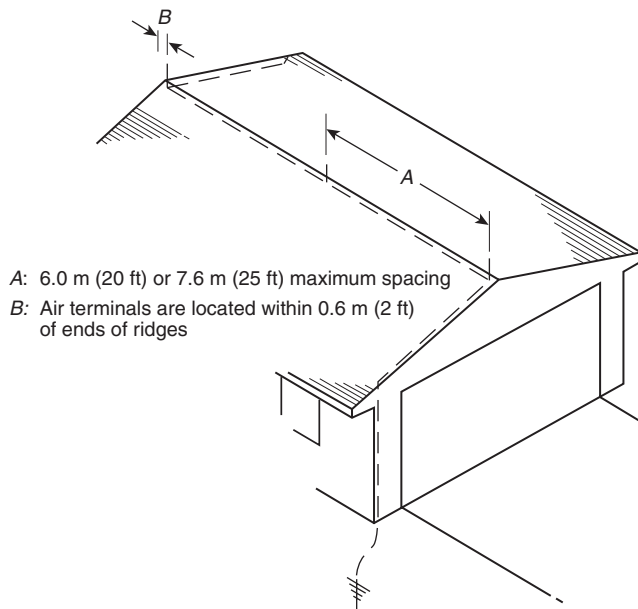


**FIGURE 4.7.3.3 Zone of Protection Utilizing Rolling Sphere Method.**



**FIGURE 4.8.2 Air Terminals on a Pitched Roof.**

**4.8.2.1** Strike termination devices shall be placed on ridges of pitched roofs, and around the perimeter of flat or gently sloping roofs, at intervals not exceeding 6 m (20 ft).

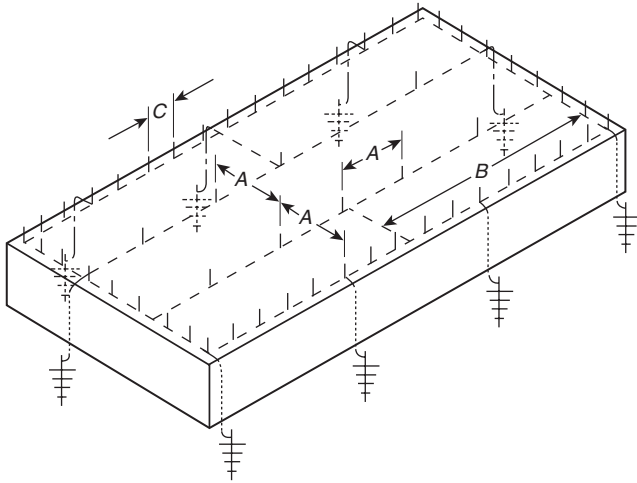
**4.8.2.2** Strike termination devices 0.6 m (2 ft) or more above the object or area to be protected shall be permitted to be placed at intervals not exceeding 7.6 m (25 ft).

**4.8.2.3 Pitched Roof Area.**

**(A)** A pitched roof with eave heights of 15 m (50 ft) or less above grade shall require protection for the ridge only where there is no horizontal portion of the building that extends beyond the eaves, other than a gutter.

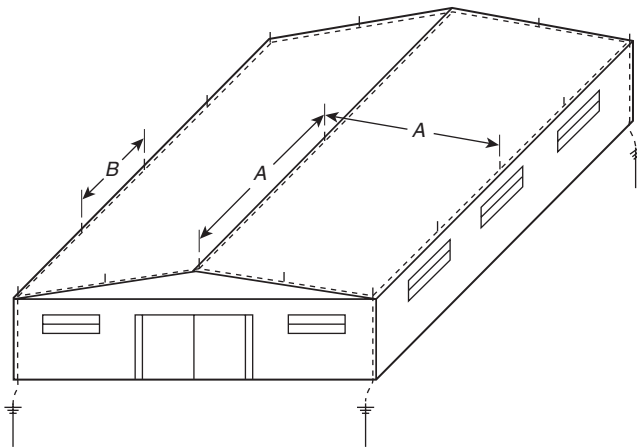
**(B)** Pitched roofs with eave heights more than 15 m (50 ft) shall have strike termination devices located according to the 46 m (150 ft) rolling sphere method. [See Figure 4.7.3.1(B) and Figure 4.7.3.3.]

