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# AVOIDING ELECTROCUTION HAZARDS

## MODULE DESCRIPTION

This module will provide information that helps you recognize and avoid common electrocution hazards in your work environment.

## OBJECTIVES

After completing this module, students will be able to:

- Identify common electrocution hazards
- Describe types of electrocution hazards
- Protect yourself from electrocution hazards
- Recognize employer requirements to protect workers from electrocution hazards

## MODULE OUTLINE

### 1. Introduction

- People who work directly or indirectly with electricity can be the victims of serious electrocution injury or death on construction sites. These accidents occur when:
  - Construction equipment comes into contact with high power lines
  - Wires are not properly insulated
  - Wires are not properly moved or labeled during work
  - Electricity is not turned off before work begins
  - Workers do not know the location of underground power lines
  - Workers do not ask local utility companies for power line information.
- The Occupational Safety and Health Administration (OSHA) recognizes electricity as a serious workplace hazard and implemented electrical standards to protect employees exposed to dangers such as electric shock, electrocution, fires, and explosions.
- Electrocutation results when a person is exposed to a lethal amount of electrical energy.

## 2. Leading Causes of Construction Industry Deaths (Fatal Focus Four)

- Bureau of Labor Statistics (BLS) of the U.S. Department of Labor is the principal Federal agency responsible for measuring working conditions.
- Falls
- Struck by an object
- Getting caught in or between objects
- Electrocution - In 2005, the BLS concluded that:
  - Electrocution was the fourth leading cause of construction deaths causing 9% of 1,243 construction worker deaths, but accounted for less than 1% of reported recordable non-fatal injuries.
  - From 2003-2005, the death rate from electrocutions for the construction industry was 1.1 per 100,000 full-time workers, an average of 121 electrocutions per year.
  - Electrical power installers, repairers, and earth drillers had the highest electrocution death rates.
  - The construction occupations with the highest number of electrocution deaths were:
    - Electricians (29)
    - >Construction laborers (19)
    - Supervisors and managers (13)
    - Electrical power installers and repairers (10)

## 3. Identify Common Electrocution Hazards

- Burns - Most common shock-related injury resulting in electrical, arc flash, or thermal contact injuries
- Electrocution - Means to kill with electricity and occurs when a person is exposed to a lethal amount of electrical energy
- Shock - A reflex response to the passage of electric current through the human body and results when electric current enters the body at one point and leaves through another
- Arc Flash or Arc Blast - Sudden release of electrical energy through the air that gives off thermal radiation (heat) and bright, intense light that can cause burns. Temperatures have been recorded as high as 35,000 °F
- Fire - Fixed wiring, such as faulty electrical outlets and old wiring, is the most common cause. Problems with extension and appliance cords, plugs, receptacles, and switches are also responsible
- Explosions - Can occur when electricity ignites an explosive mixture of materials in the air

## 4. Types of Electrocution Hazards/Common Electrocution Dangers in the Construction Industry

- **Contacting overhead power lines**
  - Overhead and buried power lines are especially dangerous to workers because they carry extremely high voltage ranging

from 120 to 750,000 volts.

