Report of the Committee on
Lightning Protection

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

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

The Report of the Technical Committee on **Lightning Protection** is presented for adoption.

This Report was prepared by the **Technical Committee on Lightning Protection** and proposes for adoption, amendments to NFPA 780, **Standard for the Installation of Lightning Protection Systems**, 2004 edition. NFPA 780 is published in the Volume 9 of the 2006 National Fire Codes and in separate pamphlet form.

This Report has been submitted to letter ballot of the **Technical Committee on Lightning Protection**, which consists of 30 voting members. The results of the balloting, after circulation of any negative votes, can be found in the report.

780-1 Log #102 **Final Action: Accept in Principle**
(Entire Document)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Replace "ground terminal" with "grounding electrode" and "ground plate" and "plate electrode" with "ground plate electrode" throughout.
3.3.5.2 ***Loop Conductor.*** A conductor encircling a structure that is used to interconnect grounding electrodes ~~terminals~~, main conductors, or other grounded bodies.
3.3.5.3* ***Main Conductor.*** A conductor intended to be used to carry lightning currents between strike termination devices and grounding electrodes ~~terminals~~.
3.3.16* Lightning Protection System. A complete system of strike termination devices, conductors, grounding electrodes ~~terminals~~, interconnecting conductors, surge suppression devices, and other connectors or fittings required to complete the system.
3.3.18.1* ***Class I Materials.*** Lightning conductors, air terminals, ground terminals, and associated fittings required for the protection of structures not exceeding 23 m (75 ft) in height.
3.3.18.2* ***Class II Materials.*** Lightning conductors, air terminals, ground terminals, and associated fittings required for the protection of structures exceeding 23 m (75 ft) in height.
3.3.29.2 ***Grounding ~~Terminal~~ Electrode.*** The portion of a lightning protection system, such as a ground rod, ground plate electrode, or ground conductor, that is installed for the purpose of providing electrical contact with the earth.
[This change will require movement of the definition from 3.3.29 to 3.3.X.]
4.9 Conductors.
Main conductors shall interconnect all strike termination devices and shall form two or more paths from each strike termination device downward, horizontally, or rising at no more than ¼ pitch to connections with grounding electrodes ~~terminals~~, except as permitted by 4.9.1 and 4.9.2.
4.13 Grounding Electrodes ~~Terminals~~.
4.13.1.1 Each down conductor shall terminate at a grounding ~~terminal~~ electrode dedicated to the lightning protection system.
4.13.1.2 The design, size, depth, and number of grounding electrodes ~~terminals~~ used shall comply with 4.13.2 through 4.13.5.
4.13.1.5 Grounding electrodes ~~terminals~~ shall be copper-clad steel, solid copper, hot-dipped galvanized steel, or stainless steel.
4.13.1.6 Grounding electrodes shall be installed below the frost line where possible (excluding shallow topsoil conditions).
4.13.6* ~~**Plate Electrode or**~~ **Ground Plate Electrode.**
4.13.6.1 A ground ~~plate or~~ plate electrode shall have a minimum thickness of 0.8 mm (0.032 in.) and a minimum surface area of 0.18 m^2 (2 ft^2).
4.13.6.2 The ground plate electrode shall be buried not less than 460 mm (18 in.) below grade.
4.13.7 Combinations. Combinations of the grounding electrodes ~~terminals~~ in Section 4.13 shall be permitted.
4.13.8 Grounding ~~Terminal~~ Electrode Selection Criteria. The site limitations and soil conditions shall determine the selection of the type or combinations of types of grounding ~~terminals~~ electrodes used.
4.13.8.1.3 The cable shall terminate by attachment to a buried copper ground plate electrode at least 0.8 mm (0.032 in.) thick and having a minimum surface area of 0.18 m^2 (2 ft^2).
4.13.8.2 Sandy Soil Conditions. Because sandy or gravelly soil conditions are characterized by high soil resistivity, multiple grounding electrodes shall be used to augment the lightning grounding ~~terminal~~ electrode system.
4.15.4 Ground Terminals. Grounding electrodes ~~terminals~~ for concealed systems shall comply with Section 4.13.
4.15.4.1 Grounding electrodes ~~terminals~~ located under basement slabs or in crawl spaces shall be installed as near as practicable to the outside perimeter of the structure.
4.15.4.2 Where rod or cable conductors are used for grounding electrodes ~~terminals~~, they shall be in contact with the earth for a minimum of 3 m (10 ft) and shall extend to a depth of not less than 3 m (10 ft) below finished grade, except as permitted by 4.13.4 and 4.13.5.
4.16.4 Grounding Electrodes ~~Terminals~~.
4.16.4.1 Grounding electrodes ~~terminals~~ shall be connected to steel columns around the perimeter of the structure at intervals averaging not more than 18 m (60 ft).
4.19.2.1 Horizontal loop conductors used for the interconnection of lightning protection system down~~lead~~ conductors, grounding electrodes ~~terminals~~, or other grounded media shall be sized no smaller than that required for the main lightning conductor, as listed in Table 4.1.1.1(A) and Table 4.1.1.1(B).
4.20.1.2 For structures exceeding 18 m (60 ft) in height, the interconnection of the lightning protection system grounding electrodes ~~terminals~~ and other grounded media shall be in the form of a ground loop conductor.
5.2.1 These slender structures shall require one strike termination device, down conductor, and grounding ~~terminal~~ electrode.
5.2.2 Electrically-continuous metal structures shall require only bonding to grounding electrodes ~~terminals~~.
5.4 Metal Towers and Tanks.
Metal towers and tanks constructed so as to receive a stroke of lightning without damage shall require only bonding to grounding electrodes ~~terminals~~ as required in Chapter 4, except as provided in Chapter 7.
6.4.2.2 They shall be located on opposite sides of the stack and shall lead from the loop conductor at the top to grounding electrodes ~~terminals~~.
6.9.1 A grounding ~~terminal~~ electrode suitable for the soil conditions encountered shall be provided for each down conductor.
6.9.2 Grounding electrodes ~~terminals~~ shall be in accordance with Section 4.13, except ground rods shall be ~~a~~ copper-clad or stainless steel rods having a diameter of not less than 15 mm (5/8 in.) and shall be at least 3 m (10 ft) in length.
6.10.2 Such metal stacks shall be grounded by means of at least two grounding electrodes ~~terminals~~ located on opposite sides of the stack.
7.4.1.4.2 A metal tank shall be grounded by one of the methods in 7.4.1.4.2(A) through 7.4.1.4.2(D).
(A) A tank shall be connected without insulated joints to a grounded metallic piping system.
(B) A vertical cylindrical tank shall rest on earth or concrete and shall be at least 6 m (20 ft) in diameter, or shall rest on bituminous pavement and shall be at least 15 m (50 ft) in diameter.
(C) A tank shall be bonded to ground through a minimum of two grounding electrodes ~~terminals~~, as described in Section 4.13, at maximum 30 m (100 ft) intervals along the perimeter of the tank.
(D) A tank installation using an insulating membrane beneath for environmental or other reasons shall be grounded as in 7.4.1.4.2(C).
8.2.3.2 The thickness of any copper ribbon or strip (except for ground~~ing~~ plate~~s~~ electrodes and strips as discussed in 8.5.4) shall be not less than 20 AWG.
8.3.5.1 The conductor shall be routed vertically to the maximum extent practical (minimizing bends, etc.) to the lightning ground~~ing~~ plate electrode, the lightning grounding strip under the watercraft, or to an equalization bus.
8.4.4.2 Large metallic masses that are subject to sideflashes shall be connected to the lightning ground~~ing~~ plate~~(s)~~ electrode(s), the lightning grounding strip, or to the equalization bus, if provided, in accordance with Section 8.6.
8.4.5 Metallic Tanks. Metallic tanks shall be connected directly to the lightning ground plate~~(s)~~ electrode(s), the lightning grounding strip, or the equalization bus.
8.4.6.1 Shrouds and stays shall be permitted as part of the path to ground from the mast (strike termination device) to the lightning ground~~ing~~ plate electrode or strip.
8.4.6.3 Where stainless steel shrouds and stays are used in the lightning protection system, every shroud or stay shall be connected at its lower end or at the chainplates directly to the lightning ground~~ing~~ plate electrode or lightning grounding strip with conductors having the minimum size of an 8 AWG copper conductor.
8.5.4 Watercraft with Nonmetallic Hulls. Ground~~ing~~ plate~~s~~ electrodes or strips shall be installed on the underside of the hull of nonmetallic watercraft to provide a path for the lightning current into the water.
8.5.4.1 Ground~~ing~~ Plate Electrode.
8.5.4.1.1 A ground~~ing~~ plate electrode of copper, copper alloys, or stainless steel shall be provided.
8.5.4.1.2 The ~~plate~~ electrode shall have a minimum size of 0.09 m^2 4.8 mm (1 ft^2 in.) thick.
8.5.4.1.3 The ~~plate~~ electrode shall be located as closely as possible below the strike termination device.
8.6.2* Seacocks and Through-Hull Fittings. Seacocks and through-hull fittings shall not be connected to the main down conductor but shall be permitted to be connected to the underwater grounding strip, the lightning ground~~ing~~ plate electrode, or the equalization bus.
8.6.3 Metal Masses. Metal masses such as engines, generators, metallic tanks, steering systems located inside the vessel, and metal life rails shall be connected to the lightning ground~~ing~~ plate electrode, grounding strip, or equalization bus as directly as possible.
8.6.4 Engine Grounding. To minimize the flow of the lightning discharge currents through the engine bearings, the engine block shall be permitted to be grounded directly to the lightning ground~~ing~~ plate electrode or lightning grounding strip rather than to an intermediate point in the system.
8.7.1 Sailboats. Sailboats without inboard engines that are equipped with metallic masts and metallic rigging shall be considered protected if the mast and the rigging chain plates are all connected to a lightning ground~~ing~~ plate electrode or lightning grounding strip located directly below the mast.
8.7.1.1.2 The rigging, metal masts, or metallic tracks on nonmetallic masts shall be connected at the lower ends to a lightning ground~~ing~~ plate electrode or a lightning strip located directly below the mast.

8.7.1.1.5 Metallic keels or centerboards shall be connected directly to the lightning ground~~ing~~ plate electrode or strip or shall be permitted to serve as the lightning grounding means if they provide the 0.09 m^2 (1 ft^2) area required to be in contact with the water.

A.4.20.1 For structures 18 m (60 ft) or less in height, a loop conductor should be provided for the interconnection of all grounding electrodes ~~terminals~~ and other grounded media. Regardless of the building height, ground loop conductors should be installed underground in contact with earth. Ground-level potential equalization allows use of a ground ring electrode as a ground loop conductor. A ground ring electrode conforming to 4.13.4 can be utilized for the ground loop conductor.

A.6.9 A ground grid located within 15 m (50 ft) of the foundation of a stack and constructed of wires meeting the requirements of this standard for main conductors is a permitted grounding ~~terminal~~ electrode and, if the stack is located within 15 m (50 ft) of the grid in all directions, can also serve as the bottom loop conductor required by 6.4.2.

B.1.1 The fundamental principle in the protection of life and property against lightning is to provide a means by which a lightning discharge can enter or leave the earth without resulting damage or loss. A low impedance path that the discharge current will follow in preference to all alternative high impedance paths offered by building materials such as wood, brick, tile, stone, or concrete should be offered. When lightning follows the higher impedance paths, damage can be caused by the heat and mechanical forces generated during the passage of the discharge. Most metals, being good electrical conductors, are virtually unaffected by either the heat or the mechanical forces if they are of sufficient size to carry the current that can be expected. The metallic path must be continuous from the grounding ~~terminal~~ electrode to the strike termination device. Care should be exercised in the selection of metal conductors to ensure the integrity of the lightning conductor for an extended period. A nonferrous metal such as copper or aluminum will provide, in most atmospheres, a lasting conductor free of the effects of rust or corrosion.

B.2.1 Lightning protection systems consist of the following three basic parts that provide the low impedance metal path required:

(1) A system of strike termination devices on the roof and other elevated locations

(2) A system of grounding electrodes ~~terminals~~

(3) A conductor system connecting the strike termination devices to the grounding electrodes. ~~terminals~~

Properly located and installed, these basic components improve the likelihood that the lightning discharge will be conducted harmlessly between the strike termination devices and the grounding electrodes ~~terminals~~.

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 lightning 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 ~~terminals~~ can be provided at the bottom, as described elsewhere in this standard. Structures with 4.8 mm (3/16 in.) thick, or thicker, metal shells or skins that are electrically continuous might not require a system of air terminals and down conductors.

B.3.8 Where practicable, each grounding ~~terminal~~ electrode connection should extend or have a branch that extends below and at least 0.6 m (2 ft) away from the foundation walls of the building in order to minimize the likelihood of damage to foundation walls, footings, and stemwalls.

C.2.1 Resistive Effect. In the situation where conductor *C* is connected only to a grounding ~~terminal~~ electrode and the water pipe is independently grounded, a large potential can exist between *B* and *F*. Assuming a resistance of 20 ohms between *C* and ground and a lightning current of 100,000 amps, then Ohm's law (voltage = current × resistance) indicates that a potential of 2 million volts exists on conductor *ABC*. Because no current is initially passing through the water pipe, its potential is zero volts. The difference of potential of 2 million volts between *B* and *F* is sufficient for a sideflash of over 1.8 m (6 ft). In order to reduce this potential difference to zero, this standard requires equalization of potentials at ground level in accordance with 4.20.1. Such a bond is shown as *CD* in Figure C.2.

D.1.2(4) All down conductors and grounding electrodes ~~terminals~~ are intact (nonsevered).

D.1.5 (4) Resistance measurements of various parts of the grounding ~~terminal~~ electrode system

D.2.2.2 (4) Measurement of resistance of grounding electrodes ~~terminals~~

F.2.5 Grounding Electrodes ~~Terminals~~. Grounding electrodes ~~terminals~~ for conductors should be in accordance with the following:

G.1.1.2 (3) Bonding structural steel to the grounding ~~terminal~~ electrode.

G.1.1.3 (3) The grid perimeter should be connected to grounding electrodes ~~terminals~~ with radial grounding extensions recommended.

G.1.2 Masts and Overhead Ground Wires. Masts (poles) on opposite sides of the grounds and near the edges should be erected. Overhead wires should be strung between the masts at least 6 m (20 ft) above the ground level. Down conductors should be connected to the overhead wires with grounding electrodes ~~terminals~~. Down conductors should be shielded with material resistant to impact and climate conditions to at least a 2.4 m (8 ft) height. The wires should be not less than 4 AWG copper or equivalent. Where steel masts are used, down leads are not necessary, but the foot of the mast should be grounded. If the area to be protected is extensive, it might be necessary to erect several masts around the perimeter so that the area is covered by a network of wires to form a zone of protection. *[See* Figure 7.3.3.2 *for an example.]*

Substantiation: The Grounding and Editorial Task Groups noted interchangeable use of the terms "ground terminal" and "grounding electrode" (for instance 4.13 1 uses each term 3 times) and the interchangeable use of the terms "ground plate," "plate electrode," and "ground plate electrode." The Task Group on Grounding recommends that a single term be chosen for each of the applications. "Grounding electrode" and "ground plate electrode" were chosen to make the terminology consistent with that used in the National Electrical Code.

Committee Meeting Action: Accept in Principle

Revise the following to read as follows:

3.3.5.2 Loop Conductor. A conductor encircling a structure that is used to interconnect grounding electrodes, main conductors, or other grounded bodies.

3.3.5.3* Main Conductor. A conductor intended to be used to carry lightning currents between strike termination devices and grounding electrodes.

3.3.16* Lightning Protection System. A complete system of strike termination devices, conductors, grounding electrodes, interconnecting conductors, surge suppression devices, and other connectors or fittings required to complete the system.

3.3.18.1* Class I Materials. Lightning conductors, air terminals, grounding electrodes, and associated fittings required for the protection of structures not exceeding 23 m (75 ft) in height.

3.3.18.2* Class II Materials. Lightning conductors, air terminals, grounding electrodes, and associated fittings required for the protection of structures exceeding 23 m (75 ft) in height.

Delete 3.3.29.2

Add new 3.3.14 to read as follows:

Grounding Electrode. The portion of a lightning protection system, such as a ground rod, ground plate electrode, or ground conductor, that is installed for the purpose of providing electrical contact with the earth.

Delete 3.3.29 Terminal.

Renumber 3.3.29.1 to be 3.3.29.

Renumber 3.3 to put definitions in alphabetical order.

4.9 Conductors.

Main conductors shall interconnect all strike termination devices and shall form two or more paths from each strike termination device downward, horizontally, or rising at no more than ¼ pitch to connections with grounding electrodes, except as permitted by 4.9.1 and 4.9.2.

4.13 Grounding Electrodes.

4.13.1.1 Each down conductor shall terminate at a grounding electrode dedicated to the lightning protection system.

4.13.1.2 The design, size, depth, and number of grounding electrodes used shall comply with 4.13.2 through 4.13.5.

4.13.1.5 Grounding electrodes shall be copper-clad steel, solid copper, hot-dipped galvanized steel, or stainless steel.

4.13.1.6 Grounding electrodes shall be installed below the frost line where possible (excluding shallow topsoil conditions).

In FIGURE 4.13.4, change "Optional ground terminals" to "Optional grounding electrodes"

4.13.6* Plate Electrode or Ground Plate Electrode.

4.13.6.1 A ground plate or plate electrode shall have a minimum thickness of 0.8 mm (0.032 in.) and a minimum surface area of 0.18 m2 (2 ft 2).

4.13.6.2 The ground plate electrode shall be buried not less than 460 mm (18 in.) below grade.

4.13.7 Combinations. Combinations of the grounding electrodes in Section 4.13 shall be permitted.

4.13.8 Grounding Electrode Selection Criteria. The site limitations and soil conditions shall determine the selection of the type or combinations of types of grounding electrodes used.

4.13.8.1.3 The cable shall terminate by attachment to a buried copper ground plate electrode at least 0.8 mm (0.032 in.) thick and having a minimum surface area of 0.18 m2 (2 ft 2).

4.13.8.2 Sandy Soil Conditions. Because sandy or gravelly soil conditions are characterized by high soil resistivity, multiple grounding electrodes shall be used to augment the lightning grounding electrode system.

4.15.4 Grounding Electrodes. Grounding electrodes for concealed systems shall comply with Section 4.13.

4.15.4.1 Grounding electrodes located under basement slabs or in crawl spaces shall be installed as near as practicable to the outside perimeter of the structure.

4.15.4.2 Where rod or cable conductors are used for grounding electrodes, they shall be in contact with the earth for a minimum of 3 m (10 ft) and shall extend to a depth of not less than 3 m (10 ft) below finished grade, except as permitted by 4.13.4 and 4.13.5.

4.16.4 Grounding Electrodes.

4.16.4.1 Grounding electrodes shall be connected to steel columns around the perimeter of the structure at intervals averaging not more than 18 m (60 ft).

4.19.2.1 Horizontal loop conductors used for the interconnection of lightning protection system down conductors, grounding electrodes, or other grounded media shall be sized no smaller than that required for the main lightning conductor, as listed in Table 4.1.1.1(A) and Table 4.1.1.1(B).

4.20.1.2 For structures exceeding 18 m (60 ft) in height, the interconnection of the lightning protection system grounding electrodes and other grounded media shall be in the form of a ground loop conductor.

5.2.1 These slender structures shall require one strike termination device, down conductor, and grounding electrode.

5.2.2 Electrically-continuous metal structures shall require only bonding to grounding electrodes.

5.4 Metal Towers and Tanks.

Metal towers and tanks constructed so as to receive a stroke of lightning without damage shall require only bonding to grounding electrodes as required in Chapter 4, except as provided in Chapter 7.

6.4.2.2 They shall be located on opposite sides of the stack and shall lead from the loop conductor at the top to grounding electrodes.

6.9.1 A grounding electrode suitable for the soil conditions encountered shall be provided for each down conductor.

6.9.2 Grounding electrodes shall be in accordance with Section 4.13, except ground rods shall be a copper-clad or stainless steel rods having a diameter of not less than 15 mm (5/8 in.) and shall be at least 3 m (10 ft) in length.

6.10.2 Such metal stacks shall be grounded by means of at least two grounding electrodes located on opposite sides of the stack.

7.4.1.4.2 A metal tank shall be grounded by one of the methods in 7.4.1.4.2(A) through 7.4.1.4.2(D).

(A) A tank shall be connected without insulated joints to a grounded metallic piping system.

(B) A vertical cylindrical tank shall rest on earth or concrete and shall be at least 6 m (20 ft) in diameter, or shall rest on bituminous pavement and shall be at least 15 m (50 ft) in diameter.

(C) A tank shall be bonded to ground through a minimum of two grounding electrodes, as described in Section 4.13, at maximum 30 m (100 ft) intervals along the perimeter of the tank.

(D) A tank installation using an insulating membrane beneath for environmental or other reasons shall be grounded as in 7.4.1.4.2(C).

8.2.3.2 The thickness of any copper ribbon or strip (except for grounding plate electrodes and strips as discussed in 8.5.4) shall be not less than 20 AWG.

8.3.5.1 The conductor shall be routed vertically to the maximum extent practical (minimizing bends, etc.) to the lightning grounding plate electrode, the lightning grounding strip under the watercraft, or to an equalization bus.

8.4.4.2 Large metallic masses that are subject to sideflashes shall be connected to the lightning grounding plate(s) electrode(s), the lightning grounding strip, or to the equalization bus, if provided, in accordance with Section 8.6.

8.4.5 Metallic Tanks. Metallic tanks shall be connected directly to the lightning ground plate(s) electrode(s), the lightning grounding strip, or the equalization bus.

8.4.6.1 Shrouds and stays shall be permitted as part of the path to ground from the mast (strike termination device) to the lightning grounding plate electrode or strip.

8.4.6.3 Where stainless steel shrouds and stays are used in the lightning protection system, every shroud or stay shall be connected at its lower end or at the chainplates directly to the lightning grounding plate electrode or lightning grounding strip with conductors having the minimum size of an 8 AWG copper conductor.

8.5.4 Watercraft with Nonmetallic Hulls. Grounding plate electrodes or strips shall be installed on the underside of the hull of nonmetallic watercraft to provide a path for the lightning current into the water.

8.5.4.1 Grounding Plate Electrode.

8.5.4.1.1 A grounding plate electrode of copper, copper alloys, or stainless steel shall be provided.

8.5.4.1.2 The plate electrode shall have a minimum size of 0.09 m2 x 4.8 mm (1 ft2 in.) thick.

8.5.4.1.3 The plate electrode shall be located as closely as possible below the strike termination device.

8.6.2* Seacocks and Through-Hull Fittings. Seacocks and through-hull fittings shall not be connected to the main down conductor but shall be permitted to be connected to the underwater grounding strip, the lightning grounding plate electrode, or the equalization bus.

8.6.3 Metal Masses. Metal masses such as engines, generators, metallic tanks, steering systems located inside the vessel, and metal life rails shall be connected to the lightning grounding plate electrode, grounding strip, or equalization bus as directly as possible.

8.6.4 Engine Grounding. To minimize the flow of the lightning discharge currents through the engine bearings, the engine block shall be permitted to be grounded directly to the lightning grounding plate electrode or lightning grounding strip rather than to an intermediate point in the system.

8.7.1 Sailboats. Sailboats without inboard engines that are equipped with metallic masts and metallic rigging shall be considered protected if the mast and the rigging chain plates are all connected to a lightning grounding plate electrode or lightning grounding strip located directly below the mast.

8.7.1.1.2 The rigging, metal masts, or metallic tracks on nonmetallic masts shall be connected at the lower ends to a lightning grounding plate electrode or a lightning strip located directly below the mast.

8.7.1.1.5 Metallic keels or centerboards shall be connected directly to the lightning grounding plate electrode or strip or shall be permitted to serve as the lightning grounding means if they provide the 0.09 m^2 (1 ft^2) area required to be in contact with the water.

A.4.20.1 For structures 18 m (60 ft) or less in height, a loop conductor should be provided for the interconnection of all grounding electrodes and other grounded media. Regardless of the building height, ground loop conductors should be installed underground in contact with earth. Ground-level potential equalization allows use of a ground ring electrode as a ground loop conductor. A ground ring electrode conforming to 4.13.4 can be utilized for the ground loop conductor.

A.6.9 A ground grid located within 15 m (50 ft) of the foundation of a stack and constructed of wires meeting the requirements of this standard for main conductors is a permitted grounding electrode and, if the stack is located within 15 m (50 ft) of the grid in all directions, can also serve as the bottom loop conductor required by 6.4.2.

B.1.1 The fundamental principle in the protection of life and property against lightning is to provide a means by which a lightning discharge can enter or leave the earth without resulting damage or loss. A low impedance path that the discharge current will follow in preference to all alternative high impedance paths offered by building materials such as wood, brick, tile, stone, or concrete should be offered. When lightning follows the higher impedance paths, damage can be caused by the heat and mechanical forces generated during the passage of the discharge. Most metals, being good electrical conductors, are virtually unaffected by either the heat or the mechanical forces if they are of sufficient size to carry the current that can be expected. The metallic path must be continuous from the grounding electrode to the strike termination device. Care should be exercised in the selection of metal conductors to ensure the integrity of the lightning conductor for an extended period. A nonferrous metal such as copper or aluminum will provide, in most atmospheres, a lasting conductor free of the effects of rust or corrosion.

B.2.1 Lightning protection systems consist of the following three basic parts that provide the low impedance metal path required:

(1) A system of strike termination devices on the roof and other elevated locations

(2) A system of grounding electrodes

(3) A conductor system connecting the strike termination devices to the grounding electrodes

Properly located and installed, these basic components improve the likelihood that the lightning discharge will be conducted harmlessly between the strike termination devices and the grounding electrodes.

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 lightning 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 4.8 mm (3/16 in.) thick, or thicker, metal shells or skins that are electrically continuous might not require a system of air terminals and down conductors.

B.3.8 Where practicable, each grounding electrode connection should extend or have a branch that extends below and at least 0.6 m (2 ft) away from the foundation walls of the building in order to minimize the likelihood of damage to foundation walls, footings, and stemwalls.

C.2.1 Resistive Effect. In the situation where conductor C is connected only to a grounding electrode and the water pipe is independently grounded, a large potential can exist between B and F. Assuming a resistance of 20 ohms between C and ground and a lightning current of 100,000 amps, then Ohm's law (voltage = current resistance) indicates that a potential of 2 million volts exists on conductor ABC. Because no current is initially passing through the water pipe, its potential is zero volts. The difference of potential of 2 million volts between B and F is sufficient for a sideflash of over 1.8 m (6 ft). In order to reduce this potential difference to zero, this standard requires equalization of potentials at ground level in accordance with 4.20.1. Such a bond is shown as CD in Figure C.2.

D.1.2(4) All down conductors and grounding electrodes are intact (nonsevered).

D.1.3(2) Ground resistance tests of the grounding electrode termination system and its individual ground electrodes, if…

D.1.5 (4) Resistance measurements of various parts of the grounding electrode system

D.2.2.2 (4) Measurement of resistance of grounding electrodes

F.2.5 Grounding Electrodes. Grounding electrodes for conductors should be in accordance with the following:

G.1.1.2 (3) Bonding structural steel to the grounding electrode.

G.1.1.3 (3) The grid perimeter should be connected to grounding electrodes with radial grounding extensions recommended.

G.1.2 Masts and Overhead Ground Wires. Masts (poles) on opposite sides of the grounds and near the edges should be erected. Overhead wires should be strung between the masts at least 6 m (20 ft) above the ground level. Down conductors should be connected to the overhead wires with grounding electrodes. Down conductors should be shielded with material resistant to impact and climate conditions to at least a 2.4 m (8 ft) height. The wires should be not less than 4 AWG copper or equivalent. Where steel masts are used, down leads are not necessary, but the foot of the mast should be grounded. If the area to be protected is extensive, it might be necessary to erect several masts around the perimeter so that the area is covered by a network of wires to

form a zone of protection. [See Figure 7.3.3.2 for an example.]
Committee Statement: The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-2 Log #CP1 **Final Action: Accept in Principle in Part**
(Chapter 3 Definitions (GOT))

Submitter: Technical Committee on Lightning Protection
Recommendation: Adopt the preferred definitions from the NFPA Glossary of Terms for the following terms:
Bonding. (preferred) NFPA 79, 2002 ed.
The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct any current likely to be imposed.
Bonding. (secondary) NFPA 780, 2004 ed.
An electrical connection between an electrically conductive object and a component of a lightning protection system that is intended to significantly reduce potential differences created by lightning currents.
Cable. (preferred) NFPA 70, 2005 ed.
A factory assembly of two or more conductors having an overall covering.
Cable. (secondary) NFPA 780, 2004 ed.
A conductor formed of a number of wires stranded together.
Class I Flammable Liquid. (preferred) NFPA 30, 2003 ed.
Any liquid that has a closed-cup flash point below 37.8°C (100°F) and a Reid vapor pressure not exceeding 2068.6 mm Hg (40 psia) at 37.8°C (100°F).
Class I Flammable Liquid. (secondary) NFPA 780, 2004 ed.
Any liquid that has a closed-cup flash point below 37.8°C (100°F) and having a vapor pressure not exceeding 2068 mm Hg (40 psia) at 37.8°C (100°F).
Fastener. (preferred) NFPA 1914, 2002 ed.
A mechanical device, such as a rivet, bolt, screw, or pin, that is used to hold two or more components together securely.
Fastener. (secondary) NFPA 780, 2004 ed.
An attachment device used to secure the conductor to the structure.
High-Rise Building. (preferred) NFPA 5000, 2002 ed.
A building greater than 23 m (75 ft) in height where the building height is measured from the lowest level of fire department vehicle access to the floor of the highest occupiable story.
High-Rise Building. (secondary) NFPA 780, 2004 ed.
A structure exceeding 23 m (75 ft) in height.
Transient Voltage Surge Suppressor (TVSS). (preferred) NFPA 70, 2005 ed.
A protective device for limiting transient voltages by diverting or limiting surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions.
Transient Voltage Surge Suppressor (TVSS). (secondary) NFPA 780, 2004 ed.
A surge protective device listed for connection on the load side of the main overcurrent protection in circuits not exceeding 600 volts rms.
Substantiation: Adoption of preferred definitions will assist the user by providing consistent meaning of defined terms throughout the National Fire Codes.
Committee Meeting Action: Accept in Principle in Part
Delete 3.3.15 High-Rise Building.
Retain the secondary definitions for Bonding, Cable, Fasteners. Adopt the preferred definitions for Class I Flammable Liquid and Transient Voltage Surge Suppression (TVSS).
Renumber remaining sections.
Committee Statement: The Committee chooses to retain the secondary definitions for Bonding, Cable, Fastener as they are specifically required for the use of NFPA 780.
The committee accepts the submitter's recommendation to adopt the preferred definitions for Class I Flammable Liquid, Transient Voltage Surge Suppressor (TVSS).
Delete 3.3.15 High-Rise Building as this term is not used in the document.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-3 Log #101 **Final Action: Accept in Principle**
(3.3 & A.3.3)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Insert new definitions in 3.3 for Nominal Discharge Current and Voltage Protection Level as follows:
3.3.X Nominal Discharge Current (In) - Peak value of 8/20 µs current waveform selected by the manufacturer for which an SPD remains functional after 15 surges.
3.3.Y * Voltage Protection Level (VPL) - A rating (or ratings) selected by the manufacturer based on the measured limiting voltage determined when the SPD is subjected to a 3 kA, 8/20 µs current waveform. The value is rounded up to the next highest 100V level.
A.3.3.Y Voltage Protection Level (VPL) - This VPL is not the same as the Voltage Protection Level (Up) in IEC 61643-1. Up is determined at In (which the manufacturer can nominate), while VPL is determined at a fixed value of 3kA, 8/20 µs for all SPDs.
Substantiation: The Task Group on Surge Protection submitted proposals introducing the terms "nominal discharge current" and "voltage protection level." If these proposals are accepted, definitions for these terms will be required. This proposal forwards recommended definitions for these terms.
Committee Meeting Action: Accept in Principle
Insert new definitions in 3.3 for Nominal Discharge Current and Voltage Protection Level as follows:
3.3.X Nominal Discharge Current (I_n) - Peak value of 8/20 µs current waveform selected by the manufacturer for which an SPD remains functional after 15 surges.
3.3.Y * Voltage Protection Level (VPL) - A rating (or ratings) selected by the manufacturer based on the measured limiting voltage determined when the SPD is subjected to a combination waveform with 6 kV open circuit voltage and 3 kA short circuit current. The value is rounded up to the next highest 100 V level.
A.3.3.Y Voltage Protection Level (VPL) - This VPL is not the same as the Voltage Protection Level (U_p) in IEC 61643-1. U_p is determined at I_n (which the manufacturer can nominate), while VPL is determined at a fixed value of 3 kA, 8/20 µs for all SPDs.
Add the following to N.2.1 IEC Publications.:
IEC 61643-1, Low-voltage surge protective devices - Part 1: Surge protective devices connected to low-voltage power distribution systems - Requirements and tests, 2005
Committee Statement: The submitter's recommendation was based on the proposed UL 1449, third Edition, at the date of submission. The committee updates the text to conform with the now revised definitions to the proposed UL 1449, third Edition. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-4 Log #4 **Final Action: Accept**
(3.3.3)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...with a cross-sectional area, of the flue, less than...".
Substantiation: Identifies which part of the chimney the required measurement applies to.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 24 Negative: 2
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
GUTHRIE, M.: Based on the wording of the definition of "Heavy-Duty Stack," it is agreed that the original intent of the definition of chimney is that it is the flue for which the cross-sectional area is defined. Upon reviewing the document for the definitions and usage of the terms "chimney" and "heavy-duty stack," it is clear that the purpose of the definition is to identify that the term "chimney" (as used in the document) refers to items containing a flue that do not meet the requirements of a "heavy-duty stack." I believe that it would be much clearer to the user of the document if we simply stated such. Otherwise, how is one to deal with those cases such as shown in Figure 4.8.8.3 where a chimney contains multiple flues? Do we add the cross-sectional area of the flues or use only one (maybe the largest if they are different sizes)?
If it is primarily height that is the key factor, why not delete the cross-section of the flue from the definition of the two terms? Is it a practical design to have a "chimney" over 75 feet high with a flue cross sectional area of less than 500 square inches?
It is recommended that the definition for chimney be revised as follows:
" **3.3.3 Chimney.** A construction containing one or more flues that does not meet the criteria defined for Heavy-Duty Stack."
TOBIAS, J.: Comments from Guthrie are correct and need consideration.

