Electrical Safety

Module Purpose

This module focuses on electrical safety and safety-related work practices. Topics include evaluating the safety of electrical equipment and protecting roadway construction workers from on-the-job hazards. Basic electrical information, safe work practices, and safe equipment use are stressed with particular emphasis on working near overhead power lines and as well as "buried power." *Many of the basic principles covered in this section for buried electrical cable can be applied generally to all buried utilities.* The relevant OSHA requirements for this module may be found in 29 CFR Part 1926, Subpart K, Electrical 1926.400 – 449.

Time

60 minutes (9:20 – 10:20 a.m.)
(A 10-minute break follows this module)

Objectives

Show slides 7.1 – 7.3

After completion of this module, participants will be able to:

- Recognize basic electrical hazards
- Identify key safe work practices for using electrical equipment, including portable power tools and extension cords
- Recognize the need for and use of GFCI protection
- Recognize responsibilities for preventing and eliminating electrical hazards
- Recognize the requirements for safe use of electrical equipment
- Recognize the hazards and mitigation techniques for identifying buried electrical cable and other utilities

	▪ Recognize the hazards (and mitigation techniques) of working near overhead power lines ▪ Recognize the general requirements of Subpart K, Electrical
Materials and Resources	PowerPoint Slides: Module 7 Activity: Appendix 7-A

Module 7: Electrical Safety
Instructional Strategy and Course Content

Facilitator Notes	Lesson
Lecture  1. What do the terms volts, ohms, amps and current mean? *Show Slide 7.4.*	**1. What do the terms volts, ohms, amps, and current mean?** ▪ ***Voltage*** is the force or pressure that causes electricity to flow through a conductor (wire). It is measured in ***volts***. (Think of water held behind a dam.) ▪ An ***Ohm*** is the measurement of ***resistance*** that impedes the flow of electricity through a conductor. (Think of pipes carrying water. The pipe size restricts the amount of water that can flow.) ▪ An ***Amp*** is the measurement of ***current*** – the flow of electrons – from the source of voltage through a conductor. (Think of water moving through a pipe.)
 2. How much electricity will hurt me, and how? *Show Slide 7.5.*	**2. How much electricity will hurt me and how?** For death to occur, the body must become part of an electrical ***circuit*** having enough current to over stimulate the nervous system and/or cause damage to internal organs. The actual amount of damage depends on the amount of current (amps), the pathway of electricity as it passes through the body, and the duration of the event.
 3. What are some basic precautions to keep in mind when working around energized power sources? *Show Slides 7.6 – 7.8.*	**3. What are some basic precautions to keep in mind when working around energized power sources?** When working near or with electrical sources, it is very important to regularly employ safe work practices. These include: ▪ De-energizing electric equipment before inspecting or making repairs ▪ Using electric tools that are in good repair ▪ Using care and good judgment when working near energized lines ▪ Obtaining information about the location of buried utilities before excavating ▪ Using appropriate protective equipment.
 4-5. What are some examples of electrical hazards? *Slide 7.9; flip chart question and answer discussion*	
	**4. What do the terms "insulation" and "grounding" mean?** Insulation and grounding are two recognized means of preventing injury during electrical equipment operation. "Insulation" deals with placement of nonconductive material, such as plastic, around the wire or "conductor" which transmits electrical energy. "Grounding" is the-

process of making a direct connection of electrical power to a known ground such as a metal cold water pipe or a wired buried in the ground to prevent electrical shock.

5. What are some examples of electrical hazards?
Consider the metal housing or enclosure around a motor or the metal box in which electrical switches, circuit breakers, and controls are placed. Such enclosures protect the equipment from dirt and moisture and prevent accidental contact with exposed wiring. However, there is a hazard associated with housings and enclosures. A malfunction within the equipment—such as deteriorated insulation—may create an electrical shock hazard. Many metal enclosures are connected to a ground to eliminate the hazard.

