

10 ways to hurt yourself on electrical systems

Application Note

Jim White, Shermco Industries

1. Thinking that it's "only 120 volts" or 208 volts or 480 volts or ...

"It's only low voltage." Okay, I'll admit that you can have an open casket with a low-voltage hit, but you'll still be dead. The only difference between low and high voltage is how fast it can kill you. High voltage kills instantly; low voltage may take a little longer.

Dr. A.G. Soto, consulting physician to Ontario Power Generation, presented a paper at the 2007 IEEE Electrical Safety Workshop discussing low-voltage shock exposures. In that paper, he stated that a 120 volt shock can kill up to 48 hours later. He also stated that many emergency room physicians are unfamiliar with electric shock and that an EKG may not show a problem. The injury to the heart muscle tends to spread over time and cannot always be identified using EKGs.

2. Working on energized systems or equipment when it can be de-energized.

This is a "man-thing". When I was working in a power plant (back in the 70s), we never de-energized anything, whether it could be or not. My boss had great contempt for anyone sissy enough to actually ask to de-energize before working. He would tell anyone foolish enough to suggest turning it off, "You're an electrician, work it hot! That's what you're trained to do!" His other favorite saying was, "If you want to be here tomorrow, you'll get this done today". Can you feel the love?

De-energizing is the only way to eliminate hazards. Arc flash personal protective equipment (PPE) just increases your chances of survival; it doesn't guarantee it. Be aware that until equipment and systems are placed in an electrically safe work condition, proper PPE and procedures must be used to protect the worker. See Article 120 in NFPA 70E 2012.

3. Not wearing PPE.

This could go into number 2 above, but people really don't like wearing rubber insulating gloves or arc flash PPE and equipment. It's hot, uncomfortable, restricts movement, and slows the entire work process down—not only by wearing it, but

by selecting the correct PPE and putting it on and taking it off. It will also save your life. One of the most likely times people neglect to wear their PPE is during troubleshooting. The rationale seems to be, "I'm not really working on it; I'm just testing it." Yet, CDC/NIOSH studies have found that 24 % of electrical accidents are caused by troubleshooting, voltage testing and like activities. We have a tendency to ignore hazards associated with tasks we consider "safe".

Back at my old job, when I was surveying a 480 volt 250 amp molded-case circuit breaker, the worker I was with put his bifocals up on his forehead so he could read the label on the breaker. He dropped his glasses back to his nose and immediately the breaker blew up! Luckily, he only had some red dots on his face and some singed hair, as he was backing his head out when it let go. Metal droplets were imbedded into the lenses of his glasses, but because of them, he wasn't seriously injured. We investigated why that breaker might have failed and never found a good reason; it was just time for it to fail. Carbon buildup from earlier fault interruption, eroded contact material that gets sprayed up into the arc chutes, weakened dielectric due to the extreme heating of arc interruption; all of these weaken circuit breakers and could have caused what seemed like a perfectly good breaker to fail suddenly. You never know.

4. Going to sleep during safety training.

Nothing like a good nap to get you ready for a hard day's work! Every Monday morning, Shermco does a one hour safety meeting for all technicians. We call it the "Monday Moaner", because the technicians really want to be at their job sites, not getting "preached to". We like to do what we are comfortable with, even if there's a better way to do things. Add that to the fact that wearing PPE and filling out forms are part of the required steps, and fugettaboutit!

The other side of the coin is that a lot of safety training is sooooooooooooo boring! I've been to some sessions that, by the end, you're praying for a mercy killing—either me or the instructor; I don't care which! Safety training has to be focused, concise and interesting, otherwise everyone tunes it out.

