected enclosed metal structure
- (3) Use of metal containers with limitations on the quantity of liquid located near the spray area

**N A.8.3.5** Spray booths and mixing rooms are not considered control areas.

**A.8.4.1** Examples of comparable properties and materials resistant to heat include those listed in FM 6036, *Flexible Hose Assemblies for Flammable Gases and/or Ignitable Liquids*, and SAE J343, *Test and Test Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies*.

**A.8.4.1.1** NFPA 77 provides information on bonding and grounding.

**A.8.4.2** Valves should be kept shut when spray application operations are not being conducted, to minimize the release of coating material in the event of fire.

**A.8.4.2.1** Materials that melt at a low temperature, including but not limited to aluminum, copper, or brass; materials that soften on fire exposure, such as plastics; or nonductile materials, such as cast iron. [30:27.2.4]

**A.8.4.3** If plastic tubing leaks within shielded areas, such as within color changers, the resulting spray fire will destroy all tubing, releasing large quantities of coating material in an area that cannot be reached by the booth protection system. Automatic protection systems should be provided for these areas.

A major cause of fire in automatic electrostatic spray booths has been the replacement of original equipment plastic tubing with other types of tubing. Such replacement tubing, particularly if conductive coatings are used, is susceptible to the development of pinhole leaks.

**A.8.4.4** The use of a spring-loaded pressure relief valve might create a situation in which the piping system experiences pressure hammer due to the cycling of the pressure relief valve. In cases where this is possible, added effort might be necessary to ensure the system is shut down before the components fail.

**A.8.5.2** NFPA 77 provides information on static protection.

**Δ A.9.1** As indicated in Chapter 8, it is not advisable to keep large quantities of ignitable (flammable or combustible) liquids in areas that expose personnel or important property to injury or loss. The primary reason is that fires in Class I [FP < 100°F (37.8°C)] liquids are difficult to extinguish by the usual methods and, if large quantities are involved, they can spread the fire by flowing over large areas. For fires in small amounts of ignitable (flammable or combustible) liquids, hand extinguishers or large extinguishers on wheels especially designed for such fires are effective. If large quantities of liquids are to be protected, suitable automatic equipment should be provided and special attention should be given to proper dikes, curbs, and drains to prevent the flow to other property.

For the extinguishment of fire in spray residues, handheld fire extinguishers suitable for fire in ordinary combustibles or hose streams are effective.

Depending on the level of filtration, residues could accumulate in the exhaust ductwork. Because the ductwork is part of the spray area, it must be protected in accordance with Chapter 9. This includes the ductwork from water-wash booths.

Because particulate filters accumulate paint residue, they must be protected. Solvent concentrator units, by their design, contain high concentrations of solvent, so they must also be protected. Additionally, the most commonly used solvent concentrators use activated carbon as the adsorption medium. This medium is highly combustible, especially with high levels of solvents absorbed. Ketone solvents pose an even greater risk.

Because suppression media other than water might damage the carbon bed, water-based suppression systems (wet pipe sprinklers, preaction sprinklers, dry pipe sprinklers, and open-head deluge systems) are recommended for this application.

The recirculated air supply unit must be protected because of the filter media it contains. Also, many large air supply units have gas-fired heaters to heat outside make-up air.

Air supply ducts from the particulate filter to the air supply unit and from the air supply unit to the spray booth are not normally protected, as all the particulates have been filtered.

The choice of an automatic fire protection system should always be based on good engineering practice. Generally, for most spray areas, automatic sprinklers are considered most appropriate (see A.9.5.1). However, consideration must be given to how much water is likely to flow and how much water is to be contained.

Dry chemical extinguishing systems are most appropriate for small spray application operations (e.g., automotive refinishing, furniture refinishing, and similar processes) that utilize dry filters to capture overspray. These systems provide economical, adequate protection. They are a viable alternative for any facility without sufficient water supply to support an automatic sprinkler system.

