

# Toolbox Talks 2

## 012: Assumptions That Can Kill You: Grounding

### ***Discussion leader duties for this session:***

Bring a high-resistance tester (or, failing that, a DMM) and a short piece of wire to this Safety Talk. If there is not a bare patch of ground nearby, put some dirt in some kind of container that will provide a few inches of exposed dirt.

### ***What this Safety Talk covers:***

What grounding really is, why it does not protect you, and assumptions that can prove lethal.

### ***Discussion notes:***

### ***Some grounding facts to think about***

- Kirchhoff's Law of Parallel Circuits says that electricity will flow in reverse proportion to the resistances presented to it. The effect is similar to what happens as you poke holes in a bucket full of water. Poking a larger second hole won't stop the flow from the first hole. We apply Kirchhoff's Law every day in circuits all around us. Yet, a myth has arisen that electricity takes the path of least resistance—this conflicts with Kirchhoff's Law. This myth underlies many assumptions about grounding—assumptions that can get you killed.
- The NEC defines grounding in Article 100. Essentially, it means connecting something to earth. One common method is driving a ground rod.
- Many people mistakenly refer to grounding when they mean bonding. The NEC defines bonding in Article 100. Essentially, it means connecting to a metallic path. One common method is attaching a wire bonding conductor to a lug for that purpose. It may be called a "grounding lug" but it's really a *bonding* lug.

### ***Assumptions***

- "Electricity is always trying to get back to earth." Electricity is always trying to get back to its *source*. Grounding does provide a path for lightning. But it does not provide a return path to the source when we are talking about power provided by the utility (or any other man-made power source).
- "Grounding creates an equipotential plane, reducing any chance of shock or flashover." As earth (dirt) is of widely varying resistances, we can apply Ohm's Law to see this is not true. Copper wire, on the other hand, is uniform in resistance out to several decimal places, as is aluminum wire. So bonding will create an equipotential plane, while grounding will not.
- "Grounding will make you safe." Grounding puts a high-resistance path in parallel with existing paths, one of which may be your own body. If your body is a 100 ohm path, then adding 10,000 ohm path in parallel to it will not protect you from a 480V fault. If you don't believe this, draw the circuit and do the math.
- "Standing with one foot on a ground rod will prevent you from being electrocuted. Again, Kirchhoff's Law applies. Your protection isn't in standing with your feet on points of differing potential. Your protection comes from following the appropriate safety practices, such as wearing the correct PPE, using equipment rated for the voltage you're working with, and performing lockout/tagout.
- "If you ground something, all of the undesired current will flow to ground." Again, Kirchhoff's Law applies.

### ***Review and discussion***

*[Demonstration. Have someone take a resistance reading between any two points on that piece of wire. Now, measure the same distance*

*between two points separated by dirt. You didn't jam the leads into the wire, so don't jam them into the dirt. Note the difference in readings. Now, move the leads to different points on the dirt and measure again.]*

1. How does the NEC define grounding? [*Connection to earth*]
2. How does the NEC define bonding? [*Metallic connection*]
3. From a safety standpoint, how do grounding and bonding differ?
4. As you add circuits in parallel, the total current flow to each circuit will drop. Does adding a circuit cause the current flow in another circuit to drop to zero? If not, how does the current flow divide?
5. Where is electricity always trying to get back to?
6. Give some examples of where bonding is used on this job site.
7. Which will give you an equipotential plane—that is, the voltage is the same on all metal components—grounding or bonding. Why?
8. Why won't grounding (as defined in the NEC, Article 100) make you safe?
9. What do you need to follow to make you safe when working around electricity?
10. What are some practices that help prevent electrical shock?

***Participant's Signature and Date***

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