First Revision No. 55-NFPA 780-2023 [Global Input]

Remove "Standard for" and "Safety for" from all UL, CAN/ULC standard titles throughout the standard .

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 12:42:20 EDT 2023

Committee Statement

Committee Statement: Change is part of broader UL program to update referenced documents.

Response Message: FR-55-NFPA 780-2023

Public Input No. 135-NFPA 780-2023 [Global Input]

First Revision No. 88-NFPA 780-2023 [Global Input]

Throughout standard change "electromagnetic impulse" to "electromagnetic pulse"

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Dec 08 12:30:15 EST 2023

Committee Statement

Committee Statement: This corrects an error in the term for EMP.

Response Message: FR-88-NFPA 780-2023

First Revision No. 39-NFPA 780-2023 [Detail]

Move 10.3.3.3 as new 10.3.1.4.

~~10.3.3.3~~10.3.1.4

Multiple air terminals shall be permitted to give the required zone of protection comprising overlapping zones of protection ~~as described in 10.3.3.2~~.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 16:00:20 EDT 2023

Committee Statement

Committee Statement: 10.3.1.4 allows the zone of protection to include any person standing upright on a deck.

Response Message: FR-39-NFPA 780-2023

First Revision No. 59-NFPA 780-2023 [Detail]

Delete annex to 11.4.2.6

A.11.4.2.6
The two methods are not listed in preferred order.

Submitter Information Verification

Committee: LIG-AAA
Submittal Date: Fri Oct 27 13:00:24 EDT 2023

Committee Statement

Committee Statement: By removing the annex, this now correlates with other sections in the document and is understood that a list in the document is not in preferential order.

Response Message: FR-59-NFPA 780-2023

Public Input No. 78-NFPA 780-2023 [Section No. A.11.4.2.6]

First Revision No. 46-NFPA 780-2023 [Section No. 1.6]

1.6* Maintenance.

~~Recommended guidelines~~ Guidelines for the maintenance of the lightning protection system shall be provided to the owner at the completion of installation.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 11:00:34 EDT 2023

Committee Statement

Committee Statement: The revision clarifies the section.

Response Message: FR-46-NFPA 780-2023

Public Input No. 148-NFPA 780-2023 [Section No. 1.6]

First Revision No. 47-NFPA 780-2023 [Section No. 1.7]

1.7 Periodic Inspection.

~~Periodic inspections~~ Inspections or testing for compliance to this standard shall be ~~done~~ conducted annually or at intervals determined by the authority having jurisdiction.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 11:28:44 EDT 2023

Committee Statement

Committee Statement: This adds a minimum compliance period in lieu of periodic as a non-defined term.

Response Message: FR-47-NFPA 780-2023

Public Input No. 149-NFPA 780-2023 [Section No. 1.7]

First Revision No. 57-NFPA 780-2023 [Section No. 2.2]

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®, *National Electrical Code®,* ~~2023~~ 2026 edition.

NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities,* ~~2020~~ 2023 edition.

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

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 12:48:09 EDT 2023

Committee Statement

Committee Statement: The standards are updated to the current edition.

Response Message: FR-57-NFPA 780-2023

First Revision No. 58-NFPA 780-2023 [Section No. 2.4]

2.4 References for Extracts in Mandatory Sections.

NFPA 70®, National Electrical Code®, ~~2023~~ 2026 edition.

NFPA 115, *Standard for Laser Fire Protection,* 2020 edition.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 12:52:06 EDT 2023

Committee Statement

Committee Statement: The standard is updated to the current edition.

Response Message: FR-58-NFPA 780-2023

First Revision No. 41-NFPA 780-2023 [New Section after 3.3.8]

3.3.8* Conductive.

Any material that has an electrical relaxation time constant less than 100 ns.

A.3.3.8 Conductive.

Whether a material is a conductor depends on the electrical recovery time (or electrical relaxation time) of the material. For an isotropic material, the recovery time constant (τ) is expressed by the following equation:

$$\tau = \varepsilon / \sigma \quad \text{[A.3.3.8]}$$

where:

τ = time constant (sec)

ε = permittivity (F/m)

σ = conductivity (S/m)

If the recovery time is shorter than the time scale of the current, then electrical fields and internal currents dissipate rapidly in the material. Currents become concentrated near the outer surface of the conductor, penetrating to about the skin depth, and electric fields outside the material terminate on surface charge at its surface rather than penetrating inside the material. Therefore, the likelihood of electrical breakdown to the surface is enhanced. In this context, carbon fiber composite contains individual conductors embedded in a nonconductive matrix.

Supplemental Information

File Name	Description	Approved
FR_41_attachment_for_new_conductive_defintion_annex.docx	FR 41 attachment for new conductive defintion annex	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 16:58:57 EDT 2023

Committee Statement

Committee Statement: Revised Section 10.3.3 addresses the concepts of “conducting” and “nonconducting” and creates new requirements for both insulating (that is, fiberglass) and anisotropic materials that may contain a mixture of conducting and nonconducting elements, in particular CFC and also wood.

Response Message: FR-41-NFPA 780-2023

First Revision No. 81-NFPA 780-2023 [New Section after 3.3.32]

3.3.34* Nonconductive.

Any material that has an electrical relaxation time constant greater than 100 ms.

A.3.3.34 Nonconductive.

See A.3.3.8 for more information on electrical relaxation time constant.

Supplemental Information

File Name	Description	Approved
FR_81_attachment_for_new_nonconductive_defintion_annex.docx	FR 81 attachment for new nonconductive definition annex	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Tue Oct 31 09:19:10 EDT 2023

Committee Statement

Committee Statement: Revised Section 10.3.3 addresses the concepts of "conducting" and "nonconducting" and creates new requirements for both insulating (that is, fiberglass) and anisotropic materials that may contain a mixture of conducting and nonconducting elements, in particular CFC and also wood.

Response Message: FR-81-NFPA 780-2023

First Revision No. 68-NFPA 780-2023 [Section No. 3.3.45]

3.3.47* Surge-Protective Device (SPD).

A protective device for limiting ~~the~~ transient voltages by diverting or limiting ~~the~~ surge current and preventing ~~the~~ continued flow of ~~the~~ follow current while remaining capable of repeating these functions.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 10:49:51 EDT 2023

Committee Statement

Committee Statement: This makes the definition clearer and more concise.

Response Message: FR-68-NFPA 780-2023

Public Input No. 144-NFPA 780-2023 [Section No. 3.3.45]

First Revision No. 64-NFPA 780-2023 [Section No. 3.3.48]

3.3.50 Turf Shoulder .

Grass, stabilized soil, ~~asphalt,~~ or any other ~~hard~~ treated surface not intended as a paved shoulder, installed from the edge of the runway or taxiway full strength pavement to just outside the airfield lighting circuits.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 15:31:07 EDT 2023

Committee Statement

Committee Statement: The revised definition provides clarity.

Response Message: FR-64-NFPA 780-2023

Public Input No. 47-NFPA 780-2023 [Section No. 3.3.48]

First Revision No. 23-NFPA 780-2023 [Section No. 4.1.1.2]

4.1.1.2

If part of a structure ~~exceeds~~ <u>is equal to or greater than</u> 75 ft (23 m) in height (e.g., a steeple) and the remaining portion does not exceed 75 ft (23 m) in height, the requirements for Class II air terminals and conductors shall apply only to that portion exceeding 75 ft (23 m) in height.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 12:49:00 EDT 2023

Committee Statement

Committee Statement: The current language in 4.1.1.1.1 and 4.1.1.1.2 excludes structures exactly 75 ft. This corrects that gap adding those structure heights to Class II materials.

Response Message: FR-23-NFPA 780-2023

Public Input No. 48-NFPA 780-2023 [Section No. 4.1.1.1.2]

First Revision No. 12-NFPA 780-2023 [Section No. 4.1.1.3]

4.1.1.3*

Class II conductors from the higher portion as described in 4.1.1.2 shall be extended to ground and ~~shall be~~ interconnected with the balance of the system.

A.4.1.1.3

Where Class II conductors are required, the impedance of the current path to ground is an important factor in limiting the voltage at upper parts of the structure. For multi-level structures that contain both Class I and Class II components, the impedance of the Class II conductors must be maintained throughout its path to ground. This is achieved through a continuous path of Class II conductors and through current division using some components of the current dissipation systems that are equipped with Class I materials.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 09:39:13 EDT 2023

Committee Statement

Committee Statement: The new annex clarifies that the Class I components in a mixed class I and II structure share in the current division during conduction of lightning current to ground, thus lowering overall system impedance.

Response Message: FR-12-NFPA 780-2023

Public Input No. 121-NFPA 780-2023 [New Section after A.4.2.2.3.1]

First Revision No. 13-NFPA 780-2023 [Section No. 4.2.2.3.1]

4.2.2.3.1*

Aluminum shall not be used within 18 in. (450 mm) of the point where the lightning protection system comes into contact with the earth, soil on vegetative roofs, or planters, or where rapid deterioration is possible.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 09:42:01 EDT 2023

Committee Statement

Committee Statement: Aluminum components of a lightning protection systems can exist in proximity to soil at other locations than at ground level.

Response Message: FR-13-NFPA 780-2023

Public Input No. 137-NFPA 780-2023 [Section No. 4.2.2.3.1]

First Revision No. 14-NFPA 780-2023 [Section No. 4.3.4.3]

4.3.4.3

~~Fittings~~ Connectors and fittings used for the connection of aluminum down conductors to copper or copper-clad grounding equipment shall be of the bimetallic type.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 09:43:38 EDT 2023

Committee Statement

Committee Statement: Section 4.3.4.3 is revised to be consistent with the intent of the overall 4.3.4 which encompasses both connectors and fittings.

Response Message: FR-14-NFPA 780-2023

Public Input No. 41-NFPA 780-2023 [Section No. 4.3.4.3]

First Revision No. 15-NFPA 780-2023 [Section No. 4.4.2]

4.4.2*

Where ~~metal pipe or tubing is used around~~ a conductor is encircled by a metallic component, pipe, raceway, or sleeve , the conductor shall be bonded to the component, pipe, raceway, or ~~tubing~~ sleeve at both ends.

A.4.4.2

Whenever a metallic sleeve encloses or encircles a lightning protection system (LPS) conductor, the LPS conductor should be bonded to the sleeve at each end. Skin effect will keep the higher frequency components of the lightning impulse current on the outer sleeve while the lower frequency currents flow through the lower resistance LPS conductor. The bond eliminates arcing that can damage the conductor.

4.4.2.1

A metallic component, pipe, raceway, or sleeve that is 8 in. (20.3 cm) or less in length shall require bonding on one end only.

4.4.2.2

A metallic component, pipe, raceway, or sleeve that is 2 in. (5.0 cm) or less in length shall not require bonding on either end.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 09:44:33 EDT 2023

Committee Statement

Committee Statement: The requirement to bond metal penetrations of LPS conductors is not explained elsewhere in the standard. Annex A.4.4.2 assists in correct implementation of the normative requirements.

Calculation of the potential for sideflash in down conductors routed through minimal length metal sleeve suggests little impact. The minimal length metal sleeve bonding rules can be relaxed.

Response Message: FR-15-NFPA 780-2023 Response to PI 67: The proposed annex material was incorporated into this revision.

Public Input No. 67-NFPA 780-2023 [New Section after A.4.8.8.1]

Public Input No. 81-NFPA 780-2023 [New Section after 4.4.2]

Public Input No. 68-NFPA 780-2023 [New Section after A.4.4.1]

First Revision No. 16-NFPA 780-2023 [Section No. 4.5.4.4]

4.5.4.4

Overhead ground wires shall be self-supporting with ~~minimum sag~~ <u>the ability to maintain calculated sag to preserve the intended zone of protection</u> under all conditions.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 09:48:22 EDT 2023

Committee Statement

Committee Statement: This revision clarifies permissible sag in overhead ground wires.

Response Message: FR-16-NFPA 780-2023

Public Input No. 127-NFPA 780-2023 [Section No. 4.5.4.4]

Public Input No. 50-NFPA 780-2023 [New Section after A.4.5.2.1]

First Revision No. 18-NFPA 780-2023 [Section No. 4.8.7.2]

4.8.7.2

Conductors shall be coursed through or around obstructions (e.g., cupolas and ventilators) in ~~a~~ the same horizontal plane ~~with~~ as the main conductor.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 09:52:43 EDT 2023

Committee Statement

Committee Statement: This clarifies that conductors should be routed in consideration of obstructions in the same horizontal plane as main conductors to avoid U or V pockets.

