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National Fire Protection Association

International

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This is one of a large number of publications on fire safety issued by the Association. All NFPA standards and recommended practices, including this text, are prepared by the technical committees of the NFPA and adopted at an Annual Meeting of the Association. They are intended to prescribe reasonable measures for minimizing losses of life and property by fire.

This text and most other NFPA standards and recommended practices are published in the **National Fire Codes,** a compilation of NFPA's official technical material. Full information on the availability of these Codes and other NFPA publications can be secured from the Association.

Official NFPA Definitions

SHALL is intended to indicate requirements.

SHOULD is intended to indicate recommendations, or that which is advised but not required.

APPROVED refers to approval by the authority having jurisdiction.

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters. One foot = 0.3048 meters. One inch = 25.40 millimeters. One pound per square inch = 0.06805 atmospheres = 2.307 feet of water.

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The National Fire Protection Association does not "approve" individual items of fire protection equipment, materials or services. The suitability of devices and materials for installation under NFPA standards is indicated by the listing of nationally recognized testing laboratories, whose findings are customarily used as a guide to approval by agencies applying these standards. Underwriters' Laboratories, Inc., Underwriters' Laboratories of Canada, the Factory Mutual Laboratories and the American Gas Association (gas equipment) test devices and materials for use in accordance with the appropriate standards, and publish lists which are available on request.

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Standard for

Spray Finishing Using Flammable Materials

NFPA No. 33 — 1963

1963 Edition of No. 33

This 1963 edition of the standard for Spray Finishing Using Flammable Materials was adopted by the National Fire Protection Association at its Annual Meeting held May 13-17, 1963 on recommendation of the NFPA Committee on Finishing Processes. It supersedes the edition of 1961.

The changes in this edition are primarily for clarification and are principally editorial in nature. These changes appear in the following Sections: 303, 509(b), 606, 608, 612(b) and 1104. In the Appendix, Section A-500, new information is included on "makeup" or "replacement" air.

Origin and Development of No. 33

The original NFPA standard on Paint Spraying and Spray Booths was initiated in 1921. The first edition was published in 1922 as part of a Standard on Dip Tanks (now NFPA No. 34). Revised editions were published in 1926, 1928, 1935, 1937, 1941, 1946, 1950, 1953, 1954, 1955, 1957, 1959, 1960 and 1961.

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Standard for

Spray Finishing Using Flammable Materials

NFPA No. 33 — 1963

FOREWORD.

The safety of life and property from fire or explosion in the spray application of flammable paints and finishes depends upon the extent, arrangement, maintenance and operation of the process.

An analysis of actual experience in industry demonstrates that largest fire losses and fire frequency have occurred where good practice standards were not observed.

In order that the best practical arrangement may be obtained for the particular installation involved and in order that the Standard Requirements may be more clearly understood, an informative Appendix discussing the basic hazards and appropriate safeguards is included in this pamphlet.

STANDARD REQUIREMENTS.

SCOPE.

1. This Standard covers the application of combustible paint, varnish, lacquer, stain and similar finishing materials when applied as a spray by whatever means, in continuous or intermittent processes.

NOTE 1: The Scope of this Standard is intended to include application by compressed air, "airless" or "hydraulic" atomization, or by steam or electrostatic methods or by other means.

NOTE 2: Pending the completion of Standards by the Committee on Chemicals and Explosives covering requirements for the storage and handling of organic peroxides which may be used in spray applications, information pertaining to safeguarding these potentially explosive materials is shown in Appendix, Section A. 900.

2. This Standard does not cover outdoor spray application of buildings, tanks or other similar structures, nor small portable spraying apparatus not used repeatedly in the same location; however, the herein described fundamental safeguards pertaining to cleanliness, care of flammable liquids, dangerous vapor-air mixtures and sources of ignition should be followed where applicable.

3. This Standard does not cover the spray application of noncombustible finishing material. Certain water-emulsion liquids, however, although involving little or no hazard in the liquid state may leave highly combustible residues upon evaporation of the liquid carrier. The provisions of this standard for minimizing the hazards of combustible residues should be followed irrespective of the characteristics of the liquid.

4. This Standard outlines practical minimum requirements to obtain reasonable safety under average contemplated conditions. Where unusual industrial processes are involved the Inspection Department having jurisdiction may for substantiated cause require additional safeguards or modify the requirements of this Standard provided equivalent safety is thereby obtained.

NOTE—See also Appendix A-100.

CHAPTER 1.
DEFINITIONS.

101. APPROVED signifies acceptance, by the authority having jurisdiction, of design, equipment, installation, or intended use as required by this Standard.

NOTE: Devices having been tested and accepted for a specific purpose by a nationally recognized testing laboratory may be deemed acceptable.

102. SPRAYING AREA. Any area in which dangerous quantities of flammable vapors or combustible residues, dusts or deposits are present due to the operation of spraying processes.

A spraying area includes:

(a) The interior of spray booths except as specifically provided in Section 1104.

(b) The interior of ducts exhausting from spraying processes.

(c) Any area in the direct path of spray or any area containing dangerous quantities of air-suspended combustible residue, dust, deposits, spray or vapor as a result of spraying operations.

The authority having jurisdiction may, for the purpose of this standard, define the limits of the spraying area in any specific case.

NOTE: The "spraying area" in the vicinity of spraying operations will necessarily vary with the design and arrangement of equipment and method of operation.

When spraying operations are strictly confined to predetermined spaces which are provided with adequate and reliable ventilation, such as a properly constructed spray booth, the "spraying area" should ordinarily not extend beyond the booth enclosure.

When, however, spraying operations are not confined to adequately ventilated spaces the "spraying area" may extend throughout the entire room containing spraying operations.

103. SPRAY BOOTH. A power-ventilated structure provided to enclose or accommodate a spraying operation, to confine and limit the escape of spray, vapor and residue, and to safely conduct or direct them to an exhaust system.

