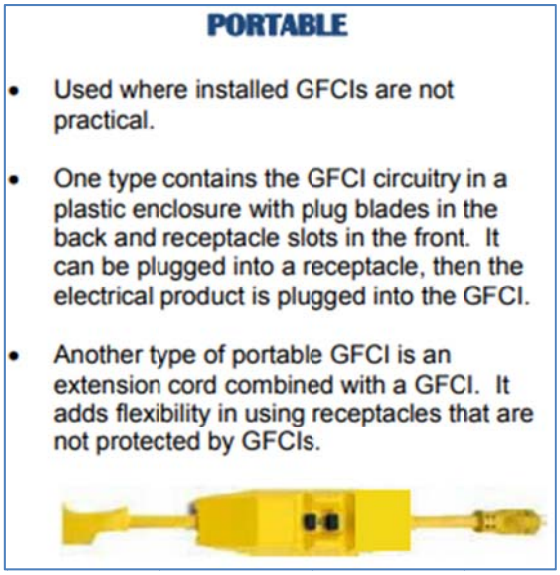
[PP 08/18/2019 - 08/31/2019]
Electrical Safety – LOTO procedures / GFI Protection

According to OSHA, electrocution injuries accounted for 82 construction worker deaths in 2016, which is 8.3% of the 991 fatalities caused by construction site hazards.

Electrocution Hazards

Electrocution is death by electric shock caused by exposure to lethal amounts of electrical energy. Electricity flows through conductors like wires and power lines to create a path or complete a circuit. The human body acts as a conductor when they come into contact with an electrical current due to things like exposed electrical wires or damaged equipment.

Electrocution can occur from contact with power lines, contact with energized sources such as faulty equipment or exposed wires and improper extension cord usage. Both overhead and underground power lines carry a high voltage. The best way to avoid electrocution from power lines is to simply stay away from them.



Ground-Fault Protection

OSHA has also established rules and regulations regarding ground-fault protection. Receptacle outlets that are not part of the permanent wiring of the structure must be protected with ground-fault circuit interrupters (GFCIs). A GFCI monitors the electrical current flow from hot to neutral and if it detects an imbalance it will trip the circuit in less than a second and cuts off the electricity.

Establish an assured equipment grounding conducting program that covers all cords, temporary receptacles, and equipment and maintain detailed records off all tests and inspections. Make sure all equipment and extension cords are in good condition by visually inspecting for cuts, frays or exposed bare wires and ensure that ground prongs haven't been removed or become defective. Make sure that the equipment grounding conductor is electrically continuous by conducting a continuity test.

590.6(A)(1) Receptacle Outlets Not Part of Permanent Wiring. *All 125-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets that are not a part of the permanent wiring of the building or structure and that are in use by personnel shall have ground-fault circuit-interrupter protection for personnel. In addition to this required ground-fault circuit-interrupter protection, listed cord*

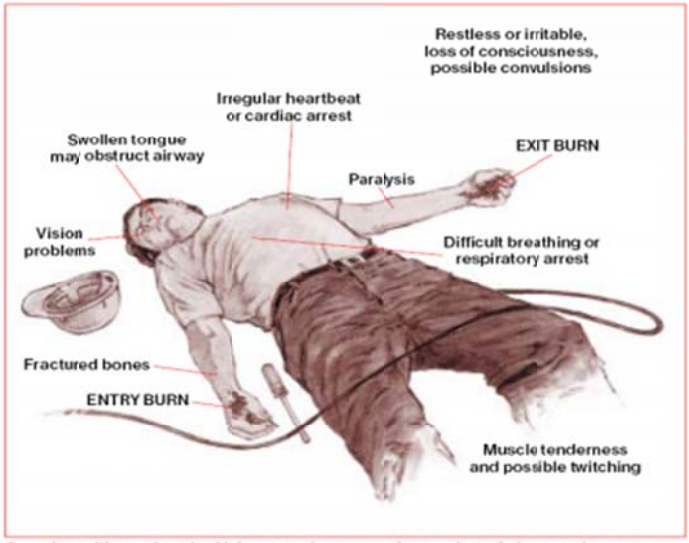
sets or devices incorporating listed ground-fault circuit interrupter protection for personnel identified for portable use shall be permitted.

Electrical Rescue Techniques in Construction

Death by electrocution can occur from exposure to as little as 50 – 100 milliamperes of current. Most 120 Volt circuits carry 15 to 20 amperes of current. 15 amperes of current are 300 times what is necessary to cause death by electrocution.

