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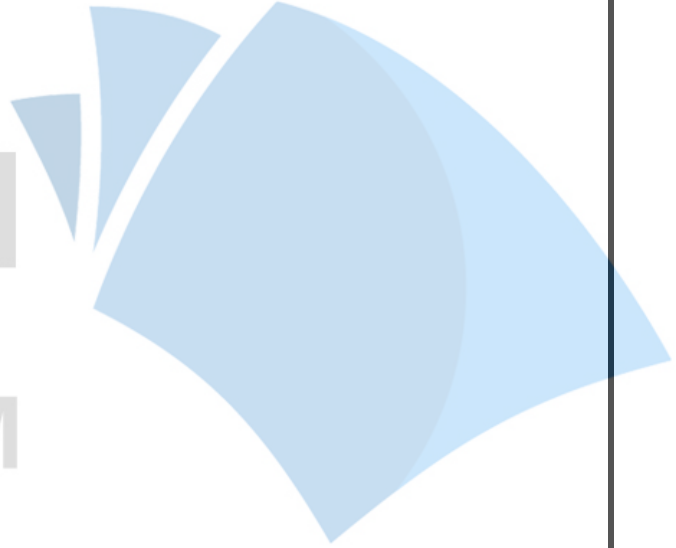
**Standard for
the Installation of
Lightning Protection
Systems**

2020



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NFPA® 780

Standard for the

Installation of Lightning Protection Systems

2020 Edition

This edition of NFPA 780, *Standard for the Installation of Lightning Protection Systems*, was prepared by the Technical Committee on Lightning Protection. It was issued by the Standards Council on April 28, 2019, with an effective date of May 18, 2019, and supersedes all previous editions.

This edition of NFPA 780 was approved as an American National Standard on May 18, 2019.

Origin and Development of NFPA 780

NFPA first adopted *Specifications for Protection of Buildings Against Lightning* in 1904. Revised standards were adopted in 1905, 1906, 1925, 1932, and 1937. In 1945, the NFPA Committee and the parallel American Standards Association (ASA) Committee on Protection Against Lightning were reorganized and combined under the sponsorship of NFPA, the National Bureau of Standards, and the American Institute of Electrical Engineers (now the IEEE). In 1946, NFPA acted to adopt Part III and in 1947 published a revised edition incorporating this part. Further revisions recommended by the Committee were adopted by NFPA in 1949, 1950, 1951, 1952, 1957, 1959, 1963, 1965, 1968, 1975, 1977, 1980, 1983, 1986, 1989, and 1992.

Commencing with the 1992 edition of the *Lightning Protection Code*, the NFPA numerical designation of the document was changed from NFPA 78 to NFPA 780.

With the issuance of the 1995 edition, the name of the document was changed from *Lightning Protection Code* to *Standard for the Installation of Lightning Protection Systems*. This change was directed by the Standards Council in order to make the title more accurately reflect the document's content. In addition, the council directed certain changes to the scope of the document to clarify that the document did not cover lightning protection installation requirements for early streamer emission systems or lightning dissipater array systems.

The 1997 edition of NFPA 780 incorporated editorial changes to make the document more user friendly.

In issuing this document, the Standards Council noted that lightning is a stochastic, if not capricious, natural process. Its behavior is not yet completely understood. This standard is intended to provide requirements, within the limits of the current state of knowledge, for the installation of those lightning protection systems covered by the standard.

The 2000 edition was amended to provide requirements for open structures such as those found on golf courses. A 1998 lightning flash density chart replaced the 1972 lightning frequency isokeraunic chart.

The 2004 edition reflected an extensive editorial revision of the standard to comply with the concurrent edition of the *Manual of Style for NFPA Technical Committee Documents*. Those revisions included the addition of three administrative chapters at the beginning of the standard: Administration, Referenced Publications, and Definitions. The International System of Units, commonly known as SI or metric, was used throughout the document. The appendixes were renamed annexes and reordered in a more logical sequence.