**4.8.2.4 Flat or Gently Sloping Roof Area.** Flat or gently sloping roofs that exceed 15 m (50 ft) in width or length shall have additional strike termination devices located at intervals not to exceed 15 m (50 ft) on the flat or gently sloping areas, as shown in Figure 4.8.2.4(a) and Figure 4.8.2.4(b), or such area can also be protected using taller air terminals that create zones of protection using the rolling sphere method so the sphere does not contact the flat or gently sloping roof area.



- A: 15 m (50 ft) maximum spacing between air terminals
- B: 45 m (150 ft) maximum length of cross run conductor permitted without a connection from the cross run conductor to the main perimeter or down conductor
- C: 6 m (20 ft) or 7.6 m (25 ft) maximum spacings between air terminals along edge

FIGURE 4.8.2.4(a) Air Terminals on a Flat Roof.



- A: 15 m (50 ft) maximum spacing
- B: 6 m (20 ft) or 7.6 m (25 ft) maximum spacing

FIGURE 4.8.2.4(b) Air Terminals on a Gently Sloping Roof.

**4.8.3\* Dormers.**

4.8.3.1 Dormers as high as or higher than the main roof ridge shall be protected with strike termination devices, conductors, and grounds, where required.

4.8.3.2 Dormers and projections below the main ridge shall require protection only on those areas extending outside a zone of protection.

4.8.4 **Roofs with Intermediate Ridges.** Strike termination devices shall be located along the outermost ridges of buildings that have a series of intermediate ridges at the same intervals as required by 4.8.2.

4.8.4.1 Strike termination devices shall be located on the intermediate ridges in accordance with the requirements for the spacing of strike termination devices on flat or gently sloping roofs.

4.8.4.2 If any intermediate ridge is higher than the outermost ridges, it shall be treated as a main ridge and protected according to 4.8.2.

4.8.5 **Flat or Gently Sloping Roofs with Irregular Perimeters.** Structures that have exterior wall designs that result in irregular roof perimeters shall be treated on an individual basis.

4.8.5.1 The outermost projections form an imaginary roof edge that shall be used to locate the strike termination devices in accordance with 4.8.2.

4.8.5.2 In all cases, however, strike termination devices shall be located in accordance with Section 4.8, as shown in Figure 4.8.5.2.

