REDUCING COPPER THEFT IN THE UTILITY INDUSTRY

Alternatives to Copper

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Introduction

With the increase in copper prices, copper theft, which was once a nuisance factor, has now become a major problem for the utility industry. Copper theft in the US alone has a cost impact in excess of US1 billion dollars per annum. Copper theft in the utility sector includes the theft of earth bars, cables and earthing conductors.

The Problem

The copper theft happens either during construction stages or later on when the sites are operational. If the theft occurs during construction then there is economic loss and an annoyance. However theft of copper in operational facilities is a larger concern because it brings about a serious safety problem not only for the copper thieves but the general public. There is serious impact on the safty level at a utility site when the earth grid is removed and this has safety, operational and litigation ramifications.

Copper is used in grounding applications widely in bare and insulated forms. Conductors used in this application are often perceived to be “not live” and are a prime target for copper thieves.

The frequency of the copper thefts seems to follow the price of copper in the scrap metal trade, which naturally follows the market price of copper. The current economic cycle is again seeing a rise in the market pricing of copper after the low pricing during the Global Financial Crisis. Hence it is envisaged that this problem will be on the rise in months and years to come, if this trend continues.

ERICO’s Solutions to Reduce Copper Theft

ERICO offers three types of solutions aimed at minimizing or eliminating theft of copper from earthing systems in utility.

1) Alternative Conductors to Copper
2) Alternative Earth Bars to Copper
3) Electronic Cable Theft Sensor System

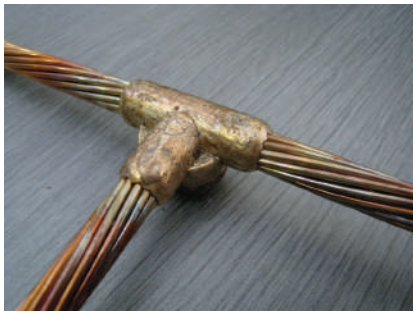
All of the solutions should be complimented with clear signage at the site stating that the conductors are not copper or in the case of theft sensing signage to state that copper theft is being monitored.

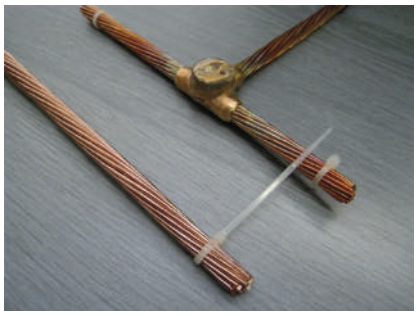
Alternative Conductors to Copper

Copper is not substituted easily with other materials because of its unique properties in terms of its conductivity and corrosion. However there are a number of conductor solutions available that can retain the use of the copper properties but yet change the composition so that it is of little or no scrap value. The conductors discussed here are well suitable for earthing applications. These newer conductors are also suited for other non-earthing applications.

Copper Coated Steel Cable.

This is a stranded cable that offers the same corrosion resistance as copper. The high heat cladding process prevents flaking or peel off at installation and after wire is installed. With much greater fatigue resistance than copper, the ERITECH CCSC gives greater reliability in almost any application.





Copperbonded steel conductor at 30% conductivity
Suggested Connection methodology: Exothermic- CADWELD

Theft Deterrent Composite Cable.

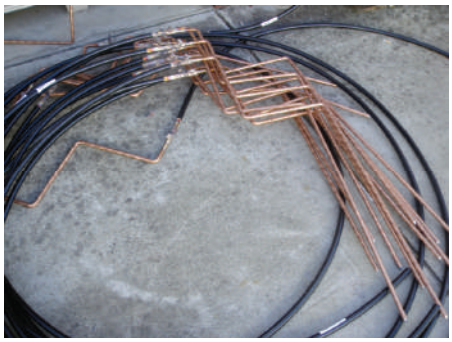
This is a bare concentric stranded conductor that consists of peripheral galvanized magnetic steel stranding , which protects and conceals the internal tinned copper stands. This conductor is ideal for exposed locations where copper theft may occur. The conductor is difficult to cut with hand tools, and the outer steel stranding is ferrous, which further deters thieves looking for copper. Copper stranding inside of conductor increases conductivity and conductor flexibility. Copper stranding is tinned for superior corrosion protection

Copper Bonded Steel Conductor- Substation bonding tails

This is solid high carbon steel (1018 grade) core and molecularly bonded with a minimum of 250µm copper. These conductors cannot be removed from the earthing system using normal copper cutting hand tools and has a significantly lower scrap value than the equivalent solid copper conductor. This type of cable is usually a fraction of the cost of copper cables.
It performs exceptionally well in terms of corrosion, both above and below ground levels.