The 2004 edition also contained a number of technical revisions throughout the standard. Those revisions included the following: a main conductor, solid strip, was added for Class II material requirements for ordinary structures exceeding 75 ft in height; handrails could be used as a substitute for down conductors; additional separation between ground rods was required where multiple ground rods are used; additional guidance was provided for those instances where it is necessary to install the grounding conductor directly on bedrock; the section entitled Surge

Suppression was entirely rewritten; titanium strike termination devices were permitted to be used; and in Annex K, the term *Faraday cage* was replaced with *metallic cage*.

The 2008 edition provided requirements for surge protective devices to be installed at all power service entrances, at the entrance of conductive communications systems and antenna systems, and where an electrical or electronic system conductor leaves the structure.

The new definition for *lightning protection system* included the term *conductive structural members*. Clarification was provided relative to the use of ancillary metal parts that cannot be substituted for the main conductor. Strike termination devices included air terminals, metal masts, certain permanent metal parts of structures, and elevated conductors. Revisions clarified that metal masts and overhead ground wires were included in the requirements of Chapter 4.

Significant changes were made to the requirements for the use of bimetallic clamps and aluminum in proximity to earth. The standard has long required that grounding electrodes be located near the outside perimeter of the structure, and in the 2008 edition, additional guidance was provided to assist the system designer. Changes were also made to better address the requirements for grounding electrodes in shallow topsoil applications.

Other significant changes in the 2008 edition include revising the requirements for the use of multiple ground rods. Requirements were added to address proper installation of lightning protection equipment on large roof top mechanical units; the installation of air terminals and main-size conductors in these applications were quantified and detailed. Revisions were made to enhance and clarify the requirements for the bonding together of all grounded media and underground metallic piping; the intent was to provide for potential equalization and not to use the metallic piping as a lightning protection system grounding electrode. Guidance was provided on the use of isolating spark gaps.

Requirements were revised pertaining to the conductors and other lightning protection system hardware used near the top of a heavy-duty stack. The 2008 edition also included a complete rewrite of Chapter 8, Protection for Watercraft; more user information in Annex B, Principles of Lightning Protection; and a revision of Annex F, Protection for Trees.

The 2011 edition included new and revised text, in addition to significant technical changes. With the addition of two new chapters, the standard presented a major change in the scope of the document. The first new chapter addressed the protection of structures housing ammunition and explosive materials. The second new chapter included requirements for providing lightning protection for wind turbines, specifically wind turbine structures that comprise externally rotating blades, a nacelle, and a supporting tower. The standard was substantially reorganized to accommodate these new chapters in a logical order.

The sections pertaining to strike termination devices, zones of protection, and the rolling sphere method were reorganized for better usability. This clarified that strike termination devices include air terminals, metal masts, permanent metal parts of structures, and overhead ground wires. The text qualified where a metal mast would be permitted to serve as the down conductor. The requirements for overhead ground wires and masts and overhead ground wires were relocated.

The 2011 edition clarified the requirements for strike termination devices at the eaves for a pitched roof, and a figure was added to graphically illustrate that condition. A new section on roof top helipads provided requirements to ensure that an adequate level of protection is provided to those areas within the height and safety criteria set forth by the Federal Aviation Administration (FAA) or other AHJs.

Chapter 7 provided requirements for the protection of structures containing flammable vapors, flammable gases, or liquids that can give off flammable vapors. The section on floating roof tanks was revised in its entirety as a result of recent testing and research conducted for aboveground storage tanks.

The lightning risk assessment methodology provided in Annex L was completely rewritten. The lightning risk assessment was provided to assist the building owner, safety professional, or architect/engineer in determining the risk of damage or injury due to lightning. This annex provided both a simplified, quick-look assessment and a more detailed assessment for those requiring a more detailed analysis.