Carbon dioxide or clean agent extinguishing systems should be used for open area protection only after careful consideration. Holding the required concentration of an agent for the period of time needed for extinguishment in a spray booth environment can be difficult. In addition, total flooding with carbon dioxide in normally or potentially occupied areas presents serious health concerns. The time delay required prior to discharge can allow a fire time to grow and spread. Carbon dioxide and clean agent systems, however, are an appropriate choice for protecting electrostatic equipment enclosures inside or immediately outside the spray area.

**A.9.1.4** It is not the intent of this standard to require the installation of additional fire alarm systems within the building beyond the requirements of this standard.

**A.9.2.1** During a fire condition, an interlock should shut down the recirculation air so as not to return smoke to the spray booth or spray room. The air make-up system and exhaust system should remain in operation.

**A.9.3** The severity and extent of fires in spray application operations have substantially increased when rubber or plastic supply hose were burned off, resulting in the addition of the entire contents of the supply system to the fire. By limiting the amount of fuel available, the magnitude of the fire can be held to more manageable limits. The shutoff should be accomplished by means of an interlock with a fire detection system or the automatic fire extinguishing system for the spray area. This shutoff is normally accomplished by shutting the distribution pumps. In some cases, it is also advisable to limit the flow from the solvent piping system. This can be accomplished with properly specified check valves in the pipe “drops.”

**A.9.5.1** Spray application operations should be located only in buildings that are completely protected by an approved system of automatic sprinklers. If the operations are located in unsprinklered buildings, sprinklers should be installed to protect spray application processes where practical. Because of the rapidity and intensity of fires that involve spray operations,

the available water should be ample to simultaneously supply all sprinklers likely to open in one fire without depleting the available water for use by hose streams. Noncombustible draft curtains can be used to limit the number of sprinklers that will open.

Even when areas adjacent to coating operations are considered under reasonably positive fire control by adequate automatic sprinkler protection, damage is possible if operations are conducted on floors above those containing contents that are highly susceptible to water damage. Waterproofing and drainage of spray room floors can assist in reducing water damage on floors below. Proper drainage of the large volume of water frequently necessary to extinguish spray finishing room fires often presents considerable difficulty.

Automatic sprinklers in spray areas, including the interior of spray booths and exhaust ducts, should be wet pipe, preaction, or deluge system so that water can be placed on the fire in the shortest possible time. Automatic sprinklers in spray booths and exhaust ducts should be of the lowest practical temperature rating. The delay in application of water with ordinary dry pipe sprinklers can permit a fire to spread so rapidly that final extinguishment is difficult without extensive resulting damage.

The location of the sprinklers inside spray booths should be selected with care to avoid heads being placed in the direct path of spray and yet afford protection for the entire booth interior. When sprinklers are in the direct path of spray, even one day's operation can result in deposits on the sprinklers that insulate the fusible link or choke open head orifices to the extent that sprinklers cannot operate efficiently.

Automatic sprinklers should also be located so that areas subject to substantial accumulations of overspray residue are protected. Generally, sprinklers are located no more than 1220 mm (4 ft) from side walls of booths and rooms and from dry overspray collectors (where applicable). Sprinklers in booths or rooms should be on Extra Hazard occupancy spacing of 9.3 m<sup>2</sup> (100 ft<sup>2</sup>).

All sprinkler systems in spray areas should be controlled by an accessible indicating control valve.

Use of water as the extinguishing agent for solvent and coating material fires might, in some cases, cause problems with splashing and “floating” of flaming liquids and residues. This possibility should be included with the other factors that are normally considered in the selection of an extinguishing agent. In addition, water from sprinkler or deluge systems, after coming into contact with coating materials, residues, or solvents, might have to be collected and treated as hazardous waste.

**A.9.5.1.1** Subsection 9.5.1.1 lists four types of automatic sprinkler systems and requires that the one “most appropriate for the portion of the spray area being protected” be used. Generally, an open-head deluge system provides the highest level of protection, given that all the sprinklers in the protected area flow simultaneously. This type of system is most appropriate for large, downdraft, water-wash spray booths when protecting automatic electrostatic spray application zones.