780-5 Log #5 **Final Action: Accept**
(3.3.4)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...and an 8/20 µs short circuit...".
Substantiation: Adds units to a quantity.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-6 Log #99 **Final Action: Accept in Principle**
(3.3.4)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Insert "µs" after 8/20 as shown below:
3.3.4* Combination Waveform Generator. A surge generator with a 2-ohm internal impedance producing a 1.2/50 µs open circuit voltage and an 8/20 µs short-circuit current waveshape.
Substantiation: For consistency with IEEE and ISO designations and the open-circuit voltage designation.
Committee Meeting Action: Accept in Principle
Committee Statement: See Committee Action on Proposal 780-5 (Log #5).
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-7 Log #6 **Final Action: Accept in Principle**
(3.3.5.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...grounded metal bodies, electrically conductive objects, and a...".
Substantiation: Makes requirement consistent with 3.3.1.
Committee Meeting Action: Accept in Principle
Revise 3.3.5.1 to read as follows:
3.3.5.1 Bonding Conductor. A conductor used for potential equalization between grounded metal bodies, or electrically conductive objects, and a lightning protection system.
Committee Statement: The Committee accepts the submitter's recommendation but adds the word "or". The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-8 Log #7 **Final Action: Accept in Principle**
(3.3.5.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...or other grounded or electrically conductive bodies."
Substantiation: Makes requirement consistent with 3.3.1.
Committee Meeting Action: Accept in Principle
Revise 3.3.5.2 to read as follows:
3.3.5.2 Loop Conductor. A conductor encircling a structure that is used to interconnect ground terminals, main conductors, or other electrically conductive bodies.
Committee Statement: The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-9 Log #103 **Final Action: Accept in Principle**
(3.3.16)

Submitter: Thomas R. Harger, Harger Lightning Protection, Inc.
Recommendation: In the definition for Lightning Protection System add the words "conductive structural members," after the word "conductors," and replace the word "suppression" with "protective" as follows:
3.3.16* Lightning Protection System. A complete system of strike termination devices, conductors, conductive structural members , ground terminals, interconnecting conductors, surge ~~suppression~~ protective devices, and other connectors and fittings required to complete the system.
Substantiation: Sections 4.8.8, 4.9.3.2, and 4.16 permit the use of conductive structural members for portions of a lightning protection system. The added text aligns the definition with other sections of the standard. Also, Section 4.18.1* uses the words "surge protective devices (SPD)" not "surge suppression".
Committee Meeting Action: Accept in Principle
Revise 3.3.16* to read as follows:
3.3.16* Lightning Protection System. A complete system of strike termination devices, conductors (which could include conductive structural members), ground terminals, interconnecting conductors, surge protective devices, and other connectors and fittings required to complete the system.
Committee Statement: The Committee accepts the submitter's recommendation. However, conductive structural members are not always required to be part of the lightning protection system. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Comment on Affirmative:
ZIPSE, D.: 3.3.16* Lightning Protection System. A complete system of strike termination devices, conductors (which could include conductive structural members), ground terminals, interconnecting conductors, surge protective devices, and other connectors and fittings required to complete the system.

780-10 Log #104 **Final Action: Accept in Principle**
(3.3.16.1)

Submitter: Thomas R. Harger, Harger Lightning Protection, Inc.
Recommendation: Delete 3.3.16.1 in its entirety.
Substantiation: The Manual of Style (18.1) does not permit single item subsections. "Catenary Lightning Protection Systems" are lightning protection systems that include elevated (overhead) conductors as strike termination devices. The definition of Strike Termination Device (3.3.22) includes a reference to catenary lightning protection systems. A separate definition is not required.
Committee Meeting Action: Accept in Principle
Change 3.3.16.1 to 3.3.X, thus relocating Catenary Lightning Protection System in alphabetical order in Section 3.3.
Committee Statement: The Committee chooses to retain the definition but to relocate it within section 3.3.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-11 Log #8 **Final Action: Accept in Principle**
(3.3.19)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...an 8/20 µs waveform."
Substantiation: Adds units to a quantity.
Committee Meeting Action: Accept in Principle
Revise 3.3.19 to read as follows:
The maximum instantaneous value of the current through the SPD having an 8/20 µs ~~waveshape~~ waveform.
Committee Statement: The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-12 Log #9 **Final Action: Reject**
(3.3.22)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...overhead ground ~~wires~~ conductors installed...".
Substantiation: Eliminates the term "wires" from document for more descriptive term "conductor."
Committee Meeting Action: Reject
Committee Statement: The term "overhead ground wires" is a term widely used to describe a specific strike termination method.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-12a Log #CP9 **Final Action: Accept**
(3.3.23 & 7.3.3.1)

Submitter: Technical Committee on Lightning Protection
Recommendation: Revise 3.3.23 to read as follows:
3.3.23 Striking Distance. The distance over which the final breakdown of the initial lightning stroke to ground or to a grounded object occurs.
Revise 7.3.3.1 to read as follows:
7.3.3.1 The zone of protection of a lightning protection mast shall be based on the striking distance of the lightning stroke ~~, that is, the distance over which final breakdown of the initial stroke to ground or to a grounded object occurs~~ .
Substantiation: The committee deletes the definition of the term "striking distance" from 7.3.3.1 and adds the affected text to the definition provided in 3.3.23. This text is a definition of a term and is incorporated into the definition provided in 3.3.23.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-13 Log #114 **Final Action: Accept**
(3.3.25)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Replace "a transient voltage surge suppressor (TVSS)" with "a surge protective device (SPD)."
Substantiation: This proposal is part of an overall effort to use the more generic term SPD where TVSS is currently used.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-14 Log #115 **Final Action: Accept**
(3.3.33.1)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Change "transient voltage surge suppressor (TVSS)" to "surge protective device (SPD)."
Substantiation: To reflect that UL 1449 3rd Edition will make this term applicable to all surge protective devices covered by the standard vice only TVSS devices.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-15 Log #10 **Final Action: Accept**
(4.2.3)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...installed on or in contact with aluminum...".
Substantiation: Clarifies intent to separate copper and aluminum materials.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-16 Log #11 **Final Action: Accept**
(4.2.4)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...installed on or in contact with copper...".
Substantiation: Clarifies intent to separate copper and aluminum materials.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-17 Log #12 **Final Action: Reject**
(4.3.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...protection components and materials due to...".
Substantiation: Materials used earlier in document, change to be complete and consistent.
Committee Meeting Action: Reject
Committee Statement: The words "and materials" do not provide further clarification. The sentence is clear as written.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-18 Log #13 **Final Action: Accept in Principle**
(4.4.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...electrically ~~connected~~ bonded to the...".
Substantiation: Bonded implies an electrical connection.
Committee Meeting Action: Accept in Principle
Revise 4.4.2 to read as follows:
4.4.2 Where metal pipe or tubing is used around the conductor, the conductor shall be ~~electrically connected~~ bonded to the pipe or tubing at both ends.
Committee Statement: The Committee accepts the submitter's recommendation. Additionally, it deletes the word "electrically". The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 25 Negative: 1
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
GUTHRIE, M.: There is absolutely no benefit gained from the proposed change. The existing wording says exactly what is intended and is perfectly clear to the user of the document. The definition of bonding makes it clear that a bond is an electrical connection so the proposal appears only to be making a change for the sake of change without any noticeable benefit to the document.

780-19 Log #14 **Final Action: Accept**
(4.5.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...not be installed on or in direct contact with copper roofing...".
Substantiation: Clarifies intent to separate copper and aluminum materials.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-20 Log #85 **Final Action: Accept in Principle**
(4.5.2)

Submitter: John M. Tobias, US Department of the Army
Recommendation: 4.5.2 Aluminum material shall not be used where they come into direct contact with earth.
Replace with: "Within 460 mm (18 in.) above."
Substantiation: Section 4.5.2.2 specifies that a bimetallic clamp needs to be used within eighteen in. of earth level. The intent is to prevent aluminum use within 18 in. of earth level and should be specified in 4.5.2.
Committee Meeting Action: Accept in Principle
Revise 4.5.2. to read as follows:
4.5.2 Aluminum materials on the exterior of the building shall not be used within 460 mm (18 in.) of soil nor in contact with soil.
Committee Statement: The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 24 Negative: 2
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
GUTHRIE, M.: The intent of the committee in accepting the proposal in principle and adding the limitation that it is only applicable to aluminum materials on the exterior of the building was to make it clear that aluminum materials may be used below grade on the interior of a structure even if it is installed on an exterior wall that is less than 18-inches thick. This intent is not properly reflected in the committee statement. This is important because I do not believe it is the intent of the committee that aluminum materials may be used where they come into direct contact with earth even if it is internal to the structure; as is allowed by the committee's proposed wording. Proposed revised wording is forwarded to indicate that aluminum is not allowed within 460 mm of the point at which the conductor enters the earth, whether this point is internal or external. This will allow aluminum material to be used on an external wall as long as it does not "enter the earth" within 18 inches of that point.
It is recommended that the committee statement be amended to reflect the reason the proposal was changed by the committee and that the revised wording be changed as follows:
"4.5.2 Aluminum materials shall not be used within 460 mm (18 in.) of the point where the lightning protection system conductor, etc. comes into contact with earth."
TOBIAS, J.: Comments from Guthrie are correct and need consideration.

780-20a Log #CP2 **Final Action: Accept**
(4.5.3)

Submitter: Technical Committee on Lightning Protection
Recommendation: Move existing 4.5.3 to existing 4.3 as new 4.3.3. Renumber 4.5.3.1 and 4.5.3.2 as new 4.3.3.1 and 4.3.3.2, respectively. Renumber existing 4.5.4 as new 4.5.3.
Substantiation: The text is currently included in the document as a subset of "4.5 Use of Aluminum," but the text is applicable for all approved materials. The text belongs in Section 4.3 rather than in Section 4.5.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-21 Log #15 **Final Action: Reject**
(4.5.4)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...not be directly attached or bonded to a...".
Substantiation: Clarifies intent to separate aluminum from other specified materials.
Committee Meeting Action: Reject
Committee Statement: The Committee does not agree with the submitter's substantiation.
The change does not add clarification to the text.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-22 Log #105 **Final Action: Accept in Principle**
(4.6.1.5)

Submitter: Thomas R. Harger, Harger Lightning Protection, Inc.
Recommendation: Add a new Section 4.6.1.5 as follows:
4.6.1.5 Strike termination devices include air terminals, metal masts, permanent metal parts of structures as described in Section 4.9 and elevated conductors. Combination of these strike terminals shall be permitted.
Substantiation: NFPA 780 Task Group on Strike Termination determined that the definition for Strike Termination Device (Chapter 3.3.22) currently includes metal masts and overhead ground wires and that application of these devices is not currently obvious in Chapter 4. Proposed new text clarifies intent and conforms to standard industry practice.
Committee Meeting Action: Accept in Principle
Add a new 4.6.1.1 to read as follows:
4.6.1.1 Strike termination devices include air terminals, metal masts, permanent metal parts of structures as described in Section 4.9 and overhead ground wires. Combination of these strike termination devices shall be permitted.
Renumber remaining sections.
Committee Statement: The Committee changes "elevated conductors" to "overhead ground wires" and "strike terminals" to "strike termination devices".
The proposed section was relocated to section 4.6.1.1 as the text applies more generally to strike termination devices.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-23 Log #17 **Final Action: Accept in Principle**
(Figure 4.6.2(2))

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...attached to the building or structure. "
Substantiation: Removes limitation to buildings.
Committee Meeting Action: Accept in Principle
Revise 4.6.3.1(2) to read as follows:
Braces that are permanently and rigidly attached to the structure.
Committee Statement: The Committee notes that the submitter incorrectly referenced the print line to Figure 4.6.2(2). The correct reference is to 4.6.3.1(2).
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-24 Log #16 **Final Action: Accept in Principle**
(4.6.3.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...secured against overturning or displacement by one of...".
Substantiation: Better clarifies intent of securing air terminals.
Committee Meeting Action: Accept in Principle
Revise 4.6.3.1 to read as follows:
Air terminals shall be secured against ~~overturning~~ displacement by one of the following methods:
Committee Statement: The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 25 Negative: 1
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
GUTHRIE, M.: Webster's New World Dictionary defines displacement as being moved from its customary place. While it is agreed that a literal interpretation of the definition would include overturning, this may not be obvious to all AHJs. I concur with the submitter's proposal to include "overturning" and "displacement" and recommend the action taken by the committee be to accept the proposal versus accept in principle with the removal of the term "overturning."

780-25 Log #18 **Final Action: Accept**
(4.6.4.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...127 mm (5 in.), or less, in diameter.
Substantiation: Allows balls less than exactly 127 mm (5 in.) in diameter.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-26 Log #71 **Final Action: Accept in Principle**
(4.7)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise text to read as follows:
"...shall determine the zone of protection. Methods, as described in Section 4.7, or a combination of methods, shall be used to determine the zone of protection."
Substantiation: There is no clear transition between methods and no direction for usage of multiple methods for determining the zone of protection for a structure.
Committee Meeting Action: Accept in Principle
Revise 4.7 to read as follows:
"...shall determine the zone of protection. One or more methods, as described in Section 4.7, shall be used to determine the overall zone of protection."
Committee Statement: The Committee accepts the submitter's recommendation and provides edit to the text by reference to an " overall zone of protection ". The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

Sequence #27 was not used

780-28 Log #19 **Final Action: Accept in Principle**
(4.7.2.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...with ~~walls~~ protection line forming...".
Substantiation: Better defines the portion of the cone of interest, not the walls of a building or structure.
Committee Meeting Action: Accept in Principle
Revise 4.7.2.2 to read as follows:
4.7.2.2 The zone of protection shall form a surface ~~cone~~ whose apex is located at the highest point of the strike termination device, with ~~walls~~ a line of protection forming a 45-degree or 63-degree angle from the vertical.
Committee Statement: The Committee accepts the submitter's recommendation and provides edit to the text. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 25 Negative: 1
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
GUTHRIE, M.: The proposed revision is incorrect. First, the zone of protection is defined as a volume, not a surface. Second, a "surface" is not typically considered to have an apex as an "apex" is defined by Webster's Dictionary as: (1) the highest point or (2) the usually pointed end of an object. It is agreed that the committee action be to Accept in Principle with the following revision:
4.7.2.2 The zone of protection ~~shall form~~ is defined as a cone whose apex is located at the highest point of the strike termination device, with ~~walls~~ surface form ed ~~ing~~ by a 45-degree or 63-degree angle from the vertical.

780-29 Log #20 **Final Action: Accept in Principle**
(4.7.3.1(C))

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...determining ~~the zone~~ zones of protection...".
Substantiation: There may be more than one zone of protection on a building.
Committee Meeting Action: Accept in Principle
Revise 4.7.3.1(C) to read as follows:
"...determining the ~~zone~~ overall zone of protection...".
Committee Statement: The Committee accepts the submitter's recommendation and provides edit to the text by reference to an " overall zone

of protection “. The change satisfies the submitter’s intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-30 Log #21 **Final Action: Accept in Principle**
(4.7.3.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
“...strike termination device device (s) or...”.
Substantiation: Ball could be between multiple termination devices.
Committee Meeting Action: Accept in Principle
Revise 4.7.3.2 to read as follows:
“...strike termination device (s) or earth.
Committee Statement: The change satisfies the submitter’s intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-31 Log #97 **Final Action: Accept in Principle**
(4.7.3.2(A))

Submitter: Terrance K. Portfleet, Michigan Lightning Protection Inc.
Recommendation: Revise text to read as follows:
“...strike termination device or earth. ~~(A)~~ The zone of protection shall be limited to the space above the horizontal plane of the lowest terminal.
Substantiation: 4.7.3.2(A) cannot stand alone (MOS mandate) and needs to compliment Paragraph 4.7.3.2 by being added as the last sentence to Paragraph 4.7.3.2.
Committee Meeting Action: Accept in Principle
Delete 4.7.3.2(A).
Committee Statement: The Committee determines the text is redundant with text of the preceding paragraph.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-32 Log #23 **Final Action: Accept**
(4.7.3.3)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
“...46 m (150 ft) ~~geometric~~ rolling sphere model...”.
Substantiation: Rolling sphere model is correct label for model.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Comment on Affirmative:
RISON, W.: To be consistent with other actions (such as Proposal 780-33), I recommend that in addition to changing “geometric” to “rolling sphere”, the word “model” should be changed to “method”, so the new text would read “...46m (150 ft) ~~geometric~~ rolling sphere ~~model~~ method ...”.

780-33 Log #22 **Final Action: Accept in Principle**
(Figure 4.7.3.3)

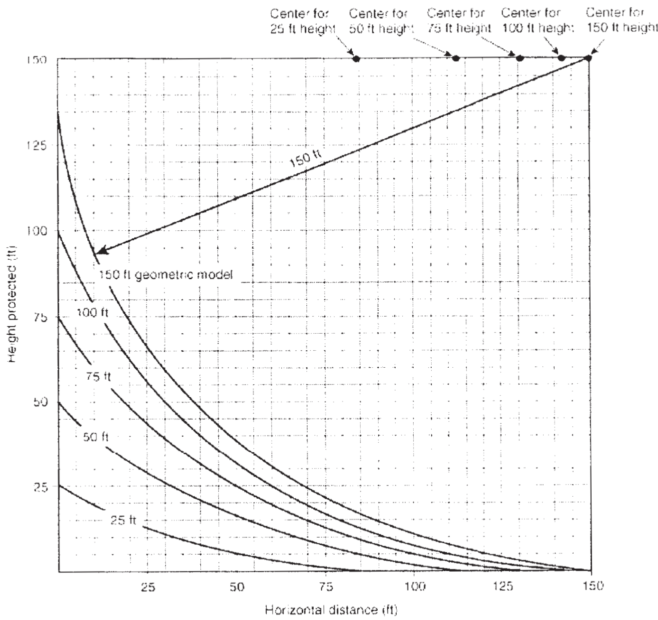
Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
“...Utilizing ~~Geometric~~ Rolling Sphere Model.”
Substantiation: Rolling sphere model is correct label for model.
Committee Meeting Action: Accept in Principle
In Figure 4.7.3.3, revise the following:
In the figure, change ~~geometric model~~ to rolling sphere method
Change the title of the figure to read as follows:
FIGURE 4.7.3.3 Zone of Protection Utilizing ~~Geometric Model.~~ to Rolling Sphere Method.
Committee Statement: The Committee accepts the submitter’s recommendation but changes “model” to “method”. Additionally, the committee makes changes to the text within the figure and changes the title of the figure. The change satisfies the submitter’s intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-34 Log #81 **Final Action: Accept in Principle**
(4.7.3.4)

Submitter: John M. Tobias, US Department of the Army
Recommendation: Existing text:
4.7.3.4 Under the rolling sphere model, the horizontal protected distance found geometrically by Figure 4.7.3.3 (“horizontal distance, ft”) also shall be permitted to be calculated using the formula:

$$d = \sqrt{h_1(300 - h_1)} - \sqrt{h_2(300 - h_2)}$$

where:
d = horizontal protected distance (ft)
h_1 = height of higher roof (ft)
h_2 = height of lower roof (top of the object) (ft)

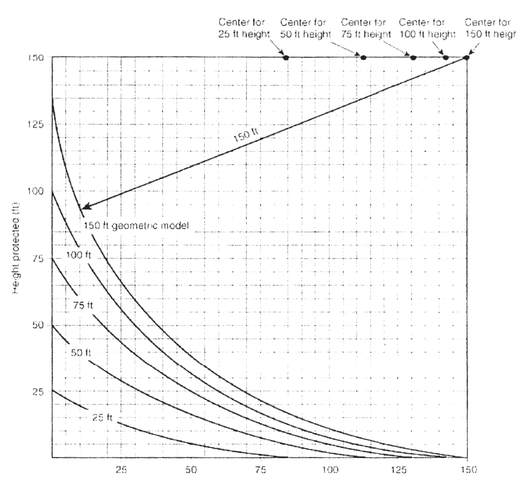


For SI units, 1 ft = 0.305 m.

Change to:
4.7.3.4 Under the rolling sphere model, the horizontal protected distance found geometrically by Figure 4.7.3.3 (“horizontal protected distance, m”) also shall be permitted to be calculated using the formula:

$$d = \sqrt{h_1(92 - h_1)} - \sqrt{h_2(92 - h_2)}$$

where:
d = horizontal protected distance (m)
h_1 = height of higher roof (m)
h_2 = height of lower roof (top of the object) (m)



For SI units, 1 ft = 0.305 m

Revised Figure 4.7.3.3 Zone of Protection Utilizing Rolling Sphere Method

Within Figure 4.7.3.3 change:
axes: (ft) to (meters)
x-axis title to “horizontal protected distance”
All numbers as follows:
25 to 7.6
50 to 15.2
75 to 22.9
100 to 30.5
150 to 45.8
Remove from figure: “For SI units, 1 ft. = 0.305 m.”

Add to Annex A:
A.4.7.3.4 (English units) Under the rolling sphere model, the horizontal protected distance found geometrically by Figure 4.7.3.3 (“horizontal distance, ft”) also shall be permitted to be calculated using the formula:

$$d = \sqrt{h_1(300 - h_1)} - \sqrt{h_2(300 - h_2)}$$

where:
d = horizontal protected distance (ft)
h_1 = height of higher roof (ft)
h_2 = height of lower roof (top of the object) (ft)

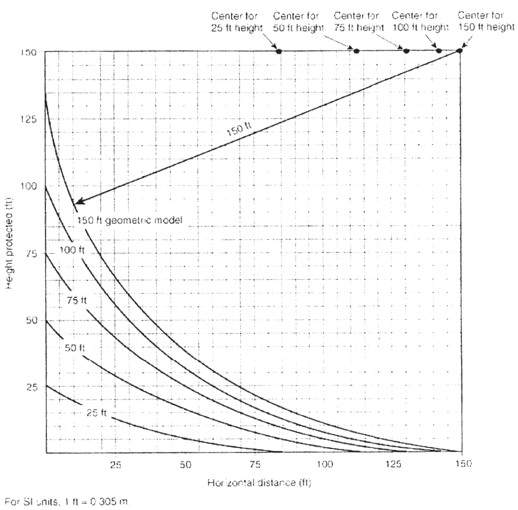


Figure A.4.7.3.3

Substantiation: Conversion to metric units mandated by style manual. Committee feels that the English units chart needs to be preserved in the Annex A material to maximize usefulness to the North American construction market, despite the requirements of the style manual.
Committee Meeting Action: Accept in Principle
Revise 4.7.3.4 to read as follows:
4.7.3.4 Under the rolling sphere model, the horizontal protected distance found geometrically by Figure 4.7.3.3 (“horizontal protected distance, m” or “horizontal protected distance, ft”) also shall be permitted to be calculated using the formula:

$$\mathrm{d} = \sqrt{h_1(D - h_1} - \sqrt{h_2(D - h_2)}$$

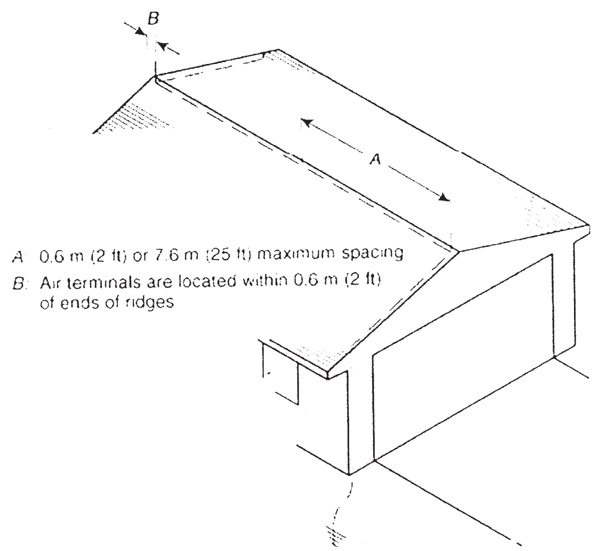
where (units shall be consistent, m or ft):
d = horizontal protected distance
h^1 = height of higher roof
h^2 = height of lower roof (top of the object)
D = rolling sphere diameter (92 m (300 ft))
Change title of Figure 4.7.3.3 to be:
FIGURE 4.7.3.3 Zone of Protection Utilizing Rolling Sphere Method.

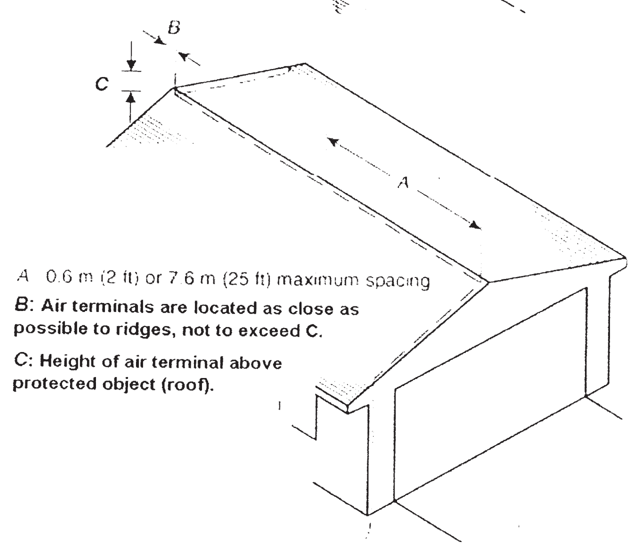
See Figure 4.7.3.3 on the next page

Committee Statement: The Committee accepts the submitter’s recommendation to change the formula following 4.7.3.3 and Figure 4.7.3.3.
The Committee accepts the submitter’s recommendation but changes “model” to “method”.
The Committee does not agree with the submitter’s recommendation to add new A.4.7.3.4 and Figure A.4.7.3.3.
The change satisfies the submitter’s intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Comment on Affirmative:
GUTHRIE, M.: I agree with the intent of the committee action. There was some discussion during the ROP meeting that there was confusion by some casual users of the formula as to the source of the value of 300 used in the formula. The substitution of the variable “D” resolves this confusion. However, the use of the variable “2R” in place of “D” (where R is the striking distance) would be even clearer as to the source and it would eliminate the need to use both an upper case and lower case “d” in the formula.

780-35 Log #83 **Final Action: Reject**
(4.8.2)

Submitter: John M. Tobias, US Department of the Army
Recommendation: Revise text to read as follows:
4.8.2 Location of Devices. As shown in Figure 4.8.2, strike termination devices shall be placed as close as possible to ridge ends on pitched roofs or edges and outside corners of flat or gently sloping roofs. This spacing shall not exceed the height of the strike termination device above the object the strike termination device is mounted on.





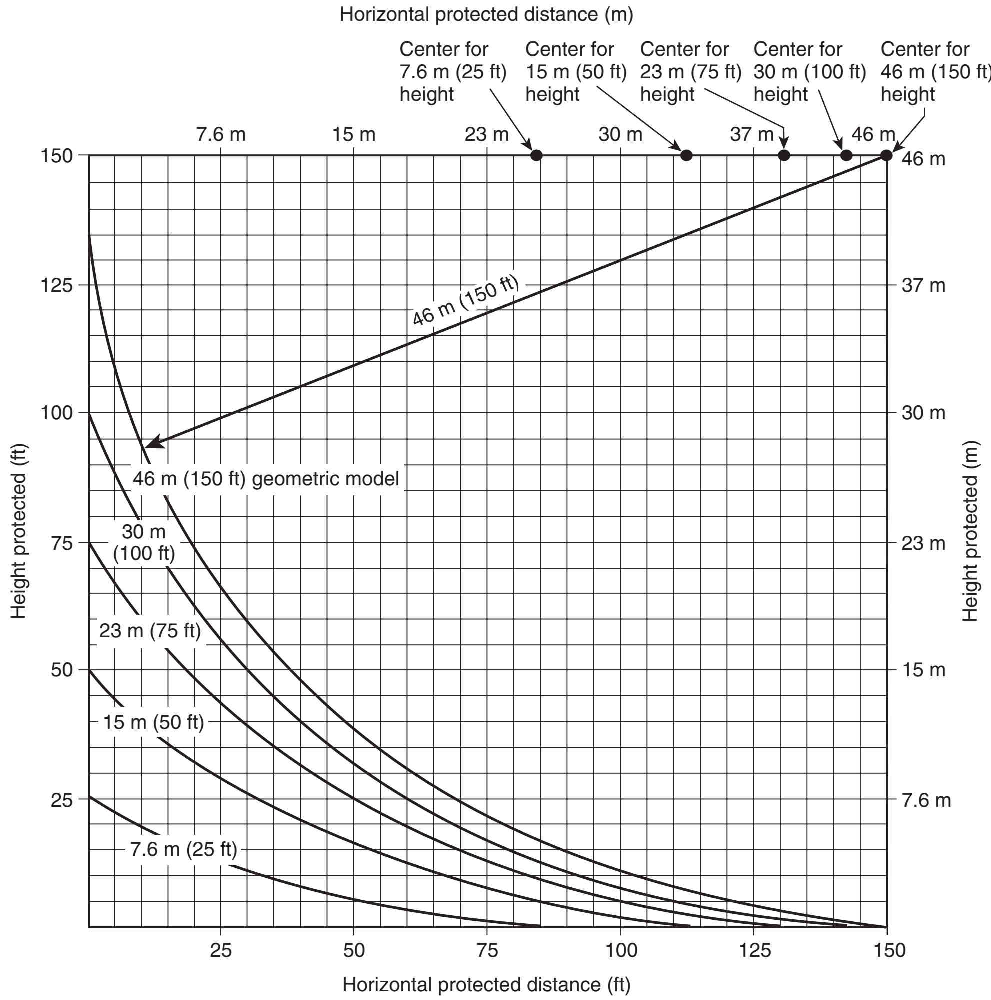


FIGURE 4.7.3.3 Zone of Protection Utilizing Rolling Sphere Method.