The 2014 edition provided reorganization of Sections 4.7 and 4.8 to better align the requirements for strike termination devices. Reorganization of these sections in a more logical order clarified the requirements and application of the standard. Section 4.8 was also revised to clarify the requirements for protection where small objects are located on roofs. Section 4.14 was revised and reorganized to include parts of Section 4.20, and explanatory text was provided to ensure clarity, alignment, and coordination with the bonding interconnections of *NFPA 70®*, *National Electrical Code®*. Sections 4.15 through 4.21 were totally restructured and revised to place similar bonding requirements together to improve the flow of the document for the user. Similar or repetitive requirements were combined or restructured to clarify the requirements.

A new subsection in the 2014 edition, 4.7.13, addressed the use on buildings of fixed metal objects that have movable or rotating metal components, for example, jib cranes, observatories/telescopes, opening roofs (typically over swimming pools), traffic cameras, and motorized photovoltaic arrays that tilt to track the sun as it moves across the sky.

Also, a new section, Section 1.4, Retroactivity, was added to address retroactivity for NFPA 780.

A new chapter, Chapter 11, was added to provide lightning protection criteria requirements and guidance for airfield lighting circuits, and to align with federal aviation requirements. Chapter 11 provided a thorough look at design and installation of lightning protection systems to afford protection to those open areas. Several figures were included that provided ample explanation and guidance to the user.

A new Chapter 12 addressed lightning protection systems for solar systems and arrays. Buildings provided with lightning protection systems might not be designed to address the new equipment. Buildings not provided with lightning protection systems might need to address the additional mechanical structure and equipment.

The requirements pertaining to catenary systems were reviewed, and significant annex material was provided to clarify computations for applications with metal or wood poles.

For the 2017 edition, new requirements were added relative to physical on-site inspection of the completed installation and for periodic inspections or testing for compliance to this standard per the AHJ. New definitions were added for the following terms: *ground loop conductor*, *integral lightning protection system*, *mast-type lightning protection system*, *rated impulse withstand voltage level (withstand voltage) (U_w)*, *smart structure*, *solar array*, and *solar panel*. Those definitions added clarity to the terms as used in the standard.

Several figures illustrating air terminal protection for lower roof protection were updated. New requirements were established for test and connection points for concrete-encased electrodes to enable periodic maintenance and testing of the ground system. Zero property line conditions were re-evaluated and revised. New bonding requirements were added for long horizontal metal bodies on roofs. The committee revised many requirements pertaining to ungrounded metal bodies, removing the term *isolated (ungrounded)* for consistency. Section 5.3, Facilities That Handle or Process Combustible or Explosive Dust, was updated. Chapter 7, Protection for Structures Containing Flammable Vapors, Flammable Gases, or Liquids That Can Give Off Flammable Vapors, was rewritten. Sections in Chapter 8, Protection of Structures Housing Explosive Materials, that pertain to single or multiple masts, railroad tracks, installation of air terminals on earth-covered magazines, wharves, and piers for explosives operations and cranes were revised. Chapter 12, Protection for Solar Arrays, was revised to provide more specific criteria.

Two new annexes, Annex J, Protection of Smart Structures, and Annex K, Guide to International Standards Dealing with the Selection of SPDs for Use on Photovoltaic (PV) Installations, were added to the 2017 edition. Annex L, Lightning Risk Assessment, was revised to provide greater clarity and correlation of requirements with other lightning protection standards.

For the 2020 edition, revisions in Section 4.9, Conductors, clarify general requirements for main conductors with emphasis on one-way paths, dead ends, and when upward conductor paths are permitted. Chapter 7 acknowledges lightning electromagnetic pulse (LEMP) as a source of ignition in classified locations. Revisions in Chapter 11, Protection for Airfield Lighting Circuits, clarify the application of the requirements for lightning protection at airfields. New Annex N, Considerations for Nonmetallic Tanks Containing Flammable Vapors or Liquids that Give Off Flammable Vapors, has been added to provide guidance on lightning protection of nonmetallic tanks containing combustible or flammable materials. Further study and public input regarding protection of these tanks is necessary before requirements can be added to the body of the standard.