- The most reliable way to know a power line's voltage is to ask the utility company that owns the line.
- Working in the vicinity of high voltage power lines exposes workers burns, falls from elevations, and fatalities due to electrocution. Workers often encounter electrocution hazards while working on cranes, ladders, man-baskets, or other equipment under or near power lines
- Some overhead power lines have a protective covering. Although, this covering protects power lines from exposure to the elements, it does not protect workers from electrocution. If you touch a power line, covered or bare, death is possible
  - **Contacting energized sources**, such as live parts, damaged or bare wires, defective equipment, or tools
    - Electrical shock and burns are the major dangers from contact with energized sources
    - Electrical shock happens when an individual comes in contact with
      - both wires of an electrical circuit
      - one wire of an energized circuit and the ground, or
      - a metallic part that is energized by contact with an electrical conductor
        - Electrical shock results when the body becomes part of the electrical circuit and current enters the body at one point and leaves through another. The severity and effects of an electrical shock depend on the following:
          - Pathway through the body
          - Amount of current
          - Length of time of the exposure
          - Presence of water on the skin because water is a great conductor of electricity, allowing current to flow more easily in wet conditions and through wet skin
      - Electrical Burns - among the most serious burns and require immediate medical attention; occur when an electric current flows through tissue or bone, generating heat that causes tissue damage, the body cannot dissipate the heat generated by current flowing through the resistance of the tissue, burns occur
      - Arc or Flash Burns - caused by an electric arc or explosion, an arc flash, or blast, is a short circuit through the air where the electricity flashes over from one exposed live conductor to another conductor or to ground, a nearby person can act as the conductor and be flash burned
      - Thermal Contact Burns - occur when skin comes in contact with hot equipment
    - **Using extension or flexible cords improperly**
      - Flexible extension cords are more susceptible to damage than fixed wiring because they are exposed and unsecured
      - Workers create hazards when cords, cord connectors, receptacles, and cord- and plug-connected equipment are not used and maintained properly

## 5. Electrocution Safety Methods

- Maintain a safe distance from overhead power lines
- Use ground-fault circuit interrupters
- Inspect extension cords and portable tools
- Use power tools and equipment as designed
- Follow proper lockout/tagout procedures

## 6. Safety Practices for Working Near Power Lines

- Avoid electrocution - safe power line clearance distance for various line voltages:

<b>Voltage (nominal, kV, alternating current)</b>	<b>Minimum Clearance Distance (feet)</b>
50 or less	10
Over 50 to 200	15
Over 200 to 350	20
Over 350 to 500	25
Over 500 to 750	35
Over 750 to 1000	45
Over 1000	Established by the power line owner, operator, or registered engineer who is qualified to assess electrical power transmission and distribution

- Working safely around power lines
  - Make sure that equipment and work activity is a safe distance away from power lines
  - Verify that the utility company has de-energized and visibly grounded the power lines or installed insulated sleeves on power lines
  - Confirm that flagged warning lines mark horizontal and vertical power line clearance distances
  - Be sure that tools and materials are nonconductive.
- Working safely around Cranes and other high reaching equipment
  - Verify the voltage of nearby power lines to determine the safe working distance
  - Use an observer, insulated link, boom cage guard, or proximity device, if applicable
- Working safely around Mobile heavy equipment
  - Use rider posts, when available, to prevent getting too close to power lines
- Working safely around Ladders
  - Use ladders made of nonconductive materials

- Retract ladder before moving them
- Working safely around Material Storage
  - Do not store materials under power lines
  - Use caution tape and signs to restrict areas under power lines
- Working safely around Excavations
  - Locate underground lines before digging
  - Know the local underground line locator service's markings
  - Hand dig within three feet of underground cables
  - Be aware that more than one underground cable may be buried in an area of locator markings

## 7. Using Ground Fault Circuit Interrupters (GFCI)

- A ground fault circuit interrupter (GFCI) is designed to protect people from severe and sometimes fatal electrocution by:
  - Monitoring the current-to-load for leakage to ground
  - Detecting when the leakage exceeds 5 mA  $\diamond$  1 mA, which is a ground fault
  - A safe and healthful workplace
  - Interrupting the flow of electric current by tripping quickly enough to prevent electrocution
  - Sense the current flowing through the worker
  - Trip the circuit
  - Cut off the electricity.
- Three types of GFCIs
  - Receptacle GFCI
    - Protects users from ground faults when someone connects electrical equipment to a GFCI protected outlet
    - Fits into the standard outlet box
    - Used on outdoor construction work sites and locations where wet conditions do or could exist
    - Workers should test after installation and once a month thereafter
  - Temporary or Portable GFCI
    - Contains an extension cord combined with a GFCI
    - Allows workers to use receptacles not protected by GFCIs
    - Used when permanent protection is not available
    - Workers should test before every use
  - Circuit Breaker GFCI
    - Controls an entire circuit
    - Replaces a circuit breaker on the main circuit board
    - Protects the entire circuit eliminating the need to install multiple GFCI outlets

- Protects specific circuits when installed in a panel box at work sites equipped with circuit breakers
- Used on outdoor construction work sites and locations where wet conditions do or could exist
- Workers should test after installation and once a month thereafter.