Response Message: FR-18-NFPA 780-2023

Public Input No. 52-NFPA 780-2023 [Section No. 4.8.7.2]

First Revision No. 19-NFPA 780-2023 [Section No. 4.11.2]

4.11.2

~~Fittings~~ Connectors used for required connections to metal bodies in or on a structure shall be secured to the metal body by bolting, brazing, welding, or screwing, or be high-compression connectors listed for the purpose.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 09:54:32 EDT 2023

Committee Statement

Committee Statement: The language is changed to a defined item in NFPA 780 and makes 4.11.2 consistent with the rest of Section 4.11.

Response Message: FR-19-NFPA 780-2023

Public Input No. 42-NFPA 780-2023 [Section No. 4.11.2]

First Revision No. 84-NFPA 780-2023 [Sections 4.15.2.5.1, 4.15.2.5.2]

4.15.2.5.1*

Grounded metal bodies shall be bonded to the lightning protection system where located within a calculated bonding distance, *D*, as determined by the following formula:

$$D = \frac{h}{6n} \times K_m \quad D = \frac{l}{6n} \times K_m \qquad [4.15.2.5.1]$$

where:

D = calculated bonding distance

~~*h* = vertical distance between the bond under consideration and the nearest interconnection to the lightning protection system or ground~~

l = length of conductor between the bond in question and the nearest grounding electrode or intermediate level equipotential bonding point

n = value related to the number of down conductors that are spaced at least 25 ft (7.6 m) apart, located within a zone of 100 ft (30 m) from the bond in question and where bonding is required within 60 ft (18 m) from the top of any structure

= 1 where there is only one down conductor in this zone

= 1.5 where there are only two down conductors in this zone

= 2.25 where there are three or more down conductors in this zone

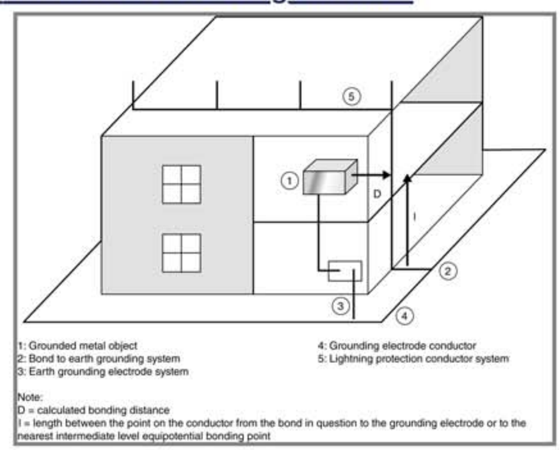
K_m = 1 if the flashover is through air~~; 0.50 if through dense material such as concrete, brick wood, and so forth~~

= 0.50 if the flashover is through dense material ~~such as~~ (e.g., concrete, brick, wood~~, and so forth~~)

A.4.15.2.5.1

See Figure A.4.15.2.5.1 for an illustration of bonding distance.

Figure A.4.15.2.5.1 Illustration of Bonding Distance.



~~**4.15.2.5.2**~~

~~The value *n* shall be calculated as follows: *n* = 1 where there is only one down conductor in this zone; *n* = 1.5 where there are only two down conductors in this zone; *n* = 2.25 where there are three or more down conductors in this zone.~~

Supplemental Information

File Name	Description	Approved
FR_84_attachment_4.15.2.5.1.docx	FR 84 attachment for 4.15.2.5.1	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Nov 08 10:39:07 EST 2023

Committee Statement

Committee Statement: Sideflash voltage is influenced by the impedance of the total distance between the point of consideration and the grounding point or the closest equipotential bonding point. Annex material has been added to point out the similarities between the standards and reasons for the differences. Existing text of 4.15.2.5.2 was moved to the proper location for “n” in equation 4.15.2.5.1.

Response Message: FR-84-NFPA 780-2023

Public Input No. 109-NFPA 780-2023 [Section No. 4.15.2.5.1]

First Revision No. 85-NFPA 780-2023 [Sections 4.15.2.6.1, 4.15.2.6.2]

4.15.2.6.1

Grounded metal bodies shall be bonded to the lightning protection system where located within a calculated bonding distance, *D*, as determined by the following formula:

~~$D = \frac{h}{6n} \times K_m$~~ $$D = \frac{l}{6n} \times K_{\mathrm{m}} \quad [4.15.2.6.1]$$

where:

D = calculated bonding distance

~~*h* = either the height of the building or the vertical distance from the nearest bonding connection from the grounded metal body to the lightning protection system and the point on the down conductor where the bonding connection is being considered~~

l = length of conductor between the bond in question and the nearest grounding electrode

n = value related to the number of down conductors that are spaced at least 25 ft (7.6 m) apart and located within a zone of 100 ft (30 m) from the bond in question and where bonding is required within 60 ft (18 m)

= 1 where there is only one down conductor in this zone

= 1.5 where there are only two down conductors in this zone

= 2.25 where there are three or more down conductors in this zone

K_m = 1 if the flashover is through air~~; 0.50 if through dense material such as concrete, brick, wood, and so forth~~

= 0.50 if the flashover is through dense material ~~such as~~ (e.g., concrete, brick, wood)~~, and so forth~~

~~**4.15.2.6.2**~~

~~The value *n* shall be calculated as follows: *n* = 1 where there is only one down conductor in this zone; *n* = 1.5 where there are only two down conductors in this zone; *n* = 2.25 where there are three or more down conductors in this zone.~~

Supplemental Information

File Name	Description	Approved
FR_85_attachement_4.15.2.6.1.docx	FR_85_attachement_4.15.2.6.1.docx	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Nov 08 10:45:54 EST 2023

Committee Statement

Committee Statement: Sideflash voltage is influenced by the impedance of the total distance between the point of consideration and the grounding point or the closest equipotential bonding point. Existing text of 4.15.2.6.2 was moved to the proper location for "n" in equation 4.15.2.6.1.

Response Message: FR-85-NFPA 780-2023

Public Input No. 110-NFPA 780-2023 [Section No. 4.15.2.6.1]

First Revision No. 26-NFPA 780-2023 [Section No. 4.19.2.11]

~~**4.19.2.11**~~

~~SPDs shall be made inaccessible to unqualified persons unless the SPDs are listed for installation in accessible locations.~~

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 13:31:37 EDT 2023

Committee Statement

Committee Statement: This deletes the section as the listing of an SPD per UL 1449 does not include certification for installation in accessible locations.

Response Message: FR-26-NFPA 780-2023

Public Input No. 82-NFPA 780-2023 [Section No. 4.19.2.11]

First Revision No. 27-NFPA 780-2023 [Section No. 4.19.2.12.1]

4.19.2.11.1

~~A surge-protective device~~ SPDs shall be permitted to be connected between any two conductors — ungrounded conductors, grounded conductors, equipment ~~grounded~~ grounding conductors, or grounding electrode conductors.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 13:39:38 EDT 2023

Committee Statement

Committee Statement: This editorial revision matches the section with the rest of Section 4.19. The correct terminology is an equipment grounding conductor.

Response Message: FR-27-NFPA 780-2023

Public Input No. 83-NFPA 780-2023 [Section No. 4.19.2.12.1]

First Revision No. 28-NFPA 780-2023 [Section No. 4.19.2.13]

4.19.2.12* ~~Earth~~ Grounding Electrode System .

The resistance of the ~~earth~~ grounding electrode system used in the grounding of SPDs shall comply with *NFPA 70*.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 13:41:38 EDT 2023

Committee Statement

Committee Statement: This removes the term "earth" and adds "system" to better correlate with NFPA 70.

Response Message: FR-28-NFPA 780-2023

Public Input No. 84-NFPA 780-2023 [Section No. 4.19.2.13]

First Revision No. 29-NFPA 780-2023 [New Section after 4.19.2.14]

4.19.2.14

SPDs shall be installed such that they are accessible for inspection and maintenance.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 13:45:20 EDT 2023

Committee Statement

Committee Statement: This adds a requirement for SPDs to be installed where they can be accessed for inspection and maintenance which is currently not addressed in the standard.

Response Message: FR-29-NFPA 780-2023

Public Input No. 74-NFPA 780-2023 [New Section after 4.19.2.14.2]

First Revision No. 30-NFPA 780-2023 [New Section after 4.19.2.14]

4.19.2.15 Indicating.

An SPD shall provide visual indication that it is functioning properly.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 13:59:23 EDT 2023

Committee Statement

Committee Statement: This harmonizes the standard with NFPA 70 and ensures the functionality of the SPD has visual indication.

Response Message: FR-30-NFPA 780-2023

Public Input No. 85-NFPA 780-2023 [New Section after 4.19.2.14.2]

First Revision No. 31-NFPA 780-2023 [Section No. 4.19.3.7]

4.19.3.7

The conductor between the surge arrester and the line and the surge arrester and the grounding connection shall either not be ~~not~~ smaller than 6 AWG copper ~~or~~ 4 AWG aluminum~~,~~ or ~~it shall utilize~~ use a conductive material that has a capacity and withstand rating equivalent to at least a 6 AWG copper conductor.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 14:01:00 EDT 2023

Committee Statement

Committee Statement: This adds a corresponding AWG size for aluminum conductors and ensures an alternative conductive material has a withstand rating at least 6 AWG of the copper type conductor.

Response Message: FR-31-NFPA 780-2023

Public Input No. 70-NFPA 780-2023 [Section No. 4.19.3.7]

First Revision No. 32-NFPA 780-2023 [New Section after 4.19.3.8]

4.19.3.9

Surge arresters shall be installed such that they are accessible for inspection and maintenance.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 14:02:38 EDT 2023

Committee Statement

Committee Statement: This adds a requirement for surge arresters to be installed where they can be accessed for inspection and maintenance which is currently not addressed in the standard.

Response Message: FR-32-NFPA 780-2023

Public Input No. 75-NFPA 780-2023 [New Section after 4.19.3.8]

First Revision No. 33-NFPA 780-2023 [Section No. 4.19.4.3]

4.19.4.3*

Surge protectors shall have a maximum discharge current (I_{max}) rating of at least 10 kA 8/20 μs ~~when installed at the entrance~~ .

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 14:03:56 EDT 2023

Committee Statement

Committee Statement: Transient energy on communication and signal systems is present on all locations not just at the entrance.

Response Message: FR-33-NFPA 780-2023

Public Input No. 71-NFPA 780-2023 [Section No. 4.19.4.3]

First Revision No. 34-NFPA 780-2023 [Section No. 4.19.4.5]

4.19.4.5

Surge protectors shall be grounded.

4.19.4.5.1*

Surge protectors that perform their protection function through isolation shall not be required to be grounded.

A.4.19.4.5.1

Additional information on the surge parameters of isolating transformers can be found in IEEE C62.69~~-2016~~ , *Standard for the Surge Parameters of Isolating Transformers Used in Networking Devices and Equipment*; IEEE C62.36~~-2016~~ , *Standard Test Methods for Surge Protectors and Protective Circuits Used in Information and Communications Technology (ICT) Circuits, and Smart Grid Data Circuits*; and IEEE C62.43~~-2005~~ , *Guide for the Application of Surge Protectors Used in Low-Voltage (Equal to or Less than 1000 V, rms, or 1200 V, dc) Data, Communications, and Signaling Circuits*.

4.19.4.5.2*

Surge protectors that do not perform their surge protection function through isolation shall be grounded in accordance with Chapter 8 of *NFPA 70*.

A.4.19.4.5.2

The purpose of a surge protector is to equalize conductor-to-conductor and conductor-to-ground potential. While a good ground is important, a good bond is imperative to minimize the damage caused by lightning and power contact or induction. ~~Common mode is a~~ Two modes of protecting telecommunications lines~~,~~ and data lines~~,~~ include common mode and differential mode ~~and so forth~~ . ~~This~~ Common mode places the protector between the signal conductor and the ground~~. It is~~ , analogous to L–G mode of protection in power systems. Differential mode ~~is a mode of protecting telecommunications lines, data lines, and so forth. In this mode,~~ places a protector ~~is placed~~ between the individual signal lines, analogous to the L–L mode of protection in power systems.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 15:10:31 EDT 2023

Committee Statement

Committee Statement: This aligns the annex material with the correct section in 4.19.4.5.1.