Substantiation: Information presented (by Dr. D'Alessandro) at May 2005 Pre-ROP meeting indicated that there are a number of "bypasses" where corners of buildings are struck despite the presence of a strike termination. Using other sources (for example derived from Tobias, J. M., ed., The basis of Conventional Lightning Protection Technology, Federal Interagency Lightning Protection Group, available on www.stinet.dtic.mil, Report No. ADA396784, p.21, June 2001) the effective protection angle for short distances is agreed to be 45 degrees. By requiring that the air terminal is placed at a distance not to exceed its height above the protected object, the 45 degree protection angle is enforced.
Committee Meeting Action: Reject
Committee Statement: The Committee sees installation as impracticable. There is a lack of observed evidence to effect this change.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 24 Negative: 2
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:

CAIE, M.: This proposal was rejected on the basis that the placement of air terminals at a distance of up to 2 ft from a likely strike point on a structure "has not caused any problems". However:

- No substantiation was provided to back this claim, e.g., the types and heights of buildings, the lightning activity in the regions supposedly identified, quantitative results of field studies, etc.
- If a proper field survey is carried out and examples are found where the 2 ft distance is, as suspected, too large in high lightning areas and on taller structures, the whole issue would need to be re-opened.

A quantitative study was carried out recently [1] and presented in three different international fora. It showed that a fixed 2 ft rule is not appropriate and for short rods, like the ones typically installed in the USA (10" or 12" length), the 2 ft rule is much too loose for protecting vulnerable points on structures. The study also showed that the maximum distance is dependent on the height of air terminal that is installed.

Furthermore, if one considers what is recommended in other international standards such as the IEC, 10" and 12" rods would need to be installed much closer that the allowable 2 ft distance. For example, IEC62305-3 shows that the "protection angle method" can be used in this situation for structures up to 200 ft in height. Appendix E, Fig. E.12, clearly shows that if a rod is positioned near an edge or corner of a building, the height of the rod and the building are applied in the normative Table 2 of the standard.

Taking a 10" rod as an example, the maximum distance from the edge or corner of the structure that is allowable for structure heights in the range 16 – 200 ft is 2.2 – 0.35 ft. This range is based on Level III protection, which is essentially equivalent to the single protection level used in NFPA 780 (150 ft rolling ball etc.). From [1], the recommended maximum distance for 10" rods on a 165 ft building is 0.27 ft, in good agreement with the value determined from the IEC standard.

So, the question remains – what is the basis or justification for the 2 ft rule in NFPA 780 and the reason to reject a rigorous quantitative analysis that agrees with the IEC standard ?

References

[1] D'Alessandro, F., 2004, "Improved placement of protective lightning rods on structures", *Proc. Internat. Conf. Grounding & Earthing (Ground'2004)* , Belo Horizonte, Brazil, pp. 138-143.

[2] International Electrotechnical Committee, "IEC 62305-3 Ed. 1.0: Protection against lightning – Part 3: Physical damage to structures and life hazard", CEI, Geneva, Switzerland, 2006.

TOBIAS, J.: Comments from Caie are correct and need consideration. Sufficient substantiation exists for the original proposal.
Comment on Affirmative:

GUTHRIE, M.: I agree with the concept of the original rejected proposal but also agree with the committee's decision to reject the proposal at this time. A preference would be to accept the original proposal in principle with some revision to the text to reflect the principles cited by Mr. Caie in his negative vote. However, I do not believe we are at the point where we can reach agreement on the specific text at this point. Mr. Caie references the D'Alessandro Ground 2004 paper as a primary justification for the need for this change and indicates that it shows the 2-foot rule is much too loose for protecting vulnerable points on structures. He also cites IEC 62305-3 as justification for this change. In response, it should be identified that NFPA 780 is one of the more stringent of the standards in use in the world as it relates to spacing of air terminals from the corners of a protected structure. It is also unclear whether any of the bypasses discussed in the D'Alessandro paper were associated with installations where the air terminal spacing met the existing requirements of NFPA 780. It is also interesting that the example given by Mr. Caie considers a structure of 165 feet height. It should be noted that the protective angle specified in IEC 62305-3 changes as a function of height of the structure/air terminal. IEC 62305-3, 5.2.2 identifies that a 45-degree angle would be excessive for structures of less than 30 meters in height. For a 10-meter tall structure, the IEC 62305-3 protective angle exceeds 60 degrees. In these cases, the 2-foot spacing is exceedingly conservative. In conclusion, I agree that the 2-foot spacing should be assessed for tall structures such as the 165-foot tall structure discussed by Mr. Caie. However, I believe it would be excessive to require that the 45-degree angle be applicable across the board as proposed in ROP 780-35.

780-35a Log #CP11 **Final Action: Accept**
(Figure 4.8.2)

Submitter: Technical Committee on Lightning Protection
Recommendation: In Figure 4.8.2, change A: to read as follows:
A: 6 m (20 ft) or 7.6 m (25 ft) maximum spacing
Substantiation: The commitee makes this change to provide the correct dimension for A.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-36 Log #62 **Final Action: Reject**
(4.8.2.3(A) and (B))

Submitter: Douglas J. Franklin, Thompson Lightning Protection, Inc.
Recommendation: Delete paragraphs 4.8.2.3(A) and (B) entirely.
Substantiation: 1) There is no real world evidence or reports of damage that require or dictate that added protection is required at eave lines for structures (pitched roof type) of any height. No special criteria beyond paragraphs 4.8.1(A), 4.8.2, 2.1 and 2.2 are required.

2) There were no problems with this type of protection, (ridge only) for decades prior to this initial change which was made to attempt consistent application of the rolling ball concept.

3) In geographic areas where snow and ice conditions exist, installing air terminals at eave lines results in either damage to the system itself and/or damage to the building roof. This type installation seldom survives the first winter intact.

4) These current criteria result in NFPA 780 compliance being dropped as a requirement for system installation. This deprives the owner of the other technical benefits of 780 compliance and negatively affects public safety.
Committee Meeting Action: Reject
Committee Statement: The submitter has not provided adequate substantiation.

The Committee does not agree with the submitter's substantiation.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 25 Negative: 1
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:

VANSICKLE, III, H.: My vote is negative on rejection of the comment. The submitter has outlined a valid problem with the installation of system components at the eave line of ridged roof structures. Following the requirements of NFPA 780 creates a hazard to people below the building perimeter, as well as a situation where proper compliance leads to system components being ripped out of the construction breaking the moisture seal of the structure's exterior. There are substantial enough negative consequences associated with compliance to these paragraphs that owners are forced to either ignore this section or risk their property and the people below.

The vote to reject by the 780 Committee cites the submitter's lack of providing adequate substantiation, but I disagree. He has indicated the problem and the need to delete the paragraphs. I would also point out that later in this same meeting, the 780 Committee accepted Proposal No. 780-100 that speaks to a similar issue. If the Committee can justify not protecting the top vertical edges of tall buildings that <u>"are subject to direct</u> <u>strikes",</u> then we have provided our own justification for not protecting eave lines on tall ridged roof structures. Protection of eave lines <u>"will not</u> <u>normally be justified"</u> because it leads to negative consequences for performance of the construction for any reasonable period of time.
Comment on Affirmative:

FRANKLIN, D.: I would like to thank the Committee for it's time and consideration.

I have been advised that the opportunity to further address these two topics would be available via the Strike Termination Task Group to review the "lack of substantiation" response of the Committee.

With this opportunity in place, my ballot on these items is affirmative with comment.

GUTHRIE, M.: I agree with Mr. VanSickle that the submitter did provide justification of the need for the deletion of the text. I also agree that the proposal warrants additional consideration by the Strike Termination Task Group in sufficient time for the submission of a comment on this proposal.

780-37 Log #121 **Final Action: Reject**
(4.8.2.3(A) & (B))

Submitter: Douglas J. Franklin, Thompson Lightning Protection, Inc.
Recommendation: Delete entire paragraph - both parts.
Substantiation: 1) Height does not have an affect if ridge only protection is acceptable. What is logical, magical, about 15 m? Same assumption is allowed at tall vertical edges.

2) No evidence that pitched eaves are a target. Loss and damage problems from lightning have not been reported or experienced where not protected.

3) Big problem with NFPA 780 being tossed out to avoid this - benefit of other provisions (grounding and bonding, etc.) are lost. Public safety is affected.

4) Big problem with structural damage at roof due to air terminal installation - or - damage to system itself, especially in northern snow and ice climates. Why install if system will be gone after first winter?
Committee Meeting Action: Reject
Committee Statement: The submitter has not provided adequate substantiation.

The Committee does not agree with the submitter's substantiation.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Comment on Affirmative:

FRANKLIN, D.: See My Affirmative with Comment on 780-36 (Log #62).

780-38 Log #24 **Final Action: Accept in Principle**
(4.8.2.3(B))

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:

"...46 m (150 ft) ~~geometric~~ rolling sphere model...".
Substantiation: Rolling sphere model is correct label for model.
Committee Meeting Action: Accept in Principle
Revise 4.8.2.3(B) to read as follows:

"...46 m (150 ft) rolling sphere method..."
Committee Statement: The Committee accepts the submitter's recommendation but changes "model" to "method". The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Comment on Affirmative:

GUTHRIE, M.: In ROP 780-32, the committee agreed to use "rolling sphere model" in a similar statement in 4.7.3.3. The committee should be consistent in its use of the terms "rolling sphere model" and "rolling sphere method."

780-39 Log #25 **Final Action: Accept**
(4.8.2.4)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:

"...contact the flat or gently sloping roof...".
Substantiation: To be consisent with the rest of the paragraph.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-40 Log #26 **Final Action: Accept in Principle**
(4.8.3.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:

"main roof ridge shall require."
Substantiation: Specifies what part of the roof is under consideration.
Committee Meeting Action: Accept in Principle

Revise 4.8.3.1 to read as follows:

4.8.3.1 Dormers as high or higher than the main roof ridge shall be protected with strike termination devices, conductors, and grounds, where required.
Committee Statement: The Committee accepts the submitter's recommendation and provides edit to the text. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-41 Log #27 **Final Action: Accept in Principle**
(4.8.7)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:

"...forth in sections 3.7.3 and 4.8."
Substantiation: Zones of protection are defined in Section 3.7.3.
Committee Meeting Action: Accept in Principle
Revise 4.8.7 to read as follows:

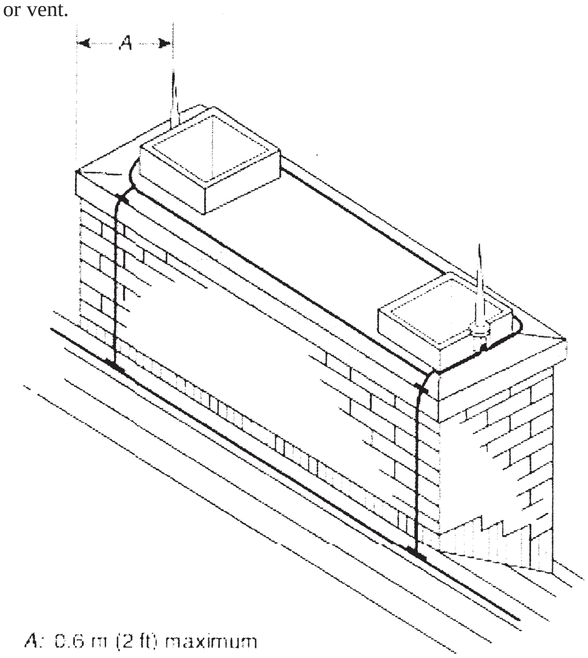
4.8.7 Domed or Rounded Roofs. Strike termination devices shall be located so that no portion of the structure is located outside a zone of protection, as set forth in Section 4.7.
Committee Statement: The submitter requested reference to Section 3.7.3. Section 3.7.3 is nonexistent.

The Committee changes Section 4.8 to Section 4.7 to encompass the various methods defined in Section 4.7.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-42 Log #82 **Final Action: Reject**
(4.8.8.3)

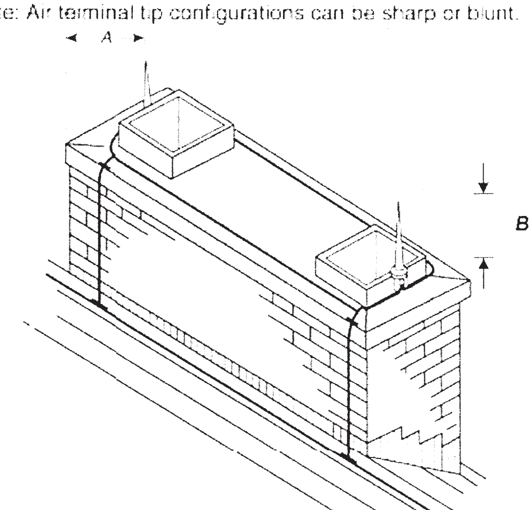
Submitter: John M. Tobias, US Department of the Army
Recommendation: Revise text to read as follows:

4.8.8.3 Required strike termination devices shall be installed on chimneys and vents, as shown in Figure 4.8.8.3, so that the distance from a strike termination device to an outside corner or the distance perpendicular to an outside edge shall be not greater than the height of the device above the protected chimney or vent.



A: 0.6 m (2 ft) maximum

Note: Air terminal tip configurations can be sharp or blunt.



A: Not to exceed B

Note: Air terminal tip configurations can be sharp or blunt.

Substantiation: Information presented (by Dr. D'Alessandro) at May 2005 Pre-ROP meeting indicated that there are a number of "bypasses" where corners of buildings are struck despite the presence of a strike termination. Using other sources (for example derived from Tobias, J. M., ed., The basis of Conventional Lightning Protection Technology, Federal Interagency Lightning Protection Group, available on www.stinet.dtic.mil, Report No. ADA396784, p.21, June 2001) the effective protection angle for short distances is agreed to be 45 degrees. By requiring that the air terminal is placed at a distance not to exceed its height above the protected object, the 45 degree protection angle is enforced.
Committee Meeting Action: Reject
Committee Statement: There is a lack of observed evidence to effect this change.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 24 Negative: 2
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
CAIE, M.: The justification here is exactly the same as 780-35 above, except that the more stringent guidelines are even more necessary. Given that this section refers to chimneys and vents, protrusions such as these on roof-tops constitute higher probability strike points.
TOBIAS, J.: Comments from Caie are correct and need consideration. Sufficient substantiation exists for the original proposal.

780-43 Log #120 **Final Action: Accept in Principle**
(4.8.8.5)

Submitter: Douglas J. Franklin, Thompson Lightning Protection, Inc.
Recommendation: New Paragraph:
Large roof top mechanical units with continuous metal housings less than 3/16 in. thick such as air conditioning/meeting units (R.T.U.s), metal air intake/ exhaust housing, cooling towers, etc., shall be protected by:
1) Installing air terminals per paragraph 4.8.8.3. These shall be mounted on bases having a minimum contact area of three square inches each secured to bare metal of the housing or mounted by drilling and tapping to the unit's frame per paragraph 4.16.3.2 and 4.16.3.3.
2) Installing at least two bonding connections of three square in. minimum contact area, 180 degrees apart, to bare metal at the base or lower edges of the unit's electrically continuous metal housing and connected to the lightning protection system with two main size conductors.
Substantiation: 1) To clarify the intent of Paragraph 4.8.8.2.
2) To bring 780 into clear compliance with current industry practice and accepted UL inspection procedures.
Committee Meeting Action: Accept in Principle
Add new 4.8.9 to read as follows:
4.8.9 Roof top mechanical units with continuous metal housings less than 4.8 mm (3/16 in.) thick such as air conditioning/heating units, metal air intake/ exhaust housing, cooling towers, etc., shall be protected by 4.8.9(A) and (B):
A) Installing air terminals in accordance with Sections 4.8.1 and 4.8.2. These shall be mounted on bases having a minimum contact area of three square inches each secured to bare metal of the housing or mounted by drilling and tapping to the unit's frame per paragraph 4.16.3.2 and 4.16.3.3.
B) Installing at least two main size conductors. The connection shall be made to bare metal at the base or lower edges of the unit using main-size lightning conductors and bonding devices that have a surface contact area of not less than 1940 mm 2 (3 in. 2) and shall provide two or more paths to ground, as is required for strike termination devices. These two main bonding plates shall be located on opposite sides or separated as far apart as practicable at the base or lower edges of the unit's electrically continuous metal housing and connected to the lightning protection system.
Committee Statement: The Committee accepts the submitter's intent and rewords the text for clarity. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 24 Negative: 2
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
HARGER, T.: The first sentence is too vague to be enforced properly. There is no minimum metal thickness required. The air terminals could conceivably be mounted to metal parts of a housing that is so thin it may not adequately support an air terminal and may not meet the minimum thickness for main conductors (solid strip in tables 4.1.1.1 (A) and (B)). The metal housings are typically painted prior to final assembly so that paint in the joints between the panels would offer high resistance paths to the bonding plates at the base of the unit.
VANSICKLE, III, H.: Remove from the committees proposed wording – "… shall be located <u>(on opposite sides or separated)</u> as far apart as practicable …"
The statement <u>"on opposite sides"</u> truly adds nothing when we are talking about a continuous metallic ventilator housing. The rest of the proposed wording makes the proper statement without this phrase. I would point out that the committee removed similar wording from paragraphs in later proposals during this session, because it doesn't apply well to circular structures or even 5-sided constructions, which may occur on certain housings.
Comment on Affirmative:
GUTHRIE, M.: I agree with Mr. Harger's suggestion that a minimum thickness should be specified for physical reasons. I also agree with Mr. VanSickle's comment that "on opposite sides" adds nothing that is not covered by the requirement that the main bonding plates be separated as widely as practicable.

780-44 Log #28 **Final Action: Accept in Principle**
(4.9.3)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follow:
... ~~Metals~~ <u>Main Lightning Conductor."</u>
Substantiation: The subject in 4.9.3.1, 4.9.3.2, and 4.9.3.3 is "main lightning conductor" not material metals.
Committee Meeting Action: Accept in Principle
Revise 4.9.3 to read as follows:
"... ~~Metals~~ <u>Main Conductor.</u>
Committee Statement: The Committee removes "lightning" to comply with the definition of main conductor in Section 3.3.5.3.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-44a Log #CP4 **Final Action: Accept**
(4.9.3.1)

Submitter: Technical Committee on Lightning Protection
Recommendation: Revise 4.9.3.1 to read as follows:
4.9.3.1 Ancillary metal parts of a structure, such as eave troughs, downspouts, chutes, or other metal parts except as permitted in Section 4.16.1, shall not be substituted for the main conductor.
Substantiation: The committee intends to permit the use of ladders as the main down. The committee notes inconsistancy between Sections 4.9.3.1 and 4.9.3.2. This change eliminates this inconsistancy.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 25 Negative: 1
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
GUTHRIE, M.: I concur with the committee decision to resolve the inconsistency between 4.9.3.1 and 4.9.3.2. However, I do not agree with the decision to allow the substitution of handrails and ladders for required conductors as they are likely installed in a location where people may be in contact with them and they may be removed without the knowledge that they are an integral part of the lightning protection system. It is recommended that 4.9.3.2 be deleted or revised to conform with the existing 4.9.3.1 versus the removal of "ladders" from 4.9.3.1.

780-44b Log #CP3 **Final Action: Accept**
(4.9.3.1, 4.9.3.3, 4.19.2.1 and B.2.3)

Submitter: Technical Committee on Lightning Protection
Recommendation: In each of the following paragraphs, change "main lightning conductor" to "main conductor"; 4.9.3.1, 4.9.3.3, 4.19.2.1 and B.2.3.
Substantiation: The committee removed "lightning" to comply with the definition of main conductor in Section 3.3.5.3.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-45 Log #70 **Final Action: Reject**
(4.9.5)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise text to read as follows:
"...as shown in Figure 4.9.5, <u>where practicable.</u> "
Substantiation: Requirements may not be possible in all situations.
Committee Meeting Action: Reject
Committee Statement: The submitter has not provided adequate substantiation.
The gradual bend radius required by 4.9.5 is essential to prevent failures.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-46 Log #29 **Final Action: Reject**
(4.9.7.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...gable, gambrel, mansard, and hip...".
Substantiation: Add "mansard" to be complete.
Committee Meeting Action: Reject
Committee Statement: The Committee intentionally did not include " mansard" as the roof conductor is not required to be on the ridge of a mansard roof.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-47 Log #30 **Final Action: Reject**
(4.9.13)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...at their upper and lower extremities of the parallel coursing."
Substantiation: Should not have a requirement for bonding at the extremities where structural steel or rebar is the down conductor.
Committee Meeting Action: Reject
Committee Statement: The submitter has not provided adequate substantiation.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-48 Log #31 **Final Action: Reject**
(4.9.13.3)

Submitter: Dick Reehl, Quest Communications
Recommendation: Delete 4.9.13.3.
Substantiation: 4.9.13.1 and 4.9.13.2 are mandatory, 4.9.13.3 says where these requirements were not satisfied, satisfy them.
Committee Meeting Action: Reject
Committee Statement: Deletion of the paragraph would remove flexibility to implement other connection methods.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-49 Log #32 **Final Action: Accept**
(4.13.1.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...with 4.13.2 through ~~4.13.5~~ 4.13.8."
Substantiation: Should include all ground terminal options.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-50 Log #86 **Final Action: Accept**
(4.13.1.3)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Insert "underground metallic piping" in the list of items that should not be used in lieu of lightning ground electrodes. Revised text to read as follows:
4.13.1.3 Underground metallic piping, ~~E~~ e lectrical system and telecommunication grounding electrodes shall not be used in lieu of lightning ground electrodes; this provision shall not prohibit the required bonding together of these items as required by 4.14.1 ~~grounding electrodes of different systems~~ .
Substantiation: NFPA 13, 10.6.8 states that in no case shall underground metallic piping be used as a grounding electrode for electrical systems (see ROP 13-456). The Task Group on Grounding was tasked to submit a proposal to NFPA 13 to resolve the conflict where the bonds to underground metallic piping required by 780, 4.14.1 are being removed. This proposal will make it clear to the users of NFPA 13 that the purpose of the bonding is for potential equalization and not to use the metallic piping as a LPS grounding electrode.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-51 Log #96 **Final Action: Accept**
(4.13.1.5)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Delete "hot-dipped galvanized steel" from 4.13.1.5 and change "ground terminals" to "grounding electrodes" as shown below:
4.13.1.5 Grounding Electrodes ~~terminals~~ shall be copper-clad steel, solid copper, ~~hot-dipped galvanized steel~~ or stainless steel.
Substantiation: NFPA 780 Task Group on Grounding identified a potential discrepancy between the NFPA 780, 4.13.2.1 and NFPA 70, 250.52(A)(5)(b) diameter requirements for iron or steel ground rods. Consideration was given to increasing the diameter of hot-dipped galvanized rods to 5/8 in. or deleting the approval for use of such material as approved grounding electrodes. Based on a 1920-1956 NERAC study on underground corrosion, a 7 year study by the Naval Civil Engineering Lab in cooperation with the National Association of Corrosion Engineers, a GROUND 2004 report from Warsaw University of Technology, a Swedish Corrosion Institute on Corrosion of zinc-coated steel, and a 1978 FAA report; it was agreed that the preferred resolution of the potential discrepancy would be to delete the use of hot-dipped galvanized steel from the standard due to galvanic corrosion concerns.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-52 Log #33 **Final Action: Reject**
(4.13.2.3(A))

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...into the earth, where practicable."
Substantiation: 8 feet may be nearly impossible.
Committee Meeting Action: Reject
Committee Statement: The Committee does not agree with the submitter's substantiation
The submitter has not provided adequate substantiation.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-53 Log #34 **Final Action: Accept**
(4.13.2.3(B))

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...of the conductor ~~or~~ and ground rod...".
Substantiation: Figure includes a conductor and a ground rod.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-53a Log #CP7 **Final Action: Accept**
(4.13.2.4)

Submitter: Technical Committee on Lightning Protection
Recommendation: Revise 4.13.2.4* to read as follows:
4.13.2.4* Multiple Ground Rods. Where multiple connected ground rods are used, the separation between any two ground rods shall be at least the sum of their driven depths where practicable.
Substantiation: The committee clarifies that the benefit from the use of multiple ground rods is gained from the summed driven depth rather than from the summed length of the ground rods.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-54 Log #76 **Final Action: Accept in Principle**
(4.13.8.1 Thru 4.13.8.1.5)

Submitter: Harold VanSickle, III, Lightning Protection Institute
Recommendation: Delete the existing wording in paragraphs 4.13.8.1 through 4.13.8.1.5 and replace with the following:
4.13.8.1 Shallow Topsoil. The methods in 4.13.3 through 4.13.7 shall be used in shallow topsoil conditions where practicable.
4.13.8.1.1 Where the methods described in 4.13.3 through 4.13.6 are found to be impractical, due to topsoil depth less than 460 mm (18 in.), it shall be permitted to provide a ground terminal to the maximum depth of topsoil available.
4.13.8.1.2 The ground terminal for shallow topsoil shall be either a ground ring electrode in accordance with 4.13.4 a minimum distance of 06. m (2 ft) from the foundation or exterior footing, radial(s) in accordance with 4.13.5, or

a plate electrode in accordance with 4.13.6 a minimum distance of 0.6 m (2 ft) from the foundation or exterior footing. The ground ring electrode, radial(s), or plate electrode shall be buried at maximum depth of topsoil available.

4.13.8.1.3 Where a method of 4.13.8.1.2 is impossible, radial(s) shall be permitted to be laid directly on bedrock a minimum distance of 3.6 m (12 ft) from the foundation or exterior footing. A ground ring electrode encircling the structure shall be permitted to be laid directly on bedrock a minimum distance of 0.6 m (2 ft) from the foundation or exterior footing.

4.13.8.1.4 In those cases where the grounding conductor is laid directly on bedrock, the conductor shall be secured to the bedrock every 0.9 m (3 ft) by nailing, conductive cement, or a conductive adhesive to ensure electrical contact and protect against movement.

Substantiation: This proposal corrects errors in the existing text and better states the position of the 780 Committee with regard to shallow soil locations.

Committee Meeting Action: Accept in Principle

Add an asterisk after 4.13.8.1 as follows:

4.13.8.1*

Revise the submitters recommendation for 4.13.8.1.2 to read as follows:

4.13.8.1.2 The ground terminal for shallow topsoil shall be either a ground ring electrode in accordance with 4.13.4 a minimum distance of 0.6 m (2 ft) from the foundation or exterior footing, radial(s) in accordance with 4.13.5, or a plate electrode in accordance with 4.13.6 a minimum distance of 0.6 m (2 ft) from the foundation or exterior footing. The ground ring electrode, radial(s), or plate electrode shall be buried at maximum depth of topsoil available.

Committee Statement: The Committee accepts the submitter's recommendation. However, the committee adds an asterisk after 4.13..8.1 to retain the Annex material. Further, the committee corrects 06. m to be 0.6 m in 4.13.8.1.2. The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-54a Log #CP5 **Final Action: Accept**

(4.14.1)

Submitter: Technical Committee on Lightning Protection

Recommendation: Revise 4.14.1 to read as follows:

4.14.1 General. All grounding media and buried metallic conductors which may assist in providing a path for lightning currents in or on a structure shall be interconnected to provide a common ground potential.

Substantiation: The committee revises 4.14.1 to clarify that underground metallic piping is not a grounding electrode, but must be bonded to the lightning protection system to provide a common ground potential.

The purpose of this proposal is to eliminate any confusion as to whether underground metallic piping is considered a grounding electrode versus a potential ground current conductor requiring bonding to the grounding system. The proposed wording should eliminate any potential confusion or conflict with the requirements of NFPA 70, NFPA 54, NFPA 13, or NFPA 24 relative to the use of the piping as a lightning protection grounding electrode.

Committee Meeting Action: Accept

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-55 Log #35 **Final Action: Accept in Principle**

(4.14.1.1)

Submitter: Dick Reehl, Quest Communications

Recommendation: Revise as follows:

"...lightning protection, ~~telephone~~ communications, and antenna...".

Substantiation: Telephone is restrictive, communications is less restrictive and includes items other than a simple tel set.

Committee Meeting Action: Accept in Principle

Revise 4.14.1.1 to read as follows:

"...lightning protection, electric service, ~~telephone~~ communications, and antenna..."

Committee Statement: The Committee accepts the submitter's recommendation. However, the committee revises the text as "electric service" was inadvertently omitted. The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-56 Log #36 **Final Action: Accept**

(4.14.2.1)

Submitter: Dick Reehl, Quest Communications

Recommendation: Revise as follows:

"...data, ~~telephone~~ communications, or other...".

Substantiation: Telephone is restrictive, communications is less restrictive and includes items other than a simple tel set.

Committee Meeting Action: Accept

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-57 Log #64 **Final Action: Reject**

(4.14.2.2)

Submitter: Dick Reehl, Quest Communications

Recommendation: Revise text to read as follows:

"...bridged with main-size conductors or sized according to NFPA 70-250.66 (whichever is larger), or the connection...".

Substantiation: The NEC has very specific sizing requirements for water meters and some sizing requirements exceed a main-size conductor.

Committee Meeting Action: Reject

Committee Statement: The submitter's recommendation does not add a requirement. The requirement is already specified by NFPA 70.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-58 Log #77 **Final Action: Reject**

(4.14.3)

Submitter: Dick Reehl, Qwest Communications

Recommendation: Add text to read as follows:

4.14.3 Where bonding and bond sizing requirements differ between NFPA 780 and NFPA 70, the bonding and bond sizing requirements of NFPA 70 shall be used.

Substantiation: Bonding to electrodes on the premises and bond sizing such as around a water meter do not agree between NFPA 70 and 780.

Committee Meeting Action: Reject

Committee Statement: The NEC may require a smaller conductor that would be required by NFPA 780.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

Sequence #59 was not used

780-60 Log #37 **Final Action: Accept in Principle**

(4.16.3.2)

Submitter: Dick Reehl, Quest Communications

Recommendation: Revise as follows:

"...with five threads minimum fully engaged...".

Substantiation: Exactly five threads is too restrictive.

Committee Meeting Action: Accept in Principle

Revise 4.16.3.2 to read as follows:

4.16.3.2 The threaded device shall be installed with at least five threads fully engaged and secured with a jam nut.

Committee Statement: The Committee clarifies the text. The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-61 Log #38 **Final Action: Accept in Principle**

(4.18.1)

Submitter: Dick Reehl, Quest Communications

Recommendation: Revise as follows:

"...electrical, communications, CATV ...".

Substantiation: Communications is covered under 4.18, Surge Protection.

Committee Meeting Action: Accept in Principle

Revise 4.18.1* to read as follows:

4.18.1* General. This section provides requirements for surge protection systems installed for the electrical, communications (including but not limited to CATV, alarm, data), antenna systems or other electrical system hardware. The requirements included within this standard are limited to permanently installed surge protective devices (SPDs).