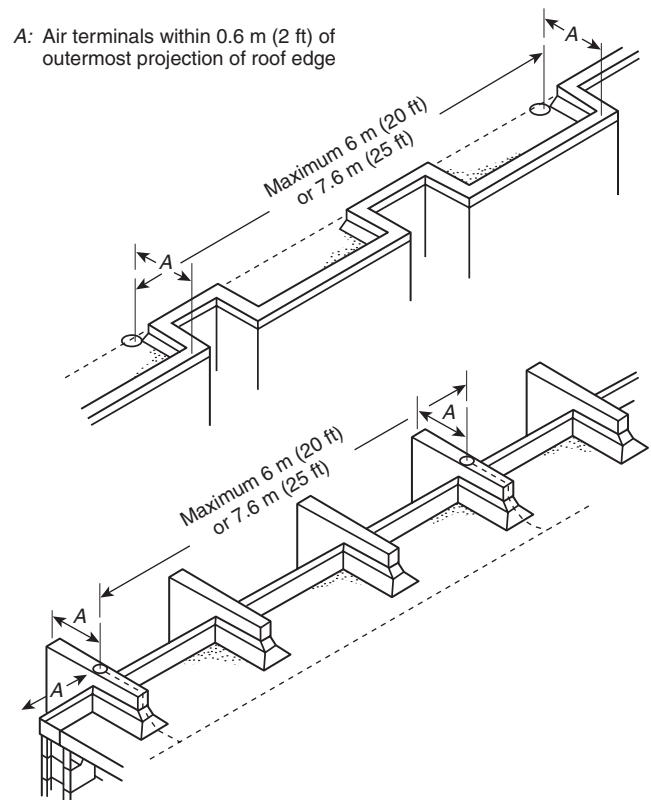


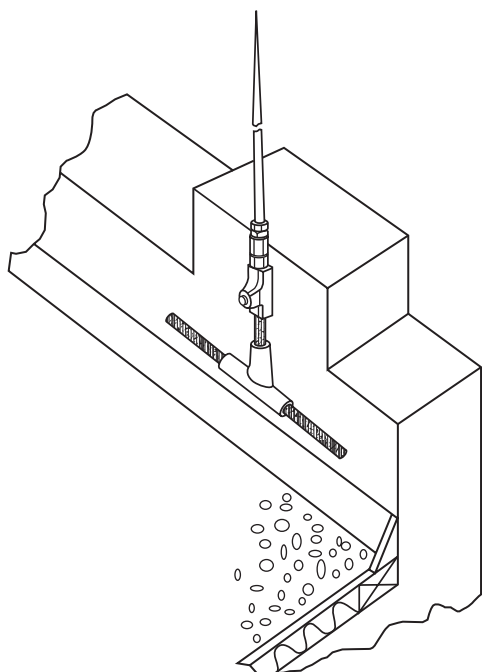
FIGURE 4.8.5.2 Flat or Gently Sloping Roof with an Irregular Perimeter.

4.8.5.3 Strike termination devices installed on vertical roof members shall be permitted to use a single main-size cable to connect to a main roof conductor.

4.8.5.4 The main roof conductor shall be run adjacent to the vertical roof members so that the single cable from the strike termination device is as short as possible and in no case longer than 4.9 m (16 ft).

4.8.5.5 The connection of the single cable to the down conductor shall be made with a tee splice, as shown in Figure 4.8.5.5.





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

**FIGURE 4.8.5.5 Irregular Roof Perimeter.**

**4.8.6 Open Areas in Flat Roofs.** The perimeter of open areas, such as light or mechanical wells, shall be protected if the open area perimeter exceeds 92 m (300 ft), provided both rectangular dimensions exceed 15 m (50 ft).

**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.

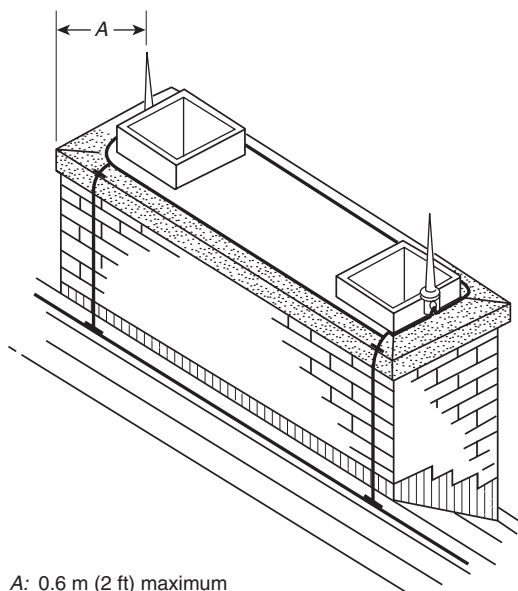
**4.8.8 Chimneys and Vents.** Strike termination devices shall be required on all chimneys and vents that are not located within a zone of protection, including metal chimneys having a metal thickness of less than 4.8 mm ( $\frac{3}{16}$  in.).

**4.8.8.1** Chimneys or vents with a metal thickness of 4.8 mm ( $\frac{3}{16}$  in.) or more shall require only a connection to the lightning protection system.

**4.8.8.2** The connection for 4.8.8.1 shall be made using a main-size lightning conductor and a bonding device that has a surface contact area of not less than 1940 mm<sup>2</sup> (3 in.<sup>2</sup>) and shall provide two or more paths to ground, as is required for strike termination devices.

