

# Inspecting Aluminum Wiring

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Between approximately 1965 and 1973, single-strand aluminum wiring was sometimes substituted for copper branch-circuit wiring in residential electrical systems due to the sudden escalating price of copper. After a decade of use by homeowners and electricians, inherent weaknesses were discovered in the metal that lead to its disuse as a branch wiring material. Although properly maintained aluminum wiring is acceptable, aluminum will generally become defective faster than copper due to certain qualities inherent in the metal. Neglected connections in outlets, switches and light fixtures containing aluminum wiring become increasingly dangerous over time. Poor connections cause wiring to overheat, creating a potential fire hazard. In addition, the presence of single-strand aluminum wiring may void a home's insurance policies. Inspectors may instruct their clients to talk with their insurance agents about whether the presence of aluminum wiring in their home is a problem that requires changes to their policy language.



## Facts and Figures

- On April, 28, 1974, two people were killed in a house fire in Hampton Bays, New York. Fire officials determined that the fire was caused by a faulty aluminum wire connection at an outlet.
- According to the Consumer Product Safety Commission (CPSC), "Homes wired with aluminum wire manufactured before 1972 ['old technology' aluminum wire] are 55 times more likely to have one or more connections reach "Fire Hazard Conditions" than is a home wired with copper."

## Aluminum as a Metal

Aluminum possesses certain qualities that, compared with copper, make it an undesirable material as an electrical conductor. These qualities all lead to loose connections, where fire hazards become likely. These qualities are as follows:

- higher electrical resistance. Aluminum has a high resistance to electrical current flow, which means that, given the same amperage, aluminum conductors must be of a larger diameter than would be required by copper conductors.
- less ductile. Aluminum will fatigue and break down more readily when subjected to bending and other forms of abuse than copper, which is more ductile. Fatigue will cause the wire to break down internally and will increasingly resist electrical current, leading to a buildup of excessive heat.

- galvanic corrosion. In the presence of moisture, aluminum will undergo galvanic corrosion when it comes into contact with certain dissimilar metals.
- oxidation. Exposure to oxygen in the air causes deterioration to the outer surface of the wire. This process is called oxidation. Aluminum wire is more easily oxidized than copper wire, and the compound formed by this process – aluminum oxide – is less conductive than copper oxide. As time passes, oxidation can deteriorate connections and present a fire hazard.
- greater malleability. Aluminum is soft and malleable, meaning it is highly sensitive to compression. After a screw has been over-tightened on aluminum wiring, for instance, the wire will continue to deform or “flow” even after the tightening has ceased. This deformation will create a loose connection and increase electrical resistance in that location.
- greater thermal expansion and contraction. Even more than copper, aluminum expands and contracts with changes in temperature. Over time, this process will cause connections between the wire and the device to degrade. For this reason, aluminum wires should never be inserted into the “stab,” “bayonet” or “push-in” type terminations found on the back of many light switches and outlets.
- excessive vibration. Electrical current vibrates as it passes through wiring. This vibration is more extreme in aluminum than it is in copper, and, as time passes, it can cause connections to loosen.

### **Identifying Aluminum Wiring**

- Aluminum wires are the color of aluminum and are easily discernible from copper and other metals.
- Since the early 1970s, wiring-device binding terminals for use with aluminum wire have been marked CO/ALR, which stands for “copper/aluminum revised.”
- Look for the word “aluminum” or the initials “AL” on the plastic wire jacket. Where wiring is visible, such as in the attic or electrical panel, inspectors can look for printed or embossed letters on the plastic wire jacket. Aluminum wire may have the word “aluminum,” or a specific brand name, such as “Kaiser Aluminum,” marked on the wire jacket. Where labels are hard to read, a light can be shined along the length of the wire.
- When was the house built? Homes built or expanded between 1965 and 1973 are more likely to have aluminum wiring than houses built before or after those years.

### **Options for Correction**

Aluminum wiring should be evaluated by a qualified electrician who is experienced in evaluating and correcting aluminum wiring problems. Not all licensed electricians are properly trained to deal with defective aluminum wiring. The CPSC recommends the following two methods for correction for aluminum wiring:

- Rewire the home with copper wire. While this is the most effective method, rewiring is expensive and impractical, in most cases.
- Use copalum crimps. The crimp connector repair consists of attaching a piece of copper wire to the existing aluminum wire branch circuit with a specially designed metal sleeve and powered crimping tool. This special connector can be properly installed only with the matching AMP tool. An insulating sleeve is placed around the crimp connector to complete the repair. Although effective, they are expensive (typically around \$50 per outlet, switch or light fixture).

Although not recommended by the CPSC as methods of permanent repair for defective aluminum wiring, the following methods may be considered:

- application of anti-oxidant paste. This method can be used for wires that are multi-stranded or wires that are too large to be effectively crimped.
- pigtailling. This method involves attaching a short piece of copper wire to the aluminum wire with a twist-on connector. the copper wire is connected to the switch, wall outlet or other termination device. This method is only effective if the connections between the aluminum wires and the copper pigtails are extremely reliable. Pigtailling with some types of connectors, even though Underwriters Laboratories might presently list them for the application, can lead to increasing the hazard. Also, beware that pigtailling will increase the number of connections, all of which must be maintained. Aluminum Wiring Repair (AWR), Inc., of Aurora, Colorado, advises that pigtailling can be useful as a temporary repair or in isolated applications, such as the installation of a ceiling fan.
- CO/ALR connections. According to the CPSC, these devices cannot be used for all parts of the wiring system, such as ceiling-mounted light fixtures or permanently wired appliances and, as such, CO/ALR connections cannot constitute a complete repair. Also, according to AWR, these connections often loosen over time.
- alumiconn. Although AWR believes this method may be an effective temporary fix, they are wary that it has little history, and that they are larger than copper crimps and are often incorrectly applied.
- Replace certain failure-prone types of devices and connections with others that are more compatible with aluminum wire.
- Remove the ignitable materials from the vicinity of the connections.

In summary, aluminum wiring can be a fire hazard due to inherent qualities of the metal. Inspectors should be capable of identifying this type of wiring.