## 8. Inspecting Extension Cords and Portable Tools

- When working with extension cords and portable tools, workers should always inspect them for cuts or abrasions, damaged insulation, and/or exposed metal parts
- When using flexible cords with temporary and portable lights, be sure they are:
  - Designed for hard or extra-hard usage
  - Marked with the usage type designation size and number of conductors
  - Marked with a 14/3 meaning the cord's conductor size (AWG) is 14 and the number of conductors is three
- Even when the power system is properly grounded, electrical equipment can instantly change from safe to hazardous due to extreme conditions or rough handling. Therefore, it is important that workers follow these tool safety tips.
  - Use only approved equipment
  - Use all equipment according to the manufacturer's instructions
  - Never carry a tool by the cord
  - Never yank the cord to disconnect a tool
  - Keep cords away from heat, oil, and sharp edges
  - Disconnect when not in use and when changing accessories such as blades and bits
  - Avoid accidental starting
  - Do not hold fingers on the switch while carrying a plugged-in tool
  - Use gloves and appropriate footwear
  - Store in dry a place when not in use
  - Do not use in wet or damp environments
  - Keep working areas well lit
  - Ensure that cords do not cause a tripping hazard
  - Remove damaged tools from use
  - Use double-insulated tools

## 9. Following Proper Lockout/Tagout Procedures

- Lockout and tagout (LOTO) or lock and tag is an essential safety procedure that protects workers from injury while working on or near electrical circuits and equipment because LOTO:
  - Locks the device or power source and prevents the turning on of hazardous power sources while performing maintenance

- or servicing work
- Requires workers to place a tag on the locked device indicating that it should not be turned on. When using a tag, other energy isolation techniques may be necessary to maintain worker safety
- Prevents contact with operating equipment parts such as, blades, gears, shafts, etc.
- Prevents the unexpected release of hazardous gases, fluids, or solid matter in areas where workers are present
- When performing LOTO on circuits and equipment, do the following:
  - Identify all sources of electrical energy for the equipment or circuits in question
  - Disable backup energy sources, such as generators and batteries.
  - Identify all shut-offs for each energy source
  - Notify all personnel that equipment and circuitry must be shut off, locked out, and tagged out because just turning a switch off is not enough
  - Shut off energy sources and lock switch gear in the OFF position. Each worker should use his or her individual lock and key and keep them on their person
  - Test equipment and circuitry to ensure they are de-energized. This must be done by a qualified, competent person
  - Deplete stored energy by bleeding, blocking, or grounding
  - Apply a lock or tag to alert other workers that an energy source or piece of equipment has been locked or tagged out
  - Make sure all workers are safe and accounted for before equipment and circuits are unlocked and turned back on. Only a qualified person can determine when it is safe to re-energize circuits

#### 10. Employers' Responsibilities for Protecting Workers

- OSHA expects employers to take every precaution to protect workers from electrocution by:
  - Ensuring overhead power line safety
  - Isolating electrical parts
  - Supplying ground-fault circuit Interrupters
  - Implementing an assured equipment grounding conductor program (AEGCP)
  - Ensuring the safety of power tools
  - Ensuring proper guarding
  - Providing training
  - Enforcing LOTO safety-related practices
  - Ensuring proper use of flexible cords

#### 11. Employer Responsibility #1: Ensuring Overhead Power Line Safety

- Before work begins near overhead power lines

- Confirm that the lines' owner or operator has de-energized and grounded the lines
- Provide personal protective equipment (PPE), such as rubber insulating gloves, hoods, sleeves, matting, blankets, line hoses, and industrial protective helmets
- Take other protective measures to prevent contact with the lines, such as guarding or insulating the lines
- Most important ways employers can minimize power line hazards are to:
  - Maintain a safe distance from lines.
  - Ask the power company to:
    - De-energize and ground power lines
    - Keep a power company representative on site
    - Install insulated sleeves, known as eels, over power lines
  - Train workers about power line hazards and available protective measures
  - Inform workers about jobs with electrical hazards and how to control these risks
  - Encourage workers to ask questions if they have any doubts about maintaining safe working conditions

