R3e™
EDITION 12
VOLUME 1

10 THINGS YOU SHOULD KNOW ABOUT COPPER GROUNDING CORROSION

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QUALITY COPPER

Southwire Continuous Rod (SCR®) Systems deliver over 50% of the global copper continuous-casting capacity. Copper rods, designated Electrolytic Tough Pitch (ETP), are transformed into fully-annealed copper commonly used for grounding. The Unified Numbering System (UNS) for ETP Copper is C11000, which applies to all copper products regardless of temper or stranding classifications. Southwire's pure copper conductors have been specified in North America for critical grounding protection of raceways and equipment in the past decades to reinforce the electrical grid and to safeguard power systems.

ELECTRICAL CONDUCTIVITY

Southwire sources a premium grade of copper cathode for casting, which yields the highest conductivity or the lowest resistance. Upon thermal annealing, soft-drawn copper exhibits an electrical conductivity of 100% at 20°C per International Annealed Copper Standard (IACS). The minimum copper percentage, or purity, is 99.9% and the maximum impurity, or oxygen or trace element content is, 0.1%. Copper is selected for grounding instead of aluminum or other alloys because of its superior electrical, thermomechanical, physical, and chemical properties.

ENVIRONMENTAL ELEMENTS

Rain and ground water are excellent electrolytes because they contain a variety of organic chemicals and minerals, which can initiate copper corrosion reactions. Combining the quality of local air with varying degrees of carbon dioxide, salt, ozone, sulfur, and other pollutants such as fertilizers or deicing agents can accelerate the rate and the extent of corrosion. Corroded copper can be found in both below-grade or above-ground installations.

EXTREME EXPOSURES

If the electrochemical reaction continues over time, it is possible for one or many copper wire strands to break due to the loss of tensile properties. Broken copper wires result in the reduction of the total copper circular mil area, or cross section, and disrupts the current path. Most grounding systems are designed per NFPA 70® National Electrical Code® (NEC) Article 250 entitled Grounding and Bonding. NEC Table 250.122 lists the minimum size required for an Equipment Grounding Conductor (EGC) to deliver recommended protection.

GALVANIC REACTION

Galvanic corrosion is an electrochemical reaction between two dissimilar metals in the presence of an electrolyte such as saltwater or floodwater under an electrically-conductive path. When two different metals are coupled together in air or the ground, one metal forms a cathode (positive) and the other becomes an anode (negative). Corrosion will take place at the negative, or reducing, anode. Connecting copper to a different metal material such as carbon steel or cast iron might trigger a galvanic sequence making copper the sacrificial site.

UNDERGROUND CONSIDERATIONS

There are many methods that can be deployed to mitigate underground copper corrosion. Replacement of acidic native soil with a non-corrosive engineered backfill is a great option. Also, improvement of drainage in the area is an excellent approach as it diverts storm water around the bare copper ground wires and minimizes concentration of the corrosive water.

Southwire®

For more information, please contact cabletechsupport@southwire.com or visit **southwire.com**.

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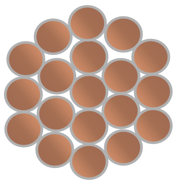
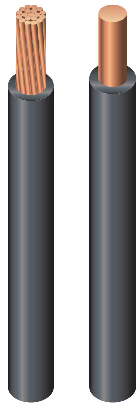


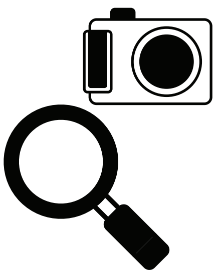
TINNED DESIGNS

Applying a thin layer of tin coating to the individual copper wire strands shields the bare copper from environmental conditions. Tinned copper designs are governed by ASTM B33 and are an acceptable alternative conductor option for many insulated cable products certified by UL & CSA. Tinning that is used for utility applications is governed by the National Electrical Safety Code® (NESC®). In fact, tinning of copper facilitates soldering and enhances its corrosion resistance significantly.



PROTECTED GROUNDS

Protected Ground Wires (PGW) are frequently installed for above ground applications due to the long-term exposures to harsh weather conditions such as saltwater or poor air quality. Bare copper grounding conductors are extruded with either a polyethylene (PE) or a crosslinked polyethylene (XLPE) layer. Since the metallic appearance of the bare copper is concealed by a black covering, it is less prone to vandalism and ultimately prevents copper theft which often occurs in above-grade applications.



VISUAL INSPECTIONS

Southwire's CableTechSupport™ Services team receives more than 1,000 requests yearly from engineers, contractors, supervisors, and maintenance crews to mitigate unforeseen damage to wire & cable due to environmental exposure. Copper corrosion is one of the most frequently asked questions. It is challenging to make an accurate GO vs. NO-GO decision based solely on photos taken in the field because the local climate, the system design, the age of the conductor, and many critical environmental variables will ultimately determine how fast the copper will oxidize and corrode.

FIELD TESTING

Southwire recommends performing an ohmic resistance check between the copper conductor and a ground plane in the field. If the measured resistance is less than 10 ohms, then replacement is not required. However, if the resistance is greater than 10 ohms, further investigation is needed. Periodic maintenance via visual inspections and ohmic checks on the exposed conductor to monitor the degree of corrosion are considered best practices. The frequency of operational maintenance should be adjusted accordingly based on the age of the grounding system and the ohmic resistance data.

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