CNC Machine Tool Grounding: Pleading your Case

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Alert the OEM of possible shock hazards, lightning damage, ground loop currents, and electrolysis in your facility. If you find its “required” ground rod causes such problems, ask the OEM to accept liability in writing.

One of the most hotly debated subjects in the fields of power quality, the NEC, and grounding today is CNC machine tool grounding. Why? Since there's often a difference between the OEM's (original equipment manufacturer's) installation requirements and the electrician's expectation of what you should do per the NEC, it often gets confusing.

For example, its common for OEM installation specifications to require the end-user to provide a ground rod at the machine tool controller. The OEM does this because it suspects the end-user's grounding electrode system may be inadequate. Caught in the middle is the end-user, who must decide between the experienced electrician and the OEM. Usually, the end-user sides with the OEM, who refuses warranty on its equipment unless the installation includes the separately driven electrode.

A separately driven electrode at the machine tool location has many drawbacks including:

Personnel safety hazard. Suppose a ground fault occurs at the equipment, which uses the ground rod as its sole equipment-grounding conductor. (See **Fig. 1**.) What happens in this situation? Usually the fault current is drawn away from the circuit conductors for a large portion of its path back to the power source. What's the result? The fault circuit's impedance increases, restricting the necessary current needed to trip the circuit breaker.

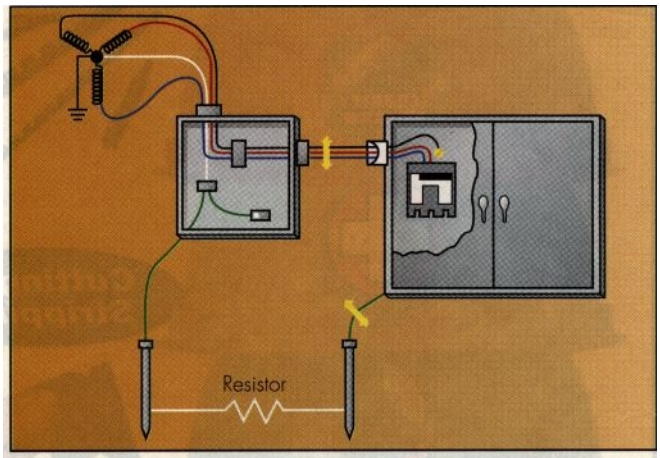

Fig. 1. *If a ground fault occurs at CNC equipment having a separately driven ground rod as its sole equipment grounding conductor, the fault current could be drawn away from the circuit conductors for a large portion of its path back to the power source. This restricts the necessary current needed to trip the circuit breaker.*

Lightning damage to equipment. Suppose lightning strikes a building, as shown in **Fig. 2**. What happens here? Most likely, transferred earth potentials develop between the main service grounding electrode and ground rod at the machine tool controller. These voltage drops may be large enough to cause damage to equipment. When this occurs, power conductors leading to the machine tool will be at a different voltage than the grounding system. The result: possibly a destructive failure of the machine tool controller's internal equipment.

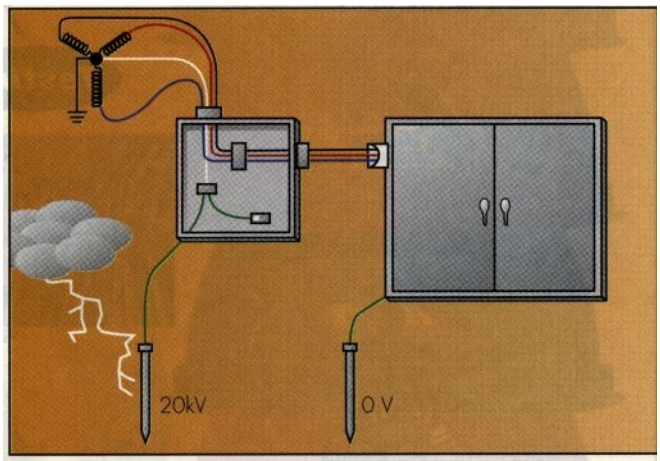

Fig. 2. *If lightning strikes a building, transferred earth potentials develop between the main service grounding electrode and the ground rod at the machine tool controller. These voltage drops may be large enough to cause damage to equipment.*

Ground loop currents. The grounding electrodes at the main service and machine tool controller act as two plates in a battery. The soil (i.e., concrete, etc.) between them acts as the electrolyte. The result: a DC electromotive force that can cause noise currents to flow between the two electrodes. Depending on their amplitude, these noise currents can disrupt equipment operation or degrade internal components.

Electrolysis. These same DC loop currents can cause galvanic corrosion through electrolysis. A typical symptom of this phenomenon is “pitting” of threaded couplings and/or pipes. It becomes more evident when the DC current between the two grounding electrodes approaches 500 mA. The result of this electrolytic corrosion: high impedance connections along the premises wiring system because it's deteriorating over time.

An alternative to a lone ground rod at the machine tool controller is to provide a *supplementary grounding electrode connection to structural steel*. Sec. 250-91(c) of the NEC allows this type of connection. It's permitted so an extensive equipment grounding system can maintain a zero-volt potential along its entire length. However, keep in mind one note of caution: Make the grounding electrode connection to the same type of electrode *as that used by the main service entrance*. Typically, structural steel should be more than adequate to reference the machine tool controller.

If you can't use a supplemental grounding electrode, make two-point bonding measurements to identify any loose connections along the equipment grounding system. Tighten all loose connections and replace all corroded connections. This should give your equipment the desired zero-volt reference.

If the OEM insists on having ground rods installed at the machine tool equipment, ask the OEM to confirm (on its letterhead) that it will accept liability if you find its “required” ground rod contributes to personnel shock, lightning damage, electrical noise, or electrolytic conditions. This approach has

convinced more that one OEM in the past to accept grounding and bonding principles compliant with the NEC as well as IEEE recommended practices.

Suggested Reading

Practical Guide to Quality Power for Sensitive Equipment, Second Edition, Order #6670;
Electronic Drives, Order #6113.

To order, call 1-800-543-7771.