Response Message: FR-34-NFPA 780-2023

Public Input No. 73-NFPA 780-2023 [Section No. A.4.19.4.5]

Public Input No. 72-NFPA 780-2023 [Section No. 4.19.4.5]

First Revision No. 35-NFPA 780-2023 [Sections 4.19.5, 4.19.6]

~~**4.19.5** Communications Surge Protection.~~

~~**4.19.5.1**~~

~~SPDs shall be provided for all communications systems (including, but not limited to, CATV, alarm, and data systems) and antenna systems at facility entrances.~~

~~**4.19.5.2**~~

~~SPDs protecting communications systems shall be grounded, with the exception of devices that perform their surge protection function through isolation.~~

~~**4.19.5.2.1***~~

~~SPDs for data and signal line protection shall provide common mode protection, with the exception of devices that perform their surge protection function through isolation.~~

~~**A.4.19.5.2.1**~~

~~Differential mode protection should also be provided where practicable.~~

~~**4.19.5.3** Utility-Owned Communication Equipment.~~

~~**4.19.5.3.1**~~

~~SPDs shall be provided on all proprietary equipment by communication utility providers or tenant communication utilities.~~

~~**4.19.6** Installation.~~

~~**4.19.6.1**~~

~~Installation of surge suppression hardware shall conform to the requirements of *NFPA 70* .~~

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 15:15:43 EDT 2023

Committee Statement

Committee Statement: This deletes legacy language intended to be removed during the last revision cycle. All the corresponding language is included in 4.19.4.

Response Message: FR-35-NFPA 780-2023

Public Input No. 86-NFPA 780-2023 [Sections 4.19.5, 4.19.6]

First Revision No. 48-NFPA 780-2023 [Section No. 5.8.3]

5.8.3

Where lights are installed at the perimeter of the pad and extend above the edge of the helipad, air terminals shall be installed ~~adjacent to the fixture~~ such that each light is included in a zone of protection .

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 11:31:19 EDT 2023

Committee Statement

Committee Statement: This clarifies to the section and helps the user implement this requirement.

Response Message: FR-48-NFPA 780-2023

Public Input No. 118-NFPA 780-2023 [Section No. 5.8.3]

First Revision No. 49-NFPA 780-2023 [New Section after 5.9]

5.10* Outdoor Athletic Scoreboards.

Where lightning detection systems are used, the inspection should include a record of historic activation in nearby lightning detection systems to confirm placement of the sensing components and performance of the integrated systems in the event of a power outage.

A.5.10

A lightning protection system for outdoor athletic scoreboards should consider egress lighting and audio mass notification systems as part of the lightning risk assessment and in the development of its maintenance schedule outlined in Section 1.7 .

5.10.1

Outdoor athletic scoreboards shall be protected in accordance with Chapter 4 .

5.10.2

Surge protection shall be provided for all circuits entering or exiting outdoor scoreboards in accordance with Section 4.19 .

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 11:35:50 EDT 2023

Committee Statement

Committee Statement: This adds specific requirements and guidance to Chapter 5 along with annex material to add information regarding systems that were not previously addresses and that may be present in athletic field locations.

Response Message: FR-49-NFPA 780-2023

Public Input No. 150-NFPA 780-2023 [New Section after 5.9.4.3]

First Revision No. 37-NFPA 780-2023 [Section No. 7.3.1]

7.3.1 Materials and Installation.

Conductors, strike termination devices, surge protection ~~devices~~ , and grounding connections shall be selected and installed in accordance with the requirements of Chapter 4 except as modified in this chapter.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 15:19:17 EDT 2023

Committee Statement

Committee Statement: The section is revised to apply to all types of surge protection permitted or required by Section 4.19 and not just SPDs.

Response Message: FR-37-NFPA 780-2023

Public Input No. 87-NFPA 780-2023 [Section No. 7.3.1]

First Revision No. 36-NFPA 780-2023 [Section No. 7.3.6.2]

7.3.6.2

Surge ~~protective devices~~ protection shall be installed outside hazardous (classified) locations where practicable.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 15:17:11 EDT 2023

Committee Statement

Committee Statement: This ensures all surge protection permitted or required in Section 4.19 is installed outside the hazardous location.

Response Message: FR-36-NFPA 780-2023

Public Input No. 88-NFPA 780-2023 [Section No. 7.3.6.2]

First Revision No. 5-NFPA 780-2023 [Section No. 7.3.7.1]

7.3.7.1*

Except as specified in 7.3.7.2 and 7.3.7.3, a ground ring electrode or ground loop conductor supplemented by one or more grounding electrodes, as identified in 4.12.2 through 4.12.7, shall be provided for structures containing flammable vapors, flammable gases, or liquids that can give off flammable vapors.

A.7.3.7.1

Paragraph 7.3.7.1 does not apply to tanks and petroleum production, processing, and storage structures.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Oct 25 14:53:20 EDT 2023

Committee Statement

Committee Statement: The addition of annex material indicates that 7.3.7.1 does not apply to tanks and petroleum production, processing, and storage structures.

Response Message: FR-5-NFPA 780-2023 The information proposed is not necessary in the body of the standard.

Public Input No. 55-NFPA 780-2023 [Section No. 7.3.7.1]

First Revision No. 8-NFPA 780-2023 [New Section after 7.3.7.3]

7.3.7.4 Additional Grounding Considerations.

Grounding as required by this standard shall only apply to lightning protection systems.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Oct 25 15:08:22 EDT 2023

Committee Statement

Committee Statement: New Section 7.3.7.5 cautions that lightning protection grounding may not meet grounding requirements for other purposes.

Response Message: FR-8-NFPA 780-2023

Public Input No. 92-NFPA 780-2023 [New Section after 7.3.7.4]

First Revision No. 69-NFPA 780-2023 [Section No. 7.3.7.3]

7.3.7.3*

A metal tank shall be grounded using one or more of the following methods:

(1)* The tank shall be connected without insulated joints to a grounded metallic piping system at two or more points .

A.7.3.7.3(1)

It is possible to ground metal tanks by ~~utilizing~~ using buried pipe in direct contact with earth. The shorter the distance from the tank to the point of entry to earth, the greater the efficacy of the ground. For a pipe or piping system to be considered a grounding electrode, it should be electrically continuous and buried in direct contact with the earth for at least 10 ft (3 m). Generally, the more pipe that is in contact with earth, the more effective it will be in serving as a grounding electrode. Multiple grounding electrodes are better for grounding metal tanks. ~~If only one ground entry point is available, additional buried length of pipe should be considered.~~ See 4.12.5~~for~~ on the requirements for length of radials.

(2) ~~The~~ Where a vertical, ~~cylindrical~~ flat-bottom tank is used, it shall rest on the earth, bitumen, or concrete ~~and shall be at least 20 ft (6 m) in diameter, or it shall rest on bituminous pavement and be at least 50 ft (15 m) in diameter~~ .

(3) The tank shall be grounded through a minimum of two grounding electrodes~~,~~ as described in Section 4.12, spaced as widely separated as practicable, and at a maximum of 100 ft (30 m) intervals along the perimeter of the tank.

(4) The tank shall be grounded at a minimum of two locations as widely separated as practicable along the perimeter of the tank to a site grounding system.

A.7.3.7.3

Where a tank is installed over an insulating membrane for environmental or other reasons, the insulating membrane (e.g., containment barrier) has no effect on the choice of grounding methods noted in 7.3.7.3 . The use of insulating membranes does not affect the lightning attachment process; however, it could pose a threat to personnel safety.

Without the addition of supplemental grounding methods, lightning strikes to the tank could pose a threat to the integrity of the membrane.

Supplemental Information

File Name	Description	Approved
FR_69_attachement_for_7.3.7.3.docx	FR 69 attachment for 7.3.7.3	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 11:10:07 EDT 2023

Committee Statement

Committee Statement: There is no known technical justification to maintain the minimum diameter requirement for the tanks within the methods recommended for grounding metal tanks provided in 7.3.7.3. The addition of item 4 introduces an alternative grounding method.

The annex material is necessary on account the removal of 7.3.7.4 in the body of NFPA 780 which had addressed the use of insulating membranes.

Response Message: FR-69-NFPA 780-2023

Public Input No. 56-NFPA 780-2023 [Section No. 7.3.7.3]

First Revision No. 7-NFPA 780-2023 [Section No. 7.3.7.4]

~~7.3.7.4~~

~~Where a tank is installed over an insulating membrane for environmental or other reasons, it shall be grounded as described in 7.3.7.3(1) or 7.3.7.3(3) .~~

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Oct 25 15:03:55 EDT 2023

Committee Statement

Committee Statement: The topic of how to ground tanks installed upon insulating membranes is relocated to A.7.3.7.3 and 7.3.7.3. Insulating membranes are considered to have no effect on the selection of a particular grounding method.

Response Message: FR-7-NFPA 780-2023

Public Input No. 89-NFPA 780-2023 [Section No. 7.3.7.4]

First Revision No. 9-NFPA 780-2023 [Section No. 7.6.2.1.1]

7.6.2.1.1

Metallic primary shoe seals shall be electrically bonded to the floating roof either inherently — through design and construction — or by a minimum of one Class I lightning protection conductor or an equivalent ~~at each end of each shoe~~ .

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Oct 25 15:10:55 EDT 2023

Committee Statement

Committee Statement: Adequate bonding can be achieved by using only one bonding jumper.

Response Message: FR-9-NFPA 780-2023

Public Input No. 59-NFPA 780-2023 [Section No. 7.6.2.1.1]

First Revision No. 10-NFPA 780-2023 [Section No. 7.8.4]

7.8.4

Ground-level potential equalization shall be established within the tank battery through interconnection of metallic components, aboveground or underground piping, and grounding systems.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Oct 25 15:13:35 EDT 2023

Committee Statement

Committee Statement: Metallic piping needs to be bonded whether the piping is above the ground or buried below the ground. Piping above the ground provides the same bonding qualities as underground piping and therefore should be allowed.

Response Message: FR-10-NFPA 780-2023

Public Input No. 60-NFPA 780-2023 [Section No. 7.8.4]

First Revision No. 11-NFPA 780-2023 [Section No. 7.8.5]

7.8.5*

~~In locations where direct strikes or arcing is likely to occur,~~ Maintenance, operating, and engineering techniques and methods shall be used in locations where direct strikes or arcing is likely to occur to minimize the accumulation of flammable vapors in areas where a source of ignition is likely to be present.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Oct 25 15:14:21 EDT 2023

Committee Statement

Committee Statement: Operating and maintenance techniques in addition to proper engineering methods also help to minimize the accumulation of flammable vapors.

Response Message: FR-11-NFPA 780-2023

Public Input No. 61-NFPA 780-2023 [Section No. 7.8.5]

First Revision No. 42-NFPA 780-2023 [Section No. 8.2.2]

8.2.2 Electromagnetic Coupling.

Where the effects of electromagnetic coupling are of concern, a mast or overhead wire (catenary) system shall be installed. *(See also A.8.3.2 .)*

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 17:18:01 EDT 2023

Committee Statement

Committee Statement: The need for the Faraday caged LPS is dependent on the sensitivity of the explosives operations conducted. In some cases, the separation accomplished by the mast or catenary system is sufficient.

Response Message: FR-42-NFPA 780-2023

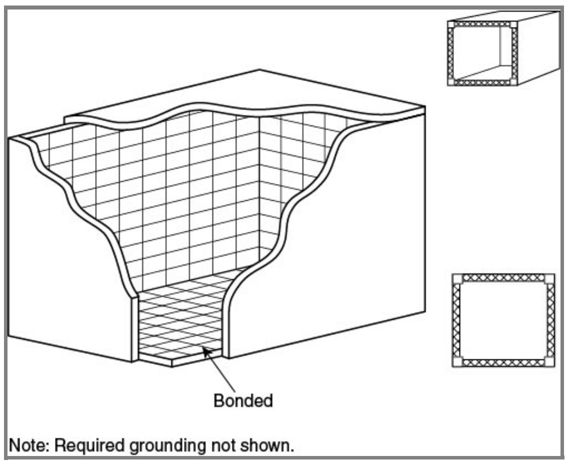
Public Input No. 99-NFPA 780-2023 [Section No. 8.2.2]

First Revision No. 43-NFPA 780-2023 [Section No. 8.3.2]

8.3.2* Metallic (Faraday-Like) Cage.