Traditional connection methods like CADWELD are ideal for this conductor. It looks like copper from the outside and may still be prone to theft is some applications. However, they are difficult to cut and remove.

Pole down earth copper alternative



Substation Earthing tails –Theft deterrent

Unsuccessful attempt to steal copper within a substation

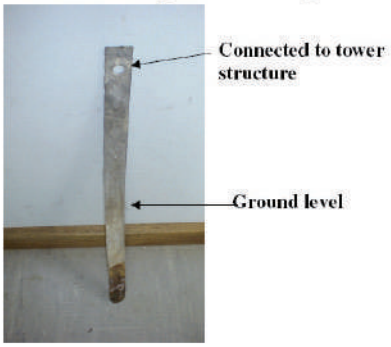
Galvanised Steel Strap Conductors

The historical reason that galvanised steel has been used, is that buried earths close to telephone exchanges may come into contact with lead sheathed cables. Lead and copper buried together was perceived as a corrosion risk.
One of the characteristics of galvanised steel is its rapid corrosion in comparison with copper. Traditionally utility carriers had procedures for annual earth resistance testing which would identify extensive corrosion.

Experience from site examinations and long-term studies have demonstrated that the rapid corrosion of galvanised steel is almost always a problem. The expected life of Galvanised Steel would be 10-15 years in comparison with 25-30 years for copper coated steel systems in the similar soil conditions.

The issue of copper theft is a worldwide problem and not many utilities have opted for galvanised steel but rather looked at more modern solutions. The image below shows the corrosion on galvanised steel strap which was in the ground for 12 years. For further reading on corrosion on copper bonded vs galvanised steel earthing systems please refer to technical paper *"A Technical Report on The Service Life of Ground Rod Electrodes"* Chris Rempe ERICO 2004 and *"Experimental Evaluation of the Corrosion Performance of Copper-Bonded and Galvanized Grounding Electrodes"* by Dr F. D'Alessandro (B.App.Sc., B.Ed. PhD, SMIEEE) and Dr. B. Baumgartner

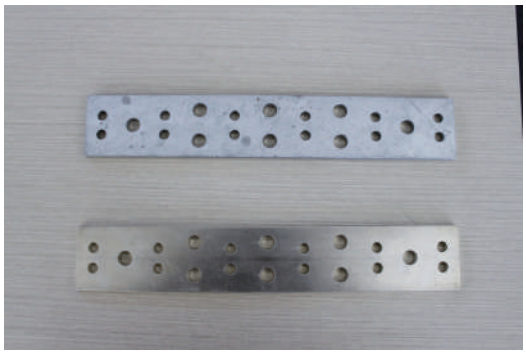
Galvanised 50 x 3mm steel tape after 12 years



Alternative Earth Bars

ERICO undertook the study of the following alternative materials available for use as ground bars.
The investigation included corrosion resistance, electrical performance and costs for the alternate materials for telecom earth bars.

Materials
C11000 Copper
Copper Plated Steel (0.2 mil)
Copper Plated Steel (0.5 mil)
Galvanized Steel (3.9 mil)
Zinc-Nickel Alloy Plated Steel
Copper-clad Aluminum
Tin-Plated Aluminum (0.02 mil)
Stainless Steel, Type 304
Aluminum



Galvanised Steel and Tinned Aluminium Earth Bars

The change of impedance and visual inspection was carried out after subjecting the earth bars to alkaline and acidic conditions to simulate long-term corrosion in soil. The simulation included salt mist treatment to Standard IEC 60068-2-52 and humid sulfurous atmosphere treatment to standard ISO 6988:1985.

- This investigation demonstrated that the earth bars that showed closest performance to solid copper earth bar are copper clad aluminum and tin plated aluminum. ***Tin Plated Aluminum is considered the best alternative to copper earth bars***. In addition to the outcomes of the test it is known from the galvanic potentials table that tin permits compatibility with the various lugs and connectors including copper.