Wet pipe automatic sprinkler systems are appropriate for protecting spray booths that utilize nonelectrostatic application processes or operations using listed electrostatic application processes. Wet pipe systems are also generally used to protect



exhaust plenums (eliminator or scrubber sections), exhaust ducts, and air recirculation filter houses.

Dry pipe systems have been included because some exhaust duct designs include sections that are subject to freezing.

Preaction systems have been included because some spray application processes and equipment can be damaged by unwanted water discharge. This damage can be disruptive and costly. Solvent concentrator (air pollution abatement) systems are examples of systems where it is appropriate to use a preaction system.

**A.9.5.1.3** Determining the water supply requirements for a paint spray application system requires identification of the credible fire scenario that results in the greatest water demand. In small booths, this is typically a combination of the sprinklers within the booth and those in the exhaust plenum and stack.

Large or complex paint spray systems can include some of the following features that require careful evaluation in determining the total system water demand in the event of a fire:

- (1) *Multiple (primary and secondary) fire protection systems.* A common example is a wet pipe system combined with a deluge or water mist system. These systems can operate simultaneously, and this possibility should be evaluated to ensure that the water supply is adequate.
- (2) *Large booths with multiple protection zones.* The fire scenario determining the required water supply needs to take into account the likelihood of involving more than one water-based fire protection system. This is especially true where optical flame detection is used to activate deluge systems. Consider the following:
  - (a) If optical flame detection can “view” a fire in adjacent zone
  - (b) Proximity of two zones
  - (c) Airflow between zones transporting hot gases to adjacent zone
- (3) *Recirculating or interconnected exhaust systems.* In simple exhaust systems, a developing fire tends to follow the airflow from the source to the exhaust point. However, in recirculating or interconnected systems, the possibility exists that airflow will also draw the fire into adjacent systems.
- (4) *Multiple exhaust plenum areas.* Supply plenums are usually devoid of paint or coating residue and cannot be expected to be part of a single fire scenario involving a spray booth or area. Exhaust plenums, including water wash/eliminator sections in downdraft booths, can contain a build-up of combustible residue and the airflow naturally draws a fire from the booth into the plenum and then on to the exhaust system. As in the multiple spray zone example, it is possible that more than one exhaust plenum could become involved.
- (5) *Concealed spaces.* In some booths, external or internal enclosures are provided for the purposes of paint and solvent supply, mixing, and recirculation. These enclosures are often protected by wet pipe sprinkler systems independent of the primary booth protection systems. Their operation might or might not be likely during a booth fire depending on the fire separation of these systems from the spray area.

Building areas outside of the spray area or paint booth are not included in the demand calculation, as the fire suppression systems and booth/spray area construction are intended to

contain a fire until manual firefighting efforts can achieve final fire extinguishment.

Figure A.9.5.1.3(a) and Figure A.9.5.1.3(b) show two examples of demand calculation worksheets to demonstrate how both simple and complex systems can be evaluated. Note that the accuracy of the decisions made in determining the water supply demand depends on the expertise of the evaluator.

**A.9.5.1.6** Water supply requirements for most industrial paint spray operations should be adequate to supply all automatic sprinklers in the spray area. Loss experience has shown that fires starting in the exhaust duct can spread to the spray booth and that fires starting in the booth can spread to the exhaust duct.

Sprinklers or sprinkler systems protecting stacks or ducts should be of a type not subject to freezing. Automatic systems are preferred, but manual systems are also acceptable. Nonfreeze or dry-type sprinkler systems can be used in ducts subject to freezing. For some industries, such as the automotive industry, manually operated open-head systems have proved to be effective protection for ducts and stacks.

Ductwork in powder coating applications does not require fire protection. Based on design duct velocity, there is no accumulation of residual powder.

