CLMI
SAFETY TRAINING

Electrical Safety: What Everyone Should Know

Student Handout

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How Electricity Works

Electricity is produced at a variety of locations including power plants, hydro electric dams, wind turbines and solar panels. Each of these methods gets tiny particles called electrons moving rapidly through the wires. This flow of electrons is called *electrical current*. Electrical current is always headed in the path of least resistance to the Earth or ground. The Earth is used to complete the circuit back to the point of generation. An electrical current will do just about anything to ground and when we get any part of our bodies in the way of this path, we can receive a painful or fatal shock.

Proper Wiring

The first and most important protection from the effects of electricity starts with proper wiring in your building. Standard 120 volt circuits are wired with three wires:

- Hot
- Neutral
- Ground

Electrical outlets correspond with these wires:

- The left side or larger slot is neutral
- The narrow slot is hot
- The round hole on the bottom is the ground

Electricity flows from hot to neutral. Current flows in a tool or circuit as long as the switch is on. The neutral and ground wires are physically tied to the Earth back at the circuit breaker panel. The ground is an emergency exit wire for current in the circuit. Ground wire is installed to protect people and equipment. Not intended to carry any current unless something goes wrong. Without a ground, a loose hot wire can cause metal tools and appliances to become energized

Effects of Electricity on the Human Body

When the body comes in contact with electricity, a variety of electrical shock injuries can occur including external burns and internal tissue damage. Our bodies are 50 to 60 percent water contains salts and minerals that make us great conductors. Coming in contact with someone who is being shocked can give you a fatal jolt.

Our bodies use small electrical currents to send signals to our hearts, brains, nerves and muscles. Any extra current can cause muscle spasms that can break bones and cause falls. Extra current can also cause paralysis of our chest and diaphragm muscles, so we stop breathing and can disrupt the rhythm of the heart.

The degree of injury depends on the amount of current, the length of time the current is going through the body and where the current comes into and goes out of the body. Electricity that transverses the torso and through the heart is much more dangerous than current that flows from a hand to a foot on the same side of the body. Internal damage can be extensive even when burn marks on the outside of a body look very small. Anyone receiving any kind of electric shock should get immediate medical attention.

Using Electricity Safely

There are four main categories of protection methods to prevent electrical injuries and incidents:

- Insulation
- Guarding
- Grounding
- Circuit protection devices

Insulators are materials that separate us from those things that are good conductors of electricity. *Conductors* allow current flow and include copper, aluminum, iron and steel. Insulators resist electricity and include rubber, plastics and glass.

Guarding keeps people physically away from electrical equipment. Guarding methods include fencing, electrical enclosures, conduits and metal raceways.

Grounding creates a direct detour to the ground to reduce or eliminate the current that might otherwise flow through you. Grounding methods include making sure that all potentially current-carrying equipment is grounded, all internal wiring has a separate grounding wire and that grounding is not disconnected or damaged.

Circuit protection devices protect against overloaded circuits, that is, too many devices asking for too much electricity at once. These devices protect against short circuits that occur when a hot wire comes in direct contact with either a neutral wire or a ground wire without completing its intended path through the appliance.

Circuit Breakers are the most common type of circuit protection device and monitor the amount of current that a circuit is carrying. Circuit breakers automatically open or trip to break the flow of electricity when the level of current gets unsafe. Remember that these devices can protect your building or equipment, but won’t protect you from a shock.

Ground Faults

The most common form of electrical shock comes from a condition called a *ground fault*. A ground fault happens when the electrical current can't make its intended complete circuit so the electricity has to go somewhere else to find ground. These can be caused by damaged insulation on wiring or getting electrical equipment wet.

We protect ourselves from ground faults by using a Ground-fault Circuit Interrupter (GFCI). A GFCI works by comparing the amount of current going into the electrical device and the amount of current returning from that device. If the amount of current difference is greater than 5 milliamps, the GFCI will trip, thereby shutting off the current. When the amount going into the device is different from the amount coming out of it, the GFCI stops the current in about one fortieth of a second. GFCIs are used in wet locations including bathrooms and kitchens. They can be used to protect outdoor circuits that could be wet or damp like construction sites.

GFCIs are not invincible and can be damaged by power surges and electrical storms. When damaged, these devices will not provide protection. That is why it is important to periodically test all GFCIs in your building or home. To test a GFCI, plug a light into a GFCI outlet and turn it on. Press the test button and the light should turn off. Press the reset button and the light should turn back on. If the light doesn't turn off when you push the test button, stop using the outlet and call a qualified electrician to check things out.