104. WATERWASH SPRAY BOOTH. A spray booth equipped with a water washing system designed to minimize dusts or residues entering exhaust ducts and to permit the recovery of overspray finishing material.

105. DRY SPRAY BOOTH. A spray booth not equipped with a water washing system as described in Section 104. A dry spray booth may be equipped with (1) distribution or baffle plates to promote an even flow of air through booth or cause deposit of overspray before it enters exhaust duct; or (2) overspray dry filters to minimize dusts or residues entering exhaust ducts; or (3) overspray dry filter rolls designed to minimize dusts or residues entering exhaust ducts.

CHAPTER 2.

LOCATION OF SPRAY FINISHING OPERATIONS.

201. Structures housing finishing operations should preferably be one story in height and separated from other important buildings by adequate clear space or standard fire walls and provided with automatic sprinkler protection.

202. Spray finishing operations shall not be conducted in a building classified as assembly, educational, institutional or residential, except in a room designed for the purpose, protected with an approved system of automatic sprinklers and separated vertically and horizontally from such occupancies by construction having not less than 2 hours fire resistance.

203. (a) In industrial and similar business buildings, spray finishing operations should be so located and protected as to minimize possible damage to other property by fire or by extinguishing agents.

(b) Where spray finishing operations are located on upper floors of buildings, they should not be located immediately over high concentrations of damageable goods and positive provisions should be made for the waterproofing and drainage of the floor of the spraying area.

(c) Waterproof floors shall be arranged to drain to the outside of building, internal drains or other suitable place. Properly designed and guarded drains or scuppers of sufficient number and size to dispose of all surplus water likely to be discharged by automatic sprinklers over the waterproof area shall be provided, conforming to Standard for Waterproofing of Floors and Drainage and the Installation of Scuppers (NFPA No. 92).

204. Spray finishing operations preferably should not be conducted in any basement area.

205. Rooms containing spray finishing operations should preferably be separated from other occupancies by tight fitting partitions. In sprinklered buildings, rooms of extensive area having spray finishing operations should be provided with noncombustible draft curtains, extending downward from ceilings as far as practical but not less than 18 inches. Such curtains aid

in preventing the opening of sprinklers outside the area enclosed by curtains and tend to confine the discharge of water to the immediate area of the fire.

206. Finishing operations within the scope of this Standard should be confined to properly constructed spray booths.

NOTE: The extent of the hazardous "spraying area" is generally materially increased if spraying is not confined to properly constructed spray booths or areas separated by tight fitting partitions.

CHAPTER 3. SPRAY BOOTHS.

301. Spray booths shall be substantially constructed of steel not thinner than No. 18 U. S. gauge, securely and rigidly supported, or of concrete or masonry, except that aluminum or other substantial non-combustible material may be used for intermittent or low volume spraying, subject to the approval of the authority having jurisdiction. Spray booths shall be designed to sweep air currents toward the exhaust outlet.

302. The interior surfaces of spray booths shall be smooth and continuous without edges and otherwise designed to prevent pocketing of residues and facilitate cleaning and washing without injury.

303. The floor surface of a spray booth and operator's working area, if combustible, shall be covered with non-combustible material of such character as to facilitate the safe cleaning and removal of residues.

304. Distribution or baffle plates, if installed to promote an even flow of air through booth or cause the deposit of overspray before it enters exhaust duct, shall be of non-combustible material and readily removable or accessible on both sides for cleaning. Such plates shall not be located in exhaust ducts.

305. Dry Type Overspray Collectors — (Exhaust Air Filters). In conventional dry type spray booths, overspray dry filters or filter rolls, if installed, shall conform to the following:

(a) The spraying operations shall be so designed, installed and maintained that the average air velocity over the open face of the booth (or booth cross section during spraying operations) shall be not less than 100 linear feet per minute. Visible gauges or audible alarm or pressure activated devices shall be installed to indicate or insure that the required air velocity is maintained. Dry spray booths equipped with a filter roll which is automatically advanced when the air velocity is reduced to that specified in this paragraph, should be arranged to cause shut down of spraying operations if the filter roll fails to advance automatically.

Maintenance procedures should be established to assure replacing filter pads before excessive restriction to air flow occurs.

Filter pads should be inspected after each period of use and clogged filter pads discarded and replaced. Filter rolls shall be inspected to insure proper replacement of filter media.

(b) All discarded filter pads and filter rolls shall be immediately removed to a safe, well detached location or placed in a water-filled metal container and disposed of at the close of the day's operation unless maintained completely in water.

(c) The location of filters in a spray booth shall be so as to not reduce the effective booth enclosure of the articles being sprayed.

(d) Space within spray booth on the down stream and up stream sides of filters shall be protected with approved automatic sprinklers.

(e) Filters or filter rolls shall not be used when applying a spray material known to be highly susceptible to spontaneous heating and ignition.

(f) Clean filters or filter rolls shall be noncombustible or of a type having a combustibility not in excess of Class 2 filters as listed by Underwriters' Laboratories, Inc.

(g) Filters and filter rolls shall not be alternately used for different types of coating materials, where the combination of materials may be conducive to spontaneous ignition. See also Section 809.

306. Each spray booth having a frontal area larger than nine square feet shall have a metal deflector or curtain not less than 2½ inches deep installed at the upper outer edge of the booth, over the opening.

307. Where conveyors are arranged to carry work into or out of spray booths, the openings therefor shall be as small as practical.

308. Each spray booth shall be separated from other operations by not less than three feet, or by a greater distance, or by such partition or wall as the inspection department having jurisdiction may require to reduce the danger from juxtaposition of hazardous operations. Where dipping, drying or baking operations are permitted in the same room with spraying operations, the authority having jurisdiction should be consulted before installation. (See also Section 401.)

309. Spray booths shall be so installed that all portions are readily accessible for cleaning. A clear space of not less than three feet on all sides shall be kept free from storage or combustible construction.