Where optimum protection for structures housing explosives is required, such as protection from electromagnetic coupling or inducing potentials such as LEMP (as determined by the AHJ), a grounded, continuously conductive enclosure~~, as~~ like that shown in Figure 8.3.2~~,~~ shall be used.

Figure 8.3.2 Metallic (Faraday-Like) Cage.



Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 17:28:38 EDT 2023

Committee Statement

Committee Statement: This revision highlights the protective characteristics of a Faraday LPS system against the effects of LEMP.

Response Message: FR-43-NFPA 780-2023

Public Input No. 100-NFPA 780-2023 [Section No. 8.3.2]

First Revision No. 45-NFPA 780-2023 [Section No. 8.8]

4.15.5* Metallic Fences.

A.4.15.5

Bonding for metallic fences is meant to protect personnel who could come in contact with two parts of a metallic fence system that might become electrically charged, even unintentionally, at different potentials through faults or charge buildup through inductance or direct/indirect strikes, and who might complete the path for the charge to go to ground. The grounding for any part of a metallic fence and objects within either sideflash distance of a person who could possibly touch two parts of a metallic fence/gate at the same time is to prevent the person from becoming the path to ground (i.e., close an open circuit) for any charge buildup before or during a direct lightning strike; this includes a worst case scenario of a person with outstretched arms with or without objects they might be holding or using to close the gate, such as a tool. It is always best practice to not transit through gates when atmospheric conditions are conducive for a lightning event to occur.

If any part of a metallic fence and gatepost, whether at an ordinary or explosives facility, is within 6 ft (1.8 m) of any part of a lightning protection, (e.g., down conductor, ground rod of an LPS), two points of bonding to the LPS are necessary.

The sideflash analysis should include the following:

(1) Consideration of auxiliary equipment mounted on a fence (e.g., cameras, IDS, access control, mounting poles) for sideflash grounding and bonding control

(2) A figure created that is similar to Figure 4.15.4.1

(3) Developed sideflash/touch potential analysis processes and equations

If the gateposts are spaced such that a person can walk through and touch both gate posts [including the worst case scenario of a person with outstretched arms, a width of typically 6 ft to 8 ft (1.8 m to 2.4 m)], bonding (no mechanical connections) is necessary at the base, underground, able to be visually inspected or tested at the bond to the gate posts, and deeply enough that the bonding conductor will not be broken or disturbed by movement of the vehicle as it passes through.

If a gate is wide enough for a person to walk through and touch both gate posts with any kind of attachment or equipment they might be holding, bonding (no mechanical connections) is necessary at the base, underground, able to be visually inspected or tested at the bond to the gate posts, and deeply enough that the bonding conductor will not be broken or disturbed by movement of the vehicle as it passes through.

If a gate is wide enough that it allows a vehicle to be driven through it, grounding and bonding are necessary. Sideflash calculations can be used to evaluate the need to bond and ground.

If a gate is to be opened electronically — with codes or switches attached to an electrical source and the control interface within sideflash hazard — the gate post must be bonded to the electrical feeder to the electronics and the ground rod at the pedestal feeder must be bonded to the gate post. If the electronic switch pedestal is within sideflash distance of the gate post and any other part of the metallic fence (e.g., another post), it must be bonded to both the gate post and the next fence post that it is between or to the two fence posts it might be between. Remotely controlled gates where personnel are expected to remain within the vehicle and where the gate operator is not adjacent to the gate area (outside sideflash or touch potential hazard) can be exempted from sideflash or touch potential consideration.

Areas where fences and gates provide for personnel to gather and dwell for a given time should be considered as a source for step potential threat.

4.15.5.1 Grounding.

4.15.5.1.1

Fences shall be grounded where located within 6 ft (1.8 m) of a structure ~~housing explosives~~ by interconnection with the grounding system of the structure.

4.15.5.1.2

Fences meeting the criteria of 4.15.5.1.1 shall also be grounded within 100 ft (30 m) on both sides of where overhead power lines cross the fence.

4.15.5.1.3

Gate posts through which ~~explosives material~~ vehicles or personnel will pass shall be grounded in accordance with 4.15.5.3.

4.15.5.1.4

Metal single-strand fences with nonconductive posts requiring grounding in accordance with 4.15.5.1 shall use a main-size conductor extending the full height of the post.

4.15.5.1.5

The main-size conductor discussed in 4.15.5.1.4 shall be bonded to each single strand to form a continuous path to ground.

4.15.5.2 Bonding.

4.15.5.2.1

Fences shall be bonded across gates and other discontinuities in accordance with the requirements of 4.15.5.3.

4.15.5.2.2

Fencing mesh covered with nonconductive material shall be bonded to posts requiring grounding by 4.15.5.1.

4.15.5.3 Gates and Gate Posts.

4.15.5.3.1

All gate posts through which ~~explosives material~~ vehicles or personnel will pass shall be provided with a grounding electrode meeting the requirements of Section 4.12 using a main-size conductor.

4.15.5.3.2

Class I main-size conductors buried not less than 18 in. (450 mm) in depth shall interconnect posts on opposite sides of a gate.

4.15.5.3.3

Gates shall be bonded to their grounded support posts using a flexible secondary-size jumper.

Supplemental Information

File Name	Description	Approved
FR_45_attachment_for_8.8.docx	FR_45_attachment_for_8.8	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 18:04:15 EDT 2023

Committee Statement

Committee Statement: The requirements and criteria for fences and gates are based in providing mitigation for personnel protection not ordnance or ordnance facilities. The requirements are moved to Chapter 4.

Response Message: FR-45-NFPA 780-2023

First Revision No. 44-NFPA 780-2023 [Section No. 8.10.7.6]

8.9.7.6 Three-Point Fall-of-Potential Test.

~~The three-point fall-of-potential test method shall be used when measuring the resistance to earth of grounding systems for explosives facilities.~~

8.9.7.6.1

The three-point fall-of-potential test method shall be used when measuring the resistance to earth of grounding systems for explosives facilities.

8.9.7.6.2

Where space or geophysical issues prevent the ability to drive test stakes or rods to properly perform the three-point fall-of potential test, a clamp-on ground resistance meter shall be used in accordance with the manufacturer's instructions as permitted by the AHJ.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 17:31:50 EDT 2023

Committee Statement

Committee Statement: The implementation of the clamp on style meter will require AHJ to ensure the proper use for this application.

Response Message: FR-44-NFPA 780-2023

Public Input No. 8-NFPA 780-2023 [Section No. 8.10.7.6]

First Revision No. 38-NFPA 780-2023 [Section No. 10.3.1]

10.3.1* Zone of Protection.

A.10.3.1

~~The techniques described in Chapter 10 should also be applied to watercraft for the placement of strike termination devices and determining the zone of protection.~~ The bow and stern of a watercraft are locations where an enhanced risk of an upward streamer or direct strike exists. Since personnel might be at these locations, enhanced protective measures are needed, such as air terminals placed outside decks and working areas. Down conductors from these air terminals should be as vertical as possible, connected to the loop conductor, and terminated at a grounding electrode near the waterline.

10.3.1.1

The zone of protection for watercraft shall be based on a striking distance of 100 ft (30 m).

10.3.1.2

The zone of protection afforded by any configuration of masts or other elevated conductive objects shall be determined graphically ~~or mathematically,~~ as shown in Figure 10.3.1.2 or in accordance with 4.7.3.3 . ~~The distance can be determined analytically for a 100 ft (30 m) striking distance with the following equation (units shall be consistent, ft or m):~~

$$d = \sqrt{h_1(2R - h_1)} - \sqrt{h_2(2R - h_2)}$$ ~~[10.3.1.2]~~

~~where:~~

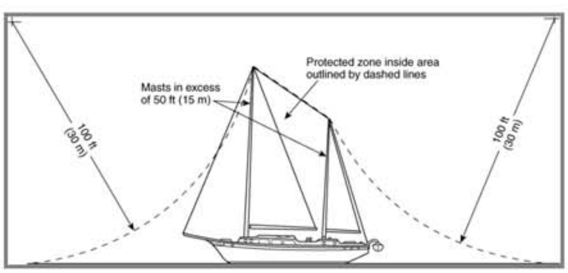
~~d = horizontal protected distance~~

~~h_1 = height of strike termination device~~

~~R = rolling sphere radius [100 ft (30 m)]~~

~~h_2 = height of object to be protected~~

Figure 10.3.1.2 Diagram ~~of~~ Defining the Zone of Protection in a Boat ~~with Masts in Excess of 50 ft (15 m) Above the Water. [Protection based on lightning strike distance of 100 ft (30 m).]~~ .



10.3.1.3

The zone of protection shall extend at least 7 ft (2.1 m) above the deck for all regions of the boat that are occupied.

Detail FR-39

10.3.1.4

Multiple air terminals shall be permitted to give the required zone of protection comprising overlapping zones of protection ~~as described in 10.3.3.2~~ .

Supplemental Information

File Name	Description	Approved
FR_38_attachement_Section_10.3.1.docx	FR_38_attachment_Section_10.3.1	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 15:43:40 EDT 2023

Committee Statement

Committee Statement: Since the electric field enhancement factor of a person standing in the "protected zone" is much larger than that of the flat surface where the ball touches the horizontal ground, the likelihood of streamer initiation may be larger for the person. For a mast that is lower than the sphere radius, this predicted zone of protection extends outside that of the cone of protection with 90 degree apex angle.

Section 10.3.1 is modified to give a higher level of protection for personnel and sensitive structures on a watercraft since any lightning damage is inherently more life threatening.

10.3.1.2 is revised to refer to 4.7.3.3 which contains the same equation.

10.3.1.3 was added to address people on the deck. Seven feet was chosen to cover a large demographic.

Response Message: FR-38-NFPA 780-2023

First Revision No. 82-NFPA 780-2023 [New Section after 10.3.3]

10.3.4* Carbon Fiber Composite (CFC) Masts and Structures.

A.10.3.4

Carbon fiber composites (CFCs) comprise a mixture of electrically conductive carbon fiber embedded in a nonconductive matrix. Since the relaxation time of the carbon is less than a picosecond, which is much shorter than the time scales of the lightning processes involved in attachment and return stroke processes, electrostatic conditions apply to physical processes such as surface charge buildup and electric field formation.

10.3.4.1

This subsection shall apply to any mast or structure constructed either of carbon fiber composite (CFC) or of materials that contain a mixture of conductive and nonconductive materials.

10.3.4.2

An air terminal shall extend a minimum of 10 in. (254 mm) above the mast and any conductive fittings on the mast.

10.3.4.3

The top of an air terminal shall be of sufficient height that the top of the mast and all masthead fittings are below the surface of a 90-degree inverted cone with its apex at the top of the air terminal.

10.3.4.4

Multiple air terminals shall be permitted to give the required zone of protection comprising overlapping zones of protection as described in 10.3.4.3 .

10.3.4.5

An air terminal shall be securely fastened to the mast and connected to a main conductor as described in 10.4.1 .

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Tue Oct 31 09:25:31 EDT 2023

Committee Statement

Committee Statement: The issue of lightning protection for watercraft is similar to that of aircraft.

Response Message: FR-82-NFPA 780-2023

First Revision No. 40-NFPA 780-2023 [Section No. 10.3.3]

10.3.3 ~~Nonmetallic~~ Nonconductive Masts.

A ~~nonmetallic~~ nonconductive mast not within the zone of protection of a strike termination device shall be provided with at least one air terminal that meets the requirements of a strike termination device.

10.3.3.1

An air terminal shall extend a minimum of 10 in. (254 mm) above any conductive fittings on the mast.

10.3.3.2

The top of an air terminal shall be ~~sufficiently high~~ of sufficient height that all masthead fittings are below the surface of a 90-degree inverted cone with its apex at the top of the air terminal.

10.3.3.3

An air terminal shall be securely fastened to the mast and connected to a main conductor as described in 10.4.1.

