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OSHA Electrical Safety

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Goals

- Describe the basic characteristics of electricity and electrical hazards
- Describe the selection and use of safe electrical work practices
- Demonstrate understanding of proper selection and use of personal protective equipment (PPE)
- Describe electrical systems safeguards

How Electricity Works

- Electricity is the flow of electrons from one place to another
- Electricity needs a complete circuit in order to flow
- Conductors allow electricity to flow through them

Voltage and Current

- Electrical power is made up of two components: voltage and current
- Voltage is the difference of electrical potential between two points
- You will sometimes hear voltage referred to as “potential”
- Components with higher voltage have higher potential, and are therefore more likely to find a path to flow

Voltage and Current

- Current (measured in amps) is the flow of electric charge
- Going back to the hose analogy, the current is the actual flow of water, while the voltage is the difference in pressure
- It is the amount of amperage delivered to a person that determines the severity of their electric shock

Electrical Power

- Electrical power is the rate at which electrical energy is transferred in a system
- It is measured in watts (w)
- Electrical power is the combination of both voltage (v) and current (I)
- Power = current * voltage

Conductors

- Conductors are materials that have very little resistance to electrical flow
- The main factors that affect the ability of a conductor to transmit electricity are:
  - Temperature
  - Material
  - Length
  - Cross-sectional area

Conductors

- Some common conductors are:
  - Brass
  - Copper
  - Gold
  - Silver
  - Stainless steel

Insulators

- Insulators are materials that have a high resistance to electrical flow
- Insulators are used to shield electrical wiring and other components
- Insulators are also used for electrical personal protective equipment (PPE)

The Path of Electricity

- Electricity will also flow in the path of least resistance
- This means it will flow through conductors and be limited through insulators
- "Grounding" electrical equipment means providing a low-resistance path to ground
  - In the case of a malfunction or short, the electricity will flow through the grounding wire and avoid harming the user

Electrical Protective Devices

- These devices will interrupt the flow of electricity in the event of a fault
- Circuit breakers "open" to break the circuit
- Fuses "melt" or "blow" when they get hot from too much current
- Never replace or reclose a protective device until you have solved the source of the problem!

Ground Fault Current Interrupters (GFCIs)

- GFCIs sense a small amount of current flow to ground and immediately turn off power
- Should be used where electrical appliances may contact water
- Can be used with portable tools and extension cords
- Use GFCIs on all 120-volt, single-phase, 15- and 20-ampere receptacles, or have an Assured Equipment Grounding Conductor Program

Basic Electrical Hazards

- There are four basic hazards from working with electricity:
  - Electrical shocks and burns
  - Falls
  - Arc-flash burns
  - Arc-blast impacts

Electric Shocks

- The severity of an electric shock depends on three things:
  - The length of time current flows through the body
  - The path of current flow through the body
  - The amount of current (amps) flowing through the body

Falls

- Falls due to electrical exposure are a common hazard
- Workers should always de-energize circuits before performing work
- If working at height, use an electrically-safe fall protection system

Arc Flash and Arc Blast

- An arc flash occurs when there is a breakdown in the resistance of the air from a higher voltage source to a lower source or ground
- The current will “jump” through the air, causing a bright flash

Arc Flash and Arc Blast

- Arc flashes usually occur in systems such as:
  - Panel boards and switchboards
  - Motor control centers
  - Metal-clad switch gear
  - Transformers
  - Motor starters and drive cabinets
  - Fused disconnects
  - Any place that can have equipment failure
- This event vaporizes the wires into a giant plasma ball, which explodes violently, reaching nearly 35,000° Fahrenheit

Static Electricity

- Static electricity is created when two materials rub against each other
- Static shock can be hazardous to employees
- This hazard can be reduced by:
  - Grounding work stations
  - Using static electricity matting
  - Using electrical PPE

Flammable or Ignitable Materials

- Electrical systems can start fires in areas with fire hazards
- Electrical equipment capable of ignition should not be used in these areas
- If electrical equipment use is required, special precautions must be taken to prevent fires or explosions

Lockout Tagout

- While any employee is working on de-energized equipment, the isolation must be locked, tagged, or both
- The employer must provide procedures that address the isolation of the equipment and address any electrical safety hazards

Applying Locks and Tags

- A lock and a tag must be placed on each disconnecting means
- Each tag will contain a statement warning people not to operate the disconnecting means or remove the tag
- If a lock cannot be applied, a tag may be used without a lock
  - If a tag is used without a lock, one additional safety measure must be employed, such as blocking of a control switch

Applying Locks and Tags

- A lock may be placed without a tag if:
  - Only one circuit or piece of equipment is de-energized
  - The lockout period does not extend beyond the work shift
  - Employees exposed to the electrical hazards are familiar with this work procedure

Verifying Equipment is De-energized

- A qualified person must operate the equipment controls to verify the machine cannot be started
- A qualified person shall use test equipment to verify the circuit elements and test equipment are de-energized
- The person must ensure that no stored or back feed voltage exists in the circuit

Verifying Equipment is De-energized

- Test instruments and associated equipment such as leads, cords, and probes must be inspected before the equipment is used
- Damaged test equipment must be removed from service
- Test instruments must be rated for the system being tested

Re-Energizing Equipment

- Once work is completed, a qualified person must:
  - Conduct tests and visual inspections to make sure that all tools and other electrical devices have been removed so that the equipment can be re-energized safely
  - Ensure that the employees who hung their locks and tags have cleared them
  - Warn others to stay clear while energizing
  - Check the area to make sure all employees are clear of the hazard

Energized Parts

- If exposed parts are not de-energized, other safety-related work practices must be used to protect employees
- These work practices must protect employees against contact with energized parts by the body or other conductive objects
- These work practices must be suitable for the conditions and voltage level of the exposed circuit parts

Proper Lighting

- Employees may not enter spaces containing exposed energized electrical parts unless there is sufficient lighting to work safely
- Employees may not perform tasks near exposed energized parts if view of the work is obstructed

Conductive Materials

- Conductive materials and equipment must be handled in a way to prevent contact with exposed energized components
- Conductive personal items such as rings, key chains, necklaces, and watches may not be worn if there is a risk of contacting energized electrical equipment
- Portable ladders must have nonconductive side rails if used near exposed energized parts

Housekeeping

- Employees may not perform housekeeping duties in areas where there is a risk of contact with live electrical parts
- Electrically-conductive cleaning materials may not be used in proximity to energized parts unless procedures are followed to prevent electrical contact

Portable Electrical Equipment

- Drills, lighting, flexible power cords, and other portable electrical equipment have many hazards and must be handled carefully in a manner that does not damage them
- Inspect tools before using
- If employees will be working in highly conductive areas, such as places with water, the tools used must be specially approved for that location

Portable Electrical Equipment

- Portable electrical tools must:
  - Have a three-wire cord with ground plugged into a grounded receptacle, or
  - Be double insulated, or
  - Be powered by a low-voltage isolation transformer

Handling and Inspection of Cords

- Flexible electric cords may not be used for raising or lowering the equipment
- Never hold or hang a tool by the cord
- Do not fasten cords with staples
- Inspect the cords for evidence of damage. Worn insulation, excessive bending of the cords, or fraying are indicators of damaged cords

Equipment Grounding

- If the equipment must be grounded, the power cord must contain an equipment-grounding conductor
- If attachment plugs or adapters are used, they may not interrupt the continuity of the grounding
- Frequently inspect electrical systems to insure path to ground is continuous
- Don’t remove ground prongs from tools or extension cords, or alter the plug grounding poles
- Ground exposed metal parts of equipment

