Electrical Safety in the Workplace

Brent Kooiman, PE

Electricity is all around us. It enables our world to operate. Almost everything that you see either operates on, or was manufactured with electricity. What most people don't realize is that it is also a dangerous and deadly resource if it is not handled correctly. This can be seen in the number of injuries from electrical energy. Electricity causes 4,000 non-disabling and 3,600 disabling injuries annually in the U.S. If you think about it, this means that on average there are more than ten non-disabling and ten disabling injuries every day. There are also about five electrocutions every week, which means that on most days, there is one person who went to work this morning that will not go home tonight because of electricity. Electricity is a very good and helpful resource, but it is also dangerous and has a significant risk of causing injuries and fires if it is not respected.

Electrical injuries can be classified into four categories. The first three are caused by direct contact with electricity with the last one being an indirect injury associated with electricity. The first is the one that most people think of: electrocution or death due to electric shock. The second is electric shock that causes an injury, but not death, and the final direct injury is burns (see photo). An indirect injury that is also associated with electrical contact is falls. I'll discuss these injuries in a little more detail.

An electrical shock is received when electrical current passes through the body. This happens when your body completes an electrical circuit by coming into contact with a live electrical wire and ground or two live wires at different voltage levels. The main misconception about electrical shock is that it takes a lot of current or a high voltage in order to cause injury. This is simply not the case. The severity of the shock depends on three main factors. The path of the current is very important. If the path is across the chest, then the shock is much more likely to cause serious problems or death. This is due to the heart being shocked and getting out of rhythm. Another key factor in the severity of the shock is the amount of current (amps) that is flowing through the body. The third factor is the duration that this current is flowing through the body. To put some numbers to this, a current of 10 mA can "freeze" the muscles and will paralyze you. If this level reaches 75 mA, the rhythm of the heart will be disrupted and a defibrillator will be needed or death will occur. When thinking about this level of current, compare it to this: most small appliances and tools will carry 60 times this amount of current. This is much less than 1 amp and most of us don't even think about the 15 to 20 amp outlets that are in our homes and offices.

COURTESY OF IAEI NEWS

Injury suffered from an electrical burn.

The other major injury that is caused by electrical energy is burns. This is actually the most common shock-related injury. This is a very serious injury that needs to be attended to right away. These burns are different than the normal burns that you are used to seeing since these burns happen from the inside out. The electricity flowing through the body burns the tissue and the injury is often not immediately seen since it is under the skin.

The indirect injury that I mentioned earlier was falls. These are caused by the reaction of the body when a shock or flash is experienced. If the worker is on a ladder or elevated surface, this reaction could cause a fall that could cause injuries such as broken bones, head injuries, and death. Any time that electrical work is being performed on an elevated level, special consideration needs to be taken into account to minimize this risk.

Now that I have discussed the injuries that can be associated with electricity, let's also take a look at what can be done to minimize this risk and some of the responsibilities that have been defined. OSHA requires that an employer shall provide electrical equipment that is free from recognized hazards that are likely to cause death or serious physical harm to employees. OSHA also requires that listed or labeled equipment be installed according to the instructions and for the specific use for which it was designed. These requirements are there in order to minimize these hazards. Another OSHA require-

COURTESY OF IAEI NEWS

A workman with suitable personal protective equipment (PPE) working on energized equipment.

ment and one thing that is essential for a complete lockout/tag-out program is proper labeling of equipment, disconnects, and starters. Only through complete and accurate labeling can a lockout program be effective.

So how do you know if you are going to meet the OSHA requirements? Well, the standard that is in place to help you meet these requirements is NFPA 70E "Electrical Safety in the Workplace." Although OSHA doesn't specifically call out the enforcement of NFPA 70E, they did help co-develop it with NFPA and they consider it an effective "how-to" manual for electrical safety compliance. If you use this as a guide, you will be on your way to a safe workplace and reduced risk of injury to your employees.

So what is in NFPA 70E? Well, it is split into four chapters. Chapter 1 is Safety Related Work Practices, Chapter 2 is Safety Related Maintenance Requirements, Chapter 3 is Safety Requirements for Special Equipment, and Chapter 4 is Installation Safety Requirements. I will briefly discuss Chapters 1 and 2. Chapter 3 is fairly specialized and Chapter 4 is mostly a summary of the NEC requirements for installations.

The Safety Related Work Practices that are included in Chapter 1 discuss the training that is required for personnel such as: hazards of electrical energy, safety related work procedures, and emergency procedures. It also defines who is a "Qualified Person" for working on live electrical equipment. This definition of a qualified person states that this person must have the skills to distinguish exposed live parts from other parts of the electrical equipment. They must also be able to determine the voltage level of the associated equipment. These requirements are so that the worker knows the equipment and appropriate methods of working on this equipment. Part of this knowledge leads to the third part of the definition—mainly, the ability to determine the approach distances corresponding to these voltage levels. The final part of the definition for a "Qualified Person" is that they must have the decision-making process to determine the degree of the hazard, proper personal protective equipment (PPE), and planning necessary to perform the task safely. NFPA doesn't give you the program to go through for a person to become qualified, but it does give the guidelines for what the outcome must be. Chapter 1 also includes the requirements for an electrical safety program and work practices.

Electrical work practices should include putting the equipment into electrically safe work practices through lock-out/tag-out programs, qualified personnel, shock hazard analysis, Arc Flash Hazard analysis, and energized work permits. Guidelines for performing this risk analysis and samples of the work permits can be found in NFPA 70E. There are many other resources and people who can help with determining the shock and arc flash hazards in your facility. Please consult a professional to help you with this determination, as it is a key part of keeping your facility safe.

Chapter 2 of the NFPA 70E contains Safety Related Maintenance Requirements. These include making sure that the single line of the facility is maintained so that the electrical power can be properly disconnected and locked out. It also requires that proper clearances and working space be maintained about the equipment so that work can be safely performed on this equipment. Grounding and bonding is also a very important part of a safety program in order to have the overcurrent devices operate properly. Live parts must be guarded to keep unauthorized personnel away from hazards and for protecting authorized personnel when they are working on the system. The safety equipment or PPE must also be available and maintained in a proper working condition. All components must be properly identified for safe working conditions and all conductors must be free from damage. These are just some of the requirements in this section. The full text should be consulted when completing your Safety Related Maintenance Requirements.

Electricity has unlimited benefits, but also has hazards. By having the proper procedures in place and following the correct work practices, we can all make sure that everyone goes home at the end of the day.

Brent Kooiman, PE, is a senior project engineer with Interstates Engineering Inc., Sioux Center, Iowa. Interstates Engineering specializes in industrial power design and consulting for facilities in industries such as food, beverage, and value-added agriculture. For more information visit www.interstates.com or contact Brent at brent.kooiman@interstates.com. ■