5. Using outdated or defective test equipment to troubleshoot.

When the leads are frayed or the meter's doggy, it's time to replace it. I worked with a technician who used the same Wiggy (solenoid tester) for seven years. You couldn't read the faceplate, the coil was so weak that it didn't even vibrate and the leads had been pulled loose from the bottom. Almost every time he used it, he got nailed! One day, right after he was shocked (for the kazillionth time) I said, "Hey, let me see your Wiggy." He handed it down and I twirled it around my head and smacked a concrete column with it. The coil came springing out and he charged down the ladder like an enraged bull! I handed him my new Wiggy and said, "Take this new one—that one's going to get you killed", to which he said, "I've had that since I was an apprentice!" Don't get emotionally attached to inanimate objects. If you really love your old voltage tester, take it home and make a little shrine to it—just don't bring it to work.

The NFPA committee was concerned enough to put two different requirements for using only portable electric tools and test equipment that were properly rated.

110.4 (A) (2) Use of Equipment, Rating states, "Test instruments, equipment and their accessories shall be rated for the circuits to which they will be connected".

120.1(5) states, "Use an adequately rated voltage detector to test each phase conductor Before and after each test, determine that the voltage tester is operating satisfactorily."

Each of these statements are followed by a reference to ANSI/ISA 61010-1, Safety Requirements for Measurement, Control and Laboratory Use - Part 1: General Requirements for rating and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 V and below."

6. Not wearing the right PPE.

No, I'm not repeating myself. Some people think that if they wear anything by way of PPE, that should be enough. While it is true that the injuries that you sustain probably won't be quite as severe as if you didn't wear any PPE, there's a high probability that if the right PPE was worn, you'd have no injury.

This could also probably go under number 4, because if you aren't paying attention during safety training, you probably can't choose the right PPE, either. Do you know how to interpret arc flash labels? What do you do if there's no arc flash label on electrical power equipment? Do you know how to use the tables in the NFPA 70E? Do you refer to the notes when you use the tables? If you answer "no" to any of these questions, you aren't choosing the right PPE. As a matter of fact, you probably would not be considered qualified by OSHA. Your company has the responsibility to provide training

so you meet OSHA's definition of a qualified electrical worker, but you have the exposure to the hazard. It's your biscuits that'll get burned; you need to do the homework to protect yourself!

7. Trusting someone else for your safety.

An OSHA compliance officer I know investigated an arc flash incident where two electricians had been working together for years. The one who was injured asked his buddy if the circuit had been checked and was dead, to which his buddy replied, "Yeah." He really didn't think that it had been done, but he didn't want to offend his partner, so he didn't pursue the question. When he started working on it, the circuit blew up, causing severe arc flash burns. He stated, "If I had to do it over again, I would have checked it myself and not worried about so-and-so's feelings." Actually, those weren't his words, but they won't allow me to print what he really did say. You get the idea, though.

Sometimes relationships cause us to not follow through when we should. Either we don't want to offend someone, like the above example, or we don't want to look less than manly to our coworkers. "Nothing personal, I'd just like to make sure I don't get my face blown off." However you want to put it, don't neglect to prove systems dead personally.

8. Not performing required maintenance of power system equipment.

Too often companies look at maintenance costs as an overhead expense. Nothing could be further from the truth. The problem is, it's difficult to put a savings on things that don't happen. Unscheduled outages, loss of production, buying equipment at premium pricing, overtime, disposing of the cratered equipment, etc. Those of us who've been through the maintenance wars have seen the costs associated with neglect, but for newer managers and accounting types, it's really difficult to appreciate. Liken it to automobile maintenance. You go out and buy that new ZR1 and then do no maintenance for 100,000 miles. What condition do you think it will be in?

9. Not carrying your gloves with you.

During my safety training classes, I like to ask how many people actually carry their rubber insulating gloves with them. Maybe one or two will raise their hands. Well, guess what, if you don't carry them, you aren't using them. This might go along with thinking low voltage won't hurt you. We get buzzed and it's no big deal. At the beginning of 2008 in Athens, Texas, three TXU workers were working on a 120/208 volt transformer. One of the workers stood and said, "Well, boys. Looks like I got bit again,"



took three steps and was dead. Carry your gloves and use your gloves, always.