If a "hot" wire contacts a grounded enclosure, a ground fault results which normally will trip a circuit breaker or blow a fuse. Metal enclosures and containers are usually grounded by connecting them with a wire going to ground. This wire is called an equipment-grounding conductor. Most portable electric tools and appliances are grounded by this means.

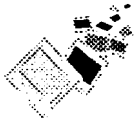
There is one disadvantage to grounding: a break in the grounding system may occur without the user's knowledge. Insulation may be damaged by hard usage on the job or simply by aging. If this damage causes the conductors to become exposed, the hazards of shocks, burns, and fire will exist.

Double insulation may be used as additional protection on the live parts of a tool, but double insulation does not provide protection against defective cords and plugs or against heavy moisture conditions. The use of a ground-fault circuit interrupter (GFCI) is one method used to overcome grounding and insulation deficiencies. GFCI's will be discussed later in this unit.

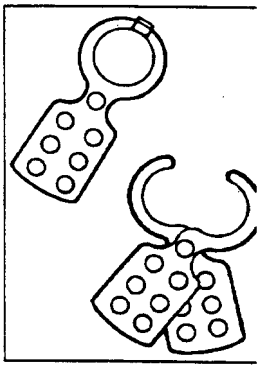
6. What are an employer's responsibilities regarding worker protection? *Show Slide 7.10.*

6. What are an employer's responsibilities regarding worker protection?
In the area of electrical safety related to power tools and equipment, employers have two choices. They may use *Ground-Fault Circuit Interrupters* (GFCIs) for receptacle outlets that are not part of the permanent wiring of the construction site, or they may conduct a scheduled and recorded *Assured Equipment Grounding Conductor Program*, covering all cord sets, receptacles which are not part of the permanent wiring of the construction sites, and equipment connected by cord and plug which are available for use or used by employees.

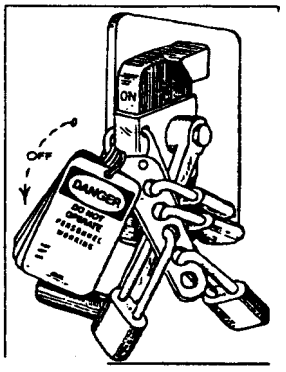
Facilitator Notes	Lesson
7. What is a GFCI? *Show Slides 7.11 – 7.13* 	**7. What is a GFCI?** The ground-fault circuit interrupter (GFCI) is a fast-acting circuit breaker that senses small imbalances in the circuit caused by current leakage to ground. When detected, in a fraction of a second, the GFCI shuts off the electricity. The GFCI continually matches the amount of current going to an electrical device against the amount of current returning from the device along the electrical path. Whenever the amount "going" differs from the amount "returning" by approximately 5 milliamps, the GFCI interrupts the electric power within as little as 1/40 of a second. A GFCI provides protection against the most common form of electrical shock hazard—the ground fault. It also provides protection against fires, overheating, and destruction of insulation on wiring. However, the GFCI will not protect the employee from line-to-line contact hazards (such as a person holding two "hot" wires or a hot and a neutral wire in each hand). GFCIs can be used successfully to reduce electrical hazards on construction sites. Wet connectors and tools sometimes cause tripping of GFCIs (interruption of current flow). It is good practice to limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors. Providing more GFCIs or shorter circuits can prevent tripping caused by the cumulative leakage from several tools or by leakage from extremely long circuits.
8. What are the elements of an Assured Equipment Grounding Conductor Program? *Show Slides 7.14 – 7.15* 	**8. What are the elements of an *Assured Equipment Grounding Conductor Program*?** An assured equipment grounding conductor program covers all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and equipment connected by cord and plug which are available for use or used by employees. OSHA requires that a written description of the employer's assured equipment grounding conductor program, including the specific procedures adopted, be kept at the job site. This program must outline the employer's specific procedures for the required equipment inspections, tests, and test schedule. The required tests must be recorded, and the record maintained until replaced by a more current record. The written program description and the recorded tests must be made available—at the job site—to OSHA and to any affected employee upon request. The employer is required to designate one or more competent persons to implement the program.

