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Does The NEC Provide a Good Equipment Ground?

Nearly all facilities that most of us deal with contain lots of critical equipment controlling critical processes or providing critical services. To ensure continued operation we should install several electrical protection systems that collect/divert electrical surges to protect the equipment's operation during lightning storms and other conditions that cause surges. The grounding system is probably the most critical because it **dissipates** the surges that the other systems collect/divert. Without a good ground, the other protection systems are ineffective.

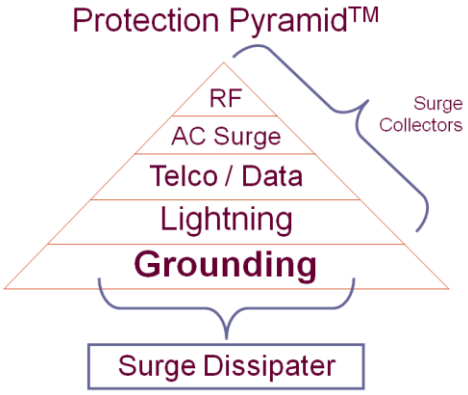

Fig 1 – Protection Pyramid™

Without a good ground, the reliability and often the operation of the equipment is at risk. The relationship between the grounding system and the other electrical protection systems is depicted in Fig. 1

With the grounding system this important, do we think something is wrong with an NEC compliant ground? First, we should realize that the NEC provides the **minimum requirement** for each and every electrical service entrance in the country. As one would imagine, grounding for an Intel microchip facility should be more rigorous than the 800 square foot row house.

Second, the NEC makes no claim of being adequate for critical electronics. Actually, it goes to great lengths to convey that it is a minimum safety requirement for each service entrance and is not a design specification. After all, the NEC is part of the National Fire Protection Association's (NFPA) fire and safety codes.

Quoting from paragraph 90.1(A) of the NEC, "The purpose of the NEC is the **practical safeguarding** of persons and property from hazards arising from the use of electricity". Also quoting from 90.1(B) the code states that compliance with the code will result in a facility free from hazard "but not necessarily efficient, convenient or adequate for good service…."

The NEC is a few hundred pages long… the publications explaining it are **thousands of pages** long and there are legions of people offering to explain it. We think it is deficient in two areas… that is the requirements for performance of the grounding system (measured in ohms resistance) for facilities utilizing sensitive/critical equipment and the lack of a requirement for an actual test with many of the allowed electrodes.

The NEC resistance requirement for a "Rod, Pipe and Plate Electrodes" (NEC – 250.56) is 25 ohms. If the electrode exceeds 25 ohms, a second one is installed at least 6 feet away and **no additional testing** is required. The ground system could be 250 ohms at that point, but it still meets the NEC requirements.

It gets worse… only "Rod, Pipe and Plate Electrodes" are required to meet even the 25 ohms as specified. All other electrodes, concrete encased (Ufers), water pipes, ground rings, building steel and "other listed electrodes" have **no resistance requirements**.

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I think everyone would agree that the situation described might be fine for the 800 square foot row house, but completely unsatisfactory for the Intel chip facility. Assuming that Ufer, water pipe, rings and building steel are **automatically good grounds** will be the topic of a future article.

Such low resistances and critical applications really merit a true grounding design based on soil resistivity and other site information. The simple formula is R = P/A where R is the ground system resistance, P is the soil resistivity and A is the effective cross sectional area of the grounding system. Although the **relationship is simple**, both soil resistivity and the effective cross sectional area of the ground system can become very complex and have been discussed in previous articles. Lyncole's years of history in designing grounding systems have shown that the ground system resistance/performance is very predictable but it requires both resistivity data and sophisticated software.

In summary, the NEC requirements for a grounding system have two weaknesses. Number one is that 25 ohms is not sufficient performance for facilities with critical equipment. Fortunately, most equipment manufacturers strengthen this with **their own requirement** of 5 ohms or so.

Number two is the assumption that a grounding system is good simply because it is made up of a Ufer, building steel, buried ring, or water pipe electrode is just bad guidance. Two years ago, we became aware of a new hospital that had no ground because of their dependence on a Ufer ground. They sealed all walls/foundations with a PVC liner to prevent water intrusion and consequently isolated their "Ufer" from any connection to earth.

Critical facilities should always have a grounding system that is testable and specifically designed for the facility.

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