10.3.3.4

The main conductor shall be permitted to be internal to the mast walls and any nonconductive fixture.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 16:26:25 EDT 2023

Committee Statement

Committee Statement: The term “nonmetallic” can apply to fiberglass, wood, or carbon fiber. These materials have very different responses to electric fields associated with lightning streamers and return strokes. The new language addresses the concepts of “conductive” and “nonconductive” and creates new requirements for both insulating (that is, fiberglass) and anisotropic materials that may contain a mixture of conductive and nonconductive elements, in particular CFC and also wood.

Section 10.4.4.4.1 was added to clarify that main conductors can be internal to nonconductive masts.

Response Message: FR-40-NFPA 780-2023

First Revision No. 87-NFPA 780-2023 [New Section after 10.4.1.8]

10.4.1.9*

Replacing the main conductor described in 10.3.4.5 with a conductor that satisfies the specifications for a main conductor appropriate for either a CFC aircraft or CFC wind turbine shall be permitted if all of the following conditions are met:

(1) The CFC mast is external to the watercraft.

(2) The alternative down conductor is connected to a main conductor at or above the location where the mast is secured to the watercraft.

A.10.4.1.9

Techniques for mitigating lightning effects in CFC using surface conductors have been used extensively in the aeronautics industry. These techniques are described in AGATE's "Lightning Direct Effects Handbook." Since there are common design considerations in the aircraft and marine industries, such as lightweight construction combined with high tensile strength, application of similar techniques to those used in aeronautics is desirable for specific marine applications. Since some of these techniques might result in potential gradients and surface breakdown that could cause injuries, application in watercraft should be limited to those structures, or parts of structures, where the risk of such an injury is unlikely.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Nov 08 11:47:02 EST 2023

Committee Statement

Committee Statement: Alternative specifications for lightning conductors are well documented. AGATE "Lightning Direct Effects Handbook" Report Reference Number: AGATE-WP3.1-031027-043-Design Guideline Work Package Title: WBS3.0 Integrated Design and Manufacturing Date of General Release: March 1, 2002. gives a comprehensive discussion of then pertinent concepts.

Response Message: FR-87-NFPA 780-2023

First Revision No. 86-NFPA 780-2023 [New Section after 10.4.4.1]

10.4.4.2*

Strike termination devices, down conductors, and connections to a carbon fiber mast shall be external to the mast.

A.10.4.4.2

Consequences of routing a down conductor internal to a CFC mast are demonstrated in "Carbon and Lightning" (Scalvini).

10.4.4.3

Penetration of the mast wall by a metallic or other conductive fastener to fasten any component of the lightning protection system to the mast shall not be permitted.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Nov 08 11:35:39 EST 2023

Committee Statement

Committee Statement: The consequences of routing a down conductor inside a CFC mast are that sparks form between the down conductor and the mast, current is injected into the composite, and the tensile strength of the mast is compromised as a result of individual fibers overheating. See the annex reference to "Carbon and Lightning", Roby Scalvini, Professional Boatbuilder, Number 128, Dec/Jan 2011, pp. 41-61 is to show the consequences of routing a down conductor internal to CFC mast.

Response Message: FR-86-NFPA 780-2023

First Revision No. 17-NFPA 780-2023 [Section No. A.4.7.2.3]

A.4.7.2.3

The purpose of Figure 4.7.2.4(b) is to provide a graphical representation of the area protected by the upper roof. The reference point is the eave because the criteria in 4.7.3 have been met ~~and, thus~~ , therefore air terminals are not required on the ~~ridge~~ eave . It has been determined that this area is not susceptible to a direct strike.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 09:50:24 EDT 2023

Committee Statement

Committee Statement: The explanatory annex material is corrected by referring to the correct figure and to the correct nomenclature in the figure (i.e., eave, not ridge).

Response Message: FR-17-NFPA 780-2023

Public Input No. 51-NFPA 780-2023 [Section No. A.4.7.2.3]

First Revision No. 20-NFPA 780-2023 [Section No. A.4.13.3]

A.4.13.3

The definitions in *NFPA 70(NEC)* and in this standard for *bonded (bonding)*, *grounded*, *grounding*, and *grounding electrode* are similar. The actual sections in the *NEC* and in this standard that define what constitutes these various items point to differences in application, equipment, and requirements.

Section 250.50 of the *NEC* requires that all electrodes present at each building or structure be bonded together to form the grounding electrode system, which coordinates with the requirements of Section 4.13 of this standard. The differences occur in 250.52 of the *NEC*, which describes grounding electrode devices not shown in Section 4.12. Grounding electrode devices described in 250.52 of the *NEC* but not referenced in this document include the following:

(1) 250.52(A)(1): 10 ft (3 m) of metallic underground water pipe that extends from the structure in contact with earth.

(2) 250.52(A)(2): The 10 ft (3 m) metal in-ground support structure with or without concrete encasement that is in contact with earth.

(3) 250.52(A)(3)(2): The concrete-encased electrode described as #4 AWG, which would need to be a main-size conductor ~~per~~ in accordance with 4.12.3.2.

(4) 250.52(A)(4): The ground ring electrode not smaller than 2 AWG that is acceptable for Class I but would not be acceptable for Class II *(see Table 4.1.1.1.2)*.

(5) 250.52(A)(5): Pipe electrodes described in item (a), which are not included, and rod electrodes described in item (b) as zinc-coated steel, which are not covered *(see 4.12.2.2)*.

(6) 250.52(A)(6): Other listed electrodes, which would need to comply with the various paragraphs of Section 4.12.

(7) 250.52(A)(7): Plate electrodes, which would need to comply with 4.12.6.

(8) 250.52(A)(8): “Other local metal underground systems or structures,” which are not referenced as grounding electrodes in this standard.

The lightning protection system designer must be familiar with these differences to coordinate interconnection with other building grounding electrodes or the structural grounding electrode system as required by 4.13.3.

Where separate but adjacent buildings or facilities are interconnected directly (not through a utility) by electric, CATV, CCTV, data, or communications wiring, the grounding systems of those buildings should be directly interconnected with a main-size conductor. The need for this interconnection can be ~~eliminated~~ minimized with the use of fiber-optic cable, shielded wire, wire run in grounded metallic conduit, or cascading surge protection [surge arresters, surge protective devices (SPDs), or surge protectors installed at the ~~entrance(s) and exit(s)~~ entrances and exits of buildings or facilities].

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 09:56:35 EDT 2023

Committee Statement

Committee Statement:	The text is revised for consistency with the NEC and that the interconnections could be minimized as opposed to eliminated.
Response Message:	FR-20-NFPA 780-2023

Public Input No. 5-NFPA 780-2023 [Section No. A.4.13.3]

Public Input No. 69-NFPA 780-2023 [Section No. A.4.13.3]

First Revision No. 25-NFPA 780-2023 [Section No. A.4.19.2.4]

A.4.19.2.4

Paragraph 4.19.2.4 is not intended to restrict the owner or LPS designer/installer from specifying or installing SPDs when they determine it is beneficial.

Most services to facilities require discrete surge suppression devices to protect against damaging surges. Occasionally, services might be located in an area or manner for which the threat from lightning-induced surges and overvoltage transients is negligible. For example, the requirement in 4.19.2.2 *(see also A.4.19.4.2)* exempts services less than 100 ft (30 m) in length that are run in grounded metal conduit between buildings requiring surge protection. Other examples where SPDs might not be required at each service entrance are those applications for which ~~fiber optic~~ fiber-optic transmission lines (with no conducting members) are used. ~~The~~ This standard recognizes that there might be some exceptions. Consequently, ~~the~~ this standard allows for such exceptions to the requirements for surge suppression on electrical utility, data, and other signal lines ~~provided~~ if a competent engineering authority determines that the threat is negligible or that the system is protected in a manner equivalent to surge suppression protection.

The allowance in this standard for the exemption of surge suppression protection at specific locations is not intended to provide a broad exemption simply because surge suppression equipment might be inconvenient to install. Rather, this allowance recognizes that all possible circumstances and configurations, particularly those in specialized industries, cannot be covered by this standard.

Determinations made by an engineering authority for exempting the installation of SPDs should focus on the likelihood of lightning activity in a region, the level of damage that might be incurred, and the potential loss of human life or essential services due to inadequate overvoltage protection.

The following four methods of analysis are commonly used for this determination, although other equivalent analysis can be used:

(1) A *risk assessment* can be performed in accordance with IEC 62305-2, *Protection Against Lightning — Part 2: Risk Management*, and surge protection requirements can be waived if justified by the assessment.

(2) A *lightning flash density/risk analysis* can be performed to determine the frequency of lightning activity in the geographic area of a facility. As a rule of thumb, if the flash density exceeds one flash per square kilometer per year, surge suppression or other physical protection should be considered. Lightning energy can indirectly couple to services at ranges greater than 0.6 mi (1 km) to create potentially damaging overvoltage.

(3) *Plant/facility statistical or maintenance records* can be used for risk analysis, if they demonstrate the lack of damage on a service caused by surges, ~~as well as to justify~~ and for justifying low risk of surge damage in particular systems or facilities.

(4) A *lightning electromagnetic environment analysis* can take the threat of an electromagnetic field from a nearby lightning strike and compute the magnitude and rise-time characteristics of transients coupled into services feeding a structure or facility. Based on the computed threat, SPDs can be sized appropriately or omitted, as warranted. This analysis is typically performed in critical communications facilities and for military applications. Electromagnetic environments for such an analysis can be found in MIL-STD-464C, ~~*Interface Standard*~~ *Electromagnetic Environmental Effects Requirements for Systems*, and IEC 62305-4, *Protection Against Lightning — Part 4: Electrical and Electronic Systems Within Structures*.

In all cases, the criticality of continued operation, potential hazard to persons and essential services, and consequences of facility damage or shutdown should be considered. If a hazardous condition results from a surge causing temporary shutdown without permanent damage (e.g., due to the disabling of a computer or communication system), then the requirements for surge suppression as articulated by Section 4.19 should not be exempted.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 13:03:35 EDT 2023

Committee Statement

Committee Statement: This clarifies that SPDs are not prohibited from being installed.

Response Message: FR-25-NFPA 780-2023

Public Input No. 106-NFPA 780-2023 [Section No. A.4.19.2.4]

First Revision No. 24-NFPA 780-2023 [Section No. A.11.4.1.1]

A.11.4.1.1

The copper counterpoise conductor size should be determined by the ~~Engineer~~ engineer of ~~Record~~ record based upon sound engineering practices. A 2 AWG bare, solid copper counterpoise conductor is recommended.

The following factors should be evaluated when considering a larger size counterpoise conductor:

(1) The airport's ability to maintain airport operations after an airfield lighting circuit or system failure

(2) Accessibility of the copper counterpoise conductor for testing or repair (e.g., if the counterpoise conductor is installed in or under pavement)

(3) Availability of qualified persons to perform airfield lighting system repairs

(4) Life cycle cost of the larger size counterpoise conductor, including consideration of counterpoise conductor replacement prior to the end of an expected 20-year life

(5) Results of a lightning risk assessment performed in accordance with Annex L

(6) Past performance of the airfield lighting counterpoise system at the airport or geographic area

The AHJ can determine and approve the size of the copper counterpoise conductor.

A 2 AWG solid copper conductor is 66,360 CM (33.6 mm^2). The 2 AWG is a few thousand circular mils larger than the required Class I conductor [57,400 CM (29.1 mm^2)]. However, a 2 AWG is the smallest standard size AWG conductor that complies with this standard's Class I requirements [4 AWG = 41,740 CM (21.1 mm^2), 3 AWG = 52,620 CM (26.7 mm^2)].

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Thu Oct 26 13:00:36 EDT 2023

Committee Statement

Committee Statement: This annex material provides the user of the standard some guidance and rationale for upsizing the conductor.

Response Message: FR-24-NFPA 780-2023

Public Input No. 77-NFPA 780-2023 [Section No. A.11.4.1.1]

First Revision No. 50-NFPA 780-2023 [Section No. A.11.4.2.6.1.2]

A.11.4.2.6.1.2

Airfield pavement systems design is an intricate engineering solution involving a large number of complex variables. Operating aircraft and pavement systems interact with each other. This interaction must be addressed by the pavement design process. Structural designs of airfield pavement systems include the determination of the overall pavement system thickness to achieve the final design objectives. Airfield pavement systems are normally constructed in courses or layers.

Many factors influence the pavement system layer thicknesses required to provide satisfactory pavement system design. Two key components that affect the structural design of the pavement system are the type of pavement and the load-bearing capacity of the supporting materials.