**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 0.6 m (2 ft).

**4.8.8.4** Where only one strike termination device is required on a chimney or vent, at least one main-size conductor shall connect the strike termination device to a main conductor at the location where the chimney or vent meets the roof surface and provides two or more paths to ground from that location in accordance with Section 4.9 and 4.9.2.



A: 0.6 m (2 ft) maximum

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

**FIGURE 4.8.8.3 Air Terminals on a Chimney.**

**4.8.9 Metal Roof Top Units.** Roof top mechanical units with continuous metal housings less than 4.8 mm ( $\frac{3}{16}$  in.) thick such as air-conditioning/heating units, metal air intake/exhaust housings, cooling towers, and so forth, shall be protected by 4.8.9.1 through 4.8.9.2.2.

**4.8.9.1** Air terminals shall be installed in accordance with 4.8.1 and 4.8.2.

**4.8.9.1.1** These shall be mounted on bases having a minimum contact area of 1940 mm<sup>2</sup> (3 in.<sup>2</sup>) each secured to bare metal of the housing or mounted by drilling and tapping to the unit's frame per 4.16.3.2 and 4.16.3.3.

**4.8.9.2** At least two main-size conductors shall be installed.

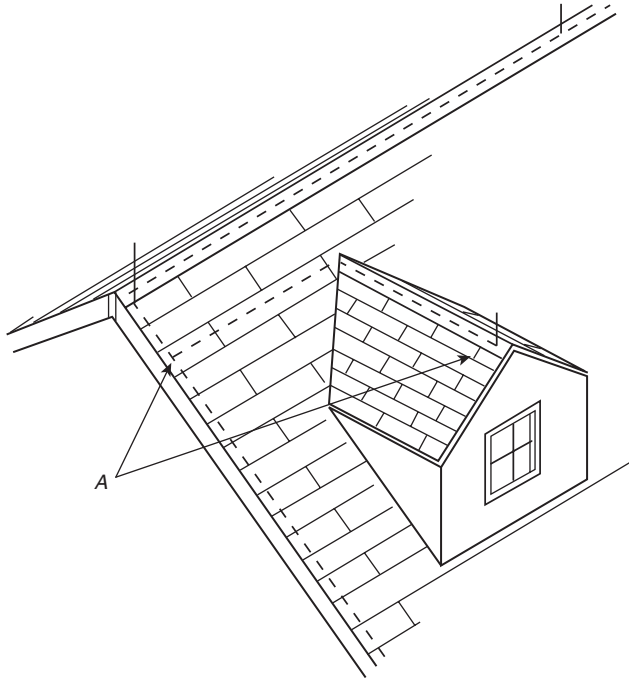
**4.8.9.2.1** The connection shall be made to bare metal at the base or lower edges of the unit using main-size lightning conductors and bonding devices that have a surface contact area of not less than 1940 mm<sup>2</sup> (3 in.<sup>2</sup>) and shall provide two or more paths to ground, as is required for strike termination devices.

**4.8.9.2.2** These two main bonding plates shall be located 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.

**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 1/4 pitch to connections with grounding electrodes, except as permitted by 4.9.1 and 4.9.2.

**4.9.1 One-Way Path.** Strike termination devices on a lower roof level that are interconnected by a conductor run from a higher roof level shall require only one horizontal or downward path to ground, provided the lower level roof conductor run does not exceed 12 m (40 ft).

**4.9.2 Dead Ends.** Strike termination devices shall be permitted to be “dead ended,” as shown in Figure 4.9.2, with only one path to a main conductor on roofs below the main protected level, provided the conductor run from the strike termination device to a main conductor is not more than 4.9 m (16 ft) in total length and maintains a horizontal or downward coursing.



A: Permissible dead-end total conductor length not over 4.9 m (16 ft)

**FIGURE 4.9.2 Dead End.**

#### 4.9.3 Substitution of Main Conductor.

**4.9.3.1** Ancillary metal parts of a structure, such as eave troughs, downspouts, ladders, chutes, or other metal parts except as permitted in 4.16.1, shall not be substituted for the main conductor.