**A.9.5.1.6(6)** Consideration should be given to duct areas resulting in the highest sprinkler discharge demand. This might actually include multiple paths of ducts, provided the total length of the ducts considered does not exceed 30.5 m (100 linear ft) and all subsections of ducts are interconnected.

While a developing fire might follow the direction of airflow and vertical rise in the ducts, it should not be assumed that a fire will only occur while the system is operating. Operations such as cutting and welding can result in ignition of residues inside the duct while equipment is idle.

It is not anticipated that both the building ceiling and spray area systems will operate simultaneously if installed in accordance with both this standard and NFPA 13, so a total demand

Spray Area/Spray Booth Water Demand Calculation Worksheet		
		Flow
<b>Total Demand:</b>		695 gpm
1.	Spray area demand*	
a.	1st Zone:	
b.	2nd Zone:	
c.	Sprinkler system:	130 gpm
2.	Exhaust system demand	65 gpm
3.	Eliminator/scrubber	
4.	Hose stream	500 gpm

Assumptions:

- (1) Small booth with straight airflow path into the booth through filter to plenum and then through stack (direct to atmosphere).
- (2) Demands for booth and exhaust (stack) sprinklers are totaled (assumes all sprinklers operate).

**FIGURE A.9.5.1.3(a) Spray Area/Spray Booth Water Demand Calculation Worksheet for a Simple Booth.**



including both building ceiling and spray area systems is not required by this section.

**A.9.5.1.6(7)** Minimal hose streams might be needed to effect final extinguishment if the fire is limited to inside the stack alone. To determine water supply requirements, see 9.5.1.3 and A.9.5.1.3 for guidance.

**A.9.5.1.7.1** Plastic bags should not be used for this purpose, as shrinkage prior to reaching the temperatures necessary to ensure sprinkler activation can interfere with proper sprinkler operation and the development of spray patterns. The ban on plastic bags should include polypropylene or other petroleum-based plastic bags commonly marketed as comparable to cellulose-based bags. Thin, clear, cellulose-based material degrades rather than melting and, like paper, does not experience shrinkage.

**A.9.5.2** This discharge is typically accomplished by means of a piping network from the fire protection system into all parts of the spray area. To avoid potential flashback of an unextinguished fire, modular fire protection units should not be used to protect areas with ducts or plenums, or areas that exceed the listing of the system. They might, however, be suited for smaller open spray areas that fall within the limits of the listing.

**A.9.6.1** This section applies to unmanned operations such as application equipment attached to a mechanical support or manipulator, including robotic devices. This section does not apply to devices that are held or manipulated by a person.

**Δ A.9.6.2** The make-up air and exhaust systems for a liquid application system have to continue to function unless there is a compelling reason to shut them down.

Spray Area/Spray Booth Water Demand Calculation Worksheet			
Total Demand:		Flow	PSI
		1,974 gpm	103 psi
1.	Spray area demand		
a.	1st Zone:	488 gpm	96 psi
b.	2nd Zone:	605 gpm	103 psi
c.	Sprinkler system:		
2.	Exhaust system demand		
a.	Path 1	360 gpm	75 psi
b.	Path 2		
c.	Path 3		
3.	Eliminator/scrubber	521 gpm	88 psi

Assumptions:

- (1) Deluge systems in two zones operate because optical flame detectors are not sufficiently isolated from adjacent zones.
- (2) Ceiling closed-head (wet) system does not operate because deluge systems are effective in controlling the fire and cooling the spray area.
- (3) Exhaust demand is based upon all heads operating along the airflow path from the fire origin to the termination of the exhaust stack.

