# NFPA® 780

# Standard for the Installation of Lightning Protection Systems

# 2023 Edition



NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471 An International Codes and Standards Organization

# IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® STANDARDS

NFPA<sup>®</sup> codes, standards, recommended practices, and guides ("NFPA Standards"), of which the document contained herein is one, are developed through a consensus standards development process approved by the American National Standards Institute. This process brings together volunteers representing varied viewpoints and interests to achieve consensus on fire and other safety issues. While the NFPA administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in NFPA Standards.

The NFPA disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on NFPA Standards. The NFPA also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making NFPA Standards available, the NFPA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is the NFPA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

The NFPA has no power, nor does it undertake, to police or enforce compliance with the contents of NFPA Standards. Nor does the NFPA list, certify, test, or inspect products, designs, or installations for compliance with this document. Any certification or other statement of compliance with the requirements of this document shall not be attributable to the NFPA and is solely the responsibility of the certifier or maker of the statement.

# **REVISION SYMBOLS IDENTIFYING CHANGES FROM THE PREVIOUS EDITION**

Text revisions are shaded. A  $\Delta$  before a section number indicates that words within that section were deleted and a  $\Delta$  to the left of a table or figure number indicates a revision to an existing table or figure. When a chapter was heavily revised, the entire chapter is marked throughout with the  $\Delta$ 

symbol. Where one or more sections were deleted, a  $\bullet$  is placed between the remaining sections. Chapters, annexes, sections, figures, and tables that are new are indicated with an N.

Note that these indicators are a guide. Rearrangement of sections may not be captured in the markup, but users can view complete revision details in the First and Second Draft Reports located in the archived revision information section of each code at www.nfpa.org/docinfo. Any subsequent changes from the NFPA Technical Meeting, Tentative Interim Amendments, and Errata are also located there.

# **REMINDER: UPDATING OF NFPA STANDARDS**

Users of NFPA codes, standards, recommended practices, and guides ("NFPA Standards") should be aware that these documents may be superseded at any time by the issuance of a new edition, may be amended with the issuance of Tentative Interim Amendments (TIAs), or be corrected by Errata. It is intended that through regular revisions and amendments, participants in the NFPA standards development process consider the then-current and available information on incidents, materials, technologies, innovations, and methods as these develop over time and that NFPA Standards reflect this consideration. Therefore, any previous edition of this document no longer represents the current NFPA Standard on the subject matter addressed. NFPA encourages the use of the most current edition of any NFPA Standard [as it may be amended by TIA(s) or Errata] to take advantage of current experience and understanding. An official NFPA Standard at any point in time consists of the current edition of the document, including any issued TIAs and Errata then in effect.

To determine whether an NFPA Standard has been amended through the issuance of TIAs or corrected by Errata, visit the "Codes & Standards" section at www.nfpa.org.

ISBN: 978-145592924-5 (Print)

# ADDITIONAL IMPORTANT NOTICES AND DISCLAIMERS CONCERNING NFPA® STANDARDS

#### **Updating of NFPA Standards**

Users of NFPA codes, standards, recommended practices, and guides ("NFPA Standards") should be aware that these documents may be superseded at any time by the issuance of a new edition, may be amended with the issuance of Tentative Interim Amendments (TIAs), or be corrected by Errata. It is intended that through regular revisions and amendments, participants in the NFPA standards development process consider the then-current and available information on incidents, materials, technologies, innovations, and methods as these develop over time and that NFPA Standards reflect this consideration. Therefore, any previous edition of this document no longer represents the current NFPA Standard on the subject matter addressed. NFPA encourages the use of the most current edition of any NFPA Standard [as it may be amended by TIA(s) or Errata] to take advantage of current experience and understanding. An official NFPA Standard at any point in time consists of the current edition of the document, including any issued TIAs and Errata then in effect.

To determine whether an NFPA Standard has been amended through the issuance of TIAs or corrected by Errata, visit the "Codes & Standards" section at www.nfpa.org.