310. When spraying areas are illuminated through glass panels or other transparent materials, only fixed lighting units shall be used as a source of illumination. Panels shall effectively isolate the spraying area from the area in which the lighting unit is located, and shall be of a non-combustible material of such a nature or so protected that breakage will be unlikely. Panels shall be so arranged that normal accumulations of residue on the exposed surface of the panel will not be raised to a dangerous temperature by radiation or conduction from the source of illumination.

CHAPTER 4.

ELECTRICAL AND OTHER SOURCES OF IGNITION.

401. All electrical equipment, open flames and other sources of ignition shall conform to the requirements of Chapter 4, except as follows:

(a) Electrostatic apparatus shall conform to the requirements of Chapters 9 and 10;

(b) Drying and baking apparatus shall conform to the requirements of Chapter 11;

(c) Automobile undercoating spray operations in garages shall conform to the requirements of Chapter 12.

402. There shall be no open flame or spark producing equipment in any spraying area as herein defined, nor within 20 feet thereof, unless separated by a partition.

403. Space heating appliances, steam pipes or hot surfaces shall not be located in a spraying area where deposits of combustible residues may readily accumulate.

High pressure steam pipes and equipment in connection with steam spraying processes should be covered with standard molded magnesia insulation 1½ inches thick or the equivalent and be provided with a clearance of at least 1 inch between insulation and combustible material or combustible construction. Pipe covering should have sewed canvas cemented surface finish or the equivalent.

404. Electrical wiring and equipment shall conform to the provisions of this section and shall otherwise be in accordance with the National Electrical Code (NFPA No. 70).

405. Unless specifically approved for locations containing both deposits of readily ignitible residue and explosive vapors, there shall be no electrical equipment in any spraying area, as herein defined, whereon deposits of combustible residues may readily accumulate, except wiring in rigid conduit or in boxes or fittings containing no taps, splices or terminal connections.

406. Electrical wiring and equipment not subject to deposits of combustible residues but located in a spraying area as herein defined shall be of explosion-proof type approved for Class I, Group D locations and shall otherwise conform to the provisions of the National Electrical Code (NFPA No. 70) for Class I, Division 1 Hazardous Locations. (See Articles 500, 501 and 516 of the Code.)

407. Electrical wiring, motors, and other equipment outside of but within twenty (20) feet of any spraying area, as herein defined, and not separated therefrom by partitions, shall not produce sparks under normal operating conditions and shall otherwise conform to the provisions of the National Electrical Code (NFPA No. 70) for Class I, Division 2 Hazardous Locations. (See Articles 500, 501 and 516 of the Code.)

408. Electric lamps outside of, but within twenty (20) feet of any spraying area as herein defined, and not separated therefrom by a partition, shall be totally enclosed to prevent the falling of hot particles and shall be protected from mechanical injury by suitable guards or by location.

409. Portable electric lamps shall not be used in any spraying area during spraying operations. Portable electric lamps, if used during cleaning or repairing operations, shall be of the type approved for hazardous Class I locations.

410. All metal parts of spray booths, exhaust ducts and piping systems conveying flammable liquids shall be properly electrically grounded in an effective and permanent manner.

NOTES ON ELECTRICAL INSTALLATIONS.

(1) As stipulated in Definitions (Section 102) the authority having jurisdiction may, for any specific installation, determine the extent of the hazardous "spraying area."

(2) From the above Section 405 it will be noted that in general electrical equipment is not permitted inside any spray booth, in the exhaust duct from a spray booth, in the entrained air of an exhaust system from a spraying operation or in the direct path of spray, unless such equipment is specifically approved for both readily ignitible deposits and flammable vapor. At present no such equipment is approved by a nationally recognized laboratory. Electric motors driving exhaust fans are specifically prohibited inside spray booths and exhaust ducts under Section 506.

(3) From the above Section 406, it will be noted that when electrical equipment is installed in locations not subject to deposits of combustible residues but, due to inadequate ventilation, is subject to explosive concentrations of flammable vapors, only approved explosion-proof equipment is permitted.

(4) When spraying operations are confined to adequately ventilated spray booths there should be no dangerous concentrations of flammable vapors, nor deposits of combustible residues outside of the spray booth under normal operating conditions.

In the interest of safety, however, it will be noted that unless separated by partitions, the area within 20 feet of the hazardous "spraying area" is considered Division 2, that is, it should contain no equipment which produces sparks under normal operation. Furthermore, within this 20-foot distance electric lamps must be enclosed to prevent hot particles falling on freshly painted stock or other readily ignitible material and if subject to mechanical injury must be properly guarded.

(5) It will be observed that because of the requirements of special safeguards, electrostatic apparatus, drying and baking ovens and automobile undercoating spray operations in garages are covered in separate chapters.

CHAPTER 5.

VENTILATION.

501. Ventilating and exhaust systems shall be in accordance with the NFPA Standard for Blower and Exhaust Systems for Vapor Removal (No. 91) where applicable and shall also conform to provisions of this section.

502. All spraying areas shall be provided with mechanical ventilation adequate to remove flammable vapors to a safe location and to confine and control combustible residues so that life or property is not endangered.

503. Mechanical ventilation shall be kept in operation at all times while spraying operations are being conducted and for a sufficient time thereafter to allow vapors from drying

coated articles and drying finishing material residue to be exhausted. When spray is automatically applied without an attendant constantly on duty and, where practical, when spraying is under manual control, the operating control of spray apparatus should be so arranged that spray cannot be applied unless exhaust fans are in operation.

504. Each spray booth shall have an independent exhaust duct system discharging to building exterior, except multiple cabinet spray booths in which identical spray finishing material is used with a combined frontal area of not more than eighteen square feet may have a common exhaust. If more than one fan serves one booth, all fans shall be so interconnected that one fan cannot operate without operating all.