**FIGURE A.9.5.1.3(b) Spray Area/Spray Booth Water Demand Calculation Worksheet for a Complex System.**

**A.9.6.3.4** Exposed areas downstream of a work piece and upstream of a dry filtration system are susceptible to build-up of paint overspray. These areas include, but are not limited to sheet metal shrouding around filter elements, guide plates that direct air flow into the dry filtration system, and maintenance walkways. Commonly, removable coatings such as plastic sheeting, foils, or greases are applied over these exposed areas to facilitate cleaning of the overspray build-up. As these coatings are intended to be removed at discrete intervals, a finite amount of overspray build-up will be present in these exposed areas during normal booth operation, requiring the need for fire protection over these areas. Depending upon the design of the dry filtration system, some or all portions of these exposed areas can be adequately protected by the main spray booth fire suppression system. In some cases, permanent design features of the dry filtration system, such as sheet metal air guide plates, baffles, or filter shrouds, obstruct the main spray booth fire suppression system from adequately protecting all exposed areas. In these cases, additional fire protection is needed to ensure all exposed areas are adequately protected.

**A.9.6.3.6(2)** When recirculation is stopped, ventilation might need to be diverted to atmosphere to maintain ventilation in accordance with Section 9.2.

**A.9.7.2.1** A fire detection system might be but does not have to be of the smoke, air aspirating, heat, or flame detection type or a combination of them. Special consideration should be given for the location of the detection units as residue built up can block the sensing elements or reduce their sensitivity. Periodic cleaning should be performed.

**A.9.7.3** See A.9.6.3.4.

**A.9.7.5(3)** When recirculation is stopped, ventilation might need to be diverted to atmosphere to maintain ventilation in accordance with Section 9.2.

**A.9.8.3** See A.9.6.3.4.

**A.9.8.4** When recirculation is stopped, ventilation might need to be diverted to atmosphere to maintain ventilation in accordance with Section 9.2.

**Δ A.10.1** The materials used in spray application processes can create serious fire hazards. For example, the vapors and mists created by the atomization of ignitable (flammable and combustible) liquids can form explosive mixtures in the air. In addition, deposits of residue can ignite spontaneously or be easily ignited. Finally, fires involving ignitable (flammable and combustible) liquids or combustible residues can spread rapidly and can produce intense heat and smoke. Properly designed equipment can do much to lessen these hazards but cannot eliminate them. These inherent characteristics should make it obvious that supervision of operations, maintenance of equipment, and daily cleaning are essential to a safe operation.

It is important that some type of periodic inspection be conducted and recorded as part of the maintenance procedures. It is also important that any inspections of spray application equipment be conducted by competent and reliable personnel who have knowledge of the equipment and the inherent characteristics of the materials used.

The frequency of the inspections depends on the individual components of the spray application process. For example, it might be acceptable to check sprinkler control valves or other control mechanisms for approved fire protection systems on a

weekly or even monthly basis. However, this frequency would not be acceptable for ensuring adequate airflow through collector filters of a spray booth. At a minimum, that should be done at the beginning of each operating shift. Similarly, the buildup of residues would need to be checked on a per-shift basis. Individual plant operations might dictate that either of these items (airflow and residue buildup) be checked every few hours.

**A.10.1.1** The use of the term *predetermined* is intended to convey the idea that one cannot arbitrarily locate or conduct spray application operations without thought to the hazards and special requirements that such operations demand. Requirements regarding electrical equipment and ventilation are of primary concern. This standard also specifies requirements that can vary based on the type of equipment used, the type of material being spray applied, and even the type of operation. Any spray application operation should also consider the storage, handling, and distribution of the coating materials used in the process. Certainly there are other factors, but these examples should adequately explain the need for predetermining the spray area and why operations should be confined to those areas.

**A.10.3** In the spray finishing of any workpiece, there is frequently a portion of the spray that does not deposit directly on the object or material being coated but does deposit on adjacent surfaces as residue material. This is referred to as *overspray*. Many of these residues are highly combustible, igniting at very low temperatures or spontaneously, resulting in fast-spreading fires. To limit the duration and intensity of fires, the accumulation of deposits has to be minimized and controlled as much as practical. The accumulation of residues represents one of the most significant challenges to fire control.