### **Interpretations of NFPA Standards**

A statement, written or oral, that is not processed in accordance with Section 6 of the Regulations Governing the Development of NFPA Standards shall not be considered the official position of NFPA or any of its Committees and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

### Patents

The NFPA does not take any position with respect to the validity of any patent rights referenced in, related to, or asserted in connection with an NFPA Standard. The users of NFPA Standards bear the sole responsibility for determining the validity of any such patent rights, as well as the risk of infringement of such rights, and the NFPA disclaims liability for the infringement of any patent resulting from the use of or reliance on NFPA Standards.

NFPA adheres to the policy of the American National Standards Institute (ANSI) regarding the inclusion of patents in American National Standards ("the ANSI Patent Policy"), and hereby gives the following notice pursuant to that policy:

NOTICE: The user's attention is called to the possibility that compliance with an NFPA Standard may require use of an invention covered by patent rights. NFPA takes no position as to the validity of any such patent rights or as to whether such patent rights constitute or include essential patent claims under the ANSI Patent Policy. If, in connection with the ANSI Patent Policy, a patent holder has filed a statement of willingness to grant licenses under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license, copies of such filed statements can be obtained, on request, from NFPA. For further information, contact the NFPA at the address listed below.

# Law and Regulations

Users of NFPA Standards should consult applicable federal, state, and local laws and regulations. NFPA does not, by the publication of its codes, standards, recommended practices, and guides, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

# Copyrights

NFPA Standards are copyrighted. They are made available for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of safe practices and methods. By making these documents available for use and adoption by public authorities and private users, the NFPA does not waive any rights in copyright to these documents.

Use of NFPA Standards for regulatory purposes should be accomplished through adoption by reference. The term "adoption by reference" means the citing of title, edition, and publishing information only. Any deletions, additions, and changes desired by the adopting authority should be noted separately in the adopting instrument. In order to assist NFPA in following the uses made of its documents, adopting authorities are requested to notify the NFPA (Attention: Secretary, Standards Council) in writing of such use. For technical assistance and questions concerning adoption of NFPA Standards, contact NFPA at the address below.

# **For Further Information**

All questions or other communications relating to NFPA Standards and all requests for information on NFPA procedures governing its codes and standards development process, including information on the procedures for requesting Formal Interpretations, for proposing Tentative Interim Amendments, and for proposing revisions to NFPA standards during regular revision cycles, should be sent to NFPA headquarters, addressed to the attention of the Secretary, Standards Council, NFPA, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101; email: stds\_admin@nfpa.org.

For more information about NFPA, visit the NFPA website at www.nfpa.org. All NFPA codes and standards can be viewed at no cost at www.nfpa.org/docinfo.

Copyright © 2022 National Fire Protection Association<sup>®</sup>. All Rights Reserved.

# **NFPA<sup>®</sup> 780**

#### Standard for the

# Installation of Lightning Protection Systems

#### 2023 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 March 20, 2022, with an effective date of April 9, 2022, and supersedes all previous editions.

This edition of NFPA 780 was approved as an American National Standard on April 9, 2022.

#### **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 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 Manual of Style for NFPA Technical Committee Documents.

Technical revisions throughout the standard included: a solid strip, main conductor was added for Class II material requirements; handrails could be used as a substitute for down conductors; additional separation was required between multiple ground rods; additional guidance was provided when installing a grounding conductor directly on bedrock; surge suppression requirements were rewritten; and titanium strike termination devices were permitted.

The 2008 edition included requirements for surge protective devices.

The definition for *lightning protection system* was revised to include *conductive structural members*. Clarification was provided to prohibit the use of ancillary metal parts as a substitute for the main conductor.

NFPA and National Fire Protection Association are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts 02169.

Significant changes were made to the requirements for the use of bimetallic clamps and aluminum in proximity to earth. Changes were made to better address grounding electrodes in shallow topsoil applications.

The requirements for the use of multiple ground rods were revised. Requirements were added to address proper installation of lightning protection equipment on large roof-top mechanical units. Revisions enhanced and clarified the requirements for bonding all grounded media and underground metallic piping. Guidance was provided on the use of isolating spark gaps.

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

The 2011 edition included the addition of two new chapters and 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. 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. 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.

The Chapter 7 section on floating roof tanks was revised 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. This annex provided both a simplified, quick-look assessment and a more detailed assessment for those requiring a more detailed analysis.