Facilitator Notes	Lesson
	Electrical equipment noted in the assured equipment grounding conductor program must be visually inspected for damage or defects before each day's use. The employee must not use any damaged or defective equipment until repaired.
9. What are the proper procedures for caring for electrical cords? *See slides 7.16 – 7.20.* 	**9. What are the proper procedures for caring for electrical cords?** With the wide use of portable tools on construction sites, the use of flexible cords often becomes necessary. Hazards are created when cords, cord connectors, receptacles, and cord- and plug-connected equipment are improperly used and maintained. Generally, flexible cords are more vulnerable to damage than fixed wiring. Flexible cords must be connected to devices and to fittings to prevent tension at joints and terminal screws. Because a cord is exposed, flexible and unsecured, joints and terminals become more vulnerable. Flexible cord conductors are finely stranded for flexibility, but the strands of one conductor may loosen from under terminal screws and touch another conductor, especially if the cord is subjected to stress or strain. A flexible cord may be damaged by activities on the job, by abrasion from adjacent materials, or simply by aging. If the electrical conductors (wires) become exposed, there is a danger of shocks, burns, or fire. When a cord connector is wet, hazardous leakage can occur to the equipment-grounding conductor and to workers who pick up that connector if they also provide a path to ground. Such leakage is not limited to the face of the connector but also develops at any wetted portion of it. To protect against electrocution when using extension cords, regularly inspect and repair or replace damaged cords.
10. Should similar precautions be taken with power tools and their cords? *Show slide 7.21.* 	**10. Should similar precautions be taken with power tools and their cords?** To maximize their own safety, workers should always use tools that work properly. Tools must be inspected before use, and those found questionable need to be removed from service and properly tagged. Tools and other equipment should be regularly maintained. Inadequate maintenance can cause equipment to deteriorate, resulting in an unsafe condition. Tools that are used by employees to handle energized conductors must be designed and constructed to withstand the voltages and stresses to which they are exposed.

