ArresterWorks

Arrester Ground Lead Material
Can Steel Be Used?

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Jonathan Woodworth

Arrester Ground Lead Material – Can Steel Be Used

Introduction

As the industry continues to optimize the cost of arresters and their mounting arrangements, the question of steel conductors arises. In particular, can steel plate be part of the ground path of an arrester at the pole top transformer and/or can steel (or SS) be used for the pole down ground. The obvious advantage of this conductor material is cost. However a more subtle advantage and perhaps even more important benefit is that with such low resale value steel or SS is less likely to be a theft issue for utilities.

Definitions

Ground Lead of an Arrester: Any conductor going from the arrester to ground that is in parallel with the insulation it is protecting, and in the surge current path.

See: ArresterFacts 001 Arrester Lead Length

Margin of Protection: A measure of the surge protection safety margin. It is the difference in the clamping voltage of the arrester and the withstand voltage of the insulation being protected.

See: ArresterFacts 013 Arrester Discharge Voltage

Rationale

The electrical characteristic of a ground lead that is important for surge protection and margin of protection is inductance. The resistance of a ground lead is not even considered in the calculations of margin of protection or inductance. The inductance of a lead is a function of its length and marginally a function of its diameter. The inductance of a steel plate or steel conductor is very similar to copper of the same length. The inductance of a conductor is calculated per Figure 1

$$Inductance = .002L\left(\ln\left(\frac{2L}{r}\right) - .75\right)$$

Where:

L = length in cm and r = radius in cm

Figure 1: Equation for inductance based on IEEE Standard 518-1982. Note material is not a factor in this formula.

Note: Inductance Calculator: An inductance calculator in excel format can be downloaded from Arresterworks.com as part of the ArresterWorks Lead Length Calculator.

Basic Question

Can steel be used as part of the ground conductor path of an arrester?

Answer

For arrester ground leads, almost any conductive material including steel, stainless steel, cast iron, cast steel, cast aluminum, steel cable, etc, can be used. In addition, the diameter or width is of minor consequence, only length is important in protection considerations.

Past Experience

Steel conductor in the ground lead of an arrester has been in use for many decades. As you can see in Figure 2, the steel plate of a standard distribution transformer is very often used as part of the ground path. It is directly in the path of the surge current on the ground side of the arrester and should be counted in the margin of protection lead length.

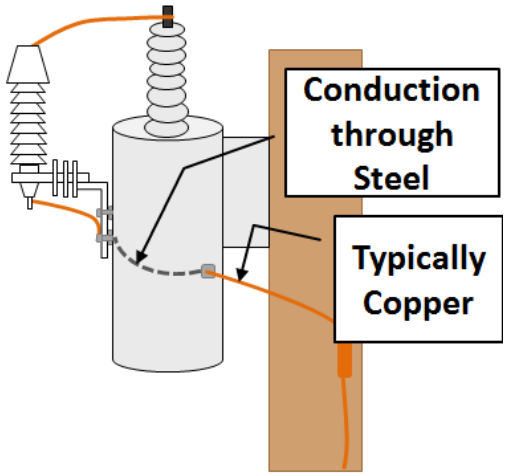

Figure 2: Steel plate in the ground path of surge

In Figure 3, the ground path is directed through a steel ground strap, to the steel tank. This was a typical installation in the 1970s.

In Figure 4, the current path is through a copper strap, steel bracket, steel tank and an aluminum bracket to the pole ground.

Arrester Design and Manufacturing

It has also been a practice in arrester design and fabrication to use steel components in the conduction path, with no effect on performance. It is safe to say that every porcelain station class arrester has stainless steel or plain steel somewhere inside that is part of the conduction path.