The 2014 edition reorganized Sections 4.7 and 4.8 to better align and clarify the requirements for strike termination devices. Section 4.8 was 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*<sup>®</sup>, *National Electrical Code*<sup>®</sup>. Sections 4.15 through 4.21 were

restructured and revised to place similar bonding requirements together to improve the flow of the document.

New subsection 4.7.13 addressed the use on buildings of fixed metal objects that have movable or rotating metal components.

Chapter 11 was added to provide lightning protection requirements and guidance for airfield lighting circuits, and to align with federal aviation requirements. 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.

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, requirements were added relative to physical on-site inspection of the completed installation and for periodic inspections or testing for compliance. New definitions included: 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.

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. Bonding requirements were added for long horizontal metal bodies on roofs. Many requirements pertaining to ungrounded metal bodies were revised and the term *isolated (ungrounded)* was deleted for consistency. Chapter 7 was rewritten. Sections in Chapter 8 pertaining 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 was revised to provide more specific criteria.

Annex J and Annex K were added to the 2017 edition. Annex L was revised to provide greater clarity and correlation of requirements with other lightning protection standards.

For the 2020 edition, revisions in Section 4.9 clarified general requirements for main conductors with emphasis on one-way paths, dead ends, and when upward conductor paths are permitted. Chapter 7 acknowledged lightning electromagnetic pulse (LEMP) as a source of ignition in classified locations. Revisions in Chapter 11 clarified the application of the requirements for lightning protection at airfields. A new Annex N provided guidance on lightning protection of nonmetallic tanks containing

combustible or flammable materials. Further study and public input regarding protection of these tanks was deemed necessary before requirements can be added to the body of the standard.

The 2023 edition has added requirements for lightning protection for additions to a protected structure. The definitions for *surge protective device, surge arrestor*, and *surge protector* have been revised, and the use of the proper terms corrected throughout the standard. Prescriptive and performance criteria have been added for each surge protective device. Definitions for various connectors have been added to clarify the proper application of NFPA 780 connector requirements. Requirements for protecting tank batteries have also been added.

2023 Edition

#### **Technical Committee on Lightning Protection**

Christine T. Porter, Chair Intertek Testing Services, WA [RT] Rep. Intertek Testing Services

Daniel Ashton, Lumen Technologies, Inc. / Centurylink, TX [U] Samuel Barrack, Consolidated Nuclear Security, LLC, TN [U] Christopher Batchelor, US Department of the Navy, MD [E] Matthew Caie, nVent/Pentair/ERICO, Inc., OH [M] Joanie A. Campbell, US Department of the Air Force, FL [E] Josephine Covino, US Department of Defense, VA [E] Kenneth Lee Friend, Jasper Thompson Lightning Protection, Inc., FL [IM] David A. Gerstetter, UL LLC, IL [RT] Chuck Graves, US Federal Aviation Administration, OK [E] Mitchell Guthrie, Engineering Consultant, NC [SE] Mark S. Harger, Harger Lightning & Grounding, IL [M] Timothy R. Harger, Lightning Protection Institute, IL [IM] Rep. Lightning Protection Institute William E. Heary, Heary Brothers Lightning Protection, NY [IM] Joshua Hoffman, Institute of Makers of Explosives (IME), DC [U] Bryan P. Holland, National Electrical Manufacturers Association (NEMA), FL [M] Rep. National Electrical Manufacturers Association

Stephen Humeniuk, Warren Lightning Rod Company, NJ [IM] Rep. United Lightning Protection Association, Inc. Carl S. Johnson, II, AVCON, Inc., FL [U] Bruce A. Kaiser, Lightning Master Corporation, FL [M] Simon C. Larter, Dobbyn Lightning Protection, Canada [IM] David E. McAfee, Lightning & Fire Protection Consultant, MI [SE] Robley B. Melton, Jr., CSI Telecommunications, GA [U] Rep. Alliance for Telecommunications Industry Solutions Mark P. Morgan, East Coast Lightning Equipment, Inc., CT [M] Luke Pettross, Lightning Eliminators & Consultants Inc., CO [M] Robert W. Rapp, National Lightning Protection Corporation, CO [M]Lon D. Santis, Explosives Risk Managers, LLC, MD [SE] Ewen Thomson, Marine Lightning Protection Inc., FL [SE] John M. Tobias, US Department of the Army, MD [U]