Circuits

Every outlet is usually connected to a number of other outlets in a single circuit. Outlets in your work area are wired on one circuit, lighting on another circuit and various pieces of equipment on their own circuits. Power used on a single circuit needs to be what it can safely provide. Overloading circuits is never a good idea. Drawing too much power from a single outlet is dangerous and could lead to equipment damage or a fire

To figure out how much power you are you using, you need to understand three terms: *Watts, Amps* and *Volts*.

The amount of power that each device uses is measured in *Watts*. Every device that we use at work and at home will have the amount of power that it uses listed on the device or appliance. We have all seen or used 100 watt light bulbs and 1500 watt hair dryers. We may have lots of things plugged into a circuit, but we don't usually run everything at once.

The amount of electricity available on a circuit is measured in *Amps*. Most outlets are wired to 15 or 20 Amp circuits. This designation is marked on the circuit breaker or fuse back at the circuit panel.

Volts are the measurement of the amount of pressure that the electrons have as they are pushed along a conductor. General household current is 120 volts while industrial circuits may be a variety of voltages: 120/208/277/480, etc.

Math Equations:

Volts X Amps = Watts
Watts / Volts = Amps

Math Equation Example:

120 *Volts* (household) X # *Amps* in the Circuit = *Watts* that the Circuit can handle

Typical Circuit Loads assuming a 120-volt current...

- A 15 Amp circuit can provide a maximum of 1800 Watts
- A 20 Amp circuit can provide a maximum of 2400 Watts

To have a safety factor, keep continuous loads to about 80% of the calculated amount:

- 1440 Watts for a 15 Amp circuit
- 1920 Watts for a 20 Amp circuit

Resetting a Circuit Breaker

Resetting a circuit breaker is something that you may need to be done when a circuit goes dead. Here's what to do:

- Find out what tripped the breaker and correct the problem. There may have been an excessive load – too many watts plugged into the circuit – or there may be damaged wiring or tool.
- If the circuit tripped when an additional appliance was plugged in and switched on, unplug the offending tool or appliance. You may also need to unplug a number of other devices plugged into the circuit.
- Look for the circuit breaker panel that supplies the outlet. The tripped breaker will not be fully in the "On" position but rather in the "Off" position or somewhere in between. The breaker may have a red indicator displayed.
- To reset the breaker, push the lever all the way to the "Off" position and then back fully to the "On" position. You will hear it click as it snaps into the "On" position. If the breaker trips again, you need to determine why the breaker is tripping and correct the problem. You may need the assistance of a qualified electrician.

Electrical Safety Tips

- Do not use any electrical equipment that is malfunctioning.
- If breaker trips, find out the reason and correct it, don't just keep resetting the breaker--get the circuit or the equipment repaired.
- Use the right extension cord for the job
  - Make sure it is UL-rated.
  - If your tool or equipment has a three-prong plug, only use a three-prong extension cord and outlet.
- Make sure that your equipment is rated for the work environment.
- If your equipment or tool uses a polarized plug (one plug prong wider than the other and does not have a ground prong), make sure that the wide prong goes into the wide slot of the outlet or extension cord.
- Use the right cord size for your equipment.
  - A 50 - 100 foot 12 gauge cord = 1875 watts (15 amps and 125 volts)
  - A 50 - 100 foot 16 gauge cord = 1250 watts (10 amps and 125 volts)
  - A 16 gauge cord up to 50 feet = 1625 watts (13 amps @ 125 volts)
  - A 50 - 100 foot 16 gauge cord =1250 watts (10 amps @ 125 volts)
- If a cord is warm to the touch, you are putting too much load on it.
- Extension cords are for temporary use and never more than 90 days.
- Keep some slack in your extension cords.
- Don't pull on the outlets that can damage the outlet, plug and cord.
- Never run a cord through a wall opening.
- Always unwind a cord before use.
- Don't walk or drive equipment over a cord, get a cord protector or reroute the cord.
- Inspect cords for any damage to insulation or ground prongs.
- Repair or replace damaged cords and plugs immediately.
- Make sure that the strain relief where the cord enters the tool is not damaged.
- Dry your hands before plugging a cord into an outlet.
- Use a tested GFCI in work in areas that could get wet.
- Watch out for wiring with exposed conductors, broken outlet covers or open electrical boxes.
- Make sure that breaker panels have all openings covered or occupied by a breaker.
- Replace worn outlets that expose prongs on plugs.
- Make sure that electrical conduits and junction boxes are in good repair and the wiring is not exposed.
- Stay clear of electrical work in your facility where service, installation or maintenance work is being performed.