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Committee Scope: This Committee shall have primary responsibility for documents on the protection from lightning of buildings and structures, recreation and sports areas, and any other situations involving danger from lightning to people or property, except those concepts utilizing early streamer emission air terminals. The protection of electric generating, transmission, and distribution systems is not within the scope of this Committee.

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NFPA 780

Standard for the

Installation of Lightning Protection Systems

2020 Edition

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

Chapter 1 Administration

1.1 Scope.

1.1.1 This document shall cover traditional lightning protection system installation requirements for the following:

- (1) Ordinary structures
- (2) Miscellaneous structures and special occupancies
- (3) Heavy-duty stacks
- (4) Structures containing flammable vapors, flammable gases, or liquids that can give off flammable vapors
- (5) Structures housing explosive materials
- (6) Wind turbines
- (7) Watercraft
- (8) Airfield lighting circuits
- (9) Solar arrays

1.1.2* This document shall address lightning protection of the structure but not the equipment or installation requirements for electric generating, transmission, and distribution systems except as given in Chapter 9 and Chapter 12.

1.1.3 This document shall not cover lightning protection system installation requirements for early streamer emission systems or charge dissipation systems.

1.2* Purpose. The purpose of this standard shall be to provide for the safeguarding of persons and property from hazards arising from exposure to lightning.

Δ 1.3 Listed, Labeled, or Approved Components.

N 1.3.1 Where fittings, devices, lightning conductors, air terminals, or other components required by this standard are available as listed or labeled, such components shall be used.

N 1.3.2 Listed or labeled equipment shall be installed and used in accordance with any limitations and instructions included in the listing or labeling.

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 in this standard, 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 Mechanical Execution of Work.

1.5.1 Lightning protection systems shall be installed in a neat and workmanlike manner.

1.5.2* The individual(s) responsible for the installation shall be certified for fitness on the requirements of this standard by the authority having jurisdiction.

1.5.3 Where required by the authority having jurisdiction, compliance of the completed installation with the requirements of this standard shall be certified through a physical on-site inspection by a qualified and impartial organization acceptable to the authority having jurisdiction.

1.6* Maintenance. Recommended guidelines for the maintenance of the lightning protection system shall be provided to the owner at the completion of installation.

1.7 Periodic Inspection. Periodic inspections or testing for compliance to this standard shall be done at intervals determined by the authority having jurisdiction.

1.8 Units of Measurement.

N 1.8.1 The values stated shall be a minimum requirement, and standard deviations are not permitted.

1.8.2 Measurements shall be presented in inch-pound units followed by the equivalent value presented in SI units in parentheses.

1.8.3 A given equivalent value shall be approximate.

Chapter 2 Referenced Publications

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

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

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2017 edition.

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

NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities*, 2015 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2017 edition.

2.3 Other Publications.

2.3.1 IEC Publications. International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC 62305-2, *Protection Against Lightning—Part 2: Risk Management, Edition 2*, 2010.

2.3.2 ISO Publications. International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

ISO 1496, *Series 1 freight containers — Specification and testing — Part 1: General cargo containers for general purposes*, 2013.

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

ANSI/UL 1449, *Standard for Safety for Surge Protective Devices*, 2014, revised 2016.

2.3.4 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 70®, *National Electrical Code*®, 2017 edition.

NFPA 115, *Standard for Laser Fire Protection*, 2016 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 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

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

3.3 General Definitions.

3.3.1* Air Terminal. A strike termination device that is a receptor for attachment of flashes to the lightning protection system and is listed for the purpose.

3.3.2* Bonded, Inherently. Bonding between metal bodies, building framework, and lightning protection system components that are joined through construction.

3.3.3 Bonding. An electrical connection between an electrically conductive object and a component of a lightning protection system that is intended to significantly reduce potential differences created by lightning currents.

3.3.4* Cable. A conductor formed of a number of wires stranded together.

3.3.5 Catenary Lightning Protection System. A lightning protection system consisting of one or more overhead ground wires.

3.3.6 Chimney. A construction containing one or more flues that does not meet the criteria defined for heavy-duty stack.