#### 12. Employer Responsibility #2: Isolating Electrical Parts

- Employers are expected to:
  - Protect electrical parts, conductors entering boxes, cabinets, and fittings from abrasion. Close openings through which conductors enter
  - Close unused openings in cabinets, boxes, and fittings. Cover pull boxes, junction boxes, and fittings
  - Ground metal covers
  - Cover each outlet box, faceplate, or fixture canopy in energized installations
  - Install proper bushings or provide smooth, well-rounded surfaces for flexible cords to pass through

#### 13. Employer Responsibility #3: Supplying Ground-Fault Circuit Interrupters

- According to OSHA's ground-fault protection rules and regulations, employers must:
  - Supply approved GFCIs on all 120-volt, single-phase, 15- and 20-ampere receptacle outlets on construction sites that are not a part of a building or structure's permanent wiring
  - Supply approved GFCIs for extension cords with receptacles
  - Install GFCI circuit breakers in the main circuit board to protect an entire circuit

#### 14. Employer Responsibility #4: Implementing an Assured Equipment Grounding Conductor Program

- Per OSHA's requirements, employers must establish and implement an assured equipment grounding conductor program (AEGCP) that:
  - Outlines specific procedures for inspecting and testing required equipment



- Covers all cord sets, receptacles not part of a building or structure's permanent wiring of the, and equipment used by employees that is connected by a cord and plug
- Records the outcomes of continuity tests that ensure the equipment grounding conductor is electrically continuous
- Electrical equipment noted in the AEGCP must be visually inspected each day by a competent person for damage or defects before use. Any damaged or defective equipment must not be used by the employee until it is repaired
- Employers must make the written program description and recorded tests available, at the jobsite, to OSHA and any affected employee, upon request. The employer is required to designate one or more competent persons to implement the program.

#### 15. Employer Responsibility #5: Ensuring the Safety of Power Tools

- Employers need to ensure that all power tools and equipment are safe for workers to use by:
  - Grounding power supply systems, electrical circuits, and electrical equipment
  - Inspecting electrical systems frequently to ensure continuous path to ground
  - Verifying that ground prongs are present in tools or extension cords.
  - Grounding exposed metal parts of equipment
  - Communicating to workers the importance of inspecting electrical equipment before using

#### 16. Employer Responsibility #6: Ensuring Proper Guarding

- Effective guarding requires equipment with exposed parts operating at 50 volts or more to be:
  - Placed where they are accessible only to authorized people qualified to work with or on the equipment
  - Confined to ensure workers do not accidentally come into contact with the equipment's live parts
  - Enclosed in a room, vault, balcony, gallery, or elevated platform at least eight feet above the floor

#### 17. Employer Responsibility #7: Providing Training

- Employers should instruct workers using electric equipment in safe work practices to:
  - De-energize electric equipment before inspecting or repairing
  - Use cords, cables, and electric tools that are in good condition
  - Follow proper lock out tag out procedures
  - Use appropriate protective equipment

#### 18. Employer Responsibility #8: Enforcing LOTO Safety-Related Practices

- Lockout/tagout deactivated controls while working on energized or de-energized equipment or circuits.

- Attach tags on deactivated equipment or circuits at all points where they can be energized.
- Attach tags to identify equipment or circuits being worked on while any worker is exposed to contact with live parts.

#### 19. Employer Responsibility #9: Ensuring Proper Use of Flexible Cords

- The OSHA construction standard requires that flexible cords are:
  - Rated for hard or extra-hard usage
  - Show the rating every foot along the length of the cord
  - Extension cords must be 3-wire type so they may be grounded, and to permit grounding of any tools or equipment connected to them
  - Limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors