110.14 Electrical Connections.

Because of different characteristics of dissimilar metals, devices such as pressure terminal or pressure splicing connectors and soldering lugs shall be identified for the material of the conductor and shall be properly installed and used. Conductors of dissimilar metals shall not be intermixed in a terminal or splicing connector where physical contact occurs between dissimilar conductors (such as copper and aluminum, copper and copper-clad aluminum, or aluminum and copper-clad aluminum), unless the device is identified for the purpose and conditions of use. Materials such as solder, fluxes, inhibitors, and compounds, where employed, shall be suitable for the use and shall be of a type that will not adversely affect the conductors, installation, or equipment.

(A) Terminals. Connection of conductors to terminal parts shall ensure a thoroughly good connection without damaging the conductors and shall be made by means of pressure connectors (including set-screw type), solder lugs, or splices to flexible leads. Connection by means of wire-binding screws or studs and nuts that have upturned lugs or the equivalent shall be permitted for 10 AWG or smaller conductors.

Terminals for more than one conductor and terminals used to connect aluminum shall be so identified.

(B) Splices. Conductors shall be spliced or joined with splicing devices identified for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices shall first be spliced or joined so as to be mechanically and electrically secure without solder and then be soldered. All splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors or with an insulating device identified for the purpose.

Wire connectors or splicing means installed on conductors for direct burial shall be listed for such use.

Field observations and trade magazine articles indicate that electrical connection failures have been determined to be the cause of many equipment burnouts and fires. Many of these failures are attributable to improper terminations, poor workmanship, the differing characteristics of dissimilar metals, and improper binding screws or splicing devices.

UL’s requirements for listing solid aluminum conductors in 12 AWG and 10 AWG and for listing snap switches and receptacles for use on 15- and 20-ampere branch circuits incorporate stringent tests that take into account the factors listed in the preceding paragraph. For further information regarding receptacles and switches using CO/ALR-rated terminals, refer to 404.14(C) and 406.2(C).

Screwless pressure terminal connectors of the conductor push-in type are for use only with solid copper and copper-clad aluminum conductors.
Instructions that describe proper installation techniques and emphasize the need to follow those techniques and practice good workmanship are required to be included with each coil of 12 AWG and 10 AWG insulated aluminum wire or cable. See also the commentary on tightening torque that follows 110.14, FPN.

New product and material designs that provide increased levels of safety of aluminum wire terminations have been developed by the electrical industry. To assist all concerned parties in the proper and safe use of solid aluminum wire in making connections to wiring devices used on 15- and 20-ampere branch circuits, the following information is presented. Understanding and using this information is essential for proper application of materials and devices now available.

FOR NEW INSTALLATIONS

The following commentary is based on a report prepared by the Ad Hoc Committee on Aluminum Terminations prior to publication of the 1975 Code. This information is still pertinent today and is necessary for compliance with 110.14(A) when aluminum wire is used in new installations.

New Materials and Devices

For direct connection, only 15- and 20-ampere receptacles and switches marked “CO/ALR” and connected as follows under Installation Method should be used. The “CO/ALR” marking is on the device mounting yoke or strap. The “CO/ALR” marking means the devices have been tested to stringent heat-cycling requirements to determine their suitability for use with UL-labeled aluminum, copper, or copper-clad aluminum wire.

Listed solid aluminum wire, 12 AWG or 10 AWG, marked with the aluminum insulated wire label should be used. The installation instructions that are packaged with the wire should be used.

Installation Method

Exhibit 110.3 illustrates the following correct method of connection:

1. The freshly stripped end of the wire is wrapped two-thirds to three-quarters of the distance around the wire-binding screw post, as shown in Step A of Exhibit 110.3. The loop is made so that rotation of the screw during tightening will tend to wrap the wire around the post rather than unwrap it.

2. The screw is tightened until the wire is snugly in contact with the underside of the screw head and with the contact plate on the wiring device, as shown in Step B of Exhibit 110.3.
3. The screw is tightened an additional half-turn, thereby providing a firm connection, as shown in Step C of Exhibit 110.3. If a torque screwdriver is used, the screw is tightened to 12 lb-in.

4. The wires should be positioned behind the wiring device to decrease the likelihood of the terminal screws loosening when the device is positioned into the outlet box.

**Exhibit 110.3** Correct method of terminating aluminum wire at wire-binding screw terminals of receptacles and snap switches. (Redrawn courtesy of Underwriters Laboratories Inc.)

**Exhibit 110.4** illustrates incorrect methods of connection. These methods should not be used.

**Existing Inventory**

Labeled 12 AWG or 10 AWG solid aluminum wire that does not bear the new aluminum wire label should be used with wiring devices marked “CO/ALR” and connected as described under Installation Method. This is the preferred and recommended method for using such wire.

For the following types of devices, the terminals should not be directly connected to aluminum conductors but may be used with labeled copper or copper-clad conductors:

1. Receptacles and snap switches marked “AL-CU”

2. Receptacles and snap switches having no conductor marking
3. Receptacles and snap switches that have back-wired terminals or screwless terminals of the push-in type

Exhibit 110.4 Incorrect methods of terminating aluminum wire at wire-binding screw terminals of receptacles and snap switches. (Redrawn courtesy of Underwriters Laboratories Inc.)