#### Alternates

# Luis M. Bas, Intertek Testing Services, FL [RT] (Alt. to Christine T. Porter)

Eric S. Boettcher, UL LLC, FL [RT]

(Alt. to David A. Gerstetter)

- Jennifer Morgan, East Coast Lightning Equipment, CT [M] (Alt. to Mark P. Morgan)
- George Portfleet, Michigan Lightning Protection, MI [IM] (Alt. to Stephen Humeniuk)

Ernest J. Gallo, Telcordia Technologies (Ericsson), NJ [U] (Alt. to Robley B. Melton, Jr.)

Kenneth P. Heary, Heary Brothers Lightning Protection, NY [IM] (Alt. to William E. Heary)

Morris Kline, Lightning Master Corporation, FL [M] (Alt. to Bruce A. Kaiser)

Joseph A. Lanzoni, Lightning Eliminators & Consultants Inc., CO  $|\mathbf{M}|$ 

(Alt. to Luke Pettross)

Andrew S. McElroy, Harger Lightning & Grounding, IL [M] (Alt. to Mark S. Harger)

Christopher Coache, NFPA Staff Liaison

Andrew Ritosa, nVent/Pentair/ERICO, Inc., OH [M] (Alt. to Matthew Caie)

Allan P. Steffes, Thompson Lightning Protection Inc., MN [M] (Voting Alt.)

Paul R. Svendsen, National Lightning Protection Corporation, CO [M]

(Alt. to Robert W. Rapp)

Leah Tietjen, Los Alamos National Laboratory, NM [U] (Voting Alt.)

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

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.

# Contents

Chapter	1 Administration	<b>780</b> – 7
1.1	Scope	<b>780</b> – 7
1.2	Purpose	<b>780</b> – 7
1.3	Listed, Labeled, or Approved Components	<b>780</b> – 7
1.4	Retroactivity.	<b>780</b> – 7
1.5	Mechanical Execution of Work	<b>780</b> – 7
1.6	Maintenance	<b>780</b> – 7
1.7	Periodic Inspection.	<b>780</b> – 7
1.8	Units of Measurement	<b>780</b> – 7
Chaptor	9 Deferenced Publications	790 9
9 1	Ceneral	780-8
2.1 9.9	NFPA Publications	780-8
2.2	Other Publications	780-8
2.4	References for Extracts in Mandatory Sections.	<b>780</b> – 8
Chapter	3 Definitions	<b>780</b> – 8
3.1	General	<b>780–</b> 8
3.2	NFPA Official Definitions.	<b>780–</b> 8
3.3	General Definitions	<b>780</b> – 8
Chanton	4 Concerel Be quinemente	780 10
Chapter	4 General Requirements	780-10 780-10
4.1	General.	780-10
4.4	Corrosion Protection	780 19
4.5	Mechanical Damage or Displacement	780-12 780-19
4.5	Strike Termination Devices	<b>780</b> –12 <b>780</b> –19
4.6	Strike Termination Devices on Roofs	<b>780</b> –13
4.7	Zones of Protection.	<b>780–</b> 18
4.8	Conductors.	<b>780</b> – 20
4.9	Conductor Fasteners.	<b>780</b> – 22
4.10	Masonry Anchors	<b>780</b> – 22
4.11	Connectors.	<b>780–</b> 22
4.12	Grounding Electrodes	<b>780–</b> 22
4.13	Common Bonding of Grounded Systems	<b>780–</b> 24
4.14	Potential Equalization.	<b>780–</b> 25
4.15	Bonding of Metal Bodies	<b>780–</b> 25
4.16	Metal Antenna Masts and Supports	<b>780–</b> 26
4.17	Concealed Systems.	<b>780–</b> 26
4.18	Structural Metallic Systems.	<b>780</b> – 27
4.19	Surge Protection.	<b>780–</b> 27
Chanter	5 Protection for Miscellaneous Structures	
Chapter	and Special Occupancies	<b>780</b> - 29
5.1	General.	<b>780</b> – 29
5.2	Masts, Spires, Flagpoles.	<b>780</b> – 29
5.3	Facilities That Handle or Process Combustible	
	or Explosive Dust	<b>780–</b> 29
5.4	Metal Towers and Tanks	<b>780–</b> 29
5.5	Air-Inflated Structures	<b>780–</b> 29
5.6	Concrete Tanks and Silos	<b>780–</b> 29
5.7	Guyed Structures	<b>780–</b> 30
5.8	Rooftop Helipads	<b>780–</b> 30
5.9	Fabric Structures	<b>780–</b> 30
Chanter	6 Protection for Heavy-Duty Stacks	<b>780</b> - 80
6.1	General	780- 30 780- 30
6.2	Materials	780- 30
6.3	Strike Termination Devices	<b>780</b> – 30
6.4	Conductors.	<b>780–</b> 31
6.5	Fasteners	<b>780–</b> 31
6.6	Splices	<b>780–</b> 31
6.7	Reinforced Concrete Stacks	<b>780–</b> 32
6.8	Bonding of Metal Bodies	<b>780–</b> 32
6.9	Grounding	<b>780–</b> 32
6.10	Metal Stacks.	<b>780–</b> 32

6.11	Metal Guy Wires and Cables	<b>780–</b> 32
Chapte	r 7 Protection for Structures Containing Flammable Vapors, Flammable Gases, or Liquids That Can Give Off Flammable	
	Vapors	<b>780–</b> 32
7.1	Applicability	<b>780–</b> 32
7.2	Principles of Protection	<b>780–</b> 32
7.3	Protective Measures.	<b>780–</b> 33
7.4	Operating Facilities (Non-Storage	
	Applications).	<b>780–</b> 33
7.5	Storage Tanks Under Pressure	<b>780–</b> 33
7.6	Aboveground Tanks at Atmospheric Pressure	<b>780–</b> 33
7.7	Earthen Containers at Atmospheric Pressure	
	Containing Flammable Vapors or Liquids That	
	Give Off Flammable Vapors	<b>780–</b> 34
7.8	Tank Batteries	<b>780–</b> 34
Chapte	r 8 Protection of Structures Housing	
- P	Explosive Materials	<b>780</b> – 35
8.1	Application.	<b>780</b> - 35
8.2	General.	<b>780</b> - 35
8.3	Types of Lightning Protection.	<b>780</b> - 35
8.4	Grounding.	<b>780</b> - 35
8.5	Bonding.	<b>780</b> - 36
8.6	Surge Protection.	<b>780</b> - 36
8.7	Protection for Specific Facilities.	<b>780</b> - 37
8.8	Metallic Fences.	<b>780</b> - 38
8.9	Maintenance and Inspection Plan.	<b>780</b> - 38
8.10	Inspection, Testing, and Maintenance	<b>780–</b> 38
Chante	r 9 Protection for Wind Turbines	780_ 39
9.1	General	780- 39
9.2	Fundamental Principles of Protection	<b>780</b> - 39
9.3	Protection of Electrical and Mechanical	100 00
0.0	Control Systems	<b>780</b> - 39
9.4	Grounding.	<b>780</b> – 39
Cl		700 90
Chapte	r 10 Protection for Watercraft	780-39
10.1	General.	780-39
10.2	Materials.	780-39
10.5	Strike Termination.	780-40
10.4	Conductors.	780-40
10.5	Grounding	780-42
Chapte	r 11 Protection for Airfield Lighting Circuits	<b>780–</b> 43
11.1	General	<b>780–</b> 43
11.2	Application	<b>780–</b> 43
11.3	Purpose	<b>780–</b> 43
11.4	Airfield Lighting Counterpoise System	<b>780–</b> 43
Chapte	r 12 Protection for Solar Arrays	<b>780–</b> 46
12.1	General.	<b>780–</b> 46
12.2	Fundamental Principles of Protection.	<b>780–</b> 46
12.3	Strike Termination Devices.	<b>780–</b> 46
12.4	Protection of Electrical and Mechanical	
	Systems.	<b>780–</b> 47
12.5	Grounding	<b>780–</b> 48
Annex	A Explanatory Material	<b>780–</b> 48
Annex	B Principles of Lightning Protection	<b>780</b> – 70
Annex	C Explanation of Bonding Principles	<b>780</b> – 73
		100-10
Annex	D Inspection and Maintenance of Lightning Protection Systems	<b>780</b> – 75