A typical pavement system design might consist of the following layers:

(1) Conditioned and compacted earth fill and subgrade below the pavement system (typically 100 percent compaction required)

(2) Enhanced sub-base course material, including additional layering, or enhanced existing subgrade

(3) Pavement base course (flexible or semi-rigid materials to support the pavement surface materials)

(4) Final pavement surface, either hot mix asphalt (HMA), a flexible pavement typically installed in multiple layers, or Portland cement concrete (PCC), a rigid pavement typically installed in one layer

The thickness of each of the overall pavement layers is determined ~~based on~~ by the structural requirements of the pavement system ~~based~~ contingent on existing conditions, aircraft sizes and weights, number of aircraft operations, environmental factors, and other features.

The airfield lighting system is incorporated into the airfield pavement system. The design of the depth and height of the various airfield lighting system components, including light bases, light base accessories, conduits, and counterpoise conductors, must be adjusted to integrate the components into the varying pavement system layer thicknesses. Although reasonable effort should be made to comply with the 8 in. (200 mm) requirement contained in 11.4.2.6.1.1, it is for these reasons that the variation described in 11.4.2.6.1.2 is necessary.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 11:53:36 EDT 2023

Committee Statement

Committee Statement: The edit clarifies the language in the section.

Response Message: FR-50-NFPA 780-2023

Public Input No. 79-NFPA 780-2023 [Section No. A.11.4.2.6.1.2]

First Revision No. 51-NFPA 780-2023 [Section No. A.11.4.5.1]

A.11.4.5.1

The grounding electrode can be installed in the same excavation or trench as the counterpoise conductor or light base .

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 11:55:14 EDT 2023

Committee Statement

Committee Statement: The grounding electrode can be installed in the same excavation as the counterpoise conductor. The additional language makes this clear to the user.

Response Message: FR-51-NFPA 780-2023

Public Input No. 80-NFPA 780-2023 [Section No. A.11.4.5.1]

First Revision No. 60-NFPA 780-2023 [Section No. B.2.3]

B.2.3

Metal parts of a structure can be used as part of the lightning protection system in some cases. For example, the structural metal framing, which has sufficient cross-sectional area to equal the conductivity of main conductors, and which is electrically continuous, can be used in lieu of separate down conductors. In such cases, air terminals can be bonded to the framework at the top, and grounding electrodes can be provided at the bottom, as described elsewhere in this standard. Structures with 3⁄16 in. (4.8 mm) thick, or thicker, steel ~~metal~~ shells or skins that are electrically continuous might not require a system of air terminals and down conductors.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 13:36:21 EDT 2023

Committee Statement

Committee Statement:	The word steel was added to narrow the scope of this paragraph in Annex B that is covering the principles of lightning protection.
Response Message:	FR-60-NFPA 780-2023

Public Input No. 123-NFPA 780-2023 [Section No. B.2.3]

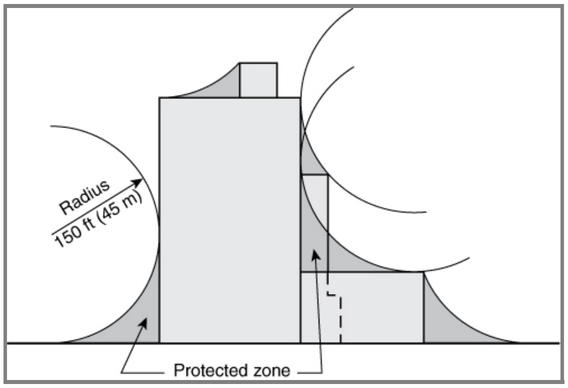
First Revision No. 61-NFPA 780-2023 [Section No. B.3.2.2]

B.3.2.2 Rolling Sphere Method.

The rolling sphere method was incorporated into NFPA 780 in the 1980 edition. It originated from the electric power transmission industry (lightning strike attachment to phase and shield wires of lines) and is based on the simple electrogeometric model. To apply the method, an imaginary sphere is rolled over the structure. All surface contact points are deemed to require protection, while the unaffected surfaces and volumes are deemed to be protected, as shown in Figure B.3.2.2.

The physical basis for the rolling sphere method is the electrogeometric model. Consider a particular peak lightning current I_p (kA) and the corresponding striking distance d_S (m), where $d_S = 10\ I_p^{0.65}$. For a typical peak current of 10 kA, the striking distance is approximately 150 ft (45 m). This is the distance at which a downward leader results in the initiation of an upward leader from the structure.

Figure B.3.2.2 Lightning Protection Design Using the Rolling Sphere Method.



Note that a smaller striking distance (implying a lower peak current of the lightning event) results in a smaller sphere that can intrude upon the standard 150 ft (45 m) zone of protection. Thus, a more conservative design is to size the sphere using a lower lightning peak current. Lightning peak currents below 5 kA to 7 kA are not common. Ten kA peak current represents 91 percent of all lightning events.

The advantage of the rolling sphere method is that it is relatively easy to apply, even to buildings with complicated shapes. However, since it is a simplification of the physical process of lightning attachment to a structure, it has some limitations. The main limitation is that it assigns an equal leader initiation ability to all contact points on the structure; ~~no account is taken of~~ the influence of electric fields in initiating ~~return~~ streamers is not considered , so it does not distinguish between likely and unlikely lightning strike attachment points. ~~In other words, for~~ For a given prospective peak stroke current, the striking distance d_S is a *constant value*. This simplification stems from the RSM's origins in the electrical power transmission industry, where there is considerable uniformity in the parameters of transmission lines (e.g., diameters, heights~~, etc.~~). In reality, lightning could preferentially strike the corner of a building rather than the vertical flat surface halfway down the side of the building. The same claims apply to the flat roof of a structure.

~~Some qualitative indication of the probability of strike attachment to any particular point can be obtained if the sphere is supposed to be rolled over the building in such a manner that its center moves at constant speed. Then the length of time that the sphere dwells on any point of the building gives a qualitative indication of the probability of that point being struck. Thus, for a simple rectangular building with a flat roof, the dwell time would be large at the corners and edges and small at any point on the flat part of the roof, correctly indicating a higher probability of the corners or edges being struck and a low probability that a point on the flat part of the roof will be struck.~~

Where the RSM is applied to a building of height greater than the selected sphere radius, the sphere ~~touches the vertical edges~~ will touch vertical walls without protrusions on the sides of the building at all points above a height equal to the sphere radius. This indicates the possibility of strikes to the sides of the building and raises the question of the need for an air terminal network in these locations. Studies show that strikes to vertical edges on the sides of tall buildings do occur but are not very common. There are theoretical reasons for believing that only flashes with low I_p, and consequently low d_S, values are likely to be able to penetrate below the level of the roof of a building and strike the sides. Hence, the consequences of a strike to the sides of a building could result in damage of a minor nature. Unless there are specific reasons for side protection, as ~~would~~ could be the case of a structure containing explosives, ~~it is considered that the cost of side protection would not normally be justified~~ a lightning risk assessment might be justified to determine whether the risk in such areas justifies protection .

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 13:37:49 EDT 2023

Committee Statement

Committee Statement: The deleted paragraph is specific to a zone of protection software. This revision also makes some editorial changes.

Response Message: FR-61-NFPA 780-2023

Public Input No. 105-NFPA 780-2023 [Section No. B.3.2.2]

First Revision No. 62-NFPA 780-2023 [Section No. D.1.2]

D.1.2 Visual Inspection.

Visual inspections ~~are made to~~ ascertain the following:

(1) The system is in good repair.

(2) There are no loose connections that might result in high-resistance joints.

(3) No part of the system has been weakened by corrosion or vibration.

(4) All down conductors and grounding electrodes are intact (not severed).

(5) All conductors and system components are fastened securely to their mounting surfaces and are protected against accidental mechanical displacement as required.

(6) There have not been additions or alterations to the protected structure that would require additional protection.

(7) There is no visual indication of damage to SPDs~~,~~ and, ~~confirm~~ where provided, status lights ~~where provided~~ are still functioning .

(8) The system complies in all respects with the current edition of this standard.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 14:43:17 EDT 2023

Committee Statement

Committee Statement: The revision to Item 7 clarifies what specifically should be inspected on the SPD.

Response Message: FR-62-NFPA 780-2023

Public Input No. 147-NFPA 780-2023 [Section No. D.1.2]

First Revision No. 66-NFPA 780-2023 [Section No. L.1 [Excluding any Sub-Sections]]

This lightning risk assessment methodology is provided to assist the building owner, safety professional, or architect/engineer in determining the risk of damage or injury due to lightning. This annex provides a simplified, quick-look assessment (Section L.5) and a more detailed assessment for those requiring a more detailed analysis (Section L.6). Once the level of risk has been determined, the development of appropriate lightning protection measures can begin. <u>This annex does not supersede any federal, state, or local requirements of the AHJ.</u>

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 15:42:53 EDT 2023

Committee Statement

Committee Statement: This clarifies that the AHJ is able to require lightning protection even where an assessment indicates a system is not required. This notifies the user that federal, state, and local requirements of the AHJ may require an LPS to be installed regardless of the risk assessment.

Response Message: FR-66-NFPA 780-2023

First Revision No. 83-NFPA 780-2023 [New Section after L.1.2]

L.1.3

This risk assessment method is a guide that considers the sources and causes of lightning damage.

L.1.3.1

The lightning current is the primary source of damage. The following sources are distinguished by the point of strike:

(1) Flashes to the structure (S1)

(2) Flashes near the structure (S2)

(3) Flashes to a line connected to the structure (S3)

(4) Flashes near a line connected to the structure (S4)

L.1.3.2

A lightning flash might cause damage in different ways, depending on the characteristics of the structure being assessed. Some of the most important characteristics are type of construction, contents and application, type of service, and damage protection measures provided.

As a result, four causes of damage might be distinguished:

(1) Electric shock to humans resulting from direct strike to those beings (D1d)

(2) Electric shock to humans resulting from resistive and inductive coupling (D1t)

(3) Dangerous sparking inside structure, triggering fire or explosion and/or leading to mechanical and chemical effects that might also endanger the environment (D2)

(4) Surges due to all sources of damage causing failures of internal systems (D3)

The damage to a structure due to lightning might be limited to a part of the structure or might extend to the entire structure. It can also involve surrounding structures or the environment (e.g., through chemical dispersion, toxic fumes, or radioactive emissions).

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Tue Oct 31 10:35:59 EDT 2023

Committee Statement

Committee Statement: New L.1.3 provides a more general description of the sources of damage and causes of damage, as well as justify the risk components addressed in L.6. This also provides coordination with international and other national lightning risk assessment standards.

Response Message: FR-83-NFPA 780-2023

Public Input No. 98-NFPA 780-2023 [Section No. L.1.3]

First Revision No. 77-NFPA 780-2023 [Section No. L.1.4]

L.1.5

Lightning risk for a structure is the product of the lightning ~~frequency~~ ground-strike density , the exposure ~~vulnerability~~ of the structure, the probability of damage , and the consequence of ~~the~~ a strike to or near the structure or object.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 12:45:31 EDT 2023

Committee Statement

Committee Statement: This revision introduces the transition from flash density to ground-strike density in determining the frequency of damage.

Response Message: FR-77-NFPA 780-2023

Public Input No. 97-NFPA 780-2023 [Section No. L.1.4]

First Revision No. 78-NFPA 780-2023 [Section No. L.2]

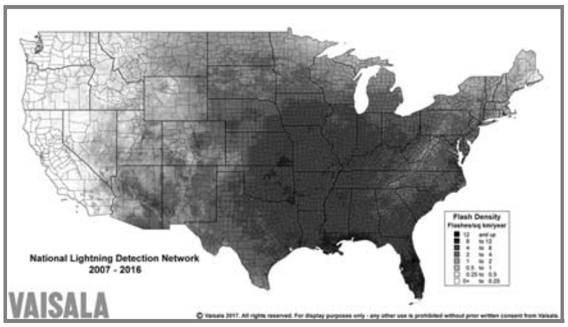
L.2 Lightning ~~Flash~~ Ground-Strike Density (N_{SG}).