Committee Statement: The Committee accepts the submitter's recommendation. Further, the Committee revises the text for clarification. The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-62 Log #93 **Final Action: Reject**
(4.18.2.1)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Revise as follows:
4.18.2.1 SPDs listed for the purpose shall be installed at all power service entrances.
Substantiation: To indicate that the SPDs used in this application shall be listed for the purpose in which it is used.
Committee Meeting Action: Reject
Committee Statement: The Committee refers the submitter to Section 1.3.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-63 Log #39 **Final Action: Accept in Principle**
(4.18.2.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...signal, CATV, alarm , data...".
Substantiation: CATV and alarm covered under 4.18, Surge Protection.
Committee Meeting Action: Accept in Principle
Revise 4.18.2.2* to read as follows:
4.18.2.2* SPDs shall be installed at entrances of conductive communications systems (including but not limited to CATV, alarm, data) and antenna systems.
Committee Statement: The Committee accepts the submitter's recommendation. Further, the committee revises the text for clarification. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-64 Log #109 **Final Action: Reject**
(4.18.2.2)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Revise as follows:
SPDs listed for the purpose shall be installed at entrances of conductive signal, data, and communication services.
Substantiation: To indicate that the SPDs used in this application shall be listed for the purpose in which it is used.
Committee Meeting Action: Reject
Committee Statement: The Committee refers the submitter to Section 1.3.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-65 Log #69 **Final Action: Accept**
(4.18.2.3)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise text to read as follows:
"...(100 ft) ~~and are not buried or enclosed in grounded metal conduit or tubing.~~
Substantiation: Transient damage is likely at a remote structure with or without conduit or burial.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-66 Log #110 **Final Action: Reject**
(4.18.2.3)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Revise as follows:
SPDS listed for the purpose shall be installed at all points where an electrical or electronic system conductor leaves a structure to...
Substantiation: To indicate that the SPDs used in this application shall be listed for the purpose in which it is used.
Committee Meeting Action: Reject
Committee Statement: The Committee refers the submitter to Section 1.3.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-67 Log #87 **Final Action: Accept in Principle**
(4.18.2.4)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Revise 4.18.2.1 as follows:
4.18.2.4 Surge protection shall be permitted for installation at subpanels or branch panels and at the point of utilization (~~receptacle~~ outlet or signal termination; also termed supplementary protection).
Substantiation: Proposed revision is more accurate as the text is applicable to any point on the wiring system where current supplies equipment.
Committee Meeting Action: Accept in Principle
Revise 4.18.2.4 as follows:
4.18.2.4 Surge protection shall be permitted for installation at subpanels or branch panels and at the point of utilization (~~receptacle~~ outlet or signal termination; also termed *supplementary protection*).
Committee Statement: The Committee revises the submitter's text to correctly reference to 4.18.2.4. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-68 Log #111 **Final Action: Reject**
(4.18.2.4)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Revise text to read as follows:
Surge protection listed for the purpose shall be permitted for installations at subpanels or branch panels and at the point of utilization (outlet or signal termination; also termed supplementary protection).
Substantiation: This proposal states that the SPDs used in this application shall be listed for the purpose in which it is installed and incorporates the 9 November 2005 proposal changing "receptacle" to "outlet"
Committee Meeting Action: Reject
Committee Statement: The Committee refers the submitter to Section 1.3.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-69 Log #41 **Final Action: Reject**
(4.18.3.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...shall ~~protect~~ provide protection against."
Substantiation: SPD protection is not absolute.
Committee Meeting Action: Reject
Committee Statement: The submitter's text does not add clarity.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-70 Log #42 **Final Action: Accept**
(4.18.3.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...1.2/50 µs , 8/20 µs ... and ... 40 kA 8/20 µs per...".
Substantiation: Add units to a quantity.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-71 Log #95 **Final Action: Accept in Principle**
(4.18.3.1)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Revise 4.18.3.1 as follows:
4.18.3.1* Electrical Power Circuits. The SPD shall protect against a surge produced by a 1.2/50 µs 8.20 µs combination waveform generator. ~~SPDs shall function at their rated maximum discharge current (I_{max}) without failure~~ Spds at the service entrance shall have an I_{max} rating of at least 40 kA 8/20 µs per phase or a nominal discharge current (I_n) rating of at least 20 KA 8/20 µs per phase.
Substantiation: The proposal deletes the requirement that the SPD remain functional after being subjected to I max , adds "µs" after the waveform descriptions for coordination with IEEE and ISO nomenclature and incorporates an acceptable nominal discharge current rating that may be used for SPD selection once the devices are available with nominal discharge current ratings.
Committee Meeting Action: Accept in Principle
Revise 4.18.3.1* as follows:
4.18.3.1* Electrical Power Circuits. The SPD shall survive a surge produced

by a 1.2/50 µs, 8/20 µs combination waveform generator. SPDs at the service entrance shall have an I_{max} rating of at least 40 kA 8/20 µs per phase or a nominal discharge current (I_n) rating of at least 20 kA 8/20 µs per phase.
Committee Statement: The Committee notes that "us" should be "µs".
The Change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-72 Log #43 **Final Action: Accept**
(4.18.3.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...10 kA 8/20 <u>µs</u> or...".
Substantiation: Add units to a quantity.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-73 Log #44 **Final Action: Accept in Principle**
(4.18.3.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...the ~~declared~~ <u>published</u> suppressed...".
Substantiation: Published is the common industry standard term.
Committee Meeting Action: Accept in Principle
Revise 4.18.4* to read as follows:
4.18.4* SPD's Measured Limiting Voltage. Where an SPD has been listed as a transient voltage surge suppressor (TVSS), the published suppressed voltage rating (SVR) for each mode of protection shall be selected to be no greater than those given in Table 4.18.4 for the different power distribution systems to which they can be connected.
Committee Statement: The Committee notes that the submitter incorrectly referenced the print line to 4.18.3.2. The correct reference is to 4.18.4*. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-74 Log #65 **Final Action: Accept in Principle in Part**
(4.18.4)

Submitter: Dick Reehl, Quest Communications
Recommendation: Correct Table 4.18.4 for 240 2W + ground and 277/480 WYE 4W + HRG.
Substantiation: 240 2W + ground shows a requirement for Line-to-Neutral, there is no neutral.
277/480 WYE 4W + HRG has no requirements for Line-to-Neutral, Line-to-Ground, or Neutral-to-Ground.
Committee Meeting Action: Accept in Principle in Part
Change the following in Table 4.18.4:
In row labeled "240 2W + ground" and "Line-to-Neutral" and "Neutral-to-Ground" columns delete "1000" from the intersecting cells. In the "Line-to-Line" column add "1000" in the intersecting cell.
Committee Statement: The Committee changes the the first row labeled "240 2W + ground".
The Committee rejects the second part pertaining to the row labeled "277/480 WYE 4W + HRG (high resistance ground)" as the submitter did not provide a recommendation for consideration in accordance with the Regulations Governing Committee Projects, Section 4-3.3(c).
Number Eligible to Vote: 30
Ballot Results: Affirmative: 25 Negative: 1
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
GUTHRIE, M.: The proposal should have been rejected because the submitter did not provide a recommended change and change made by the committee does not address fact that the standard may be used outside the US.
Comment on Affirmative:
TOBIAS, J.: The corrections agreed to in the ROP meeting need checking. I affirm the decision on the proposal, (Accept in Principle in Part) but the specific numbers need to be checked before they are finalized.

780-75 Log #45 **Final Action: Accept in Principle**
(4.18.6)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...data, <u>CATV,</u> and...".
Substantiation: CATV omitted.
Committee Meeting Action: Accept in Principle
Revise 4.18.6 to read as follows:
4.18.6 Communications Surge Protection.
Committee Statement: The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-76 Log #46 **Final Action: Accept in Principle**
(4.18.6.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...data, <u>CATV,</u> and...".
Substantiation: CATV omitted.
Committee Meeting Action: Accept in Principle
Revise 4.18.6.1 to read as follows:
4.18.6.1* SPDs shall be provided for all communications systems (including but not limited to CATV, alarm, data) and antenna systems at facility entrances.
Committee Statement: The Committee accepts the submitter's recommendation. Further, the committee revises the text for clarification. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-77 Log #47 **Final Action: Accept in Principle**
(4.18.6.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...data, <u>CATV</u> , or...".
Substantiation: CATV omitted.
Committee Meeting Action: Accept in Principle
Revise 4.18.6.2 to read as follows:
4.18.6.2 SPDs shall be selected taking into consideration aspects such as the frequency, bandwidth and voltage. Losses (such as returns loss, insertion loss, impedance mismatch, or other attenuation) introduced by the SPD(s) shall be within acceptable operational limits.
Committee Statement: The Committee accepts the submitter's recommendation. Further, the committee revises the text for clarification. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-78 Log #113 **Final Action: Accept in Principle**
(4.18.6.2)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Add "return losses and impedance mis-matching" between "(attenuation)" and "introduced." The revised clause will read as follows:
"SPDs shall be selected taking into consideration aspects such as frequency, bandwidth, and voltage of the signal, data, or other telecommunication lines; and ensuring the insertion losses (attenuation), return losses, and impedance mis-matching introduced by the SPD(s) are within acceptable operational limits."
Substantiation: This proposal identifies that return losses and impedance mis-match must also be taken into consideration.
Committee Meeting Action: Accept in Principle
Committee Statement: See Commitee Action on Proposal 780-77 (Log #47).
The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-79 Log #48 **Final Action: Accept in Principle**
(4.18.6.3)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...data, <u>CATV</u> , and...".
Substantiation: CATV omitted.
Committee Meeting Action: Accept in Principle
Revise 4.18.6.3 to read as follows:
4.18.6.3 SPDs protecting communications systems shall be grounded.
Committee Statement: The Committee accepts the submitter's recommendation. Further, the committee revises the text for clarification. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-80 Log #40 **Final Action: Reject**
(4.19.2.4)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"... ~~receptacle~~ outlet ...".
Substantiation: Outlet is the more correct generic term, receptacle is somewhat reserved for a wall outlet for cord and plug electrical loads.
Committee Meeting Action: Reject
Committee Statement: The Committee notes that the submitter referenced the incorrect section.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-80a Log #CP6 **Final Action: Accept**
(4.20.1.1)

Submitter: Technical Committee on Lightning Protection
Recommendation: Revise 4.20.1.1 to read as follows:
4.20.1.1 All grounded media and buried metallic conductors which may assist in providing a path for lightning currents in and on a structure shall be connected to the lightning protection system within 3.6 m (12 ft) of the base of the structure in accordance with Section 4.14.
Substantiation: The committee revises 4.20.1.1 to clarify that underground metallic piping is not a grounding electrode, but must be bonded to the lightning protection system within 12 feet of the base of the structure in accordance with 4.14. This proposal is needed for consistency with the proposed revision to 4.14.1. See Proposal CP-5.
The purpose of this proposal is to eliminate any confusion as to whether underground metallic piping is considered a grounding electrode vice a potential ground current conductor requiring bonding to the grounding system. The proposed wording should eliminate any potential confusion or conflict with the requirements of NFPA 70, NFPA 54, NFPA 13, or NFPA 24 relative to the use of the piping as a lightning protection grounding electrode.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-81 Log #49 **Final Action: Reject**
(4.21.2.4(A))

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...is ~~required~~ considered within...".
Substantiation: The need is being considered and is not required yet.
Committee Meeting Action: Reject
Committee Statement: The current language expresses the Committee's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-82 Log #50 **Final Action: Reject**
(4.21.2.4(B))

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...is ~~required~~ considered below...".
Substantiation: The need is being considered and is not required yet.
Committee Meeting Action: Reject
Committee Statement: The current language expresses the Committee's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-83 Log #51 **Final Action: Accept in Principle**
(5.2.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...to ground ~~terminal~~ t terminal(s)."
Substantiation: There may be only one terminal installed.
Committee Meeting Action: Accept in Principle
Revise 5.2.2 to read as follows:
5.2.2 Electrically continuous metal structures shall require only bonding to grounding electrode(s).
Committee Statement: The Committee accepts the submitter's recommendation. Further, the committee revises the text for clarification. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-84 Log #67 **Final Action: Accept in Principle**
(5.2.3 (New))

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise text to read as follows:
5.2.3 If a mast, spire, or flagpole shares the premises with a structure with a lightning protection system the mast, spire, or flagpole ground terminal(s) shall be bonded to ground terminal(s) associated with other protected structures.
Substantiation: Separate lightning grounding electrode systems should be bonded together.
Committee Meeting Action: Accept in Principle
Revise the submitters text to read as follows:
5.2.3 If a mast, spire, or flagpole shares the premises and is within 7.6 m (25 ft) of a structure with a lightning protection system, the mast, spire, or flagpole grounding electrode(s) shall be bonded to the grounding electrode(s) associated with the protected structure(s).
Committee Statement: The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 24 Negative: 2
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
MORGAN, M.: The proposed text is vague as to whether or not bonding of these structures is required for all "Masts, Spires, Flagpoles" within the specified distance or only those "Masts, Spires, Flagpoles" with lightning protection. The possibility for confusion in the interpretation of this language should be adopted to clarify what the intent of this section is.
PORTFLEET, T.: New paragraph 5.2.3 is too general and vague. Specifically there are no defined or spatial limits to the parameters of "premises". Secondly, the term "mast" could be interpreted to include any object such as a utility pole. Thirdly, I am not sure what safety enhancement we would achieve by adding this paragraph to the body of the 780 text.

780-85 Log #52 **Final Action: Accept in Principle**
(6.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"... ~~as shown in Figure 6.1.~~
Substantiation: It's not shown in Figure 6.1.
Committee Meeting Action: Accept in Principle
Revise 6.1 to read as follows:
6.1 General.
A smoke or vent stack as shown in Figure 6.1 shall be classified as heavy duty if the cross-sectional area of the flue is greater than 0.3 m 2 (500 in. 2) and the height is greater than 23 m (75 ft).
Revise top view of figure to make parallel lines for dimension A.
See Figure 6.1 on the next page

Committee Statement: The Committee makes edit to Figure 1 to eliminate an angular distance. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-86 Log #53 **Final Action: Accept in Principle**
(Figure 6.1(B))

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"All lightning equipment on...".
Substantiation: Restricts requirement to 780 Scope.
Committee Meeting Action: Accept in Principle
Revise A in Figure 6.1 to read as follows:
A. 2.4 m (8 ft) maximum spacing of air terminals.
Revise B in Figure 6.1 to read as follows:
B. All lightning protection materials on upper 7.6 m (25 ft) of stack to be lead-covered copper, stainless steel, or approved corrosion-resistant material.
Within Figure 6.1, change 8 m to 7.6 m in two (2) places and 61 m to 60 m in two (2) places.
See Figure 6.1 on the next page

Committee Statement: The Committee accepts the submitter's recommendation. Additionally, it updates Figure 6.1 as per Manual of Style requirements. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-87 Log #108 **Final Action: Accept in Principle in Part**
(6.4.1.1, Figure 6.1)

Submitter: Matthew Caie, ERICO, Inc.
Recommendation: Conductors shall be copper, weighing not less than 558g per m (375 lb per 1000 ft) without lead coating, or approved corrosion-resistant material or coating.
Substantiation: Lead has many issues associated with OH&S in a number of aspects including the sourcing, manufacture, handling both in shipping and installation. Presently, for the application to Heavy Duty Stacks per NFPA 780, no alternative is provided for lead sheathed conductors on the upper 25 ft portion of heavy-duty stacks. Stainless steel or other approved corrosion resistance material** are allowed for strike termination devices, connectors and fixings.
It is proposed that the above change is made to clause 6.4.1.1 to widen the scope of allowable materials within the context of this standard. One example of what this change will allow is as follows:
- Stainless steel tape conductor of minimum thickness in accordance with section 4.9.3.
I have chosen not to state specific options within this clause, as not to limit option, also I have not removed reference to lead coating as this is still commonly used within the industry.
Stainless steel is approximately 45-50x the resistivity of copper conductor, at between 720-770 nohm.m and 460 cmil.ohm/ft. The thermal conductivity being lower means that stainless steel conductors may not be thin stranded like copper or aluminum, however can still conduct lightning current safely in a solid or tape form, especially over such a short length as 7.6m (25 ft) as per this application.

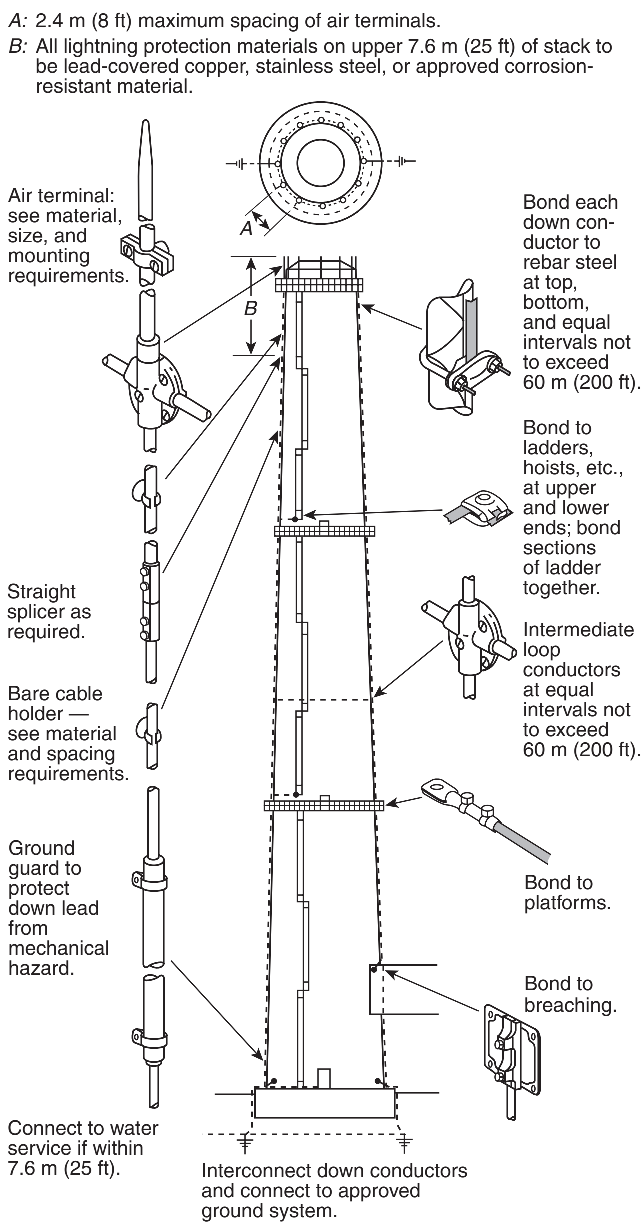


Figure 6.1 - Note B / Clause 6.3 / UL96 for Connectors

Committee Meeting Action: Accept in Principle in Part
Revise 6.4.1.1 as per the submitter's recommendation.
In Figure 6.1, delete text as follows:
Lead covered on upper 8 m (25 ft).
Committee Statement: The Committee accepts the submitter's recommendation to revise 6.4.1.1 and Figure 6.1. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-88 Log #54 **Final Action: Accept**
(6.4.2.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...shall be ~~located on opposite sides of~~ as equally spaced as practicable around the stack...".
Substantiation: Original wording will not work with a round stack or with an odd number of terminals on a rectangular stack.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-89 Log #72 **Final Action: Reject**
(6.7)

Submitter: Dick Reehl, Quest Communications
Recommendation: Add text to read as follows:
6.7 Reinforced Concrete Stacks. (new construction and where practicable)
Substantiation: Some requirements of 6.7 may not be possible on existing construction.
Committee Meeting Action: Reject
Committee Statement: The current statement reflects the committee's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-90 Log #79 **Final Action: Reject**
(6.7)

Submitter: Dick Reehl, Qwest Communications
Recommendation: 6.7 Reinforced Concrete Stacks. (new construction and where practicable)
Substantiation: Some requirements of 6.7 may not be possible on existing construction.
Committee Meeting Action: Reject
Committee Statement: The current statement reflects the Committee's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-91 Log #73 **Final Action: Reject**
(6.8)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise text to read as follows:
"6.8 Bonding of Metal Bodies. (new construction and where practicable) Bonding of metal...".
Substantiation: Some requirements of 6.8 may not be possible on existing construction.
Committee Meeting Action: Reject
Committee Statement: The current statement reflects the Committee's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-92 Log #80 **Final Action: Reject**
(6.8)

Submitter: Dick Reehl, Qwest Communications
Recommendation: 6.8 Bonding of Metal Bodies. (new construction and where practicable) "Bonding of metal..."
Substantiation: Some requirements of 6.8 may not be possible on existing construction.
Committee Meeting Action: Reject
Committee Statement: The current statement reflects the Committee's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-93 Log #55 **Final Action: Accept in Principle**
(6.10.2)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...shall be ~~located on opposite sides of~~ as equally spaced as practicable around the...".
Substantiation: Original wording will not work with a round stack or with an odd number of terminals on a rectangular stack.
Committee Meeting Action: Accept in Principle
Revise 6.10.2 to read as follows:
6.10.2 Such metal stacks shall be grounded by at least two grounding electrodes equally spaced as practicable around the stack.
Committee Statement: The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-94 Log #66 **Final Action: Accept in Principle**
(7.2.5)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise text to read as follows:
"...metallic conductors and between metallic conductors and structures and other grounded objects shall...".
Substantiation: Sparks between metallic conductors and the structure can ignite flammable vapors.
Committee Meeting Action: Accept in Principle
Revise 7.2.5 to read as follows:
7.2.5 Potential spark gaps between conductive surfaces shall not be allowed at points where flammable vapors escape or accumulate.
Committee Statement: The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-95 Log #88 **Final Action: Accept**
(7.3.1.1)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Revise text to read as follows:
"Conductors, strike termination devices, surge protection, and grounding connections shall be selected and installed in accordance with the requirements of Chapter 4 and as described in this chapter."
Substantiation: There is no location in Chapter 7 that identifies that the requirements in 4.18 are applicable for such structures.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-96 Log #84 **Final Action: Accept in Principle**
(Figure 7.3.3.3)

Submitter: John M. Tobias, US Department of the Army
Recommendation:
Changes:
Change equation to:

$$d = \sqrt{h_1(61 - h_1)} - \sqrt{h_2(61 - h_2)}$$

where:
d = horizontal protected distance (m)
h_1 = height of higher mast (m)
h_2 = height of lower mast (m)

Change axes: (ft) to (meters)
Change x-axis title to "horizontal protected distance"
Change all numbers as follows:
25 to 7.6
50 to 15.2
75 to 22.9
100 to 30.5
150 to 45.8
Remove from figure: "For SI units, 1 ft. = 0.305 m."
Substantiation: Conversion to metric units mandated by style manual.
Committee Meeting Action: Accept in Principle
Revise Note 1 in Figure 7.3.3.4 to read as follows:
The distance can be determined analytically for a 30 m (100 ft) striking distance with the following equation:

$$d = \sqrt{h_1(D - h_1)} - \sqrt{h_2(D - h_2)}$$

where (units shall be consistent, m or ft):
d = horizontal protected distance
h_1 = height of higher roof
h_2 = height of lower roof (top of the object)
D = rolling sphere diameter (60 m (200 ft))
Change title of Figure 7.3.3.4 to be FIGURE 7.3.3.4. Zone of Protection - 30 m (100 ft) Utilizing Rolling Sphere Method.

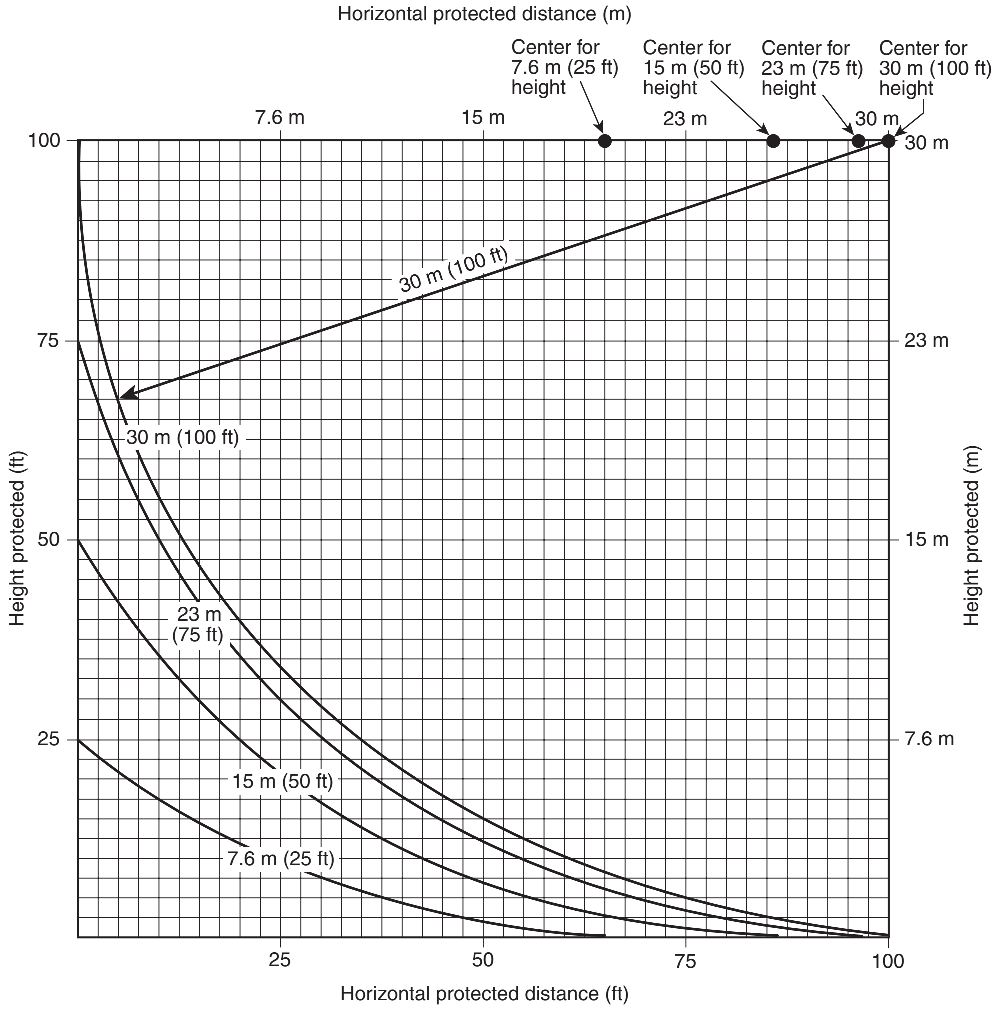
See revised Figure 7.3.3.4 on the next page
Committee Statement: The Committee notes that the submitter incorrectly referenced the print line to Figure 7.3.3.3. The correct reference is to 7.3.3.4.
The Committee accepts the submitter's recommendation to change the formula in Figure 7.3.3.4. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Comment on Affirmative:
GUTHRIE, M.: I agree with the intent of the committee action. There was some discussion during the ROP meeting that there was confusion by some casual users of the formula as to the source of the value of 200 used in the formula. The substitution of the variable "D" resolves this confusion. However, the use of the variable "2R" in place of "D" (where R is the striking distance) would be even clearer as to the source and it would eliminate the need to use both an upper case and lower case "d" in the formula.

780-96a Log #CP12 **Final Action: Accept**
(7.3.3.9)

Submitter: Technical Committee on Lightning Protection
Recommendation: Change "ground-wire" to "ground wire" in the following:
FIGURE 7.3.3.9 Alternate Grounding Methods for Overhead Ground Wire Protection. and 7.3.3.9(C).
Substantiation: The committee changes "ground-wire" to "ground wire" for consistancy.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-97 Log #119 **Final Action: Accept in Principle**
(Chapter 8)

Submitter: Ewen Thomson, Marine Lightning Protectin Inc.
Recommendation: Replace existing text as follows:
Chapter 8 Protection for Watercraft
8.1 General.
The intent of this chapter shall be to provide lightning protection requirements for watercraft while in water.
8.1.1 Lightning protection systems installed on watercraft shall be installed in accordance with the provisions of this chapter.
8.1.2 A lightning protection system does not afford protection if any part of the watercraft contacts a power line or other voltage source while in water or on shore.
8.1.3 A lightning protection system lowers, but does not eliminate, risk to personnel and the watercraft.
8.2 Materials.
8.2.1.1 The materials used in the lightning protection system shall be resistant to corrosion in a marine environment.
8.2.1.2 The use of combinations of metals that form detrimental galvanic couples shall be prohibited where they are likely to be in contact with water.
8.2.2.1 Copper conductors shall be tinned.
8.2.2.2 All copper conductors shall be the grade required for commercial electrical work and shall have at least 95 percent of the conductivity of pure copper.
8.2.2.3 The use of conducting materials other than copper, such as aluminum, stainless steel, and bronze, shall be permitted provided they meet all relevant requirements in this chapter.
***8.2.2.4** Carbon fiber composite is not permitted to be used as a conductor in a lightning protection system.
A.8.2.2.4 Carbon fiber fittings, including masts, should be isolated electrically from the lightning conductor system. Since carbon fiber is a conductor, sideflash risk is increased in the vicinity of CFC structures, especially near the water. The use of CFC reinforcement in areas such as chainplates is to be avoided.
8.3 Strike termination.



Notes:
The distance can be determined analytically for a 30 m (100 ft) striking distance with the following equation:

$$d = \sqrt{h_1 (D - h_1)} - \sqrt{h_2 (D - h_2)}$$

where (units are to be consistent, m or ft):
d = horizontal protected distance
h_1 = height of higher mast
h_2 = height of lower mast
D = rolling sphere diameter (60 m [200 ft])

Figure 7.3.3.4

***8.3.1 Zone of protection**

A.8.3.1 The techniques described in Section 4.8 should also be applied to watercraft for the placement of strike termination devices and determining the zone of protection.

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

8.3.1.2 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 8.3.1.2(a) and Figure 8.3.1.2(b).

See the following page for FIGURE 8.3.1.2(a) Zone of Protection — 30 m (100 ft) Striking Distance.

See the following page for FIGURE 8.3.1.2(b) Diagram of Boat with Masts in Excess of 15 m (50 ft) Above the Water; Protection Based on Lightning Strike Distance of 30 m (100 ft).

8.3.2 Strike Termination Devices.

***8.3.2.1** Strike termination devices shall meet the requirements of Section 4.6 or Table 4.1.1.1(A) and shall be so located and high enough to provide a zone of protection that covers the entire watercraft.

A.8.3.2 Where a standing person is not covered by the zone of protection a warning to this effect should be included in the owner's manual.

8.3.2.2 The devices shall be mechanically strong to withstand the roll and pitching action of the hull as well as heavy weather.

8.3.2.3 Metallic fittings such as masts, handrails, stanchions, bimini tops, outriggers, flybridges, and dinghy davits shall be permitted as strike termination devices providing they meet the requirements of Section 8.3.2.1.

8.3.3 Nonmetallic Masts. A nonmetallic 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 as given in Section 8.3.2.

8.3.3.1 An air terminal shall extend a minimum of 25 cm (10in.) above the mast.

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

8.3.3.3 Multiple air terminals shall be permitted to give the required zone of protection comprising overlapping zones of protection as described in Section 8.3.3.2.

8.3.3.2 An air terminal shall be securely fastened to the mast and connected to a main conductor as described in Section 8.4.1.