Approaching the accident:

- Approach the accident scene cautiously.
- Call 911 as soon as possible.
- Is the victim may be energized
- The area may be energized
- De-energize electrical circuit if at all possible



A worker with an electrical injury may have any of a number of signs and symptoms.

A SHOCKING EXPERIENCE

Why do people sometimes " freeze" when they are shocked?

When a person receives an electrical shock, sometimes the electrical stimulation causes the muscles to contract. This " freezing" effect makes the person unable to pull free of the circuit. It is extremely dangerous because it increases the length of exposure to electricity and because the current causes blisters, which reduce the body's resistance and increases the current.

The longer the exposure, the greater the risk of serious injury. Longer exposures at even relatively low voltages can be just as dangerous as short exposures at higher voltages. Low voltage does not imply low hazard.

In addition to muscle contractions that cause " freezing," electrical shocks also can cause involuntary muscle reactions. These reactions can result in a wide range of other injuries from collisions or falls, including bruises, bone fractures, and even death.

What should you do if someone" freezes" to a live electrical contact?

If a person is " frozen" to a live electrical contact, shut off the current immediately. If this is not possible, use boards, poles, or sticks made of wood or any other nonconducting materials and

safely push or pull the person away from the contact. It's important to act quickly, but remember to protect yourself as well from electrocution or shock.

How can you tell if a shock is serious?

A severe shock can cause considerably more damage than meets the eye. A victim may suffer internal hemorrhages and destruction of tissues, nerves, and muscles that aren't readily visible. Renal damage also can occur. If you or a coworker receives a shock, seek emergency medical help immediately.

What work practices help protect you against electrical hazards?

Electrical accidents are largely preventable through safe work practices. Examples of these practices include the following:

- deenergizing electric equipment before inspection or repair,
- keeping electric tools properly maintained,
- exercising caution when working near energized lines, and
- using appropriate protective equipment.

Effects of Electric Current in the Human Body

Current	Reaction [1000 milliamps makes 1 ampere]
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6–25 milliamperes (women)	Painful shock, loss of muscular control*
9–30 milliamperes (men)	The freezing current or " let-go" range.* Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated.
50–150 milliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1,000–4,300 milliamperes	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes	Cardiac arrest, severe burns; death probable

* If the extensor muscles are excited by the shock, the person may be thrown away from the power source.

Either AC or **DC currents can** cause fibrillation of the heart at high enough levels. This typically takes place at 30 mA of AC (rms, 60 Hz) or 300 – 500 mA of **DC**. Though both AC and **DC currents** and **shock** are lethal, more **DC current** is required to **have** the same effect as AC **current**.

What are the basic steps of locking and tagging out a system?

Lockout and tag out processes involve more than putting a lock on a switch. They are comprehensive step-by-step processes that involve communication, coordination, and training.

Please note the following definitions from CSA Z460-13:

Affected person - persons who are not directly involved in the work requiring the hazardous energy control, but who are (or may be) located in the work area.

Authorized person - a person who is qualified to engage in hazardous energy control because of knowledge, training, and experience and has been assigned to engage in such control.
Steps of a lockout/tag out program include:

1. Prepare for shutdown

The authorized person will identify which sources of energy are present and must be controlled; and more importantly, identify what method of control will be used. This step involves completing sets of specific work instructions that outline what controls and practices are needed to lock and tag out a system before performing any activity.

2. Notify all affected employees

The authorized person will communicate the following information to notify affected persons:

- What is going to be locked/tagged out.
- Why it is going to be locked/tagged out.
- For approximately how long will the system be unavailable.
- Who is responsible for the lockout/tag out.
- Who to contact for more information.

3. Equipment Shutdown

If the system is operating it should be shut down in its normal manner. Use manufacturer instructions or in-house work instructions. Equipment shutdown involves ensuring controls are in the off position, and verifying that all moving parts such as flywheels, gears, and spindles have come to a complete stop.

4. Isolation of system from hazardous energy

The exact written instructions will be specific to that system in the workplace. In general, the following procedures are used:

- Electrical energy - Switch electrical disconnects to the off position. Visually verify that the breaker connections are in the off position. Lock the disconnects into the off position.

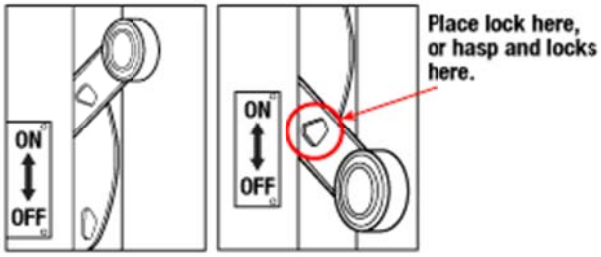


Figure 1: Electrical lockout

- Hydraulic and Pneumatic potential energy - Set the valves in the closed position and lock them into place. Bleed off the energy by opening the pressure relief valves, then closing the airlines.