**4.9.3.2** Permanent exterior metal handrails and ladders that are subject to direct lightning strikes (e.g., on roofs or between roofs) and are electrically continuous shall be permitted to be used as main conductors where the minimum thickness is 1.63 mm (0.064 in.).

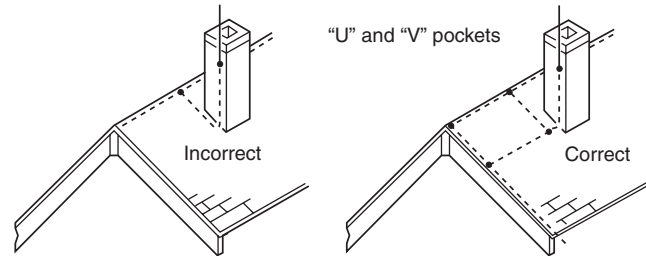
**4.9.3.3** Likewise, metal roofing or siding having a thickness of less than 4.8 mm ( $\frac{3}{16}$  in.) shall not be substituted for main conductors.

#### 4.9.4 “U” or “V” Pockets.

**4.9.4.1** Conductors shall maintain a horizontal or downward coursing free from “U” or “V” (down and up) pockets.

**4.9.4.2** Such pockets, often formed at low-positioned chimneys, dormers, or other projections on sloped roofs or at parapet walls, shall be provided with a down conductor from the base of the pocket to ground or to an adjacent downlead conductor, as shown in Figure 4.9.4.2.

**4.9.5 Conductor Bends.** No bend of a conductor shall form an included angle of less than 90 degrees, nor shall it have a radius of bend less than 203 mm (8 in.), as shown in Figure 4.9.5.



**FIGURE 4.9.4.2 Pockets.**

#### 4.9.6 Conductor Supports.

**4.9.6.1** Conductors shall be permitted to be coursed through air without support for a distance of 0.9 m (3 ft) or less.

**4.9.6.2** Conductors that must be coursed through air for distances longer than those of 4.9.6.1 shall be provided with a positive means of support that will prevent damage or displacement of the conductor.

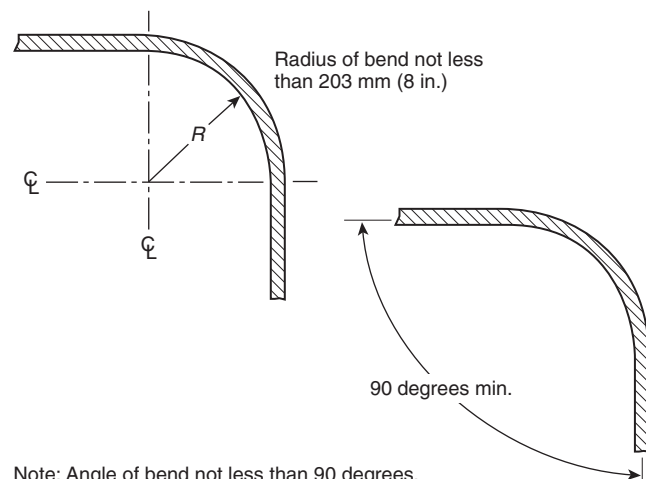
#### 4.9.7 Roof Conductors.

**4.9.7.1** Roof conductors shall be coursed along ridges of gable, gambrel, and hip roofs; around the perimeter of flat roofs; behind or on top of parapets; and across flat or gently sloping roof areas as required to interconnect all strike termination devices.

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

**4.9.8 Cross-Run Conductors.** Cross-run conductors (main conductors) shall be required to interconnect the strike termination devices on flat or gently sloping roofs that exceed 15 m (50 ft) in width.

**4.9.8.1** For example, roofs from 15 m to 30 m (50 ft to 100 ft) in width shall require one cross-run conductor, roofs 30 m to 46 m (100 ft to 150 ft) in width shall require two cross-run conductors, and so on.



Note: Angle of bend not less than 90 degrees.

**FIGURE 4.9.5 Conductor Bends.**