8.3.3.3 A grounding system meeting the requirements of Section 8.5 also shall be provided as described in Section 8.5.

8.4 Conductors.

8.4.1 Main Conductor.

8.4.1.1 A main conductor made of copper shall have a cross sectional area of at least 21 mm^2 (0.033 in^2).

A.84.1.1 See Table 9.13.5(a) of NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, for minimum strand sizes for watercraft conductors

8.4.1.2 A main conductor made of aluminum shall have a cross sectional area of at least 40 mm^2 (0.062 in^2).

***8.4.1.3** A conducting fitting constructed of metal other than copper or aluminum that neither contains electrical wiring, nor connects conductors containing electrical wiring, shall be permitted to be used as a main conductor if it has at least the cross sectional area given by the formula:

$$A = 3.8x10^9 \sqrt{\frac{\rho}{C_p D(MP - 298)}} \text{mm}^2$$

where C_p is the specific heat capacity in J kg^{-2} K^{-1}, D is the density in kg m^{-3}, ρ is the resistivity in Ω m, and MP is the melting point in degrees Kelvin.

A.8.4.1.3 If a metal with the area given by the equation in Section 8.4.1.3, is subject to the lightning heating (action integral) required to raise the temperature of a copper conductor with 21 mm^2 (0.033 in^2) from a nominal temperature of 298 K to the melting point of copper, then its temperature would be raised to the melting point of the metal. Values for silicon bronze and stainless steel are given in the table below.

Table A.8.4.1.3 Areas for Main Conductor not Containing Electrical Wiring

Metal	C_p J kg^{-2} K^{-1}	D kg m^{-3}	P Ω m	MP K	Area mm^2
Silicon bronze	360	8800	2.55x10^{-7}	1356	85
Stainless steel	510	7930	9.6x10^{-7}	1800	125

Note that conductors with these areas have a larger resistance per unit length than a main conductor made of copper and so should not be used where potential equalization is required.

***8.4.1.4** A conducting fitting constructed of metal other than copper or aluminum that either contains electrical wiring or connects conductors containing electrical wiring shall be permitted to be used as a main conductor if it has the same or smaller DC resistance per unit length as a copper conductor with a cross sectional area of 21 mm^2 (0.033 in^2).

A.8.4.1.4 The area of a conductor of uniform cross section that has the same resistance as a copper conductor of area A_{Cu} is given by:

$$A = \frac{\rho}{\rho_{\text{Cu}}} A_{Cu}$$

where ρ_{Cu}=1.7x10^{-8}Ωm is the resistivity of copper, and A_{Cu}=21 mm^2 for a main conductor. Using the same parameters in Table A8.4.1.3, the areas are 315 mm^2 (0.49 in^2) for silicon bronze and 1200 mm^2 (1.8 in^2) for stainless steel.

8.4.1.5 Metallic fittings that shall be permitted to be used as main conductors providing they meet the requirements of Section 8.4.1. include masts, handrails, toe rails, stanchions, through bolts, bimini tops, outriggers, flybridges, and dinghy davits.

***8.4.1.6** Each main conductor shall be routed either directly to a grounding terminal, described in Section 8.5.4, or outboard of crewed areas, wiring, and electronics.

A.8.4.1.6 Routing lightning conductors near the outer surface of the hull lowers the risk of internal sideflashes forming between the lightning conductors and other conducting fittings and of external sideflashes forming between conducting fittings and the water. Routing lightning conductors externally is also more consistent with the layout recommended for buildings wherein air terminals, down conductors and ground terminals are located on the outside of the building. However, in the case of internal conducting fittings being very close to the water, such as a keel-stepped mast, a grounding terminal should be provided as close as is practicable to the portion of the fitting that is closest to the water.

***8.4.1.7** No main conductor shall pass within 15 cm (6 in) of the unheeled waterline unless it is terminated in a grounding terminal (Section 8.5.4) within 60 cm (24 in).

A.8.4.1.7. All lightning conductors should be routed as far as possible from the water, and especially the waterline, to minimize the risk of an external sideflash forming between the lightning conductor and the water. Similarly, conducting fittings, electronic equipment, and electrical wiring should be located as far as possible from the water.

8.4.1.8 An air gap shall be permitted to break the path of a main conductor subject to the conditions in Section 8.5.4.3.

8.4.2 Bonding Conductor.

8.4.2.1 A bonding conductor made of copper shall have a cross sectional area of at least 8.3 mm^2 (0.013 in^2).

8.4.2.2 A bonding conductor made of aluminum shall have a cross sectional area of at least 16 mm^2 (0.025 in^2).

***8.4.2.3** A conducting fitting constructed of metal other than copper or aluminum that neither contains electrical wiring, nor connects conductors containing electrical wiring, shall be permitted to be used as a bonding conductor if it meets the minimum cross sectional area given by the formula:

$$A = 9.7x10^9 \sqrt{\frac{\rho}{C_p D(MP - 298)}} \text{mm}^2$$

A.8.4.2.3 Using the same parameters as in as in Section A8.4.1.3, the required areas are 33 mm^2 (0.052 in^2) for silicon bronze and 48 mm^2 (0.075 in^2) for stainless steel.

* **8.4.2 4** A conducting fitting constructed of metal other than copper or aluminum that either contains electrical wiring or connects conductors containing electrical wiring shall be permitted to be used as a bonding conductor if it has the same or smaller DC resistance per unit length as a copper conductor with a cross sectional area of 8.3 mm^2 (0.013 in^2).

A.8.4.2 4 Using the same equation as in Section A8.4.1.3 with the area for a copper bonding conductor, A_{Cu}=8.3 mm^2, the required areas are 125 mm^2 (0.19 in^2) for silicon bronze and 470 mm^2 (0.73 in^2) for stainless steel.

8.4.2.5 Metallic fittings that shall be permitted to be used as bonding conductors providing they meet the requirements of Section 8.4.2. include masts, handrails, stanchions, toe rails, through bolts, bimini tops, outriggers, flybridges, and dinghy davits.

8.4.2.6 No bonding conductor shall pass within 15 cm (6 in) of the unheeled waterline unless it is within 60 cm (24 in) of a grounding terminal (Section 8.5.4)

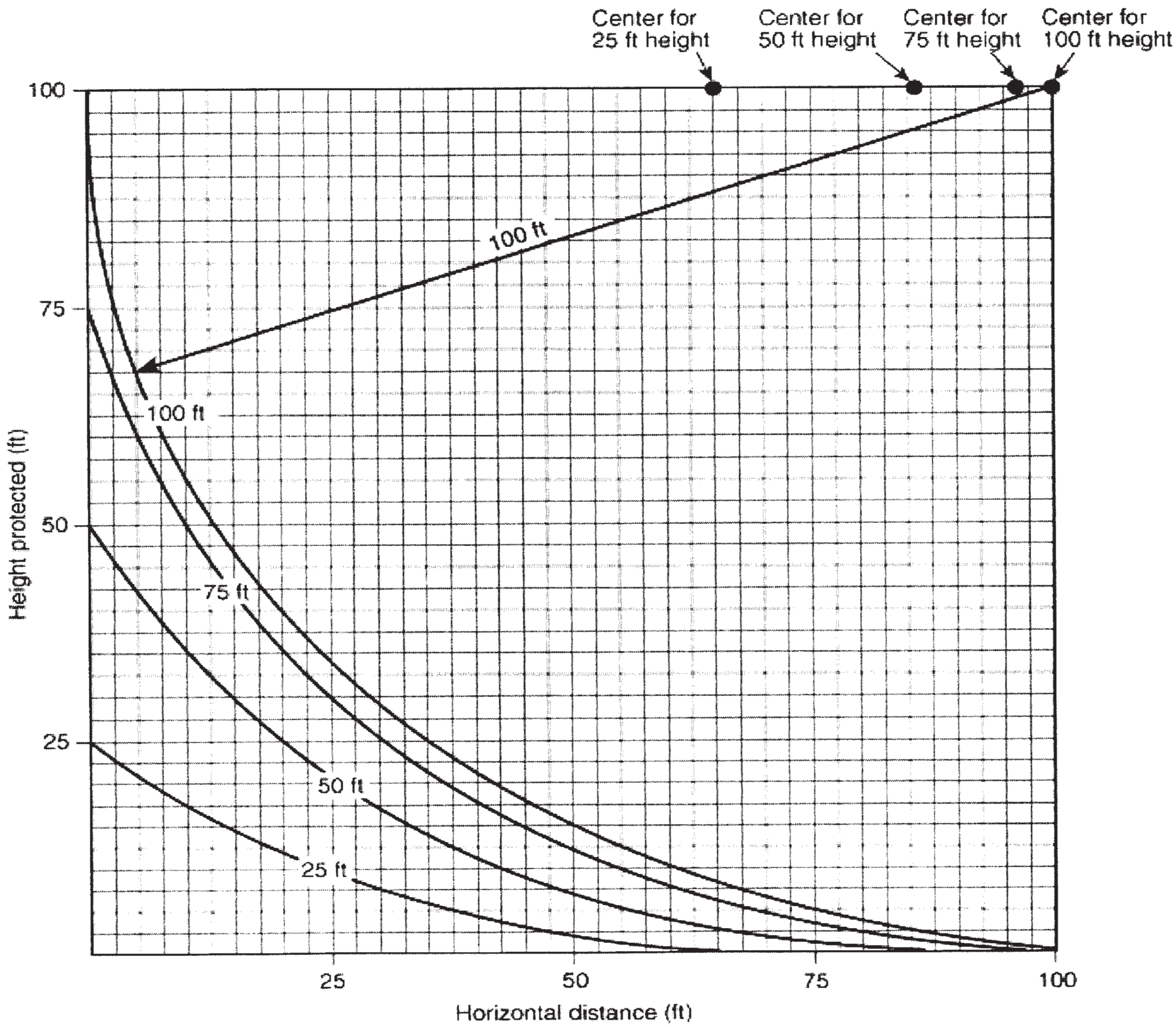


Figure 8.3.1.2(a) Zone of Protection - 30 m (100 ft) Striking Distance.

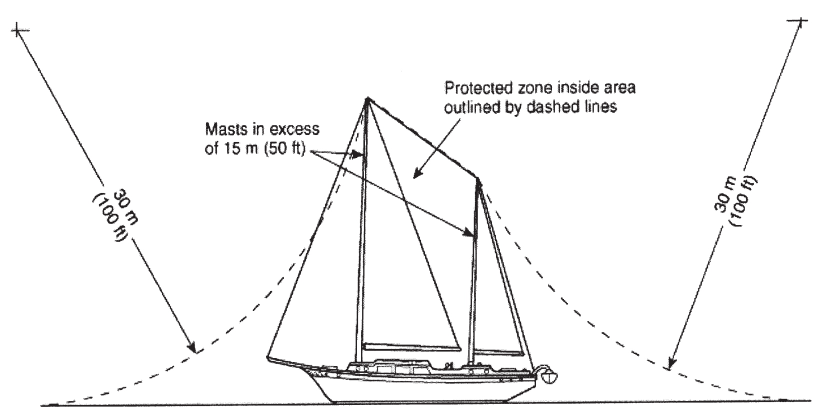


Figure 8.3.1.2(b) Diagram of Boat with Masts in Excess of 15 m (50 ft) Above the Water; Protection Based on Lightning Strike Distance of 30 m (100 ft).

8.4.2.7 Large metallic masses shall be connected to the loop conductor, a bonding conductor, or a main conductor with at least one bonding conductor. Large metallic masses include metal cabinets that enclose electronic equipment, tanks, handrails, lifeline stanchions, engines, generators, steering cables, steering wheel or tiller, engine controls, metallic arches, and bow and stern pulpits.

8.4.2.8 The lower end of each metallic shroud or stay shall be bonded horizontally to the loop conductor. The connection to the shroud or its chainplate shall be permitted to be made near deck level.

8.4.3 Loop Conductor

8.4.3.1 A loop conductor comprising either main or bonding conductors or both shall be routed horizontally at either deck level, or cabin top level, or at least 2 m (6 ft) above the waterline to form a continuous conducting loop outboard of crewed areas, wiring, and electronics.

8.4.3.2 Any portion of the loop conductor that includes a path between a strike termination device and a water terminal shall satisfy the requirements for a main conductor.

8.4.3.3 The loop conductor shall be connected to at least one main conductor with either a bonding conductor or a main conductor.

8.4.4 Conductor system

***8.4.4.1** All main conductors, bonding conductors and loop conductors shall be interconnected to form the lightning conductor system.

A.8.4.4.2 A main conductor is designed to conduct an appreciable fraction of the lightning current, typically in a vertical direction. Close to the water, and especially inside the hull below the waterline, the optimum direction for a main conductor is perpendicular to the hull directly inboard of the water terminal to which it is connected. A bonding conductor is intended to conduct the relatively small currents required to equalize potentials between conducting fittings and the lightning protection system. The optimum orientation for bonding conductors is parallel to the water surface and the best location is as far from the water surface as is practicable.

8.4.4.3 Each interconnection shall employ at least a bonding conductor, or a connecting fitting satisfying the requirements in Section 8.4.6, and each joint between conductors shall satisfy the requirements in Section 8.4.5.

8.4.4.4 The path between each strike termination device and each grounding terminal (section 8.5.4) shall be connected by at least one main conductor.

8.4.4.5 The thickness of any copper ribbon, strip or hollow conductor in the system shall be not less than 1.3 mm (0.052 in).

8.4.4.6 The thickness of any aluminum ribbon, strip, or hollow conductor in the system shall be not less than 1.6 mm (0.064 in).

8.4.4.7 The lightning conductor system shall be connected to both the DC and AC electric grounds using a bonding conductor.

8.4.5 Joints.

8.4.5 1 Joints shall be mechanically strong an able to withstand any torque, force or tension to be expected during normal operation.

8.4.5.2 When a joint is made between conductors of the same material, the contact area shall be at least as large as the cross sectional area of the conductor. Depending on the material, contact minimum area for a joint in a main conductor shall be given by Section 8.4.1.1 (for copper), 8.4.1.2 (for aluminum) or 8.4.1.3 (for other metals), and for a joint in a bonding conductor, or between a bonding conductor and main conductor, shall be given by Section 8.4.2.1 (for copper), 8.4.2.2 (for aluminum), or 8.4.2.3 (for other metals).

8.4.5.3 When a joint is made between two different metals, the minimum contact area shall be that required in Section 8.4.1.3 for a main conductor and Section 8.4.2.3 for a bonding conductor.

8.4.5.4 With the exception of bimetallic connectors, direct contact between metals whose galvanic potential differs by more than 0.5 V shall not be permitted. For plated metals, the galvanic potential shall be that of the plating.

8.4.5.5 No joint between metals whose galvanic potential differs by more than 0.5 V shall be permitted in locations such as the bilge where immersion is likely unless the joint is encapsulated in a waterproof enclosure.

8.4.5.6 In those cases where it is impractical to avoid a junction of dissimilar metals, the corrosion effect shall be reduced by the use of plating or special connectors, such as stainless steel connectors used between aluminum and copper or copper alloys.

8.4.6 Connecting fittings.

8.4.6.1 Fittings of any length that are made of aluminum shall be permitted to join two conductors if the minimum cross sectional area meets the requirements of Section 8.4.1 for main conductors or 8.4.2 for bonding conductors.

***8.4.6.2** Connecting fittings made of metals other than aluminum or copper shall either;

1. have the same resistance per unit length as the corresponding type of conductor (that is, main or bonding); or;
2. have a cross sectional area at least as large as that given in Section 8.4.1.3 for a main conductor or Section 8.4.2.3 for a bonding conductor, and have a resistance that is not more than the resistance of 61 cm (2 ft) of the corresponding copper conductor.

A.8.4.6.2

1. The area of a conductor of uniform cross section that has the same resistance per unit length as a main conductor is given by the equation in A.8.4.1.4. For connecting a main conductor, the areas are 315 mm^2 (0.49 in^2) for silicon bronze and 1200 mm^2 (1.8 in^2) for stainless steel. For connecting a bonding conductor the required areas are 125 mm^2 (0.19 in^2) for silicon bronze and 470 mm^2 (0.73 in^2) for stainless steel.

2. Equating resistances for a copper conductor of area A_{Cu}, resistivity ρ_{Cu}, and length L_{Cu} and a metal connector of area A, resistivity ρ and length L gives a maximum allowable length for the metal connector of:

$$L = L_{Cu} \frac{A}{A_{Cu}} \frac{\rho_{Cu}}{\rho}$$

The length is the same for both main and bonding conductors and is 16 cm (6.5 in) for silicon bronze and 6.3 cm (2.5 in) for stainless steel when L_{Cu}=61 cm (2 ft).

8.5 Grounding.

8.5.1 Watercraft with Metal Hulls.

Where an electrical connection exists between a metallic hull and a lightning air terminal or other metallic superstructure of sufficient height to provide the zone of protection specified in Section 8.3, no further protection shall be necessary;

8.5.2 Watercraft with Nonmetallic Hulls.

***8.5.2.1** Grounding terminals shall be installed on the nonmetallic hull of a watercraft to provide multiple paths for the lightning current to exit into the water.

A.8.5.2.1 In order to allow for main conductors to be routed externally to vulnerable areas, as described in Section 8.4.1.6, but also to reduce the risk of external sideflashes from the lightning conductors, grounding terminals should be located as close to the waterline as is practicable. Where an onboard fitting is below the waterline and close to the water, an additional supplemental grounding terminal is advisable in the vicinity of the fitting.

8.5.2.2 Each grounding terminal shall be connected either directly to a main conductor or to a main conductor through an air gap that satisfies all conditions in Section 8.5.4.3.

***8.5.2.3** Rudders, struts, seacocks, through-hull fittings, or any other metallic fittings that meet the requirements of either Section 8.5.4.1 or Section 8.5.4.2 shall be permitted to be used as grounding terminals.

A.8.5.2.3 Seacocks are particularly susceptible to damage and leaking after a strike and should be inspected after all suspected strikes.

8.5.2.4 Through-hull connectors to a grounding terminal shall be metallic and have a cross-sectional area equivalent to a main conductor.

8.5.2.5 Main grounding terminal

8.5.2.5.1 At least one grounding terminal shall comprise an immersed solid conductor that has a contact area of at least 0.09 m^2 (1.0 ft^2) with the water, and a thickness of at least 5 mm (3/16 in), and a width of at least 19 mm (3/4 in).

8.5.2.5.2 The area of a main grounding terminal shall be determined as the outward-facing area of the surface that is in contact with the water.

8.5.2.5.3 A main grounding terminal shall be immersed during all normal modes of vessel operation.

8.5.4.2 Supplemental grounding terminal.

8.5.4.2.1 Supplemental grounding terminals shall be permitted that have less than 0.09 m^2 (1.0 ft^2) in contact with the water.

***8.5.4.2.2** The outboard surface of the terminal shall be less than 1.0 mm (0.04 in) inside the outer finished surface of the hull, including coatings and paint.

A.8.5.4.2.2 A supplemental grounding terminal may be painted or covered with a thin coating (<1mm or 0.04 in) but should not be encapsulated in fiberglass.

***8.5.4.3 Air gap**

A.8.5.4.3 An air gap may be desirable to reduce corrosion in the presence of leakage currents in the water and may reduce galvanic corrosion. However, using an air gap to isolate an immersed conductor from the water may increase the risk of a ground fault current bypassing any ground fault protection device. Hence a hazardous current can be inadvertently introduced into the water. For this reason measures should be taken to ensure that loose electrical connections cannot contact any part of the isolated grounding terminal.

8.5.4.3.1 An air gap shall be permitted to break the path of a main conductor within 200 mm (8 in) of a grounding terminal.

8.5.4.3.2 The breakdown voltage of an air gap shall be not less than 600V and not greater than 15kV.

8.5.4.3.3 With the exception of the gap itself, all components in and connections to an air gap device shall have a cross sectional area meeting the requirements for a main conductor.

Substantiation: There are many issues with the present standard, both from scientific and practical perspectives. The revision covers the following main points:

1. Zones of protection: This is expanded to allow for location of strike termination devices in a similar fashion to that used in buildings.

2. Conductors: In a marine system metals such as bronze and stainless steel are used extensively. This rewrite quantifies key parameters for utilizing these metals in the lightning protection system, specifically, main, bonding, and loop conductors, joints and connections. A new requirement for a “Loop” conductor replaces the concept of the “equalization bus” to equalize potentials predominantly well above the waterline and provide for a guard ring around the deck. More details are provided for routing conductors to minimize risks of sideflashes, both internal (between onboard conductors) and external (between an onboard conductor and the water). A key point is the desirability of routing lightning conductors externally, rather than through the middle of the boat as the present standard implies.

3. Grounding: Given the advisability of using multiple grounding terminals, types of grounding conductors are divided into “main” (> 1 sq ft) and “supplemental” (<1 sq ft) so that smaller fittings can also be used for grounding.

4. Air gap: A major problem with adding interconnected immersed grounding terminals arises from electrolytic and galvanic corrosion problems. These can be averted by adding a DC block near each terminal in the form of an air gap that will spark over at less than 15kV (~the peak voltage of a boat with a 1 sq ft immersed ground in salt water, and much less than expected voltages in fresh water).

Committee Meeting Action: Accept in Principle

Replace existing Chapter 8 in its entirety with the following:

Chapter 8 Protection for Watercraft

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

8.1 General.
The intent of this chapter shall be to provide lightning protection requirements for watercraft while in water.
8.1.1 Lightning protection systems installed on watercraft shall be installed in accordance with the provisions of this chapter.
8.1.2 A lightning protection system does not afford protection if any part of the watercraft contacts a power line or other voltage source while in water or on shore.
8.1.3 A lightning protection system lowers, but does not eliminate, risk to personnel and the watercraft.
8.2 Materials.
8.2.1 Corrosion.
8.2.1.1 The materials used in the lightning protection system shall be resistant to corrosion in a marine environment.
8.2.1.2 The use of combinations of metals that form detrimental galvanic couples shall be prohibited where they are likely to be in contact with water.
8.2.2 Dissimilar Metals.
8.2.2.1 Copper conductors shall be tinned.
8.2.2.2 All copper conductors shall be the grade required for commercial electrical work and shall have at least 95percent of the conductivity of pure copper.
8.2.2.3 The use of conducting materials other than copper, such as aluminum, stainless steel, and bronze, shall be permitted provided they meet all requirements in this chapter.
8.2.2.4* Carbon fiber composite (CFC) is not permitted to be used as a conductor in a lightning protection system.
A.8.2.2.4 Carbon fiber fittings, including masts, should be isolated electrically from the lightning conductor system. Since carbon fiber is a conductor, sideflash risk is increased in the vicinity of CFC structures, especially near the water. The use of CFC reinforcement in areas such as chainplates is to be avoided.
8.3 Strike termination.
8.3.1* Zone of Protection.
A.8.3.1 The techniques described in Section 8 should also be applied to watercraft for the placement of strike termination devices and determining the zone of protection.
8.3.1.1 The zone of protection for watercraft shall be based on a striking distance of 30 m (100 ft).
8.3.1.2 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 8.3.1.2(a) and Figure 8.3.1.2(b).
The Committee made the following revisions to:

FIGURE 8.3.1.2(a) Zone of Protection — 30 m (100 ft) Striking Distance.

Revise Note 1 in Figure 8.3.1.2(a) to read as follows:
The distance can be determined analytically for a 30 m (100 ft) striking distance with the following equation:
d = √ h1 (D- h1) - √ h2 (D- h2)
where (units shall be consistent, m or ft):
d = horizontal protected distance
h1 = height of higher roof
h2 = height of lower roof (top of the object)
D = rolling sphere diameter (60 m (200 ft))

Change title to be FIGURE 8.3.1.2(a) Zone of Protection - 30 m (100 ft) Utilizing Rolling Sphere Method.
Left axis of Figure 8.3.1.2(a) to read: Height protected (ft)
Right axis of Figure 8.3.1.2(a) to read: Height protected (m)
Top axis of Figure 8.3.1.2(a) to read: Horizontal protected distance (m)
Bottom axis of Figure 8.3.1.2(a) to read: Horizontal protected distance (ft)
In Figure 8.3.1.2(a), add metric to follow each English unit as follows:
25 ft (7.6 m)
50 ft (15 m)
75 ft (23 m)
100 ft (30 m)
In Figure 8.3.1.2(a), add metric to top axis and right axis
Delete Note 2 from Figure 8.3.1.2(a), “For SI units, 1 ft. = 0.305 m.”

FIGURE 8.3.1.2(a) Zone of Protection - 30 m (100 ft) Striking Distance.

FIGURE 8.3.1.2(b) Diagram of Boat with Masts in Excess of 15 m (50 ft) Above the Water; Protection Based on Lightning Strike Distance of 30 m (100 ft).

Figures shown on page 24

8.3.2 Strike Termination Devices.
8.3.2.1* Strike termination devices shall meet the requirements of Section 4.6 and Table 4.1.1.1(A) and shall be so located and high enough to provide a zone of protection that covers the entire watercraft.
A.8.3.2.1 Where a standing person is not covered by the zone of protection a warning to this effect should be included in the owner’s manual.
8.3.2.2 The devices shall be mechanically strong to withstand the roll and pitching action of the hull as well as heavy weather.
8.3.2.3 Metallic fittings such as masts, handrails, stanchions, bimini tops, outriggers, flybridges, and dinghy davits shall be permitted as strike termination devices providing they meet the requirements of Section 8.3.2.1.
8.3.3 Nonmetallic Masts. A nonmetallic 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.
8.3.3.1 An air terminal shall extend a minimum of 25 cm (10in.) above the mast.
8.3.3.2 The top of an air terminal shall be sufficiently high that all masthead fittings are below the surface of a 90 degree inverted cone with apex at the top of the air terminal.
8.3.3.3 Multiple air terminals shall be permitted to give the required zone of protection comprising overlapping zones of protection as described in Section 8.3.3.2.
8.3.3.4 An air terminal shall be securely fastened to the mast and connected to a main conductor as described in Section 8.4.1.
8.3.3.5 A grounding system meeting the requirements of Section 8.5 also shall be provided.
8.4 Conductors.
8.4.1 Main Conductor.
8.4.1.1* A main conductor made of copper shall have a cross sectional area of at least 21 mm^2 (0.033 in^2).
A.8.4.1.1 See Table 9.1(a) of NFPA 302, *Fire Protection Standard* for *Pleasure and Commercial Motor Craft*, for minimum strand sizes for watercraft conductors. Main conductors of greater cross sectional area as discussed in 4.9 provide a greater degree of safety.
8.4.1.2 A main conductor made of aluminum shall have a cross sectional area of at least 40 mm^2 (0.062 in^2).
8.4.1.3* A conducting fitting constructed of metal other than copper or aluminum that neither contains electrical wiring, nor connects conductors containing electrical wiring, shall be permitted to be used as a main conductor if it has at least the cross sectional area given by the formula:

$$A = 9.7\times10^{9}\sqrt{\frac{\rho}{C_p D(MP\text{-}298)}}\,\text{mm}^2$$

Change *x* to x in equation above
where C_p is the specific heat capacity in J kg^{-2} K^{-1}, D is the density in kg m^{-3}, ρ is the resistivity in Ω m, and MP is the melting point in degrees Kelvin.
A.8.4.1.3 If a metal with the area given by the equation in Section 8.4.1.3, is subject to the lightning heating (action integral) required to raise the temperature of a copper conductor with 21 mm^2 (0.033 in^2) from a nominal temperature of 298 K to the melting point of copper, then its temperature would be raised to the melting point of the metal. Values for silicon bronze and stainless steel are given in Table A.8.4.1.3.

Table A.8.4.1.3 Areas for Main Conductor not Containing Electrical Wiring

Metal	C_p J kg^{-2} K^{-1}	D kg m^{-3}	P Ω m	MP K	Area mm^2
Silicon bronze	360	8800	2.55x10^{-7}	1356	85
Stainless steel	510	7930	9.6x10^{-7}	1800	125

Note that conductors with these areas have a larger resistance per unit length than a main conductor made of copper and so should not be used where potential equalization is required.