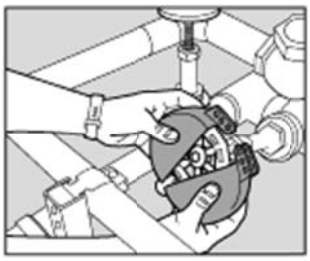


Figure 2: Hydraulic and Pneumatic lockout

- Mechanical potential energy - carefully release energy from springs that may still be compressed. If this is not feasible, block the parts that may move if there is a possibility that the spring can transfer energy to it.
- Gravitational potential energy - Use a safety block or pin to prevent the part of the system that may fall or move.
- Chemical energy - locate chemical supply lines to the system and close and lockout the valves. Where possible, bleed lines and/or cap ends to remove chemicals from the system.

5. Dissipation (removal) of residual or stored energy

In general, examples include:

- Electrical energy - To find a specific method to discharge a capacitor for the system in question, contact the manufacturer for guidance. Many systems with electrical components, motors, or switch gears contain capacitors. Capacitors store electrical energy. In some cases, capacitors hold a charge and may release energy very rapidly (e.g., similar to the flash of a camera). In other cases, capacitors are used to remove spikes and surges in order to protect other electrical components. Capacitors must be discharged in the lockout process in order to protect workers from electrical shock.
- Hydraulic and Pneumatic potential energy - Setting the valves in the closed position and locking them into place only isolates the lines from more energy entering the system. In most cases, there will still be residual energy left in the lines as pressurized fluid. This

residual energy can be removed by bleeding the lines through pressure relief valves. Verify depressurization or use flange-breaking techniques. Contact the manufacturer for more specific details, or if no pressure relief valves are available, what other methods are available.

- Mechanical potential energy - Carefully release energy from springs that may still be compressed. If this is not possible, use blocks to hold the parts that may move if the energy is released.
- Gravitational potential energy - If feasible, lower the part to a height where falling is impossible. If this is not possible, contact the manufacturer for guidance.
- Chemical energy - If available, bleed lines and/or cap ends to remove chemicals from the system.

6. Lockout/Tag out

When the system's energy sources are locked out, there are specific guidelines that must be followed to make sure that the lock cannot be removed, and the system cannot be inadvertently operated. These guidelines include:

- Each lock should only have one key (no master keys are allowed).
- There should be as many locks on the system as there are people working on it. For example, if a maintenance job requires 3 workers, then 3 locks should be present - each of the individuals should place their OWN lock on the system. Locks can only be removed by those who installed them, and should only be removed using a specific process - see step 9 below.

Figure 3: Example of multiple locks on a lockout tag

7. Verify Isolation

Verify that the system is properly locked out before beginning any work. Verification can take place in several ways:

- The machine, equipment, or process controls (push buttons, switches, etc.) are engaged or activated and the result is observed. No response means isolation is verified. Return controls to the safe position (off).
- Visual inspection of:
  - Electrical connections to make sure they are open.
  - Suspended parts are lowered to a resting position or blocked to prevent movement.

  - Other devices that restrain machine or process movement.
  - Valve positioning for double block and bleed (for pipes or ducts) - closing two valves of a section of a line, and then bleeding (or venting) the section of the line between the two closed valves.
  - Presence of solid plate used to absolutely close a line - called line blanking (for pipes or ducts).
  - Any other acceptable method of energy isolation.
- Testing of the equipment:
  - Test circuitry (should be done by a certified electrician) - note: equipment with capacitors needs to be cycled until all energy is drained.
  - Check pressure gauges to make sure hydraulic and pneumatic potential energy has been removed.
  - Check temperature gauges to make sure thermal energy has been discharged.

Choose the method that will best make sure that the energy to the system has been isolated without creating other hazards during the verification.

8. Perform Maintenance or Service Activity

Complete the activity that required the lockout process to be started.

9. Remove Lockout/Tag out devices

To remove locks and tags from a system that is now ready to be put back into service, the following general procedure can be used:

- Inspect the work area to make sure all tools and items have been removed.
- Confirm that all employees and persons are safely located away from hazardous areas.
- Verify that controls are in a neutral position.
- Remove devices and re-energize machine.
- Notify affected employees that servicing is completed.

*Note - it is good practice to make sure any individual who placed a lock on the system should also be present when the system is re-started. This practice helps make sure those employees working on the system are not in a hazardous area when the machine is restarted.