

Receiving Equipment and Amateur Transmitting Equipment

54-800 Lightning Arresters for Receiving Stations

- (1) A lightning arrester shall be provided for each lead-in conductor from an outdoor antenna to a receiving station except where such a lead-in conductor is protected by a continuous grounded metal shield between the antenna and the point of entrance to the building.
- (2) Lightning arresters for receiving stations shall be located outside the building or inside the building between the point of entrance of the lead-in and the radio set or transformer, and as near as practicable to the entrance of the conductors to the building.
- (3) Lightning arresters for receiving stations shall not be located near combustible material nor in a hazardous location.

54-802 Lightning Arresters for Transmitting Stations

Each conductor of a lead-in to a transmitting station from an outdoor antenna shall be provided with a lightning arrester or other suitable means that will drain static charges from the antenna system except:

- (a) Where protected by a continuous metal shield that is grounded; or
- (b) Where the antenna is grounded.

Grounding for Receiving Equipment and Amateur Transmitting Equipment

54-900 Material for Grounding Conductor

The grounding conductor shall be of copper, aluminum alloy, copper-clad steel, bronze, or other corrosion-resistant material unless otherwise specified.

54-902 Insulation of Grounding Conductor

The grounding conductor shall be permitted to be uninsulated.

54-904 Support for Grounding Conductor

The grounding conductor shall be securely fastened in place and may be directly attached to the supporting surface without the use of insulating supports.

54-906 Mechanical Protection of Grounding Conductor

The grounding conductor shall be protected where exposed to mechanical injury.

54-908 Grounding Conductor to Be Run in a Straight Line

The grounding conductor shall be run in as straight a line as is practicable from the lightning arresters or antenna mast, or both, to the grounding electrode.

54-910 Grounding Electrode

The grounding conductor shall be connected to a grounding electrode as specified in Section 10.

54-912 Grounding Conductors

The grounding conductor shall be permitted to be run either inside or outside the building.

54-914 Size of Protective Ground

The size of the protective grounding conductor for receiving and transmitting stations providing ground connection for mast and lightning arresters shall be in accordance with Section 10. #6 AWG

54-916 Common Ground

A single grounding conductor shall be permitted to be used for both protective and operating purposes, but must be installed so that disconnection of the operating ground will not affect the protective ground circuit.

54-922 Grounding of Antennas

Masts, metal support structures, and antenna frames for receiving stations shall be grounded in accordance with Section 10.

Transmitting Stations

54-1000 Enclosure of Transmitters

Transmitters shall be enclosed in a metal frame or grille, or thoroughly shielded or separated from the operating space by a barrier or other equivalent means.

54-1002 Grounding of Transmitters

All exposed metal parts of transmitters, including external metal handles and controls accessible to the operating personnel and accessories such as microphone stands, shall be grounded.

54-1004 Interlocks on Doors of Transmitters

All access doors of transmitters shall be provided with interlocks that will disconnect all voltages in excess of 250 V when any access door is opened.

54-1006 Amplifiers

Audio-amplifiers that are located outside the transmitter housing shall be suitably housed and shall be located so as to be readily accessible and adequately ventilated.

Grounding Electrodes

10-700 Grounding Electrodes

- (1) A grounding electrode shall be:
 - (a) A continuously conductive metal water piping system that is located underground at least 600 mm below finished grade and extends not less than 3 m beyond the extremities of the building served; or
 - (b) A metal water well casing that is not less than 75 mm in diameter and extends at least 15 m below the well head; or
 - (c) An artificial grounding electrode that complies with Rule 10-702.
- (2) Where more than one of the grounding means listed in this Rule exist at a building, they shall be bonded together with a conductor sized as for a grounding conductor required by Rule 10-812.
- (3) Notwithstanding Subrule (2), a No. 6 AWG copper conductor shall be permitted to be used to bond separate artificial grounding electrodes together.

10-702 Artificial Grounding Electrodes

- (1) An artificial grounding electrode shall consist of a concrete encased electrode, rod electrode, plate electrode, or other similar device.
- (2) A concrete encased electrode shall be encased within the bottom 50 mm of a concrete foundation footing, that extends at least 600 mm below finished grade and is in direct contact with the earth, and shall be:
 - (a) A bare copper conductor not less than 6 m in

length and of a size specified in Table 43; or

- (b) A metal plate that shall:
 - (i) Present not less than 0.4 m² of surface to the concrete encasing the plate; and
 - (ii) Be not less than 6 mm in thickness if of iron or steel; or 1.5 mm in thickness if of non-ferrous metal; and
 - (iii) Have a means of attachment for the system grounding conductor that shall be accessible after the concrete is poured.
- (3) ~~A rod electrode shall consist of not less than two~~ rods which shall:
 - (a) Be not less than 15.8 mm in diameter if of iron or steel, or ~~12.7 mm~~ in diameter if of non-ferrous metal or ferrous metal clad with a non-ferrous metal; and
 - (b) Be ~~not less than 3 m in length~~; and
 - (c) Have a clean metal surface which is not covered with paint, enamel, or other poor conducting material; and

- (d) Be ~~driven to a depth of no less than 3 m~~ regardless of the size or number used, except that:

- (i) Where rock bottom is encountered at a depth of 1.2 m or more, each rod shall be driven to rock bottom and the remainder buried at least 600 mm below finished grade level in a horizontal trench; or
- (ii) Where rock bottom is encountered at a depth of less than 1.2 m, each rod shall be buried at least 600 mm below finished grade level in a horizontal trench; and.

- (e) ~~Be spaced no less than 3 m apart.~~

- (4) A plate electrode shall:

- (a) Present not less than 0.2 m² of surface to exterior soil; and
- (b) Be not less than 6 mm thick if of iron or steel; or 1.5 mm thick if of non-ferrous metal; and
- (c) Be buried at least 600 mm below finished grade level.

- (5) Where a local condition such as rock or permafrost prevents compliance with the 600 mm burial depth, a lesser depth shall be permitted provided 450 mm granular material or 100 mm concrete is used to provide a cover that is acceptable.
- (6) Each artificial grounding electrode shall be separated at least 2 m from any other electrode including an electrode used for signal circuits, radio, lightning protection, or any other purpose.

10-706 Spacing or Bonding Electrical and Lightning Rod Systems (see Appendix G)

Where practicable, a clearance of at least 2 m shall be provided between lightning rod conductors and electrical conductors and equipment, but where this separation is not possible, the ground electrodes for the two systems shall be connected together, at or below ground level, with a copper conductor of a size not less than that of the grounding conductor for the electrical system and in no case shall the bonding conductor be smaller than No. 6 AWG copper.

A 10-710 Use of Lightning Rods (see Appendices B and G)

Lightning rod conductors and driven pipes, rods, or other electrodes, excluding buried metal water-piping systems, used for grounding lightning rods shall not be used for grounding wiring systems or other electrical equipment.

Table 43

(See Rule 10-702)

Minimum Conductor Size for Concrete Encased Electrodes

Ampacity of Largest Service Conductor or Equivalent for Multiple Conductors	Size of Bare Copper Conductor
Amperes	AWG
165 or less	4
166-200	3
201-260	2
261-355	0
356-475	00
Over 475	000

Lightning Arresters**10-1000 Lightning Arresters on Secondary Services — 750 V or Less**

- (1) Where a lightning arrester is installed on a secondary service, the connections to the service conductors and to the grounding conductor shall be as short as practicable.
- (2) The grounding conductor shall be permitted to be:
 - (a) The grounded service conductor; or
 - (b) The common grounding conductor; or
 - (c) The service equipment grounding conductor; or
 - (d) A separate grounding conductor.
- (3) The bonding or grounding conductor shall be of copper not smaller than No. 6 AWG.

10-1002 Installation Requirements and Guarding for Lightning Arrester Grounding Conductors

The grounding conductor for lightning arresters shall:

- (a) When enclosed in metal, be connected to the guard at both ends; and
- (b) Be installed and protected to meet the requirements of Rule 10-806.

10-806 Installation of System Grounding Conductors

- (1) The grounding conductor for a system shall be without joint or splice throughout its length, except in the case of busbars, thermit welded joints, compression connectors applied with a compression tool compatible with the particular connector, or, where it is necessary to control the effects of stray earth current, devices specifically approved for connection in series with the grounding conductor.
- (2) A No. 6 AWG or larger copper grounding conductor which is free from exposure to mechanical injury shall be permitted to be run along the surface of the building construction without metal covering or protection, if it is rigidly stapled to the construction; otherwise, it shall be in conduit, electrical metallic tubing, or cable armour.
- (3) A No. 8 AWG or smaller grounding conductor shall be in conduit, electrical metallic tubing, or cable armour.
- (4) Metal enclosures for grounding conductors shall be continuous from the point of attachment to cabinets or equipment to the grounding electrode and shall be securely fastened to the ground clamp or fitting.
- (5) Where a grounding conductor is run in the same raceway with other conductors of the system to which it is connected, it shall be insulated, except that where the length of the raceway does not exceed 15 m between pull points and does not contain more than the equivalent of 2 quarter bends between pull points, an uninsulated grounding conductor shall be permitted to be used.
- (6) Notwithstanding the requirements of Subrule (2), a grounding conductor No. 6 AWG or larger shall be permitted to be embedded in concrete provided that the points of emergence are so located or guarded as not to constitute exposure to mechanical injury.

The service mains (utility entrance) ground is the "single point ground system" for your home's wiring. Phone and cable service must also ground at this same entry point. A radio facility/station has special low impedance ground requirements that home wiring does not. The station, if not located at the AC service entry, must have immediately adjacent to it's equipment center, it's own single point ground system. Lightning arrestors installed at the station must be on this ground panel. All station equipment must use low impedance conductors to individually bond to this station single point ground. This is one place you should use at least 3" wide copper strap! Discard all forms of "braided" cable. Braid is something a girl does to her hair. It is not a good RF ground and it's a terrible conductor for lightning energy.

You may call this a bulkhead, master ground bus, ground window, etc., but it will be the single point at which all bonding in the station connects. And it must be as close to the station equipment as possible! Then, some part of the station grounding system must bond to the home's utility service entrance ground. That is a critical bond, and it is challenging when the station single point ground is a long distance from the service-entry.

Unfortunately, recall that you cannot maintain low impedance by a long run of wire no matter how heavy the wire is. If your station equipment is more than a few feet from the service mains ground rod, the voltage-differences along the bonding conductor will be significant to the massive energy of lightning. This is minimized by choosing the largest surface-area conductor you can get, and installing intermediate ground rods along the path to the utility service entrance ground. The better the bonding, the stronger the ground system gets. This is rephrased below, because it is so often ignored, to the destruction of equipment:

In house-wiring, the typical #12 or #14 ground wire at AC outlets all go to the service panel (where they also bond to the neutral bus), and then to the service entry single point ground rod. Fine for equipment safety, but *totally unacceptable for lightning protection*. That permits a massive electrical potential between any part of your house wiring and the potential at the service-mains ground rod. Why? Because your house wiring was never designed to handle lightning energy! But, because your house wiring comes into your station equipment, it is therefore *critical* that we bond the station single point ground system directly to the utility entrance ground! It's a code requirement (when the station ground is separate from the utilities entrance), and yet so often overlooked by amateurs who learn the hard way about Ground Potential Rise GPR damage.

When it's a long distance from the station ground to the service entrance ground, maintaining low impedance along the whole distance is impossible. But you can make a much lower impedance path than your house wiring provides, and that is vital. I used frequent references to earth-ground along the path (lots of ground rods). This prevents violent current equalization from a direct lightning strike (or high EMI and transients from a nearby strike) and the effects of cumulative impedance along the bonding path. It also gives that long path very high current handling ability, and that's good, because the voltage differences caused by lightning will be large. Bonding to the service-entrance ground is vital to controlling Ground Potential Rise (GPR) from damaging equipment.

GPR occurs when a direct or nearby strike raises and saturates the ground potential so highly that current tries to flow up into your station ground and out through utility wires and/or coax feedlines to anywhere that the ground potential is lower. Fast-acting low impedance grounding helps, but current will *not* choose your house wiring in a GPR situation if you obey the bonding rules with a direct, high-current capable bonding path to the utility mains ground rod. You will have safely provided a much lower impedance path than the telephone, cable and AC wiring can offer. Failure to shield-ground coax at the main station ground rod closest to the station SPGS can encourage the coax to feed GPR backwards through the arrestors to some distant point of the ground system of lower potential.

The goal is to make the entire ground system feel the same (equipotential) to lightning energy. Heavy gage (#2 or #4) solid copper wire and heavy gage wide copper strapping (6") and many ground rods are the tools for the job. This keeps the *designed ground paths* of such low potential and high current-carrying capacity, that once on board it, lightning will make no diversions on it's way to harmless dissipation into the earth. That's it. There is no more we can do than to make it easy for lightning to go away once it happens.