8.4.1.4* A conducting fitting constructed of metal other than copper or aluminum that either contains electrical wiring or connects conductors containing electrical wiring shall be permitted to be used as a main conductor if it has the same or smaller DC resistance per unit length as a copper conductor with a cross sectional area of 21 mm^2 (0.033 in^2).
A.8.4.1.4 The area of a conductor of uniform cross section that has the same resistance as a copper conductor of area A_{Cu} is given by:

$$A = \frac{\rho}{\rho_{Cu}} A_{Cu}$$

where ρ_{Cu}=1.7x10^{-8}Ωm is the resistivity of copper, and A_{Cu}=21 mm^2 for a main conductor. Using the same parameters in Table A8.4.1.3, the areas are 315 mm^2 (0.49 in^2) for silicon bronze and 1200 mm^2 (1.8 in^2) for stainless steel.
8.4.1.5 Metallic fittings that shall be permitted to be used as main conductors providing they meet the requirements of Section 8.4.1. include masts, handrails, toe rails, stanchions, through bolts, bimini tops, outriggers, flybridges, and dinghy davits.
8.4.1.6* Each main conductor shall be routed either directly to a grounding electrode, described in Section 8.5, or outboard of crewed areas, wiring, and electronics.
A.8.4.1.6 Routing lightning conductors near the outer surface of the hull lowers the risk of internal side flashes forming between the lightning conductors and other conducting fittings and of external side flashes forming between conducting fittings and the water. Routing lightning conductors externally is also more consistent with the layout recommended for buildings wherein air terminals, down conductors and grounding electrodes are located on the outside of the building. However, in the case of internal conducting fittings being very close to the water, such as a keel-stepped mast, a grounding electrode should be provided as close as is practicable to the portion of the fitting that is closest to the water.
8.4.1.7* No main conductor shall pass within 15 cm (6 in) of the unheeled waterline unless it is terminated in a grounding electrode (Section 8.5.4) within 60 cm (24 in).
A.8.4.1.7 All lightning conductors should be routed as far as possible from the water, and especially the waterline, to minimize the risk of an external sideflash forming between the lightning conductor and the water. Similarly, conducting fittings, electronic equipment, and electrical wiring should be located as far as possible from the water.
8.4.1.8 An air gap shall be permitted to break the path of a main conductor subject to the conditions in Section 8.5.4.3.
8.4.2 Bonding Conductor.
8.4.2.1 A bonding conductor made of copper shall have a cross sectional area of at least 8.3 mm^2 (0.013 in^2).
8.4.2.2 A bonding conductor made of aluminum shall have a cross sectional area of at least 16 mm^2 (0.025 in^2).
8.4.2.3* A conducting fitting constructed of metal other than copper or aluminum that neither contains electrical wiring, nor connects conductors containing electrical wiring, shall be permitted to be used as a bonding conductor if it meets the minimum cross sectional area given by the formula:

$$A = 3.8x10^9 \sqrt{\frac{\rho}{C_p D(MP - 298)}} \quad \text{mm}^2$$

Change *x* to x in equation above
A.8.4.2.3 Using the same parameters as in as in Section A8.4.1.3, the required areas are 33 mm^2 (0.052 in^2) for silicon bronze and 48 mm^2 (0.075 in^2) for stainless steel.
8.4.2.4* A conducting fitting constructed of metal other than copper or aluminum that either contains electrical wiring or connects conductors containing electrical wiring shall be permitted to be used as a bonding conductor if it has the same or smaller DC resistance per unit length as a copper conductor with a cross sectional area of 8.3 mm^2 (0.013 in^2).
A.8.4.2.4 Using the same equation as in Section A8.4.1.3 with the area for a copper bonding conductor, A_{Cu}=8.3 mm^2, the required areas are 125 mm^2 (0.19 in^2) for silicon bronze and 470 mm^2 (0.73 in^2) for stainless steel.
8.4.2.5 Metallic fittings that shall be permitted to be used as bonding conductors providing they meet the requirements of Section 8.4.2. include masts, handrails, stanchions, toe rails, through bolts, bimini tops, outriggers, flybridges, and dinghy davits.
8.4.2.6 No bonding conductor shall pass within 15 cm (6 in) of the unheeled waterline unless it is within 60 cm (24 in) of a grounding electrode (Section 8.5.4)
8.4.2.7 Large metallic masses shall be connected to the loop conductor, a bonding conductor, or a main conductor with at least one bonding conductor. Large metallic masses include metal cabinets that enclose electronic equipment, tanks, handrails, lifeline stanchions, engines, generators, steering cables, steering wheel or tiller, engine controls, metallic arches, and bow and stern pulpits.
8.4.2.8 The lower end of each metallic shroud or stay shall be bonded horizontally to the loop conductor. The connection to the shroud or its chainplate shall be permitted to be made near deck level.
8.4.3 Loop Conductor.
8.4.3.1 A main size loop conductor shall be routed horizontally at either deck level, or cabin top level, or at least 2 m (6 ft) above the waterline to form a continuous conducting loop outboard of crewed areas, wiring, and electronics.
8.4.3.2 The loop conductor shall be connected to at least one main conductor with a main conductor.
8.4.4 Conductor System.
8.4.4.1* All main conductors, bonding conductors and loop conductors shall be interconnected to form the lightning conductor system.
A.8.4.4.1 A main conductor is designed to conduct an appreciable fraction of the lightning current, typically in a vertical direction. Close to the water, and especially inside the hull below the waterline, the optimum direction for a main conductor is perpendicular to the hull directly inboard of the grounding electrode in contact with the water. A bonding conductor is intended to conduct the relatively small currents required to equalize potentials between conducting fittings and the lightning protection system. The optimum orientation for bonding conductors is parallel to the water surface and the best location is as far from the water surface as is practicable.
8.4.4.2 Each interconnection shall employ at least a bonding conductor, or a connecting fitting satisfying the requirements in Section 8.4.6, and each joint between conductors shall satisfy the requirements in Section 8.4.5.
8.4.4.3 The path between each strike termination device and each grounding electrode (Section 8.5.4) shall be connected by at least one main conductor.
8.4.4.4 The thickness of any copper ribbon, strip or hollow conductor in the system shall be not less than 1.3 mm (0.052 in).
8.4.4.5 The thickness of any aluminum ribbon, strip, or hollow conductor in the system shall be not less than 1.6 mm (0.064 in).
8.4.4.6 The lightning conductor system shall be connected to both the DC and AC electric grounds using a bonding conductor.
8.4.5 Joints.
8.4.5.1 Joints shall be mechanically strong and able to withstand any torque, force or tension to be expected during normal operation.
8.4.5.2 When a joint is made between conductors of the same material, the contact area shall be at least as large as the cross sectional area of the conductor. Depending on the material, contact minimum area for a joint in a main conductor shall be given by Section 8.4.1.1 (for copper), 8.4.1.2 (for aluminum) or 8.4.1.3 (for other metals), and for a joint in a bonding conductor, or between a bonding conductor and main conductor, shall be given by Section 8.4.2.1 (for copper), 8.4.2.2 (for aluminum), or 8.4.2.3 (for other metals).
8.4.5.3 When a joint is made between two different metals, the minimum contact area shall be that required in Section 8.4.1.3 for a main conductor and Section 8.4.2.3 for a bonding conductor.
8.4.5.4 With the exception of bimetallic connectors, direct contact between metals whose galvanic potential differs by more than 0.5 V shall not be permitted. For plated metals, the galvanic potential shall be that of the plating.
8.4.5.5 No joint between metals whose galvanic potential differs by more than 0.5 V shall be permitted in locations such as the bilge where immersion is likely unless the joint is encapsulated in a waterproof enclosure.
8.4.5.6 In those cases where it is impractical to avoid a junction of dissimilar metals, the corrosion effect shall be reduced by the use of plating or special connectors, such as stainless steel connectors used between aluminum and copper or copper alloys.
8.4.6 Connecting Fittings.
8.4.6.1 Fittings of any length that are made of aluminum shall be permitted to join two conductors if the minimum cross sectional area meets the requirements of Section 8.4.1 for main conductors or 8.4.2 for bonding conductors.
8.4.6.2* Connecting fittings made of metals other than aluminum or copper shall either;
1. have the same resistance per unit length as the corresponding type of conductor (that is, main or bonding); or;
2. have a cross sectional area at least as large as that given in Section 8.4.1.3 for a main conductor or Section 8.4.2.3 for a bonding conductor, and have a resistance that is not more than the resistance of 61 cm (2 ft) of the corresponding copper conductor.
A.8.4.6.2
1. The area of a conductor of uniform cross section that has the same resistance per unit length as a main conductor is given by the equation in A8.4.1.4. For connecting a main conductor, the areas are 315 mm^2 (0.49 in^2) for silicon bronze and 1200 mm^2 (1.8 in^2) for stainless steel. For connecting a bonding conductor the required areas are 125 mm^2 (0.19 in^2) for silicon bronze and 470 mm^2 (0.73 in^2) for stainless steel.
2. Equating resistances for a copper conductor of area A_{Cu}, resistivity ρ_{Cu}, and length L_{Cu} and a metal connector of area A, resistivity ρ, and length L gives a maximum allowable length for the metal connector of:

$$L = L_{Cu} \frac{A}{A_{Cu}} \frac{\rho_{Cu}}{\rho}$$

The length is the same for both main and bonding conductors and is 16 cm (6.5 in) for silicon bronze and 6.3 cm (2.5 in) for stainless steel when L_{Cu}=61 cm (2 ft).
8.5 Grounding.
8.5.1 Watercraft with Metal Hulls.
Where an electrical connection exists between a metallic hull and a lightning air terminal or other metallic superstructure of sufficient height to provide the zone of protection specified in Section 8.3, no further protection shall be necessary.
8.5.2 Watercraft with Nonmetallic Hulls.
8.5.2.1* Grounding electrodes shall be installed on the nonmetallic hull of a watercraft to provide multiple paths for the lightning current to exit into the water.
A.8.5.2.1 In order to allow for main conductors to be routed externally to vulnerable areas, as described in Section 8.4.1.6, but also to reduce the risk of external side flashes from the lightning conductors, grounding electrodes should be located as close to the waterline as is practicable. Where an onboard fitting is below the waterline and close to the water, an additional supplemental grounding electrode is advisable in the vicinity of the fitting.
8.5.2.2 Each grounding electrode shall be connected either directly to a main conductor or to a main conductor through an air gap that satisfies all conditions in Section 8.5.4.3.
8.5.2.3* Rudders, struts, seacocks, through-hull fittings, or any other metallic fittings that meet the requirements of either Section 8.5.4.1 or Section 8.5.4.2 shall be permitted to be used as grounding electrodes.
A.8.5.2.3 Seacocks are particularly susceptible to damage and leaking after a strike and should be inspected after all suspected strikes.
8.5.2.4 Through-hull connectors to a grounding electrode shall be metallic and have a cross sectional area equivalent to a main conductor.
8.5.3 Main Grounding Electrode.
8.5.3.1 At least one grounding electrode shall comprise an immersed solid conductor that has a contact area of at least 0.09 m^2 (1.0 ft^2) with the water, and a thickness of at least 5 mm (3/16 in), and a width of at least 19 mm (3/4 in).
8.5.3.2 The area of a main grounding electrode shall be determined as the outward-facing area of the surface that is in contact with the water.
8.5.3.3 A main grounding electrode shall be immersed during all normal modes of vessel operation.
8.5.4 Supplemental Grounding Electrode.
8.5.4.1* Supplemental grounding electrodes shall be permitted that have less than 0.09 m^2 (1.0 ft^2) in contact with the water.
8.5.4.2 The outboard surface of the grounding electrode shall be less than 1.0 mm (0.04 in) inside the outer finished surface of the hull, including coatings and paint.
A.8.5.4.2 A supplemental grounding electrode may be painted or covered with a thin coating (<1mm or 0.04 in) but should not be encapsulated in fiberglass.
8.5.5* Galvanic Corrosion Protection.A.8.5.5 An air gap or SPD (such as a gas discharge tube) may be desirable to reduce corrosion in the presence of leakage currents in the water and may reduce galvanic corrosion. However, using an air gap to isolate an immersed conductor from the water may increase the risk of a ground fault current bypassing any ground fault protection device. Hence a hazardous current can be inadvertently introduced into the water. For this reason measures should be taken to ensure that loose electrical connections cannot contact any part of the isolated grounding electrode. A spark gap should not be used where there is the possibility of ignitable vapors or personnel hazards.
8.5.5.1 An air gap or SPD (such as a gas discharge tube) shall be permitted to break the path of a main conductor within 200 mm (8 in) of a grounding electrode.
8.5.5.2 The breakdown voltage of an air gap or SPD (such as a gas discharge tube) shall be not less than 600V and not greater than 15kV.
8.5.5.3 With the exception of the gap itself, all components in and connections to an air gap device shall have a cross sectional area meeting the requirements for a main conductor.
Committee Statement: The Committee accepts the submitter's recommendation. Further, the committee revises the text for clarification. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Comment on Affirmative:
GUTHRIE, M.: I agree with the intent of the committee action. However, it is recommended that a modification be made to the proposed revision to equation in the note in Figure 8.3.1.2(a). There was some discussion during the ROP meeting that there was confusion by some casual users of the formula as to the source of the value of 200 used in the formula. The substitution of the variable "D" resolves this confusion. However, the use of the variable "2R" in place of "D" (where R is the striking distance) would be even clearer as to the source and it would eliminate the need to use both an upper case and lower case "d" in the formula.

780-98 Log #56 **Final Action: Reject**
(8.1.3)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
" ~~Personnel on~~ Occupants of small watercraft...".
Substantiation: Personnel implies only employees should be concerned.
Committee Meeting Action: Reject
Committee Statement: The Committee chooses to retain personnel as it is used numerous times throughout the document.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 25 Negative: 1
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:
GUTHRIE, M.: The correct action taken on the proposal should have been to accept in principle and change the word "occupant" to their preferred term. It is clear from the action taken on ROP 780-98a that the committee does not choose to retain the word "personnel" as stated in the committee statement. It is recommended that the committee action be changed to accept in principle with "occupants" changed to "persons."

780-98a Log #CP10 **Final Action: Accept**
(8.1.3)

Submitter: Technical Committee on Lightning Protection
Recommendation: In the document, change "personnel" to "persons" and "personal" and "persons" as follows:
In 8.1.3, change "Personnel" to "Persons".
In A.4.18.2.5, change "personnel" to "persons".
In A.8.1.3, change "personnel" to "personal".
In A.8.7.2, change "personnel" to "persons".
In F.1, change "personnel" to "persons".
In G.1.1(3), change "personnel" to "persons".
In I.1.4, change "personnel" to "personal".
In I.1.5, change "personnel" to "persons".
In M.1, change "Personnel" to "Persons", change "personnel" to "personal".
In M.3, change "Personnel" to "Persons"; change "personnel" to "persons".
In Index (Under "Watercraft" heading), change "Personnel safety precautions" to "Personal safety precautions".
Substantiation: The committee clarifies usage of the words "persons", "personnel" and "personal" throughout the document.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Comment on Affirmative:
GUTHRIE, M.: I agree in general with the proposal to correct the incorrect usage of the term "personnel" throughout the document although there are some locations where the less formal term "people" may be more appropriate than "persons" (such as A.8.7.2, F.1, and the first appearance in M.1).

780-99 Log #116 **Final Action: Accept in Principle**
(A.3.3.25)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: 1. Insert microseconds after 8/20 in the existing second sentence.
2. Add the following as a second paragraph:
"Devices rated in accordance with UL 1449. Edition 3 will reflect a Voltage Protection Level (VPL) in place of the SVR. This is to reflect the difference that the voltage rating test will utilize a 3 kA peak current vice the 500 A current level used in the SVR test of UL 1449, Edition 2."
Substantiation: The addition of microseconds in the first paragraph is for coordination with IEEE and ISO nomenclature. The insertion of the new paragraph introduces the term "voltage protection level" which will replace "SVR" in the proposed 3rd Edition of UL 1449.
Committee Meeting Action: Accept in Principle
Revise existing second sentence of A.3.3.25 to read as follows:
This rating is the maximum voltage developed when the SPD is exposed to a 500 A, 8/20 µs current limited waveform through the device.
Add the following as a second paragraph:
Devices rated in accordance with UL 1449, Edition 3 will reflect a Voltage Protection Level (VPL) in place of the SVR. This is to reflect the difference that the voltage rating test will utilize a 3 kA peak current instead of the 500 A current level used in the SVR test of UL 1449, Edition 2.
Committee Statement: The Committee accepts the submitter's recommendation but changes "microseconds" to "us". The Committee notes that "us" should be "µs". The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-100 Log #106 **Final Action: Accept**
(A.4.7.3.2)

Submitter: Thomas R. Harger, Harger Lightning Protection, Inc.
Recommendation: Add asterisk (*) to section number 4.7.3.2 and add new section A.4.7.3.2 to Annex A as follows:

A.4.7.3.2 It is recognized that the sides of tall structures are subject to direct lightning strikes. Due to the low risk of strikes to the sides of tall structures and the minimal damage caused by these typically low current level discharges, the cost of protection for the sides of tall structures will not normally be justified.

Substantiation: NFPA 780 Task Group on Tall Structures determined that zone of protection requirements for tall structures (structures exceeding 46 m (150 ft) do not address the sides of tall structures above where the sphere rests against the vertical surface of the structure. The proposed annex text acknowledges that strikes to the sides of tall structures are indeed possible, but damage to the structure would be minimal due to the typically low current level of side discharges. The text also recognizes that the cost of protection to the sides of tall structures would not normally be justified, however alerts the user that in some cases, the cost could be justified. The proposed text is also intended to make NFPA 780 conform to Section 5.2.3 of IEC 62305-3.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 25 Negative: 1
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Explanation of Negative:

WAKEFIELD, C.: The statement "Due to the low risk of strikes to the sides of tall structures and the minimal damage caused by these typically low current level discharges the cost of protection for the sides of tall structures will not normally be justified" has not been substantiated with scientific data. In the event that NFPA is challenged, appropriate data and justifications should be on file with the committee to properly defend the statement.

780-101 Log #57 **Final Action: Accept in Principle**
(A.4.13.2.4)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:

" ~~No~~ Limited benefit is gained..." and"...longer rod. No limited additional benefit...".

Substantiation: There is some benefit such as increased contact with earth, better access to earth at high frequencies, and redundancy.
Committee Meeting Action: Accept in Principle

Revise A.4.13.2.4 to read as follows:

A.4.13.2.4 Minimal benefit is gained from the second ground rod if placed closer than the sum of the driven depth of both rods.

Delete second sentence.

Committee Statement: The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-102 Log #75 **Final Action: Accept in Principle**
(A.4.13.8.1)

Submitter: Harold VanSickle, III, Lightning Protection Institute
Recommendation: Add new third sentence to read as follows:

Current wording:

A.4.13.8.1 For those instances in which it is necessary to install the grounding conductor directly on bedrock, it is recommended that main conductor solid strips be utilized. If there are locations along the length of the radial conductor in which there is sufficient soil available for the installation of an earth electrode, the installation of an additional earth electrode is encouraged.

Add the following sentence:

When a ground ring electrode is used in an application with insufficient soil cover, radial(s) should be considered to direct the lightning away from the protected area for all locations where property boundaries allow their addition.

Substantiation: Task group recommends annex material for system improvement, but not requirement.
Committee Meeting Action: Accept in Principle

Add new third sentence to read as follows:

Current wording:

A.4.13.8.1 For those instances in which it is necessary to install the grounding conductor directly on bedrock, it is recommended that main conductor solid strips be utilized. If there are locations along the length of the radial conductor in which there is sufficient soil available for the installation of an earth electrode, the installation of an additional earth electrode is encouraged.

Add the following sentence:

When a ground ring electrode is used in an application with insufficient soil cover, radial(s) should be considered to supplement the ground ring electrode to direct the lightning away from the protected area for all locations where property boundaries allow their addition.

Committee Statement: The Committee accepts the submitter's recommendation and provides edit to the text to clarify that the ground ring electrode is the electrode that is to be supplemented. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-103 Log #94 **Final Action: Accept in Principle**
(A.4.14.1)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Insert an asterisk after 4.14.1.2 and add the following new text to Annex A:

A.4.14.1 Isolating Spark Gaps may be used to provide the required bond in those cases where galvanic corrosion is a concern or where a direct bond is not allowed by local code. The use of isolating spark gaps are not recommended for those applications where significant follow current can be expected. It is recommended that isolating spark gaps used in this application be installed in accordance with the manufacturer's instructions and be rated for the environment for which it is to be installed (hazardous classified location, direct burial, etc. as applicable). The devices used in these applications should be rated at a maximum discharge current no less than 100 KA 8/20 μs (U_p 2.5 kV), have an isolating resistance no less than 10^8 ohms and a maximum DC spark over voltage of 500 volts.

Substantiation: There are some conditions where the required bonding of incoming piping creates galvanic corrosion concerns. This fear of galvanic damage resulting from a direct bond to underground piping has led some industries and AHJs to disconnect the bond required by 4.14.1. This proposal provides an alternative method to a direct bond that would serve the intended purpose where a direct bond may not be practicable.
Committee Meeting Action: Accept in Principle

Insert an asterisk after 4.14.1 and add the following new text to Annex A:

A.4.14.1 Isolating spark gaps may be used to provide the required bond in those cases where galvanic corrosion is a concern or where a direct bond is not allowed by local code. The use of isolating spark gaps is not recommended for those applications where significant follow current can be expected. It is recommended that isolating spark gaps used in this application be installed in accordance with the manufacturer's instructions and be rated for the environment in which it is to be installed (hazardous classified location, direct burial, etc. as applicable). The devices used in these applications should be rated at a maximum discharge current no less than 100 kA, 8/20 μs (2.5 kV spark over voltage), have an isolating resistance no less than 10 8 ohms and a maximum DC spark over voltage of 500 volts.

Committee Statement: The Committee accepts the submitter's recommendation with the following revisions:

Insert * after 4.14.1* rather than after 4.14.1.2.

Provide clarification for "spark over voltage".

The change satisfies the submitter's intent.

Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.
Comment on Affirmative:

GUTHRIE, M.: It is agreed with the recommendation that it be clarified that U p is the spark over voltage, but it is recommended that the symbol U p be maintained in the specification of the spark over voltage.

780-104 Log #118 **Final Action: Accept in Principle**
(A.4.15.4)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant
Recommendation: Insert new A.4.15.4 as follows:

"A.4.15.4 It is preferable that grounding electrodes be located no closer than 2 ft from foundation walls to minimize the probability of damage to the foundation. However, this is not practicable for all applications. IEC 62305, Part 3 requires that ring earth electrodes be buried at a depth of at least 0.5 m (18 in.) and a distance of approximately 1 m (3 ft) around external walls."

Substantiation: Prior to 1986, NFPA 78 required a 2-ft spacing of ground terminals from foundation walls. In the 1896 edition, the 2-ft spacing of ground terminals from foundation walls. In the 1986 edition, the 2-ft spacing requirement was removed from the Code by Proposal 78-50 (Log #51) and Proposal 78-53 (Log #54). The substantiation for removing the requirement was that the 2-ft spacing restriction cannot always be met. The substantiation indicated that the dimension had previously been referred to as "preferable" and if "preferable" could not be inserted before the 2-ft spacing requirement, the requirement should be deleted. The purpose of this proposal is to maintain the existing text while reflecting that the 2-ft spacing is preferable and that other standards require similar spacing requirements.
Committee Meeting Action: Accept in Principle

Insert an asterisk after 4.15.4.1.

Insert new A.4.15.4.1 to read as follows:

A.4.15.4.1 It is preferable that grounding electrodes be located no closer than 0.6 m (2 ft) from foundation walls to minimize the probability of damage to the foundation. Although this is not always practicable for all applications, it is preferable. For reference, IEC 62305, Part 3 requires that ring earth electrodes be buried at a depth of at least 0.5 m (18 in.) and a distance of approximately 1 m (3 ft) around external walls.

Add the following to N.2.1 IEC Publications.:

IEC 62305, Protection against lightning - Part 3: Physical damage to structures and life hazard, 2006.

Committee Statement: The Committee accepts the submitter's recommendation with the following revisions:

Add * after 4.15.4.1 to reflect Annex text.

Add 0.6 m to comply with Manual of Style requirements.

The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-104a Log #CP8 **Final Action: Accept**
(A.4.18.2.5)

Submitter: Technical Committee on Lightning Protection

Recommendation: Replace the 4th sentence in the first paragraph of A.4.18.2.5 as shown below:

Most services to facilities will require discrete surge suppression devices installed to protect against damaging surges. Occasionally, services will be located in an area or manner where the threat from lightning-induced surges and overvoltage transients may be negligible. For example, the requirements in 4.18.2.3 *(also see A.4.18.6.1)* exempt services less than 30 m (100 ft) in length that are run in grounded metal conduit between buildings requiring surge protection. ~~These are examples of acceptable exceptions where SPDs may not be required on each service entrance~~ . Other examples where surge protective devices may not be required to be installed at each service entrance are those applications where fiber optic transmission lines (with no conducting members) are used. The standard recognizes that there can be acceptable exceptions and consequently allows for such exceptions to the requirements for surge suppression on electrical utility, data, and other signal lines, provided a competent engineering authority has determined that the threat is negligible or that the system is protected in a manner equivalent to surge suppression.

Substantiation: This proposal is provided by the Task Group on Surge Protection in completion of Task Item 29. It identifies that the use of fiber optics transmission lines is an example where surge protection may be implemented without the installation of surge protective devices.

Committee Meeting Action: Accept

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-105 Log #117 **Final Action: Accept in Principle**
(A.4.18.4)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant

Recommendation: Add a new paragraph as follows after the existing text:

"Devices rated in accordance with UL 1449, Edition 3 will reflect a Voltage Protection Level (VPL) in place of the SVR. This is to reflect that the voltage rating test in the 3rd Edition will utilize a 3 kA peak current vice the 500 A current level used in the SVR test of UL 1449, Edition 2.

Substantiation: The proposed text will identify that SPDs rated in accordance with UL 1449, Edition 3 will utilize a VPL in place of the SVR.

Committee Meeting Action: Accept in Principle

Add a new paragraph as follows after the existing text:

Devices rated in accordance with UL 1449, Edition 3 will reflect a Voltage Protection Level (VPL) in place of the SVR. This is to reflect that the voltage rating test in the 3rd Edition will utilize a 3 kA peak current instead of the 500 A current level used in the SVR test of UL 1449, Edition 2.

Committee Statement: The Committee clarifies the text. The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-106 Log #89 **Final Action: Accept in Principle**
(A.4.18.5(4))

Submitter: Mitchell A Guthrie, Independent Engineering Consultant

Recommendation: Revise A.4.18.5(4) as follows:

The Neutral-to-Ground (N-G) mode of protection places ~~the~~ an SPD between the grounded conductor (neutral) and the grounding conductor (ground) in a power system. This ~~L-L L-N and LG~~ modes protection ~~are~~ is not required at the service entrance (primary service panel board) if the, ~~This is because a~~ neutral-ground bond is implemented at this location or within some tens of meters from this point of installation. Thus, in general, an SPD with only L-L and L-N modes of protection are required at the service entrance.

Substantiation: Clarification of intent that the N-G mode of protection is not required at the service entrance.

Committee Meeting Action: Accept in Principle

Revise A.4.18.5(4) to read as follows:

Neutral to ground (N-G) mode of protection places ~~the~~ an SPD between the grounded conductor (neutral) and the grounding conductor (ground) in a power system. This ~~L-L L-N and LG~~ mode of protection ~~are~~ is not required at the service entrance (primary service panel board) if the ~~This is because a~~ neutral-ground bond is implemented at this location or within some tens of meters from this point of installation. Thus, in general, an SPD with only L-L and L-N modes of protection may be required at the service entrance.

Committee Statement: The Committee clarifies the text. The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-107 Log #112 **Final Action: Accept**
(A.4.18.6.3.1)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant

Recommendation: Insert an asterisk after 4.18.6.3.1 and add new A4.18.6.3.1. as follows:

A.4.18.6.3.1 The purpose of the SPD is to equalize L-L, L-N, L-G, and N-G potentials. While a good ground is important, a good bond is imperative to minimize damage due to lightning and/or power contact or induction.

Substantiation: The purpose of the proposed text is to stress the importance of a good bond in the installation of surge protective devices; regardless of the resistance to earth.

Committee Meeting Action: Accept

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-108 Log #100 **Final Action: Accept in Principle**
(A.4.18.7.2)

Submitter: Mitchell A Guthrie, Independent Engineering Consultant

Recommendation: Revise text to read as follows:

A.4.18.7.2 Longer, or looped, SPD line and ground conductors increase the impedance of the SPD ground circuit. ~~The ability of the SPD to discharge current to ground is affected by this impedance.~~ Increasing the lead length serves to increase "let-through voltage" at the point where the SPD is wired into service equipment or a branch panelboard. Consequently, it is essential to minimize lead length impedance in this circuit.

Substantiation: Clarification of intent and stress that increased conductor length on both line and ground conductors increases "let-through" voltage.

Committee Meeting Action: Accept in Principle

Revise A.4.18.7.2 to read as follows:

A.4.18.7.2 Longer, or looped, SPD line and ground conductors increase the impedance of the SPD ground circuit. ~~The ability of the SPD to discharge current to ground is affected by this impedance.~~ Increasing the lead length serves to increase pass through voltage at the point where the SPD is wired into service equipment or a branch panelboard. Consequently, it is essential to minimize lead length impedance in this circuit.

Committee Statement: The Committee clarifies the text. The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-109 Log #58 **Final Action: Accept in Principle**
(A.8.7.2)

Submitter: Dick Reehl, Quest Communications

Recommendation: Revise as follows:

"...of a thunderstorm, ~~personnel~~ occupants should head...".

Substantiation: Needs to apply to more than employees.

Committee Meeting Action: Accept in Principle

Revise A.8.7.2 to read as follows:

"...of a thunderstorm, ~~personnel~~ persons should head...".

Committee Statement: The Committee accepts the submitter's recommendation and changes the text for clarification. The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-110 Log #107 **Final Action: Reject**
(Annex B)

Submitter: John M. Tobias, US Army CELCMC

Recommendation:

Proposed additions to Appendix B of NFPA 780

(additions are shown in within the region of the document annotated by *****)

Appendix B: Principles of Lightning Protection

This appendix is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Fundamental Principles of Lightning Protection.

B.1.1 The fundamental principle in the protection of life and property against lightning is to provide a means by which a lightning discharge can enter or leave the earth without resulting damage or loss. A low impedance path that the discharge current will follow in preference to all alternative high impedance paths offered by building materials such as wood, brick, tile, stone, or concrete should be offered. When lightning follows the higher impedance paths, damage may be caused by the heat and mechanical forces generated during the passage of the discharge. Most metals, being good electrical conductors, are virtually unaffected by either the heat or the mechanical forces if they are of sufficient size to carry the current that can be expected. The metallic path must be continuous from the ground terminal to the strike termination device. Care should be exercised in the selection of metal conductors to ensure the integrity of the lightning conductor for an extended period. A nonferrous metal such as copper or aluminum will provide, in most atmospheres, a lasting conductor free of the effects of rust or corrosion.

B.1.2 Parts of structures most likely to be struck by lightning are those that project above surrounding parts such as chimneys, ventilators, flagpoles, towers, water tanks, spires, steeples, deck railings, shafthouses, gables, skylights, dormers, ridges, and parapets. The edges and corners of the roof are the parts most likely to be struck on flat or gently sloping roofed buildings.

B.2 Lightning Protection Systems.

B.2.1 Lightning protection systems consist of the following three basic parts that provide the low impedance metal path required:

(1) A system of strike termination devices on the roof and other elevated locations.

(2) A system of ground terminals.

(3) A conductor system connecting the strike termination devices to the ground terminals.

Properly located and installed, these basic components improve the likelihood that the lightning discharge will be conducted harmlessly between the strike termination devices and the ground terminals.

B.2.2 While intercepting, conducting, and dissipating the main discharge, the three basic protection system components do not ensure safety from possible secondary effects of a lightning strike. Therefore, secondary conductors are provided to interconnect metal bodies to ensure that such metal bodies are maintained at the same electrical potential so as to prevent sideflashes or sparkover. Surge suppression devices are also provided to protect power lines and associated equipment from both direct discharges and induced currents.

B.2.3 The structure should be examined, and installation of air terminals should be planned for all areas or parts likely to receive a lightning discharge. The object is to intercept the discharge immediately above the parts liable to be struck and to provide a direct path to earth, rather than to attempt to divert the discharge in a direction it would not be likely to take. The air terminals should be placed high enough above the structure to obviate danger of fire from the arc.

******************************ADD*****************************

B.3 Positioning of air terminals.

Positioning of air terminals depends upon the physical lightning model used to describe the behavior of lightning. The development of these models has been ongoing for two hundred and fifty years and models have a basis in physical observations of lightning. While the models tend to be simplified compared to actual details of lightning development and propagation, empirical observations over hundreds of years have proven their effectiveness.

Air terminals are intended to intercept the lightning event by providing a preferred attachment point for lightning's electrical discharge. They operate by actually providing an upward propagating leader of ionized air to intercept a downward lightning leader. Since these leaders are ionized air of opposite charge, they attract and provide the electrical channel to earth for lightning when they connect. Air terminals placed upon a structure do not substantially increase the probability of the structure being struck by lightning. If the downward progressing lightning leader is close to the structure, it will probably attach to that structure anyway. Thus, air terminals are designed to provide a preferential attachment point on structures that already provide a likely lightning attachment point. Once lightning connects to the air terminal, it is easier to control the lightning current and direct it to earth as opposed to it taking a random, uncontrolled (and usually damaging) path through the structure otherwise.

This section is intended to educate the user of NFPA 780 by providing some background in the mechanics of the lightning models and their reduction into design rules for the placement of air terminals. <u>Some of the methods presented here ARE NOT CURRENTLY PERMITTED by NFPA 780.</u> Some of the air terminal placement methods are presented here to provide useful background information, or are in use internationally, or are in the preliminary stages of consideration for inclusion to NFPA 780. To begin the discussion, we can start with the physics of lightning attachment.

B.3.1 Physics of Lightning Attachment

The first stroke of a ground flash is normally preceded by a downward-progressing, low-current leader discharge that commences in the negatively charged region of the cloud and progresses towards the earth, depositing negative charges in the air surrounding the leader discharge channel. (Occasionally, the downward leader can be positive in charge but this does not affect its behavior in terms of attachment.) When the lower end of the leader is 100 – 300 m from the earth or grounded objects, electrical discharges (streamers) are likely to be initiated from prominent points on grounded objects, and to propagate upwards towards the leader discharge channel. Several streamers may start, but usually only one is successful in reaching the downward leader.

The high current phase (return stroke) commences at the moment the upward moving streamer meets and connects with the downward leader. The position in space of the lower portion of the lightning discharge channel is therefore determined by the path of the successful streamer, i.e. the one that succeeded in reaching the downward leader. The primary task in protecting a structure is therefore to ensure a high probability that the successful streamer originates from the air terminals and not from a part of the structure that would be adversely affected by the lightning current that subsequently flows.

As the path of the successful streamer may have a large horizontal component as well as a vertical component, an elevated air terminal will provide protection for objects spread out below it. Within limits, it is therefore possible to provide protection for a large volume with a relatively small number of correctly positioned air terminals. This is the basis for the concept of a "zone of protection" and provides the basic principle underlying interception lightning protection.

Therefore, the function of an air terminal in an LPS is to divert to itself the lightning discharge that might otherwise strike a vulnerable part of the object to be protected. It is generally accepted that the range over which an air terminal can attract a lightning discharge is not constant, but increases with the severity of the discharge.

