

Grounding Systems

Grounding of electrical equipment serves several purposes. The first is to protect personnel and equipment from over-voltages, faults and lightning. Grounding also provides stability of system voltages by providing a solid reference to earth, and establishes a reference to control electrical “noise” that might interfere with the proper operation of electronic equipment.

The term “grounding” has a wide meaning in the electrical industry. The term is used for three broad areas: (1) to establish the grounding electrode system (earth reference); (2) to bond metallic parts to form a continuous circuit that is at earth potential; and (3) to provide a low impedance equipment grounding conductor to conduct adequate current during a fault to ground and allow overcurrent devices to operate. When discussing testing of grounding, one must differentiate among these areas so the proper tests and analysis can be completed.

Grounding Electrode System

The National Electrical Code (NEC) section 250-84 establishes a requirement for a single ground rod or ground plate to have an earth resistance of 25 Ohms or less. IEEE 142, “IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems” recommends an earth resistance in the range of $1/2$ to 5 ohms. IEEE 80 for substation grounding has values of $1/2$ to 1 Ohm for generating plants and large substations. Manufacturers of sensitive electronic equipment and medical diagnostic equipment have specifications of less than 1 and up to 5 Ohms.

With these types of standards and specifications, the testing of the grounding electrode, water pipe, Ufer system, ground ring, ground rod, or ground grid, is one of the most common tests performed. The applicable standards used for testing are IEEE 81 and IEEE 81.2 with the “Three Point Fall-of Potential” procedure being the most common. IEEE 81 and the Fall-of-Potential method are adequate for systems that are relatively small and have a required earth resistance of greater than 1 OHM. For large grids and systems requiring a ground resistance of less than 1 OHM, the IEEE 81.2 standard should be considered.

Future maintenance test results are compared to previous results and provide valuable information on existing conditions and future trends. It should be noted that the Mine Safety and Health Administration (MSHA) requires annual testing of mine power system grounding electrodes or grounding electrode systems. (See Why Mines Test Grounding Systems.)

Bonding

Bonding ensures electrical continuity of all metallic parts in the circuit, from the service or source to the end utilization equipment. The main purpose is to ensure that these components remain at the same potential, relative to earth or the ground reference. By keeping these metallic parts at this level, the potential for shock hazard is reduced.

Testing of bonding is generally performed by a simple continuity test using a multimeter or by measuring the voltage drop across a resistor that is connected in series with the bonded equipment. Health care facilities are the most common location for this testing, as very low stray potentials can be fatal to patients.

Another important aspect of bonding is establishing a signal reference ground, such as in a computer room with a raised floor. In this case, testing should include the testing of all the components that the raised floor is comprised of. This includes the frames, pedestals and floor tiles.

Equipment Grounding Conductors

The equipment grounding conductor is required by the NEC to provide a low impedance path for ground fault current to return to the source. This low impedance ensures adequate current flow to allow overcurrent protection to operate. The equipment ground is normally a current carrying conductor that is smaller than the phase wires. The size is not based on continuous amperage capacity (ampacity), but on withstand rating or the ability to carry a very large current for a short time, typically in cycles.

Testing of equipment grounds is critical in special installations, especially those with sensitive electronic equipment. Testing is performed using a low resistance type ohmmeter to verify each metalequipment enclosure with reference to the main grounding system.