505. Fan rotating element shall be non-ferrous or non-sparking or the casing shall consist of or be lined with such material. There shall be ample clearance between fan rotating element and fan casing to avoid a fire by friction, necessary allowance being made for ordinary expansion and loading to prevent contact between moving parts and the duct or fan housing. Fan blades shall be mounted on a shaft sufficiently heavy to maintain perfect alignment even when the blades of the fan are heavily loaded, the shaft preferably to have bearings outside the duct and booth. All bearings shall be of the self-lubricating type, or lubricated from outside duct.

506. Electric motors driving exhaust fans shall not be placed inside booths or ducts. (See also Chapter 4.)

507. Belts shall not enter duct or booth unless belt and pulley within the duct or booth are thoroughly enclosed.

508. Exhaust ducts shall be constructed of steel and shall be substantially supported. Exhaust ducts should be without dampers; however, if manually adjustable dampers are installed, they shall be kept in a full open position at all times ventilating system is in operation. When spray booths are not in use and it is necessary to shut off ducts during cold weather, non-combustible removable covers completely closing ducts may be used.

509. (a) Exhaust ducts shall have a clearance from unprotected combustible construction or other combustible material of not less than 18 inches.

(b) If combustible construction is provided with the following protection applied to all surfaces within 18 inches, clearances may be reduced to the distances indicated:

(1) 28 gauge sheet metal on ¼-inch asbestos mill board..... 12 inches

(2) 28 gauge sheet metal on ⅛-inch asbestos mill board spaced out one inch on non-combustible spacers.... 9 inches

(3) 22 gauge sheet metal on 1-inch rockwool bats reinforced with wire mesh or the equivalent..... 3 inches

(4) Where ducts are protected with an approved automatic sprinkler system, properly maintained; the clearance required in Section 509(a) may be reduced to 6 inches

510. Unless spray booth exhaust duct terminal is from a waterwash spray booth, the terminal discharge point shall be not less than six feet from any combustible exterior wall or roof nor discharge in the direction of any combustible construction or unprotected opening in any non-combustible exterior wall within 25 feet.

511. Air exhausted from spraying operations shall not be recirculated. Exhaust ducts should pass directly through the nearest outside wall or through the building roof. Ducts should not pass through fire walls or floors.

512. When necessary to facilitate cleaning, exhaust ducts shall be provided with an ample number of access doors.

513. Air intake openings to rooms containing spray finishing operations shall be adequate for the efficient operation of exhaust fans and shall be so located as to minimize the creation of dead air pockets.

514. Freshly sprayed articles shall be dried only in spaces provided with adequate ventilation to prevent the formation of explosive vapors. In the event adequate and reliable ventilation is not provided such drying spaces shall be considered a spraying area as herein defined. (See also Chapter 11.)

CHAPTER 6.

FLAMMABLE LIQUIDS — STORAGE AND HANDLING.

601. The storage of flammable liquids in connection with spraying operations shall conform to the requirements of the Flammable and Combustible Liquids Code (NFPA No. 30), where applicable.

602. The quantity of flammable liquids kept in the vicinity of spraying operations shall be the minimum required for operations and should ordinarily not exceed a supply for one day or one shift. Bulk storage of portable containers of flammable liquids shall be in a separate, properly constructed building detached from other important buildings or cut off in a standard manner.

603. Where spraying is only occasional and involves the use of many different colors or types of flammable liquids, not exceeding a total quantity of 50 gallons in original closed containers may be stored in a properly constructed metal cabinet located near spraying operations.

604. Original closed containers, approved portable tanks, approved safety cans or a properly arranged system of piping shall be used for bringing flammable liquids into spray finishing room. Open or glass containers shall not be used.

605. Except as provided in Section 608 the withdrawal of volatile flammable liquids from containers having a capacity of greater than 60 gallons shall be by approved pumps. For withdrawal from portable drums, hand pumps are recommended.

606. The withdrawal of volatile flammable liquids from containers and the filling of containers, including portable mixing tanks, shall be done only in a suitable mixing room or in a spraying area when the ventilating system is in operation. Adequate precautions shall be taken to protect against liquid spillage and sources of ignition.

607. Containers supplying spray nozzles shall be of closed type or provided with metal covers kept closed. Containers not resting on floors shall be on metal supports or suspended by wire cables. Containers supplying spray nozzles by gravity flow shall not exceed 10 gallons capacity.

608. Original shipping containers shall not be subjected to air pressure for supplying spray nozzles. Containers under air pressure supplying spray nozzles shall be of limited capacity, not exceeding that necessary for one day's operation; shall be designed and approved for such use; shall be provided with a visible pressure gauge; and shall be provided with a relief valve set to operate in conformance with the requirements of the ASME Code for Unfired Pressure Vessels.

609. Containers under air pressure supplying spray nozzles, air storage tanks and coolers shall conform to the standards of the A.S.M.E. Code for unfired pressure vessels for construction, tests and maintenance.

610. All containers or piping to which is attached a hose or flexible connection shall be provided with a shut-off valve at the connection. Such valves shall be kept shut when not in use.

611. If a spray liquid heater is used it should preferably be low-pressure steam or hot water type. If electric, it shall be approved and listed for the specific location in which it is used. (See Chapter 4) Heaters shall not be located in spray booths nor other locations subject to the accumulation of deposits or combustible residue. Agitators, if used, should preferably be driven by compressed air, water or low-pressure steam. If electric motor is used, see Chapter 4.

612. (a) Unless flammable liquid piping, hose and equipment have been designed to meet the requirements of high pressure processes (airless atomization) employing pressures in excess of 100 psig, existing circulating systems should not be used for this purpose.

(b) If flammable liquids are supplied to spray nozzles by positive displacement pumps, pump discharge line shall be provided with an approved relief valve discharging to pump suction or a safe detached location, or a device provided to stop the prime mover if the discharge pressure exceeds the safe operating pressure of the system.

613. (a) Whenever flammable liquids are transferred from one container to another, both containers shall be effectively bonded and grounded to prevent discharge sparks of static electricity.