The path of a lightning discharge near a structure is determined by the path of the successful streamer (see Paragraph B2.2) that will usually be initiated from a conducting part of the structure nearest to the downward leader. The initiation of streamers is also influenced by the local electric field. Conductive objects with a small radius of curvature will concentrate the electric field. Thus, air terminals, as well as the upper outer edges and corners of buildings or structures, and especially protruding parts, are likely to have higher local electric fields than elsewhere, and are therefore likely places for the initiation of upward streamers. When the downward leader is within about 200 m of the building, the electric field at these protruding parts and corners will exceed the breakdown field strength of air, resulting in corona currents that cause these parts to be surrounded by ionized air. At some point, this ionized air will begin to move in response to the elevated electric field provided by the downward leader. Upward streamers of ionized air will form and move toward the downward leader. Consequently, the most probable strike attachment point on a building is the edge, corner, or other protruding part in the vicinity of the downward leader. Hence, if air terminals are placed at all locations where high electric fields and streamer initiation are likely, there will be a high probability that the discharge will be intercepted successfully.

B.3.2 Overview of Methods

A "design method" is used to identify the most suitable locations placing for strike termination devices, based on the area of protection afforded by each one. These "placement methods" typically fall into one of four categories:

(a) Purely geometrical constructions, such as the "Cone of Protection" or "Protection Angle" method;

(b) "Faraday Cage" concepts, in which a "meshwork" of conductors or air terminations is placed at set intervals over a structure;

(c) Electrogeometric models (EGM's), in which empirical relationships for striking distance and lightning peak current are invoked. The most common example is the "Rolling Sphere Method", which is also partly a geometric construction;

(d) Physical models, where air breakdown mechanisms are applied to the lightning scale; these models have been derived from laboratory investigations of long sparks and, to a lesser extent, field studies of natural lightning.

The methods in categories (a), (b) and (c) are conceptually simple and relatively easy to apply. However, they do have inherent limitations that limit their applicability across a wide range of structures, particularly over a large range in height.

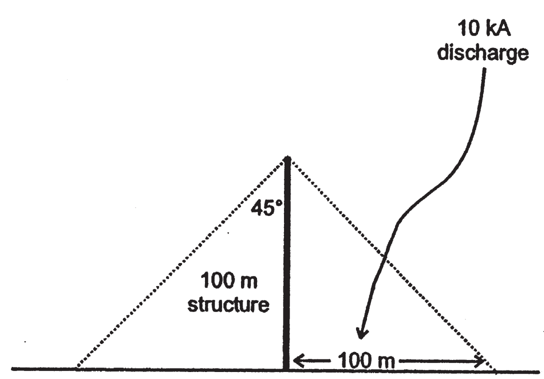


Figure B1: The "Cone of Protection" method.

B.3.2.1 Cone of Protection ("Protection Angle") Method

This method is based on the assumption that an air terminal or an elevated, grounded object creates an adjacent, conical space that is essentially immune to lightning, as illustrated in Figure 1. The concept of a cone of sufficient angle to define the protected zone has its roots in the very beginning of lightning protection studies. Although Franklin recognized a limit as to the range of the air terminal in the late 1700's, the concept was first formally proposed by the French Academy of Science in 1823 and initially used a base of twice the height, i.e., an angle of 63°. By 1855, this angle was changed to 45° due to field reports that the method was failing. Generally, this angle was preserved in standards for more than one hundred years. In some standards today, a variable angle depending on the height of the structure is used.

It should be noted that the protected space is not totally immune to all lightning discharges. Using the Electrogeometric Model (see section 3.5 for more details), for a downward leader carrying a charge corresponding to a peak stroke current of 10 kA, if it approaches at a lateral distance greater than 45 meters it may bypass the structure and enter the assumed zone of protection of 100 m.

B.3.2.2 Mesh Method

A true "Faraday cage", in which a solid sheet of metal of sufficient thickness completely covers a structure, is an extremely good means of lightning protection. The concept is simple since no special "design method" is needed. Unfortunately, such a system is impractical, both aesthetically and in terms of cost. The practical Faraday cage or "mesh" is typically comprised of a series of horizontal air terminations (typically copper tape or conductor) which are bonded to vertically descending, external downconductors. The horizontal strips are bonded at set intervals between 5 and 20 m. The structural steel, if bonded, may also be used to conduct the current. The overall scheme is illustrated in Figure 2.

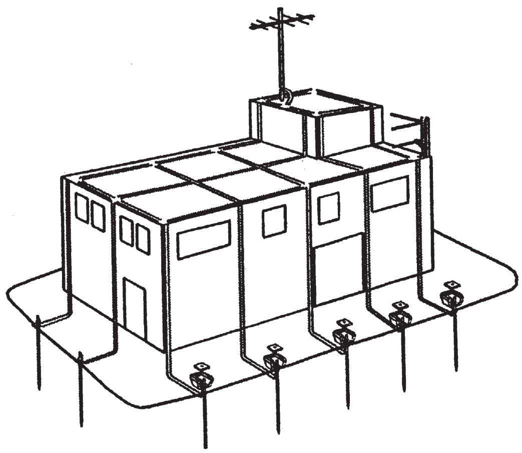


Figure B2: The "Faraday Cage" or "Mesh" method.

Users of this method need to be aware that, if it is applied with zero-height conductors, there is no guarantee that the conductors will be struck by lightning in preference to some other nearby exposed point. Furthermore, protection of exposed items such as communication dishes is much more critical difficult and requires special bonding procedures. <u>Note that this method is not used in NFPA 780 but is permitted in some international lightning protection standards.</u>

B.3.2.3 Rolling Sphere Method

The Rolling Sphere method is the most common design method, superseding the cone of protection method in NFPA 780 in the 1980 edition. It originated from the electric power transmission industry, i.e., 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, typically 45 m (150 ft) in radius, is rolled over the structure. All surface contact points are deemed to require protection, whilst the unaffected surfaces and volumes are deemed to be protected, as shown in Figure 3.

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 $d_s = 10\, I_p^{0.65}$ [as reported by Uman]. For a typical peak current of 10 kA, the striking distance is ~ 45 m, i.e., this is the distance at which a downward leader results in the initiation of an upward leader from the structure. A sphere of this radius is rolled over the structure in all directions. Each radial line to the point the sphere contacts the structure represents a possible path of the lowest portion of the leader channel. The surface traced out by the centre of the sphere defines all possible points in space from which a downward leader can attach to the structure. This is illustrated in Figure 4.

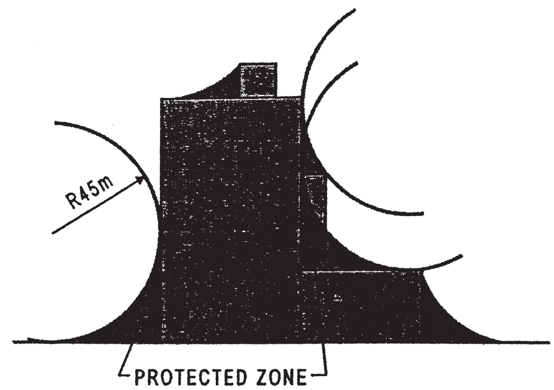


Figure B3: Lightning protection design using the Rolling Sphere Method.

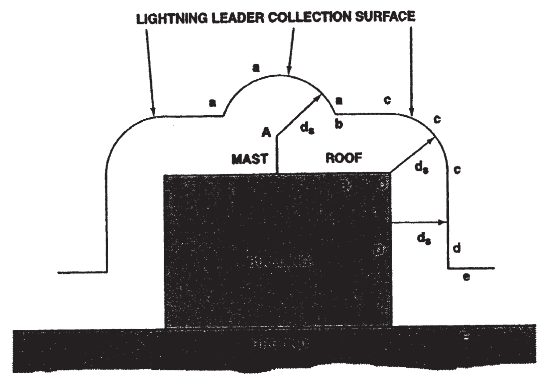


Figure B4: Illustration of the lightning leader "collection surface" (after Mackerras *et al* [5]).

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 45 meter zone of protection. Thus, more conservative design is to size the sphere using a lower lightning peak current. Lightning peak currents below 5 kA – 7 kA are not realistic, however, and the 10 kA peak current represents 96% to 98% of all lightning events.

The advantage of the RSM 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, i.e., no account is taken of the influence of electric fields in initiating return streamers, so it does not distinguish between likely and unlikely lightning strike attachment points. In other words, for a given prospective peak stroke current, the striking distance d_s is a *constant* value. This simplification stems from its origins in the electrical power transmission industry, where there is considerable uniformity in the parameters of transmission lines (diameters, heights, etc). These points are illustrated in Figure 4, where the implication is that the attractive range of the corner of the building (point C) is the same as the vertical flat surface half way down the side of the building (point D). The same claims apply to the flat roof of a structure, e.g., point B.

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 high 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.

When the RSM is applied to a building of height greater than the selected sphere radius, then the sphere touches the vertical edges 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 the building and strike the sides. Hence, the consequences of a strike to the sides of a building may result in damage of a minor nature. Unless there are specific reasons for side protection, as would be the case of a structure containing explosives, it is considered that the cost of side protection would not normally be justified.

B.3.2.4 Collection Volume/Electric Field Intensification Method

After the development of the RSM, Eriksson presented an improved EGM which allowed for points of different electric field intensification. The improved model took a more physical approach than the simple EGM by utilizing the fact that the striking distance, d_s, is dependent on both the peak stroke current (or downleader charge) **and** the degree of electric field intensification, hereafter termed the "field intensification factor", K_i, of the prospective strike point.

For structures, the K_i is determined to a large extent by the height and width, but the shape and radius of curvature of the structure or structural features are also important. In the case of strike termination devices, the K_i depends on the height and tip radius of curvature as has been demonstrated in numerous papers by Moore *et al*. When air terminals are placed on buildings, the K_i's are multiplied up by a factor which depends on the structure dimensions and their location on the structure.

Hence, a suggested improvement to lightning protection design is to assume all points on a structure are able to launch an intercepting upward leader, but to differentiate those points based on the local field intensification factor. The field intensification factor at any point in space, $K_i(x,y,z)$, is computed relatively easily using numerical techniques such as the finite element method. The CVM considers the approach of the lightning downward leader to a structure and, using the $K_i(x,y,z)$ of the air terminals and structural features, determines the point at which an upward leader will be launched. Eriksson's original model used the critical radius concept, but any other valid leader inception criteria can be used. Furthermore, the CVM stipulates that interception will occur only if an adjacent competing feature does not "win the race" to interception with the downward leader. This criterion introduces a "time" variable which is taken into account by the ratio of downward and upward leader velocity, K_v. From field observations of natural lightning, this ratio is typically of the order of unity.

The above analysis results in the definition of a parabolic-like volume above a point on a structure, e.g., edge, corner, parapet, mast, air terminal, etc. This volume represents the three dimensional "capture" or "collection volume" of that point. For a particular leader charge and velocity ratio, a downward leader will only terminate on a nominated point on the structure if the striking distance is attained **and** the leader path is contained within the boundary of the collection volume.

This information is often summarised in the form of an "attractive radius", R_a, which is simply the sectional radius of the collection volume, i.e., radius at the intersection point of the (upper) striking distance surface and velocity-limited (outer) boundary. The attractive radius is perhaps the most important output parameter of a collection volume analysis as it can then be used to compute the "attractive", "capture" or "protective area" of a given structure, structural feature or air terminal.

Eriksson's basic model has been extended to the protection of practical (3D) structures via:

- *3D Electric Field Modelling*: Modern desktop computers, along with modelling software that utilises the finite element or charge simulation methods, or a combination of both have made it possible to compute with relative ease the electric field distribution over and around a structure and its microgeometry. This can be done in either 2D XY plane, 2D RZ plane, or full 3D, depending on the particular geometry that is to be modelled. Hence, field intensification factors can be computed at any location in space, on or near prospective strike points, for input to the CVM design process.
- *Consideration of "competing features"*: A collection volume is computed for each structural feature, including air terminals, masts, antennas etc. The attractive areas (plan view of the collection volumes) are then compared to ascertain the coverage of the protection system areas over the "competing feature" areas. A simple visual inspection can determine whether any parts of the structure are not protected and hence require additional strike termination devices.

Figure 5 shows a simple structure and the number of strike termination devices required to protect it according to a CVM analysis.

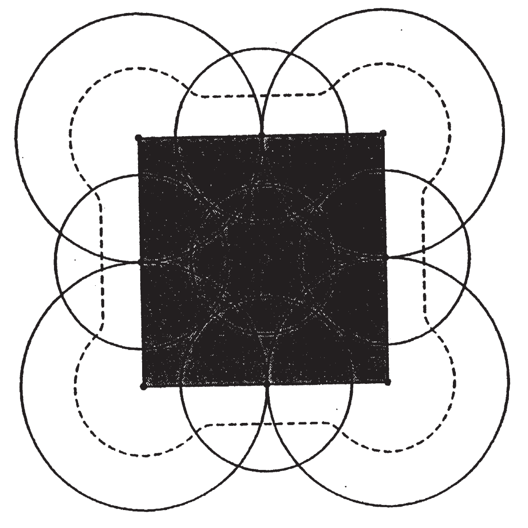


Figure B5: Example of the result of a Collection Volume design for a simple building. The dotted lines represent the competing features (i.e., the structure capture areas), and the solid lines show the corresponding air terminal capture areas, which vary depending on their location on the structure.

The CVM is much more computationally-intensive than the RSM and, ideally, is most easily applied using a computer program. This is the main trade-off with engineering models that are more complex than the simple EGM, as applied in the RSM. However, the advantage of being a very practical model that places greater design emphasis on protection of points on a structure with greatest field intensification and hence lightning attachment probability are significant points that make the additional computations worthwhile. The parameters of the model can also be updated as new research comes to hand.

While NOT CURRENTLY USED IN NFPA 780, CVM is currently under study and consideration for possible future inclusion as an alternative method to RSM.

B 3.2.5 Other Models and Design Methods

Other lightning models exist and are considered by a NFPA 780 subcommittee for development into design methods for inclusion into NFPA 780. One lightning model considered for development into a design method was Leader Progression Model (LPM). In this model, the incremental progression of a downward leader and an upward streamer through the air is calculated. At each increment of distance, the electric field between the streamer and the leader is computed and the direction of progression is determined by direction of the maximum electric field. The computation is repeated iteratively until the leader and streamer connect providing the electrical channel for the lightning event.

While potentially more physically accurate, several challenges prevented the development of the LPM into a useful design method for air terminal placement. The primary problem is that LPM is computationally intensive and cannot account for several structural features, air terminals, etc., without the use of sophisticated electromagnetic software models. In short, the gain in accuracy compared to existing models compared to the difficulty of practical application is not enough to merit its further development.

****

The sections below need to be renumbered.

B.3 Items to Consider When Planning Protection.

B.3.1 The best time to design a lightning protection system for a structure is during the structure's design phase, and the best time to install the system can be during construction. System components can be built in so as to be protected from mechanical displacement and environmental effects. In addition, aesthetic advantages may be gained by such concealment. Generally, it is less expensive to meet lightning protection requirements during construction.

- B3.2 moved up to section B.2

B.3.3 Conductors should be installed to offer the least impedance to the passage of stroke current between the strike termination devices and earth. The most direct path, without sharp bends or narrow loops, is best. The impedance of the conductor system is practically inversely proportional to the number of widely separated paths. Accordingly, there should be at least two paths to ground and more, if practicable, from each strike termination device. The number of paths is increased and the impedance decreased by connecting the conductors to form a cage enclosing the building.

B.3.4 Properly made ground connections are essential to the effective functioning of a lightning protection system, and every effort should be made to provide ample contact with the earth. This does not necessarily mean that the resistance of the ground connection should be low, but rather that the distribution of metal in the earth or upon its surface in extreme cases should be such as to permit the dissipation of a stroke of lightning without damage.

B.3.5 Low resistance is desirable, but not essential, as may be shown by the extreme case on the one hand of a building resting on moist clay soil, and on the other by a building resting on bare solid rock. In the first case, if the soil is of normal resistivity or from 4,000 ohm-centimeters to 50,000 ohm-centimeters, the resistance of a ground connection made by extending the conductor 10 ft (3 m) into the ground will be from about 15 ohms to 200 ohms, and two such ground connections on a small rectangular building have been found by experience to be sufficient. Under these favorable conditions, providing adequate means for collecting and dissipating the energy of a flash without serious chance of damage is a simple and comparatively inexpensive matter.

B.3.6 In the second case, it would be impossible to make a ground connection in the ordinary sense of the term because most kinds of rocks are insulating, or at least of high resistivity, and in order to obtain effective grounding other more elaborate means are necessary. The most effective means would be an extensive wire network laid on the surface of the rock surrounding the building to which the down conductors could be connected. The resistance to earth at some distant point of such an arrangement would be high but at the same time the potential distribution about the building would be substantially the same, as though it were resting on conducting soil, and the resulting protective effect also would be substantially the same.

B.3.7 In general, the extent of the grounding arrangements will depend on the character of the soil, ranging from simple extension of the conductor into the ground where the soil is deep and of high conductivity to an elaborate buried network where the soil is very dry or of very poor conductivity. Where a network is required, it should be buried if there is soil enough to permit it, as this adds to its effectiveness. Its extent will be determined largely by the judgment of the person planning the installation with due regard to the following rule: The more extensive the underground metal available, the more effective the protection.

B.3.8 Where practicable, each ground terminal connection should extend or have a branch that extends below and at least 2 ft (0.6 m) away from the foundation walls of the building in order to minimize the likelihood of damage to foundation walls, footings, and stemwalls.

B.3.9 When a lightning conductor system is placed on a building, within or about which there are metal objects of considerable size within a few feet of a conductor, there will be a tendency for sparks or sideflashes to jump between the metal object and the conductor. To prevent damage, interconnecting conductors should be provided at all places where sideflashes are likely to occur.

B.3.10 Lightning currents entering protected buildings on overhead or underground power lines, or telephone conductors, or television or radio antennas are not necessarily restricted to associated wiring systems and appliances. Therefore, such systems should be equipped with appropriate protective devices and bonded to ensure a common potential.

B.3.11 Because a lightning protection system is expected to remain in working condition for long periods with minimum attention, the mechanical construction should be strong and the materials used should offer resistance to corrosion and mechanical injury.

B.4 Inspection and Maintenance of Lightning Protection Systems.
It has been shown that in cases where damage has occurred to a protected structure, the damage was due to additions or repairs to the building or to deterioration or mechanical damage that was allowed to go undetected and unrepaired, or both. Therefore, it is recommended that an annual visual inspection be made and that the system be thoroughly inspected every five years.

B.5 Indirect Losses. In addition to direct losses such as destruction of buildings by lightning, fire resulting from lightning, and the killing of livestock, indirect losses sometimes accompany the destruction or damage of buildings and their contents. An interruption to business or farming operations, especially at certain times of the year, may involve losses quite distinct from, and in addition to, the losses arising from the direct destruction of material property. There are cases where whole communities depend on the integrity of a single structure for their safety and comfort. For example, a community may depend on a water-pumping plant, a telephone relay station, a police station, or a fire station. A stroke of lightning to the unprotected chimney of a pumping plant might have serious consequences such as a lack of sanitary drinking water, irrigating water, or water for fire protection. Additional information on this topic is available in the documents identified in Appendix M.1.2.1.

Substantiation: The 780 committee contends that more information is desirable for inclusion to the appendix to better describe the theory and application of lightning protection methods.

Committee Meeting Action: Reject

Committee Statement: The proposal is beyond the scope of the document.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 23 Negative: 3

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

Explanation of Negative:

CAIE, M.: The extended Annex B was rejected on the basis that the material was "outside the Scope of the NFPA document", that it "did not support the material in the main body of the standard" and the "volume of annex material was too large". However, there is a lot of annex material in the standard presently, some old and some new and approved at the ROP meeting, that also fits these criteria.

It is requested that this annexe is revisited in an appropriate manner at the ROC meeting. If, as appears to be the case, the committee feels the above criteria are valid, then the negative vote on this item could be reversed by the following two-fold action item:

1. For consistency, the whole standard should be reviewed for any material that is not in the Scope or does not support the main body of the document. Any sections identified using these criteria should be deleted.

2. During the revision cycle, the Modelling Task Force spent considerable time discussing Annex B and reported back to the committee that there was a need for additional explanatory material in this annex. There were no objections from the committee. However, in the ROP meeting, all of the additional explanatory material was rejected, literally in a matter of minutes, without consideration of how this material improved the standard. Hence, the annex should be revisited.

TOBIAS, J.: Much of the submitted Proposal 110 contains information within the scope of NFPA 780 and should be retained as explanatory material. It should have been accepted 'in part' or 'in part in principle.'

Please find below the suggested revised text with the sections considered out-of-scope removed. This section needs inclusion to the annex to provide useful design guidance and explanations for existing methods in use in the NFPA 780 document.

Proposed additions to Annex B of NFPA 780

(additions are shown in within the region of the document annotated by *****)

Annex B: Principles of Lightning Protection

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Fundamental Principles of Lightning Protection.

B.1.1 The fundamental principle in the protection of life and property against lightning is to provide a means by which a lightning discharge can enter or leave the earth without resulting damage or loss. A low impedance path that the discharge current will follow in preference to all alternative high impedance paths offered by building materials such as wood, brick, tile, stone, or concrete should be offered. When lightning follows the higher impedance paths, damage may be caused by the heat and mechanical forces generated during the passage of the discharge. Most metals, being good electrical conductors, are virtually unaffected by either the heat or the mechanical forces if they are of sufficient size to carry the current that can be expected. The metallic path must be continuous from the ground terminal to the strike termination device. Care should be exercised in the selection of metal conductors to ensure the integrity of the lightning conductor for an extended period. A nonferrous metal such as copper or aluminum will provide, in most atmospheres, a lasting conductor free of the effects of rust or corrosion.

B.1.2 Parts of structures most likely to be struck by lightning are those that project above surrounding parts such as chimneys, ventilators, flagpoles, towers, water tanks, spires, steeples, deck railings, shafthouses, gables, skylights, dormers, ridges, and parapets. The edges and corners of the roof are the parts most likely to be struck on flat or gently sloping roofed buildings.

B.2 Lightning Protection Systems.

B.2.1 Lightning protection systems consist of the following three basic parts that provide the low impedance metal path required:

(1) A system of strike termination devices on the roof and other elevated locations.

(2) A system of ground terminals.

(3) A conductor system connecting the strike termination devices to the ground terminals. Properly located and installed, these basic components improve the likelihood that the lightning discharge will be conducted harmlessly between the strike termination devices and the ground terminals.

B.2.2 While intercepting, conducting, and dissipating the main discharge, the three basic protection system components do not ensure safety from possible secondary effects of a lightning strike. Therefore, secondary conductors are provided to interconnect metal bodies to ensure that such metal bodies are maintained at the same electrical potential so as to prevent sideflashes or sparkover. Surge suppression devices are also provided to protect power lines and associated equipment from both direct discharges and induced currents.

B.2.3 The structure should be examined, and installation of air terminals should be planned for all areas or parts likely to receive a lightning discharge. The object is to intercept the discharge immediately above the parts liable to be struck and to provide a direct path to earth, rather than to attempt to divert the discharge in a direction it would not be likely to take. The air terminals should be placed high enough above the structure to obviate danger of fire from the arc.

******************************ADD*****************************

B.3 Positioning of air terminals.

Positioning of air terminals depends upon the physical lightning model used to describe the behavior of lightning. The development of these models has been ongoing for two hundred and fifty years and models have a basis in physical observations of lightning. While the models tend to be simplified compared to actual details of lightning development and propagation, empirical observations over hundreds of years have proven their effectiveness.

Air terminals are intended to intercept the lightning event by providing a preferred attachment point for lightning's electrical discharge. They operate by actually providing an upward propagating leader of ionized air to intercept a downward lightning leader. Since these leaders are ionized air of opposite charge, they attract and provide the electrical channel to earth for lightning when they connect. Air terminals placed upon a structure do not substantially increase the probability of the structure being struck by lightning. If the downward progressing lightning leader is close to the structure, it will probably attach to that structure anyway. Thus, air terminals are designed to provide a preferential attachment point on structures that already provide a likely lightning attachment point. Once lightning connects to the air terminal, it is easier to control the lightning current and direct it to earth as opposed to it taking a random, uncontrolled (and usually damaging) path through the structure otherwise.

This section is intended to educate the user of NFPA 780 by providing some background in the mechanics of the lightning models and their reduction into design rules for the placement of air terminals. To begin the discussion, we can start with the physics of lightning attachment.

B.3.1 Physics of Lightning Attachment

The first stroke of a ground flash is normally preceded by a downward-progressing, low-current leader discharge that commences in the negatively charged region of the cloud and progresses towards the earth, depositing negative charges in the air surrounding the leader discharge channel. (Occasionally, the downward leader can be positive in charge but this does not affect its behavior in terms of attachment.) When the lower end of the leader is 100 – 300 m from the earth or grounded objects, electrical discharges (streamers) are likely to be initiated from prominent points on grounded objects, and to propagate upwards towards the leader discharge channel. Several streamers may start, but usually only one is successful in reaching the downward leader.

The high current phase (return stroke) commences at the moment the upward moving streamer meets and connects with the downward leader. The position in space of the lower portion of the lightning discharge channel is therefore determined by the path of the successful streamer, i.e. the one that succeeded in reaching the downward leader. The primary task in protecting a structure is therefore to ensure a high probability that the successful streamer originates from the air terminals and not from a part of the structure that would be adversely affected by the lightning current that subsequently flows.

As the path of the successful streamer may have a large horizontal component as well as a vertical component, an elevated air terminal will provide protection for objects spread out below it. Within limits, it is therefore possible to provide protection for a large volume with a relatively small number of correctly positioned air terminals. This is the basis for the concept of a "zone of protection" and provides the basic principle underlying interception lightning protection.

Therefore, the function of an air terminal in an LPS is to divert to itself the lightning discharge that might otherwise strike a vulnerable part of the object to be protected. It is generally accepted that the range over which an air terminal can attract a lightning discharge is not constant, but increases with the severity of the discharge.

The path of a lightning discharge near a structure is determined by the path of the successful streamer (see Paragraph B2.2) that will usually be initiated from a conducting part of the structure nearest to the downward leader. The initiation of streamers is also influenced by the local electric field. Conductive objects with a small radius of curvature will concentrate the electric field. Thus, air terminals, as well as the upper outer edges and corners of buildings or structures, and especially protruding parts, are likely to have higher local electric fields than elsewhere, and are therefore likely places for the initiation of upward streamers. When the downward leader is within about 200 m of the building, the electric field at these protruding parts and corners will exceed the breakdown field strength of air, resulting in corona currents that cause these parts to be surrounded by ionized air. At some point, this ionized air will begin to move in response to the elevated electric field provided by the downward leader. Upward streamers of ionized air will form and move toward the downward leader. Consequently, the most probable strike attachment point on a building is the edge, corner, or other protruding part in the vicinity of the downward leader. Hence, if air terminals are placed at all locations where high electric fields and streamer initiation are likely, there will be a high probability that the discharge will be intercepted successfully.

B.3.2 Overview of Methods

A "design method" is used to identify the most suitable locations placing for strike termination devices, based on the area of protection afforded by each one. There are generally two categories of "placement methods" as used in NFPA 780:

(a) Purely geometrical constructions, such as the "Cone of Protection" or "Protection Angle" method;

(b) Electrogeometric models (EGM's), in which empirical relationships for striking distance and lightning peak current are invoked. The most common example is the "Rolling Sphere Method", which is also partly a geometric construction;

B.3.2.1 Cone of Protection ("Protection Angle") Method

This method is based on the assumption that an air terminal or an elevated, grounded object creates an adjacent, conical space that is essentially immune to lightning, as illustrated in Figure 1. The concept of a cone of sufficient angle to define the protected zone has its roots in the very beginning of lightning protection studies. Although Franklin recognized a limit as to the range of the air terminal in the late 1700's, the concept was first formally proposed by the French Academy of Science in 1823 and initially used a base of twice the height, i.e., an angle of 63°. By 1855, this angle was changed to 45° due to field reports that the method was failing. Generally, this angle was preserved in standards for more than one hundred years.

In some standards today, a variable angle depending on the height of the structure is used.

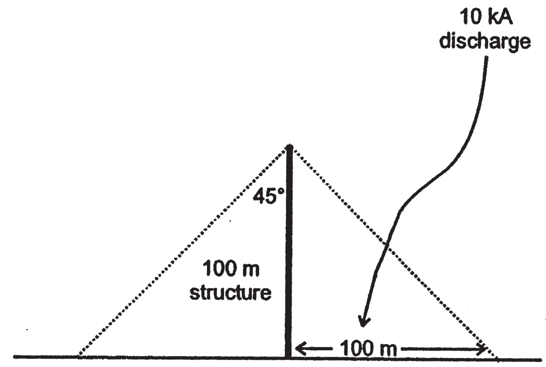


Figure B1: The "Cone of Protection" method.

It should be noted that the protected space is not totally immune to all lightning discharges. Using the Electrogeometric Model (see section 3.5 for more details), for a downward leader carrying a charge corresponding to a peak stroke current of 10 kA, if it approaches at a lateral distance greater than 45 meters it may bypass the structure and enter the assumed zone of protection of 100 m.

B.3.2.2 Rolling Sphere Method

The Rolling Sphere method is the most common design method, superseding the cone of protection method in NFPA 780 in the 1980 edition. It originated from the electric power transmission industry, i.e., 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, typically 45 m (150 ft) in radius, is rolled over the structure. All surface contact points are deemed to require protection, whilst the unaffected surfaces and volumes are deemed to be protected, as shown in Figure 3.

The physical basis for the Rolling Sphere method is the Electrogeometric Model. Consider a particular peak lightning current Ip (kA) and the corresponding "striking distance" ds (m), where ds = 10 Ip 0.65 [as reported by Uman]. For a typical peak current of 10 kA, the striking distance is ~ 45 m, i.e., this is the distance at which a downward leader results in the initiation of an upward leader from the structure.

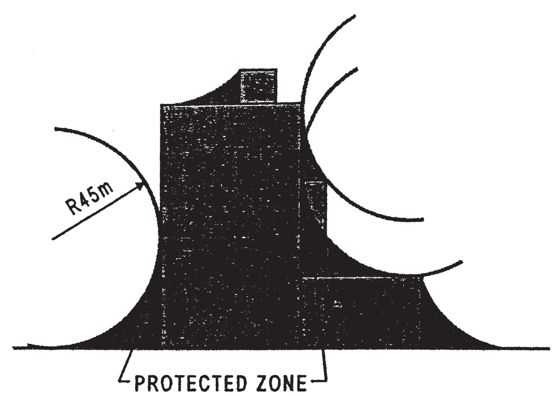


Figure B3: Lightning protection design using the Rolling Sphere Method

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 45 meter zone of protection. Thus, more conservative design is to size the sphere using a lower lightning peak current. Lightning peak currents below 5 kA – 7 kA are not realistic, however, and the 10 kA peak current represents 96% to 98% of all lightning events.

The advantage of the RSM 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, i.e., no account is taken of the influence of electric fields in initiating return streamers, so it does not distinguish between likely and unlikely lightning strike attachment points. In other words, for a given prospective peak stroke current, the striking distance ds is a constant value. This simplification stems from its origins in the electrical power transmission industry, where there is considerable uniformity in the parameters of transmission lines (diameters, heights, etc). In reality, lightning may preferentially strike the corner of the building rather than the vertical flat surface half way 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.

When the RSM is applied to a building of height greater than the selected sphere radius, then the sphere touches the vertical edges 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 Ip and consequently low ds values are likely to be able to penetrate below the level of the roof of the building and strike the sides. Hence, the consequences of a strike to the sides of a building may result in damage of a minor nature. Unless there are specific reasons for side protection, as would be the case of a structure containing explosives, it is considered that the cost of side protection would not normally be justified.