~~Lightning flash density, the yearly number of flashes to ground per square kilometer, can be found in Figure L.2 . A color version of this map with resolution of 2 km can be found at www.vaisala.com/en/products/data/data-sets/nldn.~~

L.2.1

Lightning ~~flash~~ ground-strike density, the yearly number of ~~flashes~~ strike points to ground per square kilometer, can be found in Figure L.2.1 . A color version of this map with a resolution of 2 km can be found at www.vaisala.com/en/products/data/data-sets/nldn.

Figure L.2.1 ~~2007–2016~~ Average US Lightning ~~Flash~~ Ground-Strike Density Map (~~Flashes~~ Ground Stikes per Square Kilometer per Year). ***(Courtesy Vaisala, Inc.)***



L.2.2

When ground-strike-point density is not available, ground flash density can be converted to strike-point density by multiplying the value 1.7 times.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 12:48:59 EDT 2023

Committee Statement

Committee Statement: This revision introduces the transition from flash density to ground-strike density in determining the frequency of damage.

Response Message: FR-78-NFPA 780-2023

Public Input No. 128-NFPA 780-2023 [Section No. L.2]

First Revision No. 79-NFPA 780-2023 [Section No. L.3]

L.3 Annual Threat of Occurrence (N_D).

The yearly annual threat of occurrence (N_D) to a structure is determined by the following equation:

$$N_D = (N_G)(A_D)(C_D)(10^{-6}) = \text{events/year}$$

$$N_D = (N_{SG})(A_D)(C_D)(10^{-6}) = \text{ev}$$ [L.3]

where:

N_D = average lightning strike frequency to the structure or object

N_{SG} = lightning ground ~~flash~~ strike-point density ~~in flashes/~~ (km^2/year)

A_D = the equivalent collection area of the structure (m^2)

C_D = location factor

Supplemental Information

File Name	Description	Approved
FR_79_attachment_for_L.3.docx	FR 789 attachment for L.3	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 12:56:39 EDT 2023

Committee Statement

Committee Statement: This revision introduces the transition from flash density to ground-strike density in determining the frequency of damage.

Response Message: FR-79-NFPA 780-2023

Public Input No. 129-NFPA 780-2023 [Section No. L.3]

First Revision No. 80-NFPA 780-2023 [Section No. L.4.2]

L.4.2

The location factor accounts for the topography of the site of the structure and any objects located within the distance 3*H* from the structure that can affect the collection area. Location factors for structures and adjacent structures are given in Table L.4.2.

Table L.4.2 Location Factor, C_D/ C_{DJ}

Relative Structure Location	C_D/ C_{DJ}
Structure surrounded by taller structures or trees within a distance of 3*H*	0.25
Structure surrounded by structures of equal or lesser height within a distance of 3*H*	0.5
Isolated structure, with no other structures located within a distance of 3*H*	1
Isolated structure on hilltop	2

Supplemental Information

File Name	Description	Approved
FR_80_attachment_for_L.4.2.docx	FR 80 attachment for L.4.2.	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 13:07:02 EDT 2023

Committee Statement

Committee Statement: Table L.4.2 is revised to add consideration of the effect of adjacent structures.

Response Message: FR-80-NFPA 780-2023

Public Input No. 131-NFPA 780-2023 [Section No. L.4.2]

First Revision No. 70-NFPA 780-2023 [New Section after L.5.2]

L.5.3 Critical Facilities.

L.5.3.1

The following are identified as critical facilities:

(1) Emergency operations centers (EOCs)

(2) Fire and police stations

(3) Hospitals and other medical facilities

(4) Public works facilities (e.g., water treatment plants, wastewater treatment plants, transportation facilities)

(5) Telecommunications facilities (e.g., telephone and internet service providers)

(6) Hazardous material storage, operating, and processing facilities

(7) Government buildings (e.g., courthouses, city halls)

(8) Educational institutions (e.g., schools, universities)

(9) Energy facilities (e.g., power plants, fuel refineries, natural gas facilities)

(10) Financial institutions (e.g., banks, stock exchanges)

(11) Transportation facilities (e.g., airports, seaports, bus stations, train stations)

L.5.3.2

Critical facilities should have a lightning protection system installed in compliance with this standard or have a detailed risk assessment conducted in accordance with Section L.6 .

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 11:44:12 EDT 2023

Committee Statement

Committee Statement: This annex identifies facilities that may have greater need for a lightning protection system.

Response Message: FR-70-NFPA 780-2023 FEMA was removed as source of the list because it could not be confirmed as the source and retail facilities was removed because lightning damage affects smaller areas than wildfires, floods or hurricanes/tornados.

Public Input No. 113-NFPA 780-2023 [New Section after L.6]

First Revision No. 75-NFPA 780-2023 [Section No. L.6.6 [Excluding any Sub-Sections]]

Each component of risk, R_X, depends on the average annual threat of occurrence, N_X (strikes in the area of interest), the probability of damage, P_X (or step and touch voltages to humans), and the expected loss related to the event, L_X. The value of each component of risk, R_X, can be calculated using the following expression:

$$R_X = N_X P_X L_X \quad \text{[L.6.6]}$$

where:

N_X = number of lightning strikes affecting the structure or service

P_X = probability of damage

L_X = loss factor

Specific formulas for the calculation of the risk components identified in L.6.4 are given in Table L.6.6.

Table L.6.6 Risk Components Formulas

Risk Component	Descriptor
$R_A = N_D P_A L_A$	Risk of injury due to direct strike to structure
$R_B = N_D P_B L_B$	Risk of physical damage to structure due to ~~a~~ direct strike to ~~the~~ structure
$R_C = N_D P_C L_C$	Risk of failure of internal systems due to direct strike to structure
$R_M = N_M P_M L_M$	Risk of failure of internal systems due to strike near structure
$R_U = (N_L + N_{DJ}) P_U L_U$	Risk of injury due to strike to incoming service
$R_V = (N_L + N_{DJ}) P_V L_V$	Risk of physical damage due to direct strike to incoming service
$R_W = (N_L + N_{DJ}) P_W L_W$	Risk of failure of internal systems due to direct strike to incoming service
$R_Z = (N_I - N_L) P_Z L_Z$	Risk of failure of internal systems due to strike near incoming service

Note: Where there are no structures within a distance of three times the height of the structure under consideration, $N_{DJ} = 0$.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 12:24:26 EDT 2023

Committee Statement

Committee Statement: The table note is added to reiterate what constitutes an adjacent structure and how NDJ is treated in the formulas if there are no adjacent structures.

Response Message: FR-75-NFPA 780-2023

First Revision No. 71-NFPA 780-2023 [Section No. L.6.6.1.2]

L.6.6.1.2

The annual threat of occurrence due to strikes near a structure (N_M) is given by the following equation *(see Figure L.6.6.1.2)*:

~~$N_M = N_G (A_M - A_D)(C_D)10^{-6}$ events/year~~ $N_M = N_{SG} (A_M - A_D)(C_D)10^{-6}$ events/year [L.6.6.1.2]

where:

N_{SG} = lightning ground ~~flash~~ strike-point density ~~in flashes/~~ (km^2/year) *(see Section L.2)*

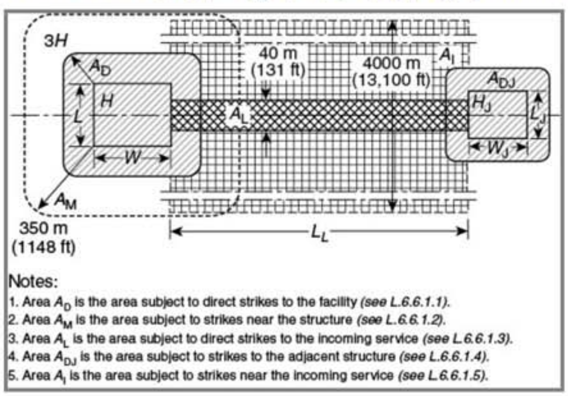
A_M = collection area of ~~flashes~~ ground strike-points near the structure (m^2) *(see Figure L.6.6.1.2)*

A_D = equivalent collection area of the structure (m^2) *(see Figure L.6.6.1.2)*

C_D = environmental coefficient *(see Table L.4.2)*

The collection area for flashes near the structure (A_M) includes the area extending a distance of 350 m (1148 ft) around the perimeter of the structure. For cases where N_M is negative, a value of 0 is ~~assigned to N_M~~ used instead .

Figure L.6.6.1.2 Collection Areas (A_D, ~~A_M~~ , A_L, A_{DJ}, A_I). *(Source: IEC.)*



Supplemental Information

File Name	Description	Approved
FR_71_attachment_for_L.6.6.1.2.docx	FR 71 attachment for L.6.6.1.2	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 11:51:37 EDT 2023

Committee Statement

Committee Statement: The revision introduces the transition from flash density to ground-strike density in determining the frequency of damage. Flash density underestimates total strike density to earth. Ground strike density is a more accurate estimate of total threat.

Response Message: FR-71-NFPA 780-2023

Public Input No. 130-NFPA 780-2023 [Section No. L.6.6.1.2]

First Revision No. 72-NFPA 780-2023 [Section No. L.6.6.1.3]

L.6.6.1.3

The annual threat of occurrence due to a strike to an incoming service (N_L) is characterized by the following formula:

$$N_L = N_G A_L C_E C_T 10^{-6} \text{ events/year} \quad N_L = N_{SG} A_L C_E C_T 10^{-6} \text{ events/year} \quad [L.6.6.1.3]$$

where:

N_{SG} = lightning ground ~~flash~~ strike-point density ~~in flashes/~~ (km^2/year) *(see Section L.2)*

A_L = collection area of ~~flashes striking~~ ground strike-points to the service (m^2) *(see Figure L.6.6.1.2)*

C_E = environmental coefficient of the incoming service *(see Table L.6.7.1)*

C_T = correction factor for the presence of an HV/LV transformer located between the point of strike and the structure

~~where:~~

For the above equation, A_L = 40 × L_L, with the value of L_L = being the length of the incoming service *(see Figure L.6.6.1.2)*. Where the value of L_L is not known, a value of 1 km should be assumed for the assessment.

~~L_L the length of the incoming service *(see Figure L.6.6.1.2)*~~

~~Where the value of L_L is not known, a value of 1 km should be assumed for the assessment.~~

If the installation incorporates underground cables run underneath a ground mesh, A_l could be assumed to be 0 for that cable set (N_L = 0).

C_T applies to line sections between the transformer and the structure. A value of 0.2 is applicable for installations having a transformer located between the strike and the structure. Otherwise, a value of 1 is assigned to this variable.

Supplemental Information

File Name	Description	Approved
FR_72_attachment_for_L.6.6.1.3.docx	FR 72 attachment for l.6.6..1.3	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 12:09:32 EDT 2023

Committee Statement

Committee Statement: The revision introduces the transition from flash density to ground-strike density in determining the frequency of damage. Flash density underestimates total strike density to earth. Ground strike density is a more accurate estimate of total threat.

Response Message: FR-72-NFPA 780-2023

Public Input No. 132-NFPA 780-2023 [Section No. L.6.6.1.3]

First Revision No. 73-NFPA 780-2023 [Section No. L.6.6.1.5]

L.6.6.1.5

The annual threat of occurrence due to flashes near a service (N_I) can be estimated using the following equation:

$$N_I = N_G A_I C_E C_T 10^{-6} \text{events/year} \quad N_I = N_{SG} A_I C_E C_T 10^{-6} \text{events/year} \quad [L.6.6.1.5]$$

where:

N_{SG} = lightning ground ~~flash~~ strike-point density ~~in flashes/~~ (km^2/year) *(see Section L.2)*

A_I = equivalent collection area of ~~flashes to~~ ground strike-points near the service (m^2) *(see Figure L.6.6.1.2)*

C_E = service environmental coefficient *(see Table L.6.7.1 where A_I = 4000 × L_L and L_L = the length of the incoming service)*

C_T = correction factor for the presence of an HV/LV transformer located between the point of strike and the structure

Supplemental Information

File Name	Description	Approved
FR_73_attachment_for_L.6.6.1.5.docx	FR 73 attachment for L.6.6.1.5	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 12:16:37 EDT 2023

Committee Statement

Committee Statement: The revision introduces the transition from flash density to ground-strike density in determining the frequency of damage. Flash density underestimates total strike density to earth. Ground strike density is a more accurate estimate of total threat.