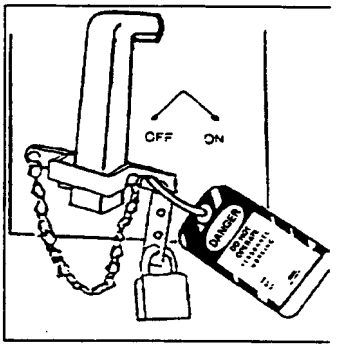
Safety Lockout-Tagout Methods



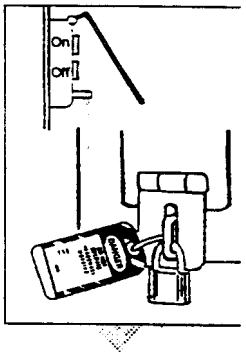
Multiple Lock Hasp



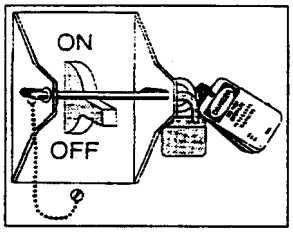
Lockout/Tagout of Main Power Switch



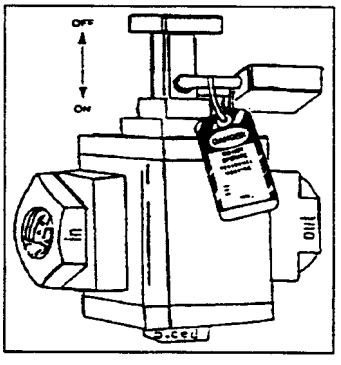
Rotary Type Switch Lockout



Hinged Plate and Common Hasp for Push Button Switch



Toggle Switch Lockout



Shut-off and Bleed Valve Lockout for Pneumatic Valves

Facilitator Notes	Lesson
11. What does lockout – tag-out mean and why is it important? *Show slides 7.22 - 7.26.* 	**11. What does "Lock-Out – Tag-Out" mean and why is it important?** The accidental or unexpected sudden starting of electrical equipment can cause severe injury or death. Before ***any*** inspections or repairs are made—even on the so-called low-voltage circuits—the current must be turned off at the switch box and the switch padlocked in the OFF position (locked-out). At the same time, the switch or controls of the machine or other equipment being locked out of service must be securely tagged to show which equipment or circuits are being worked on (tagged-out). Maintenance employees should be qualified electricians who have been well instructed in lockout procedures. No two locks should be alike; each key should fit only one lock, and only one key should be issued to each maintenance employee. If more than one employee is repairing a piece of equipment, each should lock out the switch with his or her own lock and never permit anyone else to remove it. The maintenance worker should be certain at all times that he or she is not exposing other employees to danger.

Facilitator Notes	Lesson
12. What if work is being conducted around overhead power lines? *Show slides 7.27 – 7.31.*	**12. What if work is being conducted around overhead power lines?** If work is to be performed near overhead power lines, the lines must be de-energized and grounded by the owner or operator of the lines, or other protective measures must be provided before work is started. Protective measures (such as guarding or insulating the lines) must be designed to prevent workers from contacting the lines. Unqualified employees and mechanical equipment must stay at least 10 feet (3.05 meters) away from overhead power lines. If the voltage is more than 50,000 volts, the clearance must be increased by 4 inches (10 centimeters) for each additional 10,000 volts. When mechanical equipment is being operated near over-head lines, employees standing on the ground may not contact the equipment unless it is located so that the required clearance cannot be violated even at the maximum reach of the equipment. Employees whose duties require that they work directly with electricity must use the personal protective equipment required for the jobs they perform. This equipment may consist of rubber insulating gloves, hoods, sleeves, matting, blankets, line hose, and industrial protective helmets.
13. Are employers required to train workers regarding electrical safety? *Show slides 7.32 – 7.35.*	**13. Are employers required to train workers regarding electrical safety?** To ensure that safe work practices are employed on roadway construction sites, employees must be aware of the electrical hazards to which they will be exposed. Employees must be trained in safety-related work practices as well as any other procedures necessary for safety from electrical hazards. That training must be commensurate to protect them from the hazards to which they are exposed. As in all situations, an effective safety and health program requires the cooperation of both the employer and employees.
	
Activity	**14. Activity — *Identify the Hazard*** Identify the hazards in the video clip.
	
14. Identify the hazards in the video clip, *Slides 7.36 – 7.37; see appendix 7-A*	

Facilitator Notes	Lesson
15. Elicit additional questions and summarize. *Slide 7.38.* 	**15. Question and summary period.**
16. Transition to prepare participants for Module 9.	**16. Transition to Module 9.**
Instructor Note: When planning your program, remember to use the OSHA rules and regulations as a guide to ensure employee safety and health. Following these rules and regulations will help reduce the number of injuries and accidents from electrical hazards.	

Identify the Hazard – Crane & Electrical Safety

Objective: This short activity will allow participants to view a brief video clip and the list the hazards that they have observed in the clip. It is designed to serve as a means for the instructor to summarize lessons in Modules 6 & 7 regarding equipment safety and overhead power lines.

Materials:

- Power Point Slides 7.34 & 7.35 (Double click the image to begin video). The Instructor may want to play the clip several times to allow students to watch it carefully.

Time: 10 minutes

Activity: Instruct the students that they are to watch the video clip and identify all the hazards that they observe. (You may also ask them to identify safety practices as well.) After reviewing the clip, ask students to share their observations with the class.

Important points to identify are:

- Danger of overhead power lines
- Protecting the swing radius of the crane
- Worker understanding of hazards around operating equipment
- The placement of the water cooler "luring" workers into a dangerous situation