Figure 3: Surge current path through steel ground strap and steel tank

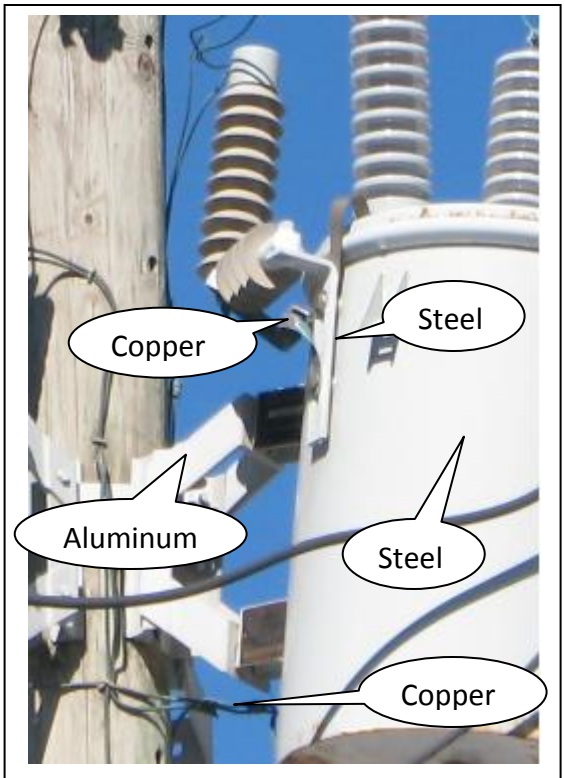

Figure 4: Conduction through Copper, Steel and Aluminum

Potential Material and Cost Savings for Arrester Ground Leads

In substations, often times large copper conductors are used to run the ground up to the base of an arrester mounted on a pedestal or on a transformer. This use of copper is unnecessary if the pedestal is construction steel. The inductance of the lattice structure is generally as good as or better than a conductor. The conductivity of the structure is not important. If an arrester is mounted on a steel arm that projects out from the transformer, a copper conductor in parallel with the arm is also not necessary because it does not affect the lead length effect.

If a tower is shielded or has line arresters installed on it anywhere, a down conductor is used to insure that the tower is not damaged as it conducts a lightning stoke down the tower. If there is no transformer or other equipment that requires a ground conductor, the conductor for the arrester or shield can be steel and only need be as large as what is conveniently handled.

Steel as a down ground for Overhead Ground Wires of Transmission Lines

Taking the above argument one step further to the down ground found on shielded transmission lines, it can also be concluded that the use of steel or stainless steel in these cases is also not an issue. In fact the material of overhead ground wires is often steel and not copper so if it is adequate for the shield wire; why not use steel or stainless steel for the down ground also.

Summary

Due to the rising cost of copper, theft is a growing concern for power companies. For this reason the use of galvanized steel or stainless steel ground conductors should be seriously considered. Since there is no technical reason not to use steel or stainless steel for this application it only makes sense to do so.

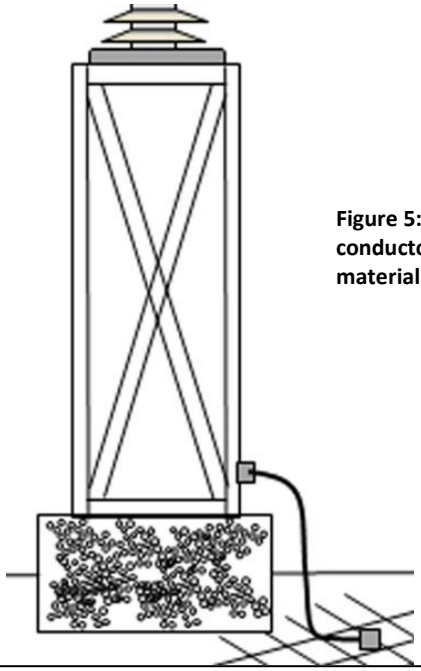

Figure 5: Using the Pedestal as a conductor for the arrester would save on material

ArresterFacts are a compilation of facts about arresters to assist all stakeholders in the application and understanding of arresters. All ArresterFacts assume a base knowledge of surge protection of power systems; however, we always welcome the opportunity to assist a student in obtaining their goal, so please call if you have any questions. Visit our library of ArresterFacts for more reading on topics of interest to those involved in the protection of power system at: http://www.arresterworks.com/arresterfacts/arresterfacts.php

About the author:

Jonathan started his career after receiving his Bachelor's degree in Electronic Engineering from The Ohio Institute of Technology, at Fermi National Accelerator Laboratory in Batavia, IL. As an Engineering Physicist at Fermi Lab, he was an integral member of the high energy particle physics team in search of the elusive quark. Wishing to return to his home state, he joined the design engineering team at McGraw Edison (later Cooper Power Systems) in Olean, New York. During his tenure at Cooper, he was involved in the design, development, and manufacturing of arresters. He served as Engineering Manager as well as Arrester Marketing Manager during that time. Jonathan has been active for the last 30 years in the IEEE and IEC standard associations. Jonathan is inventor/co-inventor on five US patents. Jonathan received his MBA from St. Bonaventure University.

Jonathan Woodworth
ArresterWorks'
Principle Engineer

www.arresterworks.com
jonathan.woodworth@arresterworks.com
+1.716.307.2431