(b) Piping systems conveying flammable liquids shall be of steel or other material having comparable properties of resistance to heat and physical damage; they should be so installed that a rupture of the system for any reason is unlikely. Piping systems shall be properly bonded and grounded.

CHAPTER 7.

PROTECTION.

701. Spray finishing operations should preferably be located in buildings protected throughout with an approved system of automatic sprinklers.

702. In sprinklered buildings, the automatic sprinkler system in rooms containing spray finishing operations shall conform to the NFPA Standard for the Installation of Sprinkler Systems (No. 13), provisions for Extra Hazard Occupancy, and in unsprinklered buildings where sprinklers are installed only to protect spraying areas, the installation shall conform to such standards insofar as they may be applicable. Sprinkler installations shall also conform to the provisions of this section.

703. Sprinklers in rooms containing spray finishing operations should be on a wet pipe system.

704. Unusual or out-of-the-ordinary spray operations may require open head deluge or a combination of open and closed head automatic sprinkler protection, subject to the approval of the authority having jurisdiction.

705. Water supply for sprinklers in rooms containing spray finishing operations should be sufficient to supply all sprinklers likely to open in one fire without depleting the available water for use in hose streams. Where sprinklers are installed to protect spraying areas only, water may be furnished from the domestic supply, subject to the approval of the authority having jurisdiction.

706. Each spray booth having a frontal area in excess of nine square feet should be protected with an automatic system of one or more sprinklers. Sprinkler heads shall be located to effect water distribution throughout entire booth.

707. Interior of ducts should be protected with sprinklers. Such sprinklers should be installed not more than 12 feet apart in horizontal ducts and shall be accessible through duct access doors.

708. Automatic sprinklers protecting each spray booth (together with its connecting exhaust) shall be under an accessibly located separate O. S. and Y. sub-control valve. Where sprinklers in ducts or stacks are subject to freezing, they may be open head and only under manual control, subject to the approval of the authority having jurisdiction.

709. Sprinklers protecting spraying areas shall be kept as free from deposits as practical by cleaning daily if necessary. (See also Chapter 8.)

710. An adequate supply of suitable portable fire extinguishers shall be installed near all spraying areas. (See NFPA Standard for Portable Fire Extinguishers, No. 10.)

CHAPTER 8.

OPERATIONS AND MAINTENANCE.

801. Spraying shall not be conducted outside of predetermined spraying areas and all provisions of this Standard applying to spraying areas should be strictly followed.

802. High pressure hose conveying flammable material in "airless" spray finishing operations should be frequently inspected and properly maintained. Hose and equipment should be so located that in the event of a leak or rupture, finishing material will not be discharged into any space having a source of ignition.

803. All spraying areas shall be kept as free from the accumulation of deposits of combustible residues as practical, with cleaning conducted daily if necessary.

804. Scrapers, spuds or other such tools used for cleaning purposes shall be of non-sparking material.

805. Residue scrapings and debris contaminated with residue shall be immediately removed from premises and properly disposed of.

806. Approved metal waste cans shall be provided wherever rags or waste are impregnated with finishing material and all such rags or waste deposited therein immediately after use. The contents of waste cans shall be properly disposed of at least once daily at the end of each shift.

807. Spray finishing employees' clothing shall not be left on the premises overnight unless kept in metal lockers.

808. (a) Solvents used for cleaning purposes should preferably be non-flammable as there are a number of such cleaning materials which are practical for this purpose.

(b) The use of flammable solvents for cleaning operations shall be restricted to those having flash points no less than kerosene except solvents with flash points not less than those normally used in spraying operations may be used for cleaning spray nozzles and auxiliary equipment, provided such cleaning is conducted inside spray booths and ventilating equipment is operating during cleaning.

809. Spray booths shall not be alternately used for different types of coating materials, where the combination of the materials may be conducive to spontaneous ignition, unless

all deposits of the first used material are removed from the booth and exhaust ducts prior to spraying with the second. Examples of dangerous combinations are:

(a) Deposits of lacquers containing nitrocellulose with finishes containing drying oils, such as varnishes, oil-based stains, air-drying enamels, and primers.

(b) Bleaching compounds based on hydrogen peroxide, hypochlorites, perchlorates, or other oxidizing compounds, with any organic finishing materials.

810. If there are excessive accumulations of residue in booths, ducts or duct discharge points or other spraying areas, then all spraying operations should be discontinued until conditions are corrected.

811. "No Smoking" signs in large letters on contrasting color background shall be conspicuously posted at all spraying areas and paint storage rooms.

812. Conspicuous signs should be posted at all spraying areas and paint storage rooms conveying the following warning:

NO WELDING—The use of welding or cutting equipment in, on, or around this spray booth and duct (or paint storage room) is dangerous because of fire and explosion. Welding and cutting shall be done only under the supervision of the foreman in charge.

CHAPTER 9

FIXED ELECTROSTATIC APPARATUS.

900. Where installation and use of electrostatic spraying equipment is judged by enforcing authorities to be permissible, such installation and use shall conform to all other chapters of this Standard, and shall also conform to the requirements of this chapter.

901. Electrostatic apparatus and devices used in connection with paint spraying operations shall be of approved types.

902. Transformers, power packs, control apparatus, and all other electrical portions of the equipment, with the exception of high voltage grids and electrostatic atomizing heads and their connections, shall be located outside of the Spraying Area as defined in Chapter 1, or shall otherwise conform to the requirements of Chapter 4 of this Standard.

903. Electrodes and electrostatic atomizing heads shall be rigidly supported in permanent locations and shall be effectively insulated from ground. Insulators shall be non-porous and non-combustible. Fine wire elements when used should be under tension at all times and should be of unkinked hardened steel or material of comparable strength.

904. High voltage leads to electrodes and electrostatic atomizing heads shall be effectively and permanently supported on suitable insulators, and shall be effectively guarded against accidental contact or grounding.