- Copper plated steel and galvanized steel showed similar characteristic to each other but had higher DC and AC resistance than copper and tin-plated aluminum even before the corrosion tests. ***Some of these bars can be considered as alternatives to copper earth bar under certain conditions.***

- Zinc-Nickel Alloy Plated Steel and Stainless Steel either showed high DC or AC resistance or high corrosion and were deemed not suitable for use as earth bars. ***These are not good materials to use as alternative to copper earth bars.***

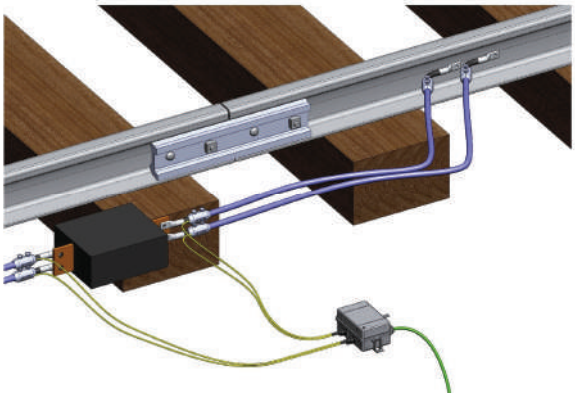
- The aluminum bar under investigation showed that its DC and AC resistance is higher than tinned and it showed a higher inclination to corrode than tinned aluminum and tinned copper. Aluminum oxides naturally in air and maintains a hard coating of aluminum oxide through its life. This is not be a big issue if the lugs are terminated to plain aluminium, but the oxides would have to be removed prior to any additional terminations made at a later date. Bare Aluminum is not compatible with copper. It cannot be used for any underground earthing. In the case of Tinned Aluminum, its surface is cleaned before the tinning process. ***In general bare aluminum not deemed an alternative to copper earth bars but can be used if precautions are taken about cleaning prior to future connections and it is not in direct contact with copper.***

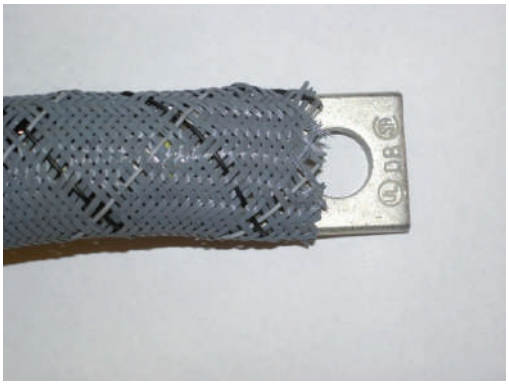
Electronic Cable Theft Sensor Systems

ERICO has developed an electronic cable theft sensor system for critical railway, utility or utility sites.

The system:

- Can sense loss of cable
- Triggers an alarm if theft occurs
- Can be used with existing installations. Uses sleeves with sensors embedded within
- It does not alter existing cables
- Detects if sensor conductors in sleeve have been altered or cut
- Continuously monitors at a high sample rate for fast alarm
- Monitors 12-16 Cables
- Operates off 8, 24, or 48 DC volts
- NO/NC Alarm outputs, 240 Volts, 0.1A rating





Conclusion

ERICO has been involved in the earthing business for more than 100 years and has produced innovative solutions to meet the changing needs of the market. Many of these changes have been due to improvement in technology. Its theft deterrent solutions have been developed in response to the general increase in copper thefts in last few years, which is a worldwide problem. ERICO work with utilities throughout the world jointly developing innovative earthing solutions including theft deterrent.

BIBLIOGRAPHY

1. *A Technical Report on The Service Life of Ground Rod Electrodes by* Chris Rempe ERICO 2004

2. *Experimental Evaluation of the Corrosion Performance of Copper-Bonded and Galvanized Grounding Electrodes* by Dr F. D'Alessandro (B.App.Sc., B.Ed. PhD, SMIEEE) and Dr. B. Baumgartner

3. *NEW APPROACHES TO REDUCING COPPER THEFT IN THE UTILITY INDUSTRY* by Brenton Williams Presented at E21C Utility Conference, 2009

4. *Theft Deterrent Composite Cable* - Product brochure ERICO