# 2023 Edition

Annex E	Ground Measurement Techniques	<b>780</b> – 76
Annex F	Protection for Trees	<b>780</b> – 77
Annex G	Protection for Picnic Grounds, Playgrounds, Ball Parks, and Other Open Places	<b>780</b> – 78
Annex H	Protection for Livestock in Fields	<b>780–</b> 79
Annex I	Protection for Parked Aircraft	<b>780–</b> 79
Annex J	Protection of Smart Structures	<b>780–</b> 80
Annex K	Guide to International Standards Dealing with the Selection of SPDs for Use on Photovoltaic (PV) Installations	<b>780</b> – 85

Annex L	Lightning Risk Assessment	<b>780–</b> 86
Annex M	Guide for Personal Safety from Lightning	<b>780–</b> 101
Annex N	Considerations for Nonmetallic Tanks Containing Flammable Vapors or Liquids that Give Off Flammable Vapors	<b>780</b> – 102
Annex O	Informational References	<b>780–</b> 103
Index		<b>780–</b> 106

2023 Edition

# NFPA 780

#### Standard for the

# **Installation of Lightning Protection Systems**

#### 2023 Edition

IMPORTANT NOTE: This NFPA document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading "Important Notices and Disclaimers Concerning NFPA Standards." They can also be viewed at www.nfpa.org/disclaimers or obtained on request from NFPA.

UPDATES, ALERTS, AND FUTURE EDITIONS: New editions of NFPA codes, standards, recommended practices, and guides (i.e., NFPA Standards) are released on scheduled revision cycles. This edition may be superseded by a later one, or it may be amended outside of its scheduled revision cycle through the issuance of Tentative Interim Amendments (TIAs). An official NFPA Standard at any point in time consists of the current edition of the document, together with all TIAs and Errata in effect. To verify that this document is the current edition or to determine if it has been amended by TIAs or Errata, please consult the National Fire Codes® Subscription Service or the "List of NFPA Codes & Standards" at www.nfpa.org/docinfo. In addition to TIAs and Errata, the document information pages also include the option to sign up for alerts for individual documents and to be involved in the development of the next edition.

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. **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.

#### 1.3 Listed, Labeled, or Approved Components.

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

**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.

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.

**1.4.3** 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 onsite 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.

# $\Delta$ 1.8 Units of Measurement.

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

Shaded text = Revisions.  $\Delta$  = Text deletions and figure/table revisions. • = Section deletions. N = New material.

2023 Edition

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, 2020 edition.

NFPA 70<sup>®</sup>, National Electrical Code<sup>®</sup>, 2023 edition.

NFPA 122, Standard for Fire Prevention and Control in Metal/ Nonmetal Mining and Metal Mineral Processing Facilities, 2020 edition.

NFPA 664, Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities, 2020 edition.

### 2.3 Other Publications.

#### 2.3.1 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<sup>®</sup>, National Electrical Code<sup>®</sup>, 2023 edition. NFPA 115, Standard for Laser Fire Protection, 2020 edition. 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.

 $\Delta$  3.3.1\* Air Terminal. A manufactured strike termination device intended to provide an intentional attachment point for flashes to the lightning protection system.

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

# **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.

# $\Delta$ 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 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.

3.3.7\* Combination Waveform Generator. A surge generator with a 2-ohm internal impedance producing a 1.2/50 µs open circuit voltage and an 8/20 µs short-circuit current waveshape.

# 3.3.8 Conductor.

3.3.8.1 Bonding Conductor: A conductor used for potential equalization between grounded metal bodies or electrically conductive objects and a lightning protection system.

3.3.8.2 Counterpoise Conductor. A bare underground electrical conductor providing an area of protection from the effects of lightning for underground raceway(s) or cable(s).

3.3.8.3 Down Conductor. A main conductor used to connect roof conductors to grounding electrodes.

3.3.8.4\* Ground Loop Conductor: A main-size loop conductor installed within 12 ft (3.6 m) vertically of the base of the structure to provide a common ground potential.

2023 Edition

Shaded text = Revisions.  $\Delta$  = Text deletions and figure/table revisions. • = Section deletions. N = New material.