An automatic means shall be provided for grounding and discharging any accumulated residual charge on the electrode assembly or the secondary circuit of the high voltage transformer when the transformer primary is disconnected from the source of supply.

905. A space shall be maintained between goods being painted and electrodes or electrostatic atomizing heads or conductors of at least twice the sparking distance. A suitable sign stating the sparking distance shall be conspicuously posted near the assembly.

906. Goods being painted using this process are to be supported on conveyors. The conveyors shall be so arranged as to maintain safe distances between the goods and the electrodes or electrostatic atomizing heads at all times. Any irregularly

shaped or other goods subject to possible swinging or movement shall be rigidly supported to prevent such swinging or movement which would reduce the clearance to less than that specified in Section 905 above.

907. This process is not approved where goods being coated are manipulated by hand. When finishing materials are applied by electrostatic equipment which is manipulated by hand, see Chapter 10 for applicable requirements.

908. Electrostatic apparatus shall be equipped with automatic controls which will operate without time delay to disconnect the power supply to the high voltage transformer and to signal the operator under any of the following conditions:

(a) Stoppage of ventilating fans or failure of ventilating equipment from any cause.
(b) Stoppage of the conveyor carrying goods through the high voltage field.
(c) Occurrence of a ground or of an imminent ground at any point on the high voltage system.
(d) Reduction of clearance below that specified in Section 905.

909. Adequate booths, fencing, railings or guards shall be so placed about the equipment that they, either by their location or character or both, assure that a safe isolation of the process is maintained from plant storage or personnel. Such railings, fencing and guards shall be of conducting material, adequately grounded, and should be at least 5 ft. from processing equipment.

910. Signs designating the process zone as dangerous as regards fire and accident should be posted.

911. All insulators shall be kept clean and dry.

912. Where electrostatic atomization is used the spraying area shall be so ventilated as to insure safe conditions from a fire and health standpoint. (See NFPA Standard for Blower and Exhaust Systems, No. 91.)

913. All areas used for spraying, including interior of booth, shall be protected by automatic sprinklers where this protection is available. Where this protection is not available, other approved automatic extinguishing equipment shall be provided.

CHAPTER 10.

ELECTROSTATIC HAND SPRAYING EQUIPMENT.

1001. This Chapter shall apply to any equipment using electrostatically charged elements for the atomization and (or) precipitation of materials for coatings on articles, or for other similar purposes in which the atomizing device is hand held and manipulated during the spraying operation.

1002. Electrostatic hand spraying equipment shall conform with the other provisions of this Standard and shall also conform to the provisions of Chapter 10.

1003. Electrostatic hand spray apparatus and devices used in connection with paint spraying operations shall be of approved types. The equipment should be so designed that the maximum surface temperature of the equipment in the spraying area shall not exceed 150° F. under any condition. The high voltage circuits shall be designed so as to be intrinsically safe and not produce a spark of sufficient intensity to ignite any vapor-air mixtures nor result in appreciable shock hazard upon coming in contact with a grounded object. The electrostatically charged exposed elements of the hand gun shall be capable of being energized only by a switch which also controls the paint supply.

1004. Transformers, power packs, 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 of the spraying area or shall otherwise conform to the requirements of Chapter 4 of this Standard.

1005. The handle of the spraying gun shall be electrically connected to ground by a metallic connection and be so constructed that the operator in normal operating position is in intimate electrical contact with the grounded handle. This requirement is to prevent buildup of a static charge on the operator's body.

1006. All electrically conductive objects in the spraying area shall be adequately grounded. This requirement shall apply to paint containers, wash cans and any other objects or devices in the area. The equipment shall carry a prominent permanently installed warning regarding the necessity for this grounding feature.

1007. Objects being painted shall be maintained in metallic contact with the conveyor or other grounded support. Hooks shall be regularly cleaned to insure this contact and areas of contact shall be sharp points or knife edges where possible. Points of support of the object shall be concealed from random spray where feasible and where the objects being sprayed are supported from a conveyor, the point of attachment to the conveyor shall be so located as to not collect spray material during normal operation.

1008. The electrical equipment shall be so interlocked with the ventilation of spraying area that the equipment cannot be operated unless the ventilation fans are in operation.

1009. The spraying operation shall take place within a spray area which is adequately ventilated to remove solvent vapors released from the operation.

CHAPTER 11.

DRYING APPARATUS.

1101. Drying and baking apparatus in connection with spray application of flammable finishes shall conform to the NFPA Standard for Ovens and Furnaces (No. 86A) where applicable and shall also conform to the following.

1102. Spray booths, rooms or other enclosures used for spraying operations shall not alternately be used for the purpose of drying by any arrangement which will cause a material increase in the surface temperature of the spray booth, room or enclosure.

NOTE: The susceptibility to spontaneous heating and ignition of over-spray residue may be greatly increased at temperatures above normal. Hence the use of hot air drying in a space which has been used for spray finishing may create a severe hazard.

1103. Except as specifically provided in Section 1104, drying or baking units utilizing a heating system having open flames or which may produce sparks shall not be installed in a spraying area as defined in Chapter 1, but may be installed adjacent thereto when equipped with an interlocked ventilating system arranged to:

(a) Thoroughly ventilate the drying space before heating system can be started;

(b) Maintain a safe atmosphere at any source of ignition;

(c) Automatically shut down heating system in the event of failure of the ventilating system.

1104. Automobile refinishing spray booths or enclosures, otherwise installed and maintained in full conformity with this standard, may alternately be used for drying with portable electrical infra-red drying apparatus when conforming with the following:

(a) The procedure shall be restricted to low-volume, occasional spray application.

(b) Interior (especially floors) of spray enclosures shall be kept free of overspray deposits.

(c) During spray operations, the drying apparatus and electrical connections and wiring thereto shall not be located within spray enclosure nor in any other location where spray residue may be deposited thereon.

