History of Personal Protective Grounding

Section 1

CHANCE®

www.hubbellpowersystems.com
E-mail: hpsliterature@hps.hubbell.com

HUBBELL®

Phone: 573-682-5521 Fax: 573-682-8714 210 North Allen Centralia, MO 65240, USA

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History of Personal Protective Grounding

Worker protection has always been an important activity. Worker safety has become a more important issue than ever before and has received increased attention in recent years. As the country has grown so have the electrical needs of the population: More people, more businesses and factories, all using more power. Electric power lines have been upgraded and new ones constructed to supply the increasing demand for electric power. Today we are seeing higher voltage lines, with higher levels of both rated and fault current.

This growth has increased the difficulty in providing a safe worksite. In many cases the "old" methods are not only inappropriate but are also unsafe. One of the "old timers" at a mid-west rural utility related that they used to cut a "fat green weed" to ground the line. Thankfully, the days of grounding with "fat green weeds" and grounding chains are long gone. Back then, the probability that a worker happened to be in contact at the very instant that the line accidentally became re-energized was very small. In most cases the absence of injuries was more the result of the worker lacking contact at that moment than the protection scheme in use at the time.

Now it is important to be aware of fault current levels, available protective equipment, techniques for establishing safe working areas and the condition of the equipment to be used. New and more appropriate methods of personal protective grounding to meet today's needs are reviewed in this publication.

The growth of the utility industry has been accompanied by an increase in the number of accidents and injuries. This has resulted in an increased awareness for the need of improved safe working conditions within the industry and also from governmental regulating agencies. At the federal level rules by the Occupational Safety and Health Administration (OSHA) were published in January 1994. CFR 29 1910.269 Subpart R[7] regulates a broad scope of utility activities. It puts forth requirements relating to operation and maintenance of generation, transformation, transmission and distribution of lines and equipment and of tree trimming activities. Other rulings by OSHA address other utility related topics. Very little is being left to chance. These rules carry the weight of law and violators may face severe penalties and monetary fines. Some states have adopted their own version of the OSHA regulations. This is allowed if the state version is at least as stringent as the federal regulations.

Worker protection is the focus of the decade.

This publication intends to assist utility personnel at many levels to understand and apply techniques for workers to use during maintenance after a line has been de-energized and taken out of service. Each section has been written with a particular reader in mind. The sections are arranged in a sequential manner, and each stands alone on the information it provides. This allows a reader with more experience to skip over the more basic sections that are provided for the lineworker new to the industry.

Earlier literature referred to this topic as "grounding" or "jumpering." However, confusion existed with these terms. For example, there are "hot jumpers" used to maintain an energized electrical connection that remain energized during their use. Did grounding mean a connection to earth or could it be a connection to neutral? The terminology was officially changed to personal protective grounding in our national standards in an attempt to eliminate this confusion. A generation of linemen will probably pass before the new terminology is commonly used.

Looking back through the years, a variety of protection schemes followed the use of grounding chains. Early methods involved connecting a separate jumper from each conductor to a separate earth connection [13,14]. This is diagramed in Figures 1-1.a and 1-1.b. The worker is represented in the following figures by the symbol of resistance, designated as R_M. As you can see, this resulted in the worker being placed in series between a possibly energized conductor and ground as a separate or fourth path for current flow to earth if the structure was conductive, e.g., steel tower.

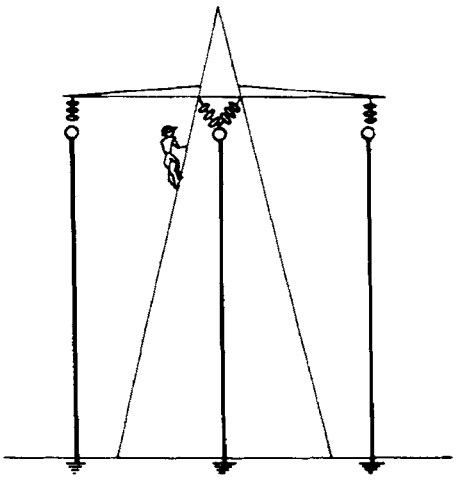

Fig. 1-1.a

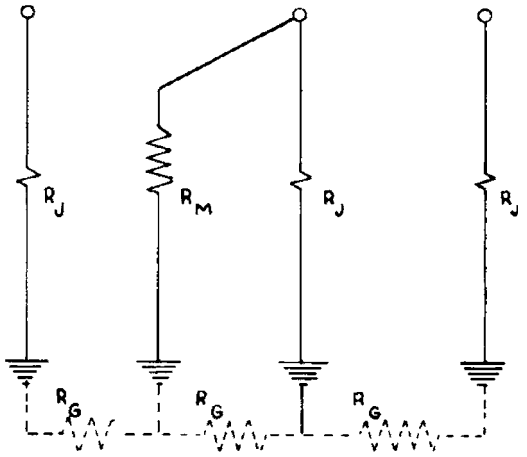

Fig. 1-1.b

Separate Jumpers To Separate Earth Connections

A later modification to this method brought the three connections to a single Earth connection point [13,14]. It was believed to improve worker safety. However, this modification still left the worker as a separate current return path to the power source through the earth if working on a conductive structure. This is diagramed in Figures 1-2.a and 1-2.b.

