

We informally discuss safety issues throughout this course, eg. with high-impedance ground faults (typical of downed lines) we can look analytically at the issue, in terms of a) voltage gradient along the surface of the ground you are standing on, b) step potential, and c) touch potential.

On the following page, find a scanned version of our local utility's safety warnings issued to customers. Periodically there have been public service messages on TV, warning people to stay away from downed power lines. Now we know why, from an engineer's point of view. Another useful reference, from IEEE, is:

- *Downed Power Lines: Why They Can't Always be Detected*, IEEE Power Engineering Society, © February 22, 1989.

There are many safety issues that can be mentioned here, that you as power systems engineers should be aware of. Utilities, consultants, and contractors will make sure their employees take safety training before going out in the field, and comply with OSHA and other safety stds. **Pay attention.** Safety is not just for linemen, and you may need to direct electricians and linemen. Even 120-V ac circuits and 125-V dc circuits can be dangerous, and there are many potentially dangerous situations that you might not have thought of. A few examples are provided here. Engineering knowledge, basic safety training, and common sense provide most of the needed understanding and confidence. Never get lax. A line-man told me that accidents tend to occur to rookies who don't know better and to veterans who get lax.

- If possible, always make wiring changes in CT secondary circuits when the circuit is de-energized. If you temporarily remove a hard-wired relay, meter, or transducer, you must first ALWAYS short out the upstream CT leads before re-energizing the circuit. If you must make a live change, ALWAYS place an upstream short on the CT before disconnecting/changing any downstream leads. NEVER open-circuit a CT secondary when making live changes in relay connections or CT ratio. If you do, a potentially fatal high voltage will be induced at the open-circuited connections.
- When designing CT secondary circuits, a) ALWAYS provide a set of "shorting blocks" (special terminal blocks that can be used to short out the CTs), and b) ground the CT secondary circuit at ONE point, typically the neutral. Note that multiple grounds cause circulating ground currents and may result in misoperation of relays.
- Beware of step and touch potential hazards. Be observant of frayed or corroded equipment grounds - these can result in unsafe touch potentials. Do not touch or lean against any metallic equipment, structures, fences, or surfaces unless you need to. Never lean against a bucket truck whose outriggers are up.
- ALWAYS practice the one-hand rule. When taking voltage measurements, a practical procedure is to use an alligator lead on one of the meter leads, so you never have to hold both leads. Know in advance what voltage magnitude you expect to measure. Pay attention to your multi-meter function settings. A meter set for AMPS will be a short circuit and will initiate a fault. A coworker of mine did that on a 480-volt circuit. He was flash-blinded (temporary blindness) and badly burned his hands. Note that above 240 volts there may be enough energy to ionize an arc path through air - if you initiate a fault it will not be self-extinguishing!