(d) Spraying apparatus, drying apparatus, and ventilating system of spray enclosure shall be equipped with suitable interlocks so arranged that:

(1) Spraying apparatus cannot be operated while drying apparatus is inside spray enclosure.

(2) Spray enclosure will be purged of spray vapors for a period of not less than 3 minutes before drying apparatus can be energized.

(3) Ventilating system will maintain a safe atmosphere within the enclosure during the drying process and drying apparatus will automatically shut off in the event of failure of the ventilating system.

(e) All electrical wiring and equipment of drying apparatus shall conform to the applicable sections of the National Electrical Code (NFPA No. 70). Only equipment of a type approved for Class I, Division 2 hazardous locations shall be located within 18 inches of floor level. All metallic parts of drying apparatus shall be properly electrically bonded and grounded.

(f) Drying apparatus shall contain a prominently located, permanently attached warning sign indicating that ventilation should be maintained during the drying period and spraying should not be so conducted in the vicinity that spray will deposit on apparatus.

CHAPTER 12.
AUTOMOBILE UNDERCOATING IN GARAGES.

1201. Automobile undercoating spray operations in garages, conducted in areas having adequate natural or mechanical ventilation, may be exempt from the requirements pertaining to spray finishing operations, when using undercoating materials not more hazardous than kerosene (as listed by Underwriters' Laboratories in respect to fire hazard rating 30-40) or undercoating materials using only solvents listed as having a flash point in excess of 100 degrees F. There should be no open flames or other sources of ignition within 20 feet while such operations are conducted.

1202. Undercoating spray operations not conforming to the provisions of Section 1201 are subject to all requirements of this standard pertaining to spray finishing operations.

APPENDIX.

A. 100. Scope. Combustible finishing materials contemplated by this standard do not ordinarily include water solutions nor water-emulsion liquids. Certain water-emulsion liquids, however, although involving little or no hazard in the liquid state, may leave highly combustible residues upon evaporation of the liquid carrier. The provisions of this standard for minimizing the hazards of combustible residues should be followed irrespective of the characteristics of the liquid carrier.

This standard does not cover the outdoor spraying of buildings, bridges, tanks or similar structures. With such occasional applications, over-spray deposits are not likely to create a hazardous condition and the space in which explosive vapor-air mixtures may be present is limited because of atmospheric dilution.

The occasional operation of small portable spraying apparatus for spraying building interiors and similar uses is such that hazardous accumulations of over-spray deposits are not likely to occur. Such operations are not within the scope of this standard.

When building or maintenance spraying are considered outside the scope of this standard by the authority having jurisdiction because of the infrequency of application, the following safeguards should be observed:

(a.) Adequate ventilation should be provided at all times when conducting indoor spraying operations, particularly in small enclosures.

(b.) Spraying should not be conducted in the vicinity of open flames or other sources of ignition.

(c.) Cans or other containers of paints, thinners or other protective coatings should be kept tightly closed at all times when they are not required to be open to replenish the supply of such material at the place of application.

(d.) Oily or paint laden rags or waste should be promptly disposed of at the end of each day's operations because of the danger of spontaneous ignition. The same fundamental requirements of cleanliness should be observed as are required in the spray application of coating materials in industrial processes.

A. 200. General. The safety of life and property from fire or explosion as a result of spray application of flammable paints and finishes may be severe or mild depending upon the arrangement and operation of a particular installation.

The principal hazards of spray operations originate from flammable liquids and their vapors and from highly combustible residues which may be deposited in the area of operations.

Properly constructed spray booths, provided with adequate mechanical ventilation, may be so utilized as to discharge vapors to a safe location and reduce to a minimum the possibility of a vapor explosion. In like manner, the accumulation of overspray residues, many of which are not only highly combustible but subject to spontaneous ignition, can be controlled.

The elimination of all sources of ignition in areas where either flammable liquids, vapors or combustible residues are present, together with constant intelligent supervision and maintenance, are essential to the safe operations of spraying.

The human element necessitates careful consideration of the location of the operations and the installation of extinguishing equipment so that if a fire does occur the possibility of its spread to other property will be reduced and the probability of damage to other property by extinguishing agents will be minimized.

In factories conducting extensive spray finishing, it is desirable that finishing processes be confined to a building detached or separated by fire walls from storage or other processing buildings, wherever practical.

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

A. 300. Spray Booths. Spray booths may be of a wide variety of shapes and sizes to accommodate the various industrial applications of spray finishing. Without the use of a spray booth, the "spraying area" as defined in Chapter 1, may be of considerable magnitude, with all of the requirements of this standard for a "spraying area" applicable thereto. Spray booth assemblies are no longer listed by the Underwriters' Laboratories, Inc., although many component devices and types of equipment used in connection with spray applications are listed for specific purposes. It is important that only equipment suitable for specific purposes be utilized in connection with the handling and spraying of flammable liquids.

A. 400. Electrical and Other Sources of Ignition. It is obvious that there should be a total absence of open flames or spark producing equipment in any area where, because of inadequate ventilation, explosive vapor-air mixtures are present. It is equally obvious that no open flames or spark producing equipment should be so located that there will be deposited on them highly combustible spray residues. Because some residues may be ignited at very low temperatures, additional consideration must be given to operating temperatures of equipment subject to residue deposits. Many deposits may be ignited at temperatures produced by incandescent light globes, even of the explosion-proof type, or low pressure steam pipes.

The area in the vicinity of spraying operations which may contain dangerous quantities of flammable vapors or residue deposits will necessarily vary with design and arrangement of equipment and methods of operation.

For the usual cabinet spray booth it has been generally considered that limited areas not separated by partitions and in the front of a booth may be dangerous. When, however, ventilation is inadequate and spraying is not strictly confined to the inside of the booth, the dangerous area may extend throughout the entire room.

On the other hand, when adequate, reliable, supervised ventilation is provided and spraying operations strictly confined to the predetermined designated spaces, the hazardous areas may not extend beyond the booth enclosure.