B 3.2.3 Other Models and Design Methods

Other lightning models exist and are periodically considered by a NFPA 780 subcommittee for development into design/air terminal placement methods for inclusion into NFPA 780. No further consideration of other models is given here as they do not fall within the scope of NFPA 780.

****

The sections below need to be renumbered .

B.3 Items to Consider When Planning Protection.

B.3.1 The best time to design a lightning protection system for a structure is during the structure's design phase, and the best time to install the system can be during construction. System components can be built in so as to be protected from mechanical displacement and environmental effects. In addition, aesthetic advantages may be gained by such concealment. Generally, it is less expensive to meet lightning protection requirements during construction.

- B3.2 moved up to section B.2

B.3.3 Conductors should be installed to offer the least impedance to the passage of stroke current between the strike termination devices and earth. The most direct path, without sharp bends or narrow loops, is best. The impedance of the conductor system is practically inversely proportional to the number of widely separated paths. Accordingly, there should be at least two paths to ground and more, if practicable, from each strike termination device. The number of paths is increased and the impedance decreased by connecting the conductors to form a cage enclosing the building.

B.3.4 Properly made ground connections are essential to the effective functioning of a lightning protection system, and every effort should be made to provide ample contact with the earth. This does not necessarily mean that the resistance of the ground connection should be low, but rather that the distribution of metal in the earth or upon its surface in extreme cases should be such as to permit the dissipation of a stroke of lightning without damage.

B.3.5 Low resistance is desirable, but not essential, as may be shown by the extreme case on the one hand of a building resting on moist clay soil, and on the other by a building resting on bare solid rock. In the first case, if the soil is of normal resistivity or from 4,000 ohm-centimeters to 50,000 ohm-centimeters, the resistance of a ground connection made by extending the conductor 10 ft (3 m) into the ground will be from about 15 ohms to 200 ohms, and two such ground connections on a small rectangular building have been found by experience to be sufficient. Under these favorable conditions, providing adequate means for collecting and dissipating the energy of a flash without serious chance of damage is a simple and comparatively inexpensive matter.

B.3.6 In the second case, it would be impossible to make a ground connection in the ordinary sense of the term because most kinds of rocks are insulating, or at least of high resistivity, and in order to obtain effective grounding other more elaborate means are necessary. The most effective means would be an extensive wire network laid on the surface of the rock surrounding the building to which the down conductors could be connected. The resistance to earth at some distant point of such an arrangement would be high but at the same time the potential distribution about the building would be substantially the same, as though it were resting on conducting soil, and the resulting protective effect also would be substantially the same.

B.3.7 In general, the extent of the grounding arrangements will depend on the character of the soil, ranging from simple extension of the conductor into the ground where the soil is deep and of high conductivity to an elaborate buried network where the soil is very dry or of very poor conductivity. Where a network is required, it should be buried if there is soil enough to permit it, as this adds to its effectiveness. Its extent will be determined largely by the judgment of the person planning the installation with due regard to the following rule: The more extensive the underground metal available, the more effective the protection.

B.3.8 Where practicable, each ground terminal connection should extend or have a branch that extends below and at least 2 ft (0.6 m) away from the foundation walls of the building in order to minimize the likelihood of damage to foundation walls, footings, and stemwalls.

B.3.9 When a lightning conductor system is placed on a building, within or about which there are metal objects of considerable size within a few feet of a conductor, there will be a tendency for sparks or sideflashes to jump between the metal object and the conductor. To prevent damage, interconnecting conductors should be provided at all places where sideflashes are likely to occur.

B.3.10 Lightning currents entering protected buildings on overhead or underground power lines, or telephone conductors, or television or radio antennas are not necessarily restricted to associated wiring systems and appliances. Therefore, such systems should be equipped with appropriate protective devices and bonded to ensure a common potential.

B.3.11 Because a lightning protection system is expected to remain in working condition for long periods with minimum attention, the mechanical construction should be strong and the materials used should offer resistance to corrosion and mechanical injury.

B.4 Inspection and Maintenance of Lightning Protection Systems.
It has been shown that in cases where damage has occurred to a protected structure, the damage was due to additions or repairs to the building or to deterioration or mechanical damage that was allowed to go undetected and unrepaired, or both. Therefore, it is recommended that an annual visual inspection be made and that the system be thoroughly inspected every five years.

B.5 Indirect Losses. In addition to direct losses such as destruction of buildings by lightning, fire resulting from lightning, and the killing of livestock, indirect losses sometimes accompany the destruction or damage of buildings and their contents. An interruption to business or farming operations, especially at certain times of the year, may involve losses quite distinct from, and in addition to, the losses arising from the direct destruction of material property. There are cases where whole communities depend on the integrity of a single structure for their safety and comfort. For example, a community may depend on a water-pumping plant, a telephone relay station, a police station, or a fire station. A stroke of lightning to the unprotected chimney of a pumping plant might have serious consequences such as a lack of sanitary drinking water, irrigating water, or water for fire protection. Additional information on this topic is available in the documents identified in Appendix M.1.2.1.

VANSICKLE, III, H.: The Committee rejected this proposal because it is "beyond the scope of the document". There is much good information included that is pertinent to the scope. The valid information should be included, and the non-compliant deleted. Generally the "Cone of Protection" and "Rolling Sphere" Methods information should be included, while the "Mesh", "Collection Volume/Electric Field Intensification", and "Leader Progression" Methods information should be deleted.

780-111 Log #59 **Final Action: Accept in Principle**
(C.2.1)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...to reduce this potential ~~to zero,~~ this standard...".
Substantiation: Can't get to zero.
Committee Meeting Action: Accept in Principle
Revise C.2.1 to read as follows:
"...to reduce this potential to essentially zero, this standard..."
Committee Statement: The Committee accepts the submitter's recommendation and changes the text for clarification. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-112 Log #98 **Final Action: Accept in Principle**
(Table C.2.3)

Submitter: Terrance K. Portfleet, Michigan Lightning Protection Inc.
Recommendation: Revise Table C.2.3 Sample Calculations of Bonding Distances SI/English Unit Conversions as follows:

Table C.2.3 Sample Calculations of Bonding Distances

h(ft)	Km	D n=1.0	n=1.5	n=2.25
10 3.05m	1	1 ft 8 in. .50m	1 ft 1-3/8 in. .33m	9 in. .22m
	0.5	10 in. .25m	6-3/4 in. .17m	4-1/2 in. .11m
20 6.10	1	3 ft 4 in. 1.01m	2 ft 2-3/4 in. .67m	1 ft 6 in. .45m
	0.5	1 ft 1-3/8 in. .50m	1 ft 1-3/8 in. .33m	9 in. .22m
30 9.15m	1	5 ft 0 in. 1.52m	3 ft 4 in. 1.01m	2 ft 2-3/4 in. .67m
	0.5	2 ft 6 in. .76m	1 ft 8 in. .50m	1 ft 1-3/8 in. .33m
40 12.2m	1	6 ft 8 in. 2.03m	4 ft 6 in. 1.37m	3 ft .91m
	0.5	3 ft 4 in. 1.01m	2 ft 3 in. .68m	1 ft 6 in. .45m

Substantiation: MOS mandated SI/English Conversions.
Committee Meeting Action: Accept in Principle
Replace existing Table C.2.3 in its entirety with the following:

Table C.2.3 Sample Calculations of Bonding Distances

h	Km	D n=1.0	n=1.5	n=2.25
10 ft 3.05 m	1	1 ft 8 in. 0.50 m	1 ft 1-3/8 in. 0.33 m	9 in. 0.22 m
	0.5	10 in. 0.25 m	6-3/4 in. 0.17 m	4-1/2 in. 0.11 m
20 ft 6.10 m	1	3 ft 4 in. 1.01 m	2 ft 2-3/4 in. 0.67 m	1 ft 6 in. 0.45 m
	0.5	1 ft 1-3/8 in. 0.50 m	1 ft 1-3/8 in. 0.33 m	9 in. 0.22 m
30 ft 9.15 m	1	5 ft 0 in. 1.52 m	3 ft 4 in. 1.01 m	2 ft 2-3/4 in. 0.67 m
	0.5	2 ft 6 in. 0.76 m	1 ft 8 in. 0.50 m	1 ft 1-3/8 in. 0.33 m
40 ft 12.2 m	1	6 ft 8 in. 2.03 m	4 ft 6 in. 1.37 m	3 ft 0.91 m
	0.5	3 ft 4 in. 1.01 m	2 ft 3 in. 0.68 m	1 ft 6 in. 0.45 m

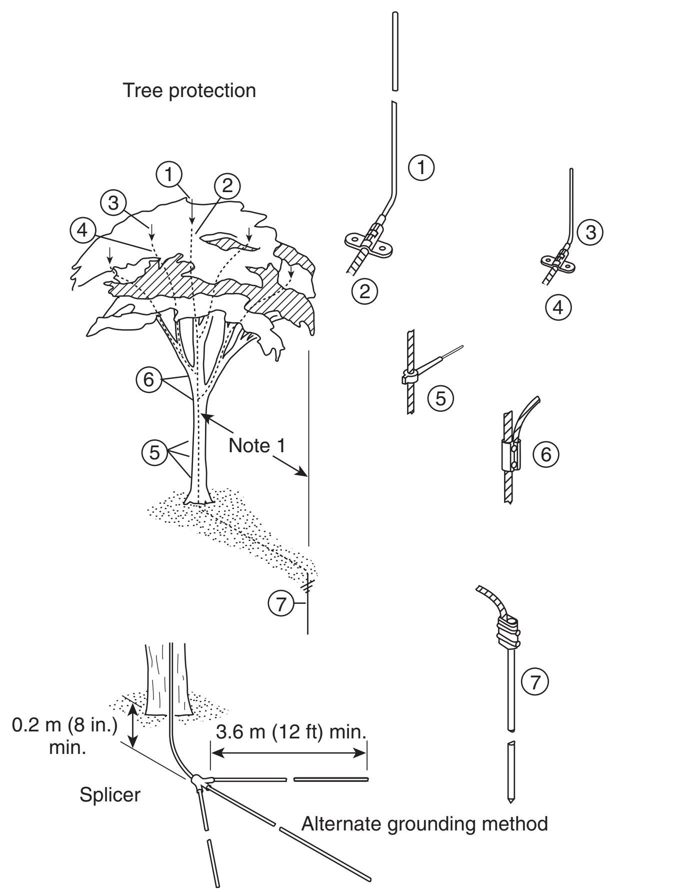
Committee Statement: The Committee accepts the submitter's recommendation. Additionally, it updates Table C.2.3 as per Manual of Style requirements. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-113 Log #60 **Final Action: Accept in Principle**
(E.1.3)

Submitter: Dick Reehl, Quest Communications
Recommendation: Revise as follows:
"...and allows direct reading of R. NOTE: The individual equipment manufacturers recommended operational procedures ~~should~~ shall be used in all cases."
Substantiation: Equipment manufacturers may have procedures which differ from 780.
Committee Meeting Action: Accept in Principle
Revise E.1.3 to read as follows:
"...and allows direct reading of R. NOTE: The individual equipment manufacturer's recommended operational procedures should be used.
Committee Statement: The Committee accepts the submitter's recommendation and changes the text for clarification and to comply with the Manual of Style. The change satisfies the submitter's intent.
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R

780-114 Log #3 **Final Action: Accept in Principle in Part**
(Figure F.1)

Submitter: E. Thomas Smiley, Bartlett Tree Research Laboratory
Recommendation: Revise Figure as follows:
Figure F.1 Protection for Trees
Note 1 Locate ground ~~approximately at branch line to avoid root damage~~ at least 3 m (10 ft) from trunk.
Within figure descriptions - ground conductor depth
~~0.3 m (1 ft)~~
0.2 m (8 in.)
Air terminals - Please show blunt terminals not sharp points.
2. ~~Class 1 or Class II full-size cable.~~
Class 1 bonding conductor or Class 1 conductor.
Substantiation: These recommendations are intended to harmonize the NFPA 780F with the ANSI A300 Part 4. Tree Lightning Protection standards. Currently, the two standards conflict on the noted points. This causes confusion with consumers and professionals.
Committee Meeting Action: Accept in Principle in Part
Revise Figure F.1 as follows:



1. Main trunk air terminal
2. Class I or Class II full-size cable
3. Branch air terminal
4. Branch conductor (bonding size conductor, minimum)
5. Drive-type cable clip at 0.9 m (3 ft) O/C
6. Splicer
7. Ground rod and clamp

Note 1: Locate grounding electrode approximately at branch line to avoid root damage at least 3 m (10 ft) from trunk.
Note 2: Install cable loosely to allow for tree growth.
Note 3: Air terminal tip configurations can be blunt or sharp.

In the figure, change the following:

"0.3 m (1 ft) min." to "0.2 m (8 in.) min."

Change appearance or air terminals from sharp tips to blunt tips in two places

Change "3 m (10 ft) min." to "3.6 m (12 ft) min."

In the notes, change the following:

Note 1: Locate grounding electrode approximately at branch line to avoid root damage at least 3 m (10 ft) from trunk.

In the callout, change the following:

4. to read as follows: "Branch conductor (bonding size conductor, minimum)"

Committee Statement: The Committee rejects the submitter's recommendation from Class I or Class II full-size cable to Class I bonding conductor or Class I conductor.

The committee accepts the submitter's recommendation to change dimensions, air terminal appearance, Note 1 and callout 4.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-115 Log #1 **Final Action: Reject**
(F.2.1)

Submitter: E. Thomas Smiley, Bartlett Tree Research Laboratory

Recommendation: Revise text as follows:

F.2.1 Conductors should conform to the requirements of <u>Table 4.1.1.1(A) for bonding conductor, cable</u> .

Substantiation: These recommendations are intended to harmonize the NFPA 780F with the ANSI A300 Part 4. Tree Lightning Protection standards. Currently, the two standards conflict on the noted points. This causes confusion with consumers and professionals.

Committee Meeting Action: Reject

Committee Statement: The intent of the Committee is to require the use of appropriate main conductors for the application.

See Committee Action on Proposal 780-114 (Log #3).

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-116 Log #2 **Final Action: Accept in Principle**
(F.2.5)

Submitter: E. Thomas Smiley, Bartlett Tree Research Laboratory

Recommendation: Revise text as follows:

F.2.5 Ground terminal...extend ~~three~~ <u>one</u> or more...in trenches ~~0.3 (1 ft)~~ <u>0.2 (8 in.)</u> deep...or a single driven rod installed outside the ~~dripline of the tree~~ <u>at least 3 m (10 ft) from the trunk of the tree</u> .

Substantiation: These recommendations are intended to harmonize the NFPA 780F with the ANSI A300 Part 4. Tree Lightning Protection standards. Currently, the two standards conflict on the noted points. This causes confusion with consumers and professionals.

Committee Meeting Action: Accept in Principle

Revise F.2.5 to read as follows:

Ground Terminals. Ground terminals for conductors should be in accordance with the following:

(1) Be connected to all conductors that descend the trunk of the tree, extend one or more radial conductor(s) in trenches 0.2 m (8 in) deep, and be spaced at equal intervals about the base to a distance of not less than 3 m (10 ft) or a single driven rod installed a distance of not less than 3 m (10 ft) from the trunk of the tree. (See Figure F.1.)

(2) Have the radial conductor(s) extended to the branch line but not less than 3.6 m (12 ft).

(3) Connect the terminations of the radials to a ground loop conductor that encircles the tree at a depth of not less than 0.2 m (8 in).

(4) Retain (4) with no change.

Committee Statement: The Committee clarifies the text. The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-117 Log #61 **Final Action: Accept in Principle**
(G.1.1(3))

Submitter: Dick Reehl, Quest Communications

Recommendation: Revise as follows:

"...to ~~personnel~~ <u>humans and animals</u> ".

Substantiation: Need to provide guidance to more than employees.

Committee Meeting Action: Accept in Principle

Revise G.1.1(3) to read as follows:

"...to ~~personnel~~ <u>persons and animals</u> ".

Committee Statement: The Committee clarifies the text. The change satisfies the submitter's intent.

Number Eligible to Vote: 30

Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

780-118 Log #74 **Final Action: Reject**
(Annex I)

NOTE: The following proposal consists of Comment 780-20 on Proposal 780-33 in the 2004 May Meeting Report on Comments. This comment was held for further study during the processing of the A2004 ROC.

The Recommendation on Proposal 780-33 was as follows:

Add a new Annex I to read as follows:

"Annex I Protection for Electronic Facilities

I.1 General. This annex provides information on increased protection of the structure and the electronics within for facilities that primarily house critical electronic equipment such as data processing and telecommunication.

I.2 Materials and Installation. Materials should be Class I or Class II as shown in Tables 3.1.1(a)(b) and installed in accordance Chapter 3, except as noted in this chapter.

I.3 Strike Termination Devices. To provide additional protection, an increase in height of air terminals, a decrease in spacing of air terminals, and a decrease in rolling sphere diameter from those values given in Chapter 3 may be desired.

I.6.4 Down conductors. To provide additional protection, the down conductor spacing may be reduced from those values given in Chapter 3. In addition, connection to the building structural steel is encouraged to increase the shielding affect and reduce the impedance to ground.

I.6.5 Fasteners. Fasteners should be as described and installed in accordance with Chapter 3.

I.6.6 Splices. Splices should be as described and installed in accordance with Chapter 3 except that conductor-to-conductor splices should be designed to further reduce inductive impedance. Tee connections are not encouraged for this reason.

I.6.7 Grounding. Grounding should comply with the requirements of Chapter 3 and NEC (Article 250). Facilities with multiple electronic equipment entrances of conduits, axial cables, wave-guides, etc., should be grounded by means of a ground ring electrode. All conductive services should be bonded to the ground ring electrode at their respective entrances.

I.6.8 Bonding. In addition to the bonding requirements of Chapter 3, additional bonding may be required to reduce radiated energy resulting from unintended arcing.

I.6.9 Surge Protection. Surge protection should be installed as described in Section 3.18. Secondary and point of utilization surge suppression is recommended for this application."

Submitter: Mitchell A Guthrie, Independent Engineering Consultant

Recommendation: Delete the proposed annex and return the document to a task force for additional development.

Substantiation: The proposal is not currently mature enough for publication as an annex to the document and should be returned to a task force for further development.

Committee Meeting Action: Reject

Committee Statement: The Committee added Section 4.18 to this document. This section satisfies the submitter's intent.

Number Eligible to Vote: 30

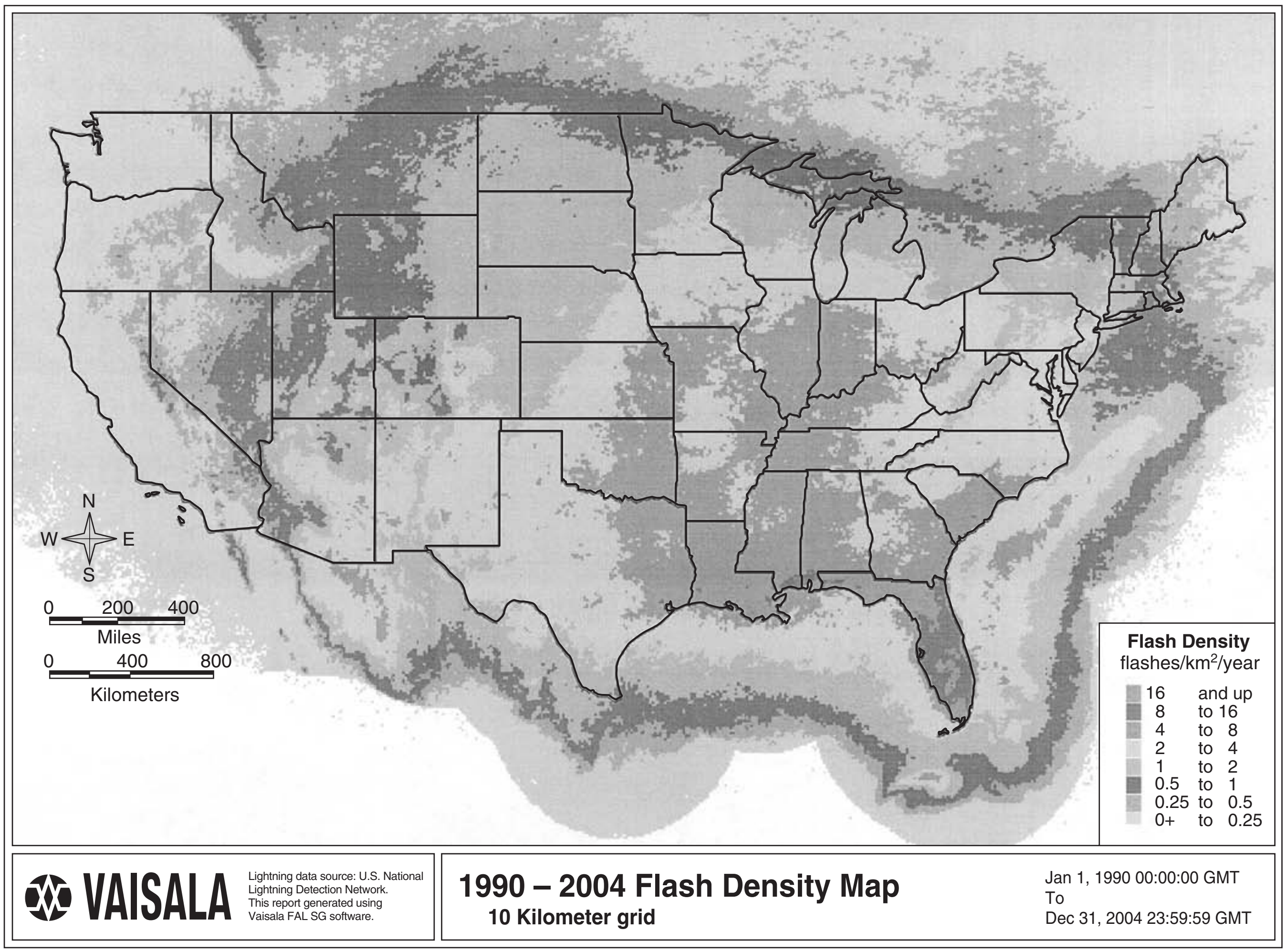
Ballot Results: Affirmative: 26

Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.

Sequence #780-119 was not used

780-120 Log #92 **Final Action: Accept**
(Figure L.2)

Submitter: David E. McAfee, Knoxville, TN
Recommendation: Replace Figure L.2 1989-1998 Lightning Flash Map with the following new map:
Substantiation: The old figure gave data from 1989-1998. The proposed new map has data from 1990-2004 for improved accuracy.
Committee Meeting Action: Accept
Number Eligible to Vote: 30
Ballot Results: Affirmative: 26
Ballot Not Returned: 4 Dyl, D., Goldbach, W., Heary, W., Rapp, R.



FORM FOR COMMENTS ON NFPA REPORT ON PROPOSALS
2007 ANNUAL REVISION CYCLE
FINAL DATE FOR RECEIPT OF COMMENTS: 5:00 pm EDST, September 1, 2006

For further information on the standards-making process, please contact the Codes and Standards Administration at 617-984-7249

For technical assistance, please call NFPA at 617-770-3000

FOR OFFICE USE ONLY

Log #: ______

Date Rec'd: ______

Please indicate in which format you wish to receive your ROP/ROC ☐ **electronic** ☐ **paper** ☐ **download**

(Note: In choosing the download option, you intend to view the ROP/ROC from our website; no copy will be sent to you.)

Date ______ **Name** ______ **Tel. No.** ______

Company ______

Street Address ______ **City** ______ **State** ______ **Zip** ______

Please indicate organization represented (if any) ______

1. (a) NFPA document title ______ **NFPA No. & Year** ______

(**b) Section/Paragraph** ______

2. Comment on Proposal No. (from ROP): ______

3. Comment recommends (check one): ☐ new text ☐ revised text ☐ deleted text

4. Comment (include proposed new or revised wording, or identification of wording to be deleted): (Note: Proposed text should be in legislative format; i.e., use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).

5. Statement of Problem and Substantiation for Comment: (Note: State the problem that will be resolved by your recommendation; give the specific reason for your comment, including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.)

6. Copyright Assignment

(a) ☐ **I am the author of the text or other material (such as illustrations, graphs) proposed in this comment.**

(b) ☐ **Some or all of the text or other material proposed in this comment was not authored by me. Its source is as follows** (please identify which material and provide complete information on its source)**:**

______

I hereby grant and assign to the NFPA all and full rights in copyright in this comment and understand that I acquire no rights in any publication of NFPA in which this comment in this or another similar or analogous form is used. Except to the extent that I do not have authority to make an assignment in materials that I have identified in (b) above, I hereby warrant that I am the author of this comment and that I have full power and authority to enter into this assignment.

Signature (Required) ______

PLEASE USE SEPARATE FORM FOR EACH COMMENT • NFPA Fax: (617) 770-3500

Mail to: Secretary, Standards Council, National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471

5/25/2006

Notice of Intent to Make a Motion (NITMAM)

Sequence of Events Leading to Issuance of an NFPA Committee Document

Step 1 **Call for Proposals**

▼ Proposed new Document or new edition of an existing Document is entered into one of two yearly revision cycles, and a Call for Proposals is published.

Step 2 **Report on Proposals (ROP)**

▼ Committee meets to act on Proposals, to develop its own Proposals, and to prepare its Report.

▼ Committee votes by written ballot on Proposals. If two-thirds approve, Report goes forward. Lacking two-thirds approval, Report returns to Committee.

▼ Report on Proposals (ROP) is published for public review and comment.

Step 3 **Report on Comments (ROC)**

▼ Committee meets to act on Public Comments to develop its own Comments, and to prepare its report.

▼ Committee votes by written ballot on Comments. If two-thirds approve, Reports goes forward. Lacking two-thirds approval, Report returns to Committee.

▼ Report on Comments (ROC) is published for public review.

Step 4 **Technical Report Session**

▼ *"Notices of intent to make a motion"* are filed, are reviewed, and valid motions are certified for presentation at the Technical Report Session. ("Consent Documents" that have no certified motions bypass the Technical Report Session and proceed to the Standards Council for issuance.)

▼ NFPA membership meets each June at the Annual Meeting Technical Report Session and acts on Technical Committee Reports (ROP and ROC) for Documents with "certified amending motions."

▼ Committee(s) vote on any amendments to Report approved at NFPA Annual Membership Meeting.

Step 5 **Standards Council Issuance**

▼ Notification of intent to file an appeal to the Standards Council on Association action must be filed within 20 days of the NFPA Annual Membership Meeting.

▼ Standards Council decides, based on all evidence, whether or not to issue Document or to take other action, including hearing any appeals.

The Technical Report Session of the NFPA Annual Meeting

The process of public input and review does not end with the publication of the ROP and ROC. Following the completion of the Proposal and Comment periods, there is yet a further opportunity for debate and discussion through the Technical Report Sessions that take place at the NFPA Annual Meeting.

The Technical Report Session provides an opportunity for the final Technical Committee Report (i.e., the ROP and ROC) on each proposed new or revised code or standard to be presented to the NFPA membership for the debate and consideration of motions to amend the Report. The specific rules for the types of motions that can be made and who can make them are set forth in NFPA's rules which should always be consulted by those wishing to bring an issue before the membership at a Technical Report Session. The following presents some of the main features of how a Report is handled.

What Amending Motions are Allowed. The Technical Committee Reports contain many Proposals and Comments that the Technical Committee has rejected or revised in whole or in part. Actions of the Technical Committee published in the ROP may also eventually be rejected or revised by the Technical Committee during the development of its ROC. The motions allowed by NFPA rules provide the opportunity to propose amendments to the text of a proposed code or standard based on these published Proposals, Comments and Committee actions. Thus, the list of allowable motions include motions to accept Proposals and Comments in whole or in part as submitted or as modified by a Technical Committee action. Motions are also available to reject an accepted Comment in whole or part. In addition, Motions can be made to return an entire Technical Committee Report or a portion of the Report to the Technical Committee for further study.

The NFPA Annual Meeting, also known as the World SafetyConference and Exposition®, takes place in June of each year. A second Fall membership meeting was discontinued in 2004, so the NFPA Technical Report Session now runs once each yearat the Annual Meeting in June.

Who Can Make Amending Motions. Those authorized to make these motions is also regulated by NFPA rules. In many cases, the maker of the motion is limited by NFPA rules to the original submitter of the Proposal or Comment or his or her duly authorized representative. In other cases, such as a Motion to Reject an accepted Comment, or to Return a Technical Committee Report or a portion of a Technical Committee Report for Further Study, anyone can make these motions. For a complete explanation, NFPA rules should be consulted.

The filing of a Notice of Intent to Make a Motion. Before making an allowable motion at a Technical Report Session, the intended maker of the motion must file, in advance of the session, and within the published deadline, a Notice of Intent to Make a Motion. A Motions Committee appointed by the Standards Council then reviews all notices and certifies all amending motions that are proper. The Motions Committee can also, in consultation with the makers of the motions, clarify the intent of the motions and, in certain circumstances, combine motions that are dependent on each other together so that they can be made in one single motion. A Motions Committee report is then made available in advance of the meeting listing all certified motions. Only these Certified Amending Motions, together with certain allowable Follow-Up Motions (that is, motions that have become necessary as a result of previous successful amending motions) will be allowed at the Technical Report Session.

Consent Documents. Often there are codes and standards up for consideration by the membership that will be non-controversial and no proper Notices of Intent to Make a Motion will be filed. These "Consent Documents" will bypass the Technical Report Session and head straight to the Standards Council for issuance. The remaining Documents are then forwarded to the Technical Report Session for consideration of the NFPA membership.

Important Note: *The filing of a Notice of Intent to Make a Motion is a new requirement that takes effect beginning with those Documents scheduled for the Fall 2005 revision cycle that reports to the June 2006 Annual Meeting Technical Report Session. The filing of a Notice of Intent to Make a Motion will not, therefore, be required in order to make a motion at the June 2005 Annual Meeting Technical Report Session. For updates on the transition to the new Notice requirement and related new rules effective for the Fall 2005 revision cycle and the June 2006 Annual Meeting, check the NFPA website.*

Action on Motions at the Technical Report Session. In order to actually make a Certified Amending Motion at the Technical Report Session, the maker of the motion must sign in at least an hour before the session begins. In this way a final list of motions can be set in advance of the session. At the session, each proposed Document up for consideration is presented by a motion to adopt the Technical Committee Report on the Document. Following each such motion, the presiding officer in charge of the session opens the floor to motions on the Document from the final list of Certified Amending Motions followed by any permissible Follow-Up Motions. Debate and voting on each motion proceeds in accordance with NFPA rules. NFPA membership is not required in order to make or speak to a motion, but voting is limited to NFPA members who have joined at least 180 days prior to the session and have registered for the meeting. At the close of debate on each motion, voting takes place, and the motion requires a majority vote to carry. In order to amend a Technical Committee Report, successful amending motions must be confirmed by the responsible Technical Committee, which conducts a written ballot on all successful amending motions following the meeting and prior to the Document being forwarded to the Standards Council for issuance.

Standards Council Issuance

One of the primary responsibilities of the NFPA Standards Council, as the overseer of the NFPA codes and standards development process, is to act as the official issuer of all NFPA codes and standards. When it convenes to issue NFPA documents it also hears any appeals related to the Document. Appeals are an important part of assuring that all NFPA rules have been followed and that due process and fairness have been upheld throughout the codes and standards development process. The Council considers appeals both in writing and through the conduct of hearings at which all interested parties can participate. It decides appeals based on the entire record of the process as well as all submissions on the appeal. After deciding all appeals related to a Document before it, the Council, if appropriate, proceeds to issue the Document as an official NFPA code or standard. Subject only to limited review by the NFPA Board of Directors, the Decision of the Standards Council is final, and the new NFPA code or standard becomes effective twenty days after Standards Council issuance. The illustration on page 9 provides an overview of the entire process, which takes approximately two full years to complete.