Response Message: FR-73-NFPA 780-2023

Public Input No. 133-NFPA 780-2023 [Section No. L.6.6.1.5]

First Revision No. 74-NFPA 780-2023 [Section No. L.6.7.13]

L.6.7.13

Table L.6.7.13 provides values for the hazard factor, h_Z, of a structure.

Table L.6.7.13 Values for Increasing the Loss Due to a Special Hazard Factor (h_Z)

Kind of Hazard	h_Z
No special hazard	1
Low level of panic (e.g., structures limited to two floors and ~~the number of people not greater~~ less than 100 people)	2
Average level of panic (e.g., structures designed for cultural or sporting events with ~~a number of people between~~ 100 ~~and~~ to 1000 people)	5
Difficulty of evacuation (e.g., structures with immobilized people, such as hospitals)	5
Production facilities where production quantities of electro-explosive devices or flammable or combustible materials might be present	7
Explosives storage in approved magazines	7
High level of panic (e.g., structures designed for cultural or sporting events with ~~the number of people greater~~ more than 1000 people)	10
Hazard to surrounding area or environment	20
Contamination of surrounding area or environment	50

Supplemental Information

File Name	Description	Approved
FR_74_attachement_Table_L.6.7.13.docx	FR 74 attachment for Table L.6.7.13	

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 12:21:14 EDT 2023

Committee Statement

Committee Statement: The additional line items characterize hazards related to frequent questions about how these hazards should be addressed. The hazard factors were selected to reflect the reality of these locations.

Response Message: FR-74-NFPA 780-2023

First Revision No. 1-NFPA 780-2023 [Section No. N.1]

Global FR-88

N.1 General.

The protection of nonmetallic tanks that might contain flammable vapors, flammable gases, or liquids that can give off flammable vapors requires measures above and beyond protection of other structures discussed in this standard. It is recommended that nonmetallic tanks not be used in applications where flammable vapors might be present. The recommendations in this annex are provided to identify methods that can be used to mitigate, but not eliminate, lightning-related damage. ~~It is critical that the lightning protection address the threat of coupling of lightning electromagnetic impulse (LEMP) onto conductors in or on the nonmetallic tank.~~

Among the problems associated with nonmetallic tanks are electrical insulation properties, the accumulation and retention of static charge, thermal energy transmission, and transparency to inducing potentials. Therefore, it is critical that lightning protection address the thermal and physical effects of direct lightning attachment. This should include the thermal effects associated with the successful interception of a direct strike by the lightning protection system. It is critical that the lightning protection address the threat of coupling of lightning electromagnetic pulse (LEMP) onto conductors in or on the nonmetallic tank.

~~When nonmetallic tanks are employed, the lightning protection system design must be studied to ensure that the installation does not create an unintentional hazard. Given the complexity and varied geometries of the systems involved, an in-depth study should be completed to account for all ignition sources that can arise from the installation of the lightning protection system and the interaction with other associated systems. These include direct strikes, LEMP, internal arcing based on the induced voltages, and the associated thermal energies. It must be ensured that these threats are reduced to a level that does not exceed the autoignition properties of the fuel-air mixture that accumulates in the tank.~~

~~The owner/operator should determine the use of nonmetallic tanks based on the risks identified in the study.~~

Despite the fact that a lightning protection system in accordance with Chapter 4 can safely conduct the lightning current to ground, applied potentials of hundreds of kV or more will be impressed directly onto the tank's metallic components which should be bonded to the lightning protection system. Any metallic components that are not bonded to the lightning protection system could create sideflash hazards.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Oct 25 14:31:38 EDT 2023

Committee Statement

Committee Statement: This revision clarifies the pros and cons of non-conductive tanks and clarifies ignition causes.

Response Message: FR-1-NFPA 780-2023

Public Input No. 53-NFPA 780-2023 [Section No. N.1]

First Revision No. 2-NFPA 780-2023 [Section No. N.2]

N.2 Zone of Protection.

~~To protect~~ When the rolling sphere method is used to determine protection against direct strikes to nonmetallic tanks containing flammable vapors, flammable gases, or liquids that can give off flammable vapors, the radius of the rolling sphere should be 100 ft (30 m) or less.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Oct 25 14:34:43 EDT 2023

Committee Statement

Committee Statement: This clarifies that the rolling sphere method for a zone of protection is not the only approach to be considered or a required method per N.1.

Response Message: FR-2-NFPA 780-2023

Public Input No. 103-NFPA 780-2023 [Section No. N.2]

First Revision No. 3-NFPA 780-2023 [Section No. N.4]

N.4 Charge Neutralization.

~~Reduction of differences in potential between the bound charge on the contained product and metallic components internal to the tank should be considered in parallel with and complementary to lightning protection. Accelerating the relaxation of differences in potential can reduce the likelihood of arcing.~~

~~One technique is to install an inductive neutralizer as described in NFPA 77 . This type of device could serve to increase the availability of ions to equalize charge between areas of different charge within the contained product and between charges on the contained product and tank metallic appurtenances.~~

~~This appliance could take the form of a low-impedance, conductive appliance suspended from and electrically bonded to the thief hatch or other grounded tank appurtenance and extending to the bottom of the tank so it penetrates the surface of the fluid at all fill levels. This appliance will not equalize the potential in all areas of the tank but can serve to equalize potential local to the appliance.~~

When oil and gas are extracted, they are accompanied by large volumes of produced water. When the fluid enters a tank, the pressure is reduced such that entrapped gas effervesces out, producing a flammable mixture above the already flammable product. The process of the fluid entering the tank can create charge pockets within the tank. API RP 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents* ; API 12P, *Specification for Fiberglass Reinforced Plastic Tanks* ; NFPA 77 ; and other documents such as those referenced in O.1.2.1 provide recommendations on methods for charge neutralization.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Oct 25 14:38:26 EDT 2023

Committee Statement

Committee Statement: The material provided in N.4 regarding charge neutralization is revised to directly point the reader to the applicable documents that discuss charge neutralization.

Response Message: FR-3-NFPA 780-2023

Public Input No. 104-NFPA 780-2023 [Section No. N.4]

First Revision No. 4-NFPA 780-2023 [New Section after N.5]

N.6 LEMP Mitigation.

It might be advantageous to employ a level of protection applicable to the threat, such as a faraday-like approach coordinated with bonding, grounding, and transient suppression systems, to reduce electromagnetic field effects and to mitigate coupling of LEMP onto conductive masses and conductors on and in a tank.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Wed Oct 25 14:40:23 EDT 2023

Committee Statement

Committee Statement: This new section addresses the problems of LEMP and suggests a potential approach to addressing them.

Response Message: FR-4-NFPA 780-2023

Public Input No. 54-NFPA 780-2023 [New Section after N.5]

First Revision No. 56-NFPA 780-2023 [Section No. O.1.1]

O.1.1 NFPA Publications.

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

NFPA 70®, *National Electrical Code®*, ~~2023~~ 2026 edition.

NFPA 70B, *~~Recommended Practice~~ Standard for Electrical Equipment Maintenance*, ~~2022~~ 2023 edition.

NFPA 70E®, *Standard for Electrical Safety in the Workplace®*, ~~2021~~ 202 4 edition.

NFPA 77, *Recommended Practice on Static Electricity*, ~~2019~~ 2026 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, ~~2020~~ 2025 edition.

NFPA 407, *Standard for Aircraft Fuel Servicing*, 2022 edition.

NFPA 410, *Standard on Aircraft Maintenance*, ~~2020~~ 2025 edition.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 12:45:41 EDT 2023

Committee Statement

Committee Statement: The standards are updated to the current edition.

Response Message: FR-56-NFPA 780-2023

First Revision No. 52-NFPA 780-2023 [Section No. O.1.2.1]

O.1.2.1 API Publications.

American Petroleum Institute, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001-5571.

API 12P, *Specification for Fiberglass Reinforced Plastic Tanks* , 2016.

API 650, *Welded Steel Tanks for Oil Storage*, ~~November~~ 1998, ~~; Errata, April~~ errata 2007.

API RP 545, *Recommended Practice for Lightning Protection of Aboveground Storage Tanks for Flammable or Combustible Liquids*, ~~October~~ 2009.

API RP 2003, *Protection Against Ignitions Arising out of Static, Lightning, and Stray Currents* , 2015, reaffirmed 2020.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 11:59:50 EDT 2023

Committee Statement

Committee Statement: The change updates the API publications to reflect changes since the last cycle and adds API 12P which in now referenced in the standard.

Response Message: FR-52-NFPA 780-2023

Public Input No. 124-NFPA 780-2023 [Section No. O.1.2.1]

First Revision No. 53-NFPA 780-2023 [Section No. O.1.2.6]

Global FR-55

O.1.2.6 UL Publications.

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

UL 497, *~~Safety~~ Protectors for Paired-Conductor Communications Circuits*, ~~2013~~2001, revised 2022.

UL 497A, *~~Standard for~~ Secondary Protectors for Communications Circuits*, 2001, revised 2019.

UL 497B, *~~Standard for~~ Protectors for Data Communications and Fire-Alarm Circuits*, 2004, revised 2022.

UL 497C, *~~Standard for~~ Protectors for Coaxial Communications Circuits*, 2001, revised 2022.

UL 497D, *Outline of Investigation for Component Secondary Protectors for Communications Circuits Used with Specified Voltage Suppression*, 2007.

UL 497E, *Outline of Investigation for Protectors for Antenna Lead-In Conductors*, ~~2007~~2011.

UL 1449, *~~Safety for~~ Surge Protective Devices*, ~~2018~~2021, revised 2022.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 12:00:58 EDT 2023

Committee Statement

Committee Statement: This updates all the UL documents that are applicable to this standard and incorporates the removing the word "Standard" from the title.

Response Message: FR-53-NFPA 780-2023

Public Input No. 136-NFPA 780-2023 [Section No. O.1.2.6]

Public Input No. 151-NFPA 780-2023 [Section No. O.1.2.6]

Public Input No. 125-NFPA 780-2023 [Section No. O.1.2.6]

First Revision No. 67-NFPA 780-2023 [Section No. O.1.2.7]

O.1.2.7 Other Publications.

ANSI C2, *National Electrical Safety Code® (NESC®)*, ~~2017~~ 2023 .

Bengtsson, et al., 2001.

Hernández, et al., 2011.

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

“Lightning Direct Effects Handbook,” Advanced General Aviation Transportation Experiments (AGATE), National Institute for Aviation Research (NIAR), Wichita State University, Kansas, 2002.

López, R. E., and L. R. Holle~~.~~ , “Lightning Casualties and Damages in the United States from 1959 to 1994,” *Journal of Climate*, No. 13 ~~Issue~~ (19) ~~(October 2000)~~ : pp. 3448–3464, October 2000 .

Moore, C. B., et al., ~~W. Rison, J. Mathis, and G. Aulich.~~ “Lightning Rod Improvement Studies,” *Journal of Applied Meteorology and Climatology* , No. 39 (5): pp. ~~:~~ 593–609, May 2000 .

NEMA 250, *Enclosures for Electrical Equipment (1,000 Volts Maximum)*, ~~2018~~ 2020 .

Scalvini, R., “Carbon and Lightning,” *Professional Boatbuilder* , No. 128: pp. 41–61, December/January 2011.

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Mon Oct 30 10:32:35 EDT 2023

Committee Statement

Committee Statement: This adds the new references in annex material to Section 10.3.4 on carbon fiber composites. The references are updated to the current editions.

Response Message: FR-67-NFPA 780-2023

First Revision No. 54-NFPA 780-2023 [Section No. O.2.4]

~~**O.2.4** UL Publications.~~

~~Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.~~

~~UL 497, *Protectors for Paired Conductor Communications Circuits* , revision 2017.~~

~~UL 497A, *Secondary Protectors for Communications Circuits* , revision 2019.~~

~~UL 497B, *Protectors for Data Communications and Fire Alarm Circuits* , revision 2017.~~

~~UL 497C, *Protectors for Coaxial Communications Circuits* , revision 2017.~~

~~UL 497E, *Outline of Investigation for Protectors for Antenna Lead-In Conductors* , revision 2011.~~

Submitter Information Verification

Committee: LIG-AAA

Submittal Date: Fri Oct 27 12:30:01 EDT 2023

Committee Statement

Committee Statement: Section O.2.4 is deleted as the text is already contained in O.1.2.6.

Response Message: FR-54-NFPA 780-2023