When areas of spraying known to contain hazardous quantities of vapor or residue under normal operation have been determined, the unpartitioned-off areas adjacent to hazardous areas which are safe under normal operating conditions but which may become dangerous due to accident or careless operation should be considered. In these adjacent areas, equipment

known to produce sparks or flames under normal operating conditions should not be installed.

Sufficient lighting for operations, booth cleaning, and repair should be provided at the time of equipment installation in order to avoid the unjustified use of "temporary" or "emergency" electric lamps connected to ordinary extension cords. A satisfactory and practical method of lighting is the use of ¼ inch thick wired or tempered glass panels in the top or sides of spray booths with electrical light fixtures outside the booth, hence not in the direct path of the spray.

Areas adjacent to a spray booth, particularly where paint stocks are located, should be provided with ventilation sufficiently adequate and reliable to prevent the presence of flammable vapors or deposits. It is nevertheless advisable that electric lamps be totally enclosed to prevent the falling of hot particles in any area where there may be freshly painted stock, accidentally spilled flammable liquids, or readily ignitible refuse or flammable liquid containers accidentally left open.

Where electric lamps are in areas subject to atmospheres of flammable vapor, the replacing of lamp globes should only be done when electricity is off, otherwise there may be a spark from this source.

The determination of the extent of hazardous areas involved in spray application requires an understanding of the dual hazards of flammable vapors and highly combustible deposits together with intelligent judgment of the objectives, applied to each individual installation.

A. 500. Ventilation. Adequate mechanical ventilation, together with the proper control of deposited residues and proper handling of flammable liquids, constitute major factors in the fire control of spraying hazards. In general, if sufficient ventilation is provided to prevent the formation of explosive atmospheres outside of the immediate space of spraying, residues from spraying operations will be directed to and confined to the spaces provided for their control.

Vapors. The possibility of explosions and fires from the vapors of flammable liquids should not be underestimated, nor should they be viewed with such concern as to assume they cannot be controlled by proper engineering.

Paints, varnishes, lacquers and other finishing materials may contain volatile flammable solvents and in addition such solvents may be added as "thinners." Such solvents when exposed

to the atmosphere give off vapors which mix with the surrounding air and if the concentration of these vapors reaches as much as approximately 1%, an explosion may occur, if at the same time a spark or other source of ignition is present.

Theoretical considerations may assist in hazard evaluation in some instances. For example, one gallon of the average flammable solvent will occupy approximately 23 cubic feet when evaporated into vapor at average room temperature. Therefore if one gallon of solvent is completely evaporated and thoroughly mixed with the surrounding air of an enclosure, the enclosure must be over 2,300 cubic feet to avoid an explosive mixture if the lower limit of the explosive range of the solvent is 1% in air. In attempting to utilize such theoretical considerations extreme caution should be exercised to prevent erroneous conclusions. For example, vapors from most flammable solvents are heavier than air and small quantities of vapor may form an explosive mixture at low unventilated spaces in the vicinity of or even remote from the point of evaporation before they so mix with air by natural diffusion that the mixture becomes too "lean" to explode. When flammable liquid is sprayed, the rate of evaporation is greatly increased so that the lower explosive limit is quickly reached.

Adequate mechanical ventilation throughout all areas where flammable vapors may be present is essential to prevent the formation of explosive mixtures. The volume of air movement necessary will obviously vary with the arrangement of spraying operations, the amount of spray material used in a given length of time and the rate of evaporation of the particular solvent. Where spraying is intermittently conducted entirely inside a conventional cabinet spray booth, an average air velocity of approximately 100 linear feet per minute across the open frontal booth area (fan capacity in c.f.m. divided by the frontal area in square feet) should ordinarily be sufficient for vapor removal. Where spraying operations are extensive, or where canopy or down draft spray booths are used, additional ventilation is generally necessary. When spray booths are provided with adequate ventilation, booths may be so located with respect to finishing room air intake that air in the entire finishing room moves toward spray booth exhausts and "dead air pockets" are eliminated, thus making unnecessary additional mechanical ventilation for the finishing room. With moderately uniform air movement throughout a finishing room, an air change of once every three to five minutes should be sufficient to prevent the formation of explosive vapors under ordinary conditions.

Where large objects such as railway cars are being sprayed, it is frequently necessary to provide multiple air inlets and exhausts in the proximity of all portions of the object, simultaneously producing a rather high air velocity at all points where spray may be applied. In many cases this has been accomplished by strategically locating overhead duct air inlets and exhausting air at the floor level.

Since the air exhausted from spray finishing rooms should not be recirculated, consideration should be given to the heating of incoming air in cold weather. Total heat lost by ventilation should be the same, irrespective of whether air intake is from other portions of the building or filters in through loose fitting doors and windows, or enters through openings designed for the purpose. An efficient and satisfactory method of heating rooms containing several spray booths is to strategically locate air intakes so as to provide a uniform sweep of air throughout the entire room towards exhaust fans and provide each air intake with steam heating coils.

In some heating arrangements, forced "makeup" or "replacement" air directly compensating for the contaminated air exhausted from spray finishing, is used in place of or to augment general area heating and ventilation.

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

The features which should be considered include (a) the location of heat sources to conform to Chapter 4; (b) the location of air intakes to prevent recirculating contaminated air and the equipping of air intakes with appropriate screens or filters; (c) automatic temperature and proportioning controls, including an independent excess temperature limit control; (d) an interlocking safety system to automatically provide for safe ignition and to minimize the hazards which might result from failure of proper cycle of operations, proper pressure of fuel supply, ventilation and electrical power; (e) an interlocking of the spray booth exhaust and air replacement system to insure that spray booth exhaust will be running during the operation of air replacement system in order to provide a proper balance of supply and replacement air; and (f) in the case of direct-fired units, the avoidance of concentrations of unburned fuel or products of combustion that would be injurious to personnel if inhaled.