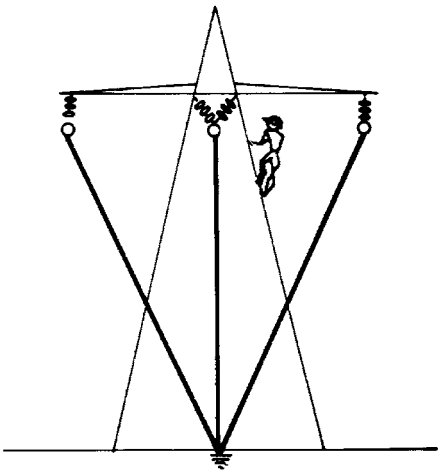

Fig. 1-2.a

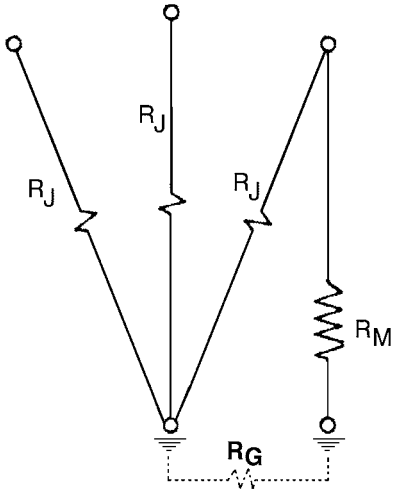

Fig. 1-2.b

Separate Jumpers To Common Earth Connection

Another modification used shortened jumpers between phases and a single jumper to a single Earth connection [13], as diagramed in Figures 1-3a and 1-3b. This was another attempt to improve worker protection that did not change the basic circuitry. The worker remains a separate current return path.

All of these schemes protected the system by indicating a fault, but left the worker in a situation that could prove fatal. As can be seen in the diagrams and the associated schematics, substantial voltage can be developed across the worker. This was not a satisfactory solution.

What if the structure is wood? If a pole down wire is present and the worker is near or touching it, the separate current path remains. If there is no pole down wire, the pole may have a resistance high enough to keep the body current flow to a low level but not necessarily to a safe level. Each pole is different. Pole resistance depends upon the amount of moisture sealed in the wood during the pressure treating, the surface contaminants, and the amount of water present on the surface and the type of wood.

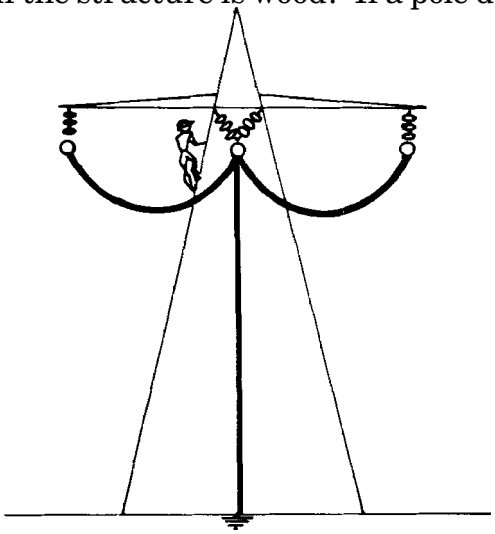

Fig. 1-3.a

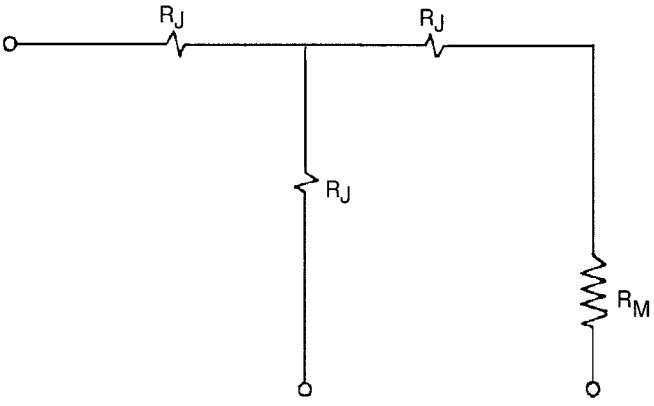

Fig. 1-3.b

Phase to Phase to Single Earth Connection

Some companies had adopted a policy of placing a full set of grounds on the pole at the worksite and also on each pole on both sides of the worksite. This offered protection but required three full sets of protective grounds. This increased both the cost and the difficulty of the work for the lineman. In 1955 Bonneville Power Administration engineers theorized that a set of grounds on the center worksite pole was adequate, if properly sized and installed. Testing indicated that this was correct. A paper[17] of this work was authored by E. J. Harrington and T.M.C. Martin in 1954. This was the beginning of the "worksite" grounding movement, but was basically ignored for many years. The low probability of a worker being in contact during the extremely short period the line was re-energized was probably a major factor in the low number of accidents. The prevailing philosophy was that the old methods had kept the number of accidents low before, so why change? Unfortunately, this philosophy exists in some areas today.

Additional protection schemes have been devised. "Bracket grounding" became the most accepted and commonly used one. Its use and faults are discussed in detail in a later section of this publication. Temporary protective grounds today offer protection to workers during maintenance on lines believed to be de-energized that are actually energized through induction or that later become energized accidentally. However, they must be installed in a correct manner, which is the focus of this publication.