*Cleaning.* The interior of spray booths, exhaust fan blades, and exhaust ducts should be cleaned regularly to avoid the accumulation of residues. Either spray operators should be allowed ample time for this cleaning, or a special maintenance crew should be provided for cleaning at the close of each day's operation. If equipment is so designed that during cleanup hose streams or fixed water nozzles can be used in ducts and spray booths without water damage to building and contents, cleaning operations are greatly facilitated. Many plants have found that by coating the interior of spray booths with a suitable soap-like or water-soluble material immediately after cleaning, adhesive spray deposits can be removed the following day with the use of water streams. Other materials, such as plastics that can be readily peeled off the interior of the spray booth, can also be used to facilitate cleaning of the overspray residue.

Properly maintained water-wash booths offer lower fire loading than dry booths. To maintain this advantage, it is necessary to perform regular and scheduled maintenance. This maintenance schedule should be recorded and the records filed. When the nozzles, jets or orifices, eliminator packs, and strainer screens become fouled with accumulated sludge or overspray, combustible residues will be deposited on the interior of the exhaust duct and fan blades. The nozzles, jets, orifices, and eliminator packs should be inspected each work shift. Strainer screens should be removed and cleaned each work shift.

The booth interior, exhaust stack, and fan blades should be checked periodically, and accumulations of overspray and dirt should be removed as required. Exhaust ducts or stacks should

not be entered for cleaning or repairs unless they are free from flammable vapors and have been thoroughly wet down.

**A.10.6** Many fires have originated from the spontaneous ignition of fabric and waste impregnated with coating materials. When sprayed articles are rubbed with rags or waste, all unclean rags and waste should be immediately placed in approved waste cans and removed from the premises at least daily at the close of each shift. When employees change clothes on plant premises, soiled clothing should be kept in metal lockers provided in a segregated dressing room.

**A.10.6.3** See NFPA 77 for information on bonding and grounding.

**A.10.8.4** See NFPA 77 for information on bonding and grounding.

**A.10.10** Bleaching compounds, such as hydrogen peroxide, hypochlorites, perchlorates, or other oxidizing compounds, can cause fires when in contact with organic finishing materials. Hence, if bleaching compounds are to be used in spray booths, the booths should be thoroughly cleaned and used only for that purpose. The alternate use of spray booths for bleaching compounds and other finishing materials or the alternate use of finishing materials containing nitrocellulose and other types of finishing materials containing drying oils, such as varnishes, oil-based stains, air-drying enamels, primers, and so forth, without first thoroughly removing all traces of deposits can result in a spontaneous ignition fire.

**A.10.11** Stricter environmental regulation has given rise to the increased use of chlorinated solvents, such as 1,1,1-trichloroethane and methylene chloride. These solvents are not photochemically reactive and, therefore, can be useful in helping to meet standards regarding volatile organic compound emissions. However, these solvents have a well-documented characteristic of being chemically reactive with aluminum. The reaction that occurs is unpredictable both in terms of when it will occur and to what degree it will proceed. In most situations there is no apparent reaction. Other situations have noted effects ranging from simple corrosion to catastrophic explosion-like failure accompanied by considerable shrapnel and a fireball. Understanding and controlling the subsequent hazard is hindered by this unpredictability. Although there is some understanding of the actual reaction, the following factors acting as independent variables have been found to have an effect on the initiation and rate of reaction:

- (1) Heat
- (2) Pressure
- (3) Ratio of aluminum surface area to volume of solvent, presence of moisture (condensation), aluminum alloy content, metal content of the coating, and the introduction of other solvents or materials

Therefore, the only assuredly safe condition is to keep these materials separate.

It is important to realize that aluminum has been used as a primary material for spray equipment construction over many years. Incorporating these solvents into existing spray systems cannot be done safely without first determining the construction material of the equipment and then replacing those components where contact with aluminum and chlorinated solvent will occur within a pressurizable device (e.g., pumps, heaters, piping, fluid valves, and spray gun cups).