10. Not using an Energized Electrical Work Permit system.

People tend to hate paperwork, including myself. This is one great exception. OSHA wants us to plan each job, have the right tools and equipment to do the job safely and follow our work plan. How do we document the Hazard/Risk Analysis or our PPE Assessment? The OSHA Field Safety Compliance Officers I know all tell me the same thing; if it's not documented, you can't prove that you did it. The Energized Electrical Work Permit provides the means to plan the work, assess the hazard and the

risk, choose the proper PPE for the job and document it. The side bar shows an example of the Energized Electrical Work Permit and has a brief description of each section and its purpose.

Summary

There's always something else that could be included in this list, but 10 gets you thinking. We go through life making small mistake after small mistake and nothing happens, until we happen to get the wrong alignment of small mistakes and we now have an accident. Once the accident starts, we have no control over it, so the best thing to do is to avoid the small mistakes and tighten up the way we work.

Figure 1 shows the Energized Electrical Work Permit found in Annex J of the NFPA 70E. Anything in the Annexes is optional and can be modified to suit your specific requirements. This permit is split into three sections, each having a specific purpose. Section I is completed by the person who wants the work done energized. Item 3 is of particular interest; if they cannot provide a satisfactory reason why the work needs to be done energized at this point, they certainly won't be able to after a blow up occurs. The person requiring the work be done energized must also sign and date it—a clear warning to any manager or supervisor that they are accepting shared responsibility if something goes wrong.

Section II is the Hazard/Risk Analysis. Approach boundaries, PPE selection and plans for securing the work area are included. One purpose is to make the qualified person plan out how the work is to be done and what will be required to do it. I really like Item 7. If the person doing the work does not think it is safe to proceed, everyone needs to look at Plan B. You do have one, don't you?

Section III is for the approvals. This is extremely important. The company is ultimately responsible if someone is killed and must be aware of any energized work that is to be done. You don't want a loose cannon out there performing energized work to satisfy their ego or to please a supervisor. At one company, I taught a 2 1/2 day safety training class complete with gory videos, photos and examples, went over the OSHA regulations and the 70E. At the end of the course, one attendee said, "My supervisors really like me." I said, "Is that so?" He said, "Yeah, I'll do this work hot and the other guys won't." I almost passed out! Talk about unending lawsuits if this worker is injured or killed!

Limit energized work to that necessary and unavoidable. Don't kid yourself—someone's life may depend on it!

The form is titled "ENERGIZED ELECTRICAL WORK PERMIT" and is divided into three main sections:

- PART I: TO BE COMPLETED BY THE REQUESTER:** Includes fields for Job/Work Order Number, Description of circuit/equipment/job location, Description of work to be done, and Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage. It also has fields for Requester's Name and Date.
- PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS DOING THE WORK:** Includes checkboxes for "Check when complete" and fields for:
 - Detailed job description/procedure to be used.
 - Description of safe work practices to be employed.
 - Results of the shock hazard analysis, including:
 - Limited approach boundary
 - Restricted approach boundary
 - Prohibited approach boundary
 - Necessary shock personal and other protective equipment to safely perform assigned task.
 - Results of the arc flash hazard analysis, including:
 - Available incident energy or hazard/risk category
 - Necessary arc flash personal and other protective equipment to safely perform the assigned task
 - Arc flash boundary
 - Means employed to restrict the access of unqualified persons from the work area.
 - Evidence of completion of a job briefing, including discussion of any job-related hazards.
 - A Yes/No question: "Do you agree the above-described work can be done safely?" with a field for "If no, return to requester".
- PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:** Includes signature and date lines for Manufacturing Manager, Safety Manager, General Manager, Maintenance/Engineering Manager, and Electrically Qualified Person.

At the bottom, it states: "Note: Once the work is complete, forward this form to the site Safety Department for review and retention." and includes the NFPA 70E logo and version information (2012 Edition, ELECTRICAL SAFETY IN THE WORKPLACE, 70E-89).

Figure 1. Sample Permit for Energized Electrical Work.

Figure 1. Energized Electrical Work Permit. NFPA 70E, Standard for Electrical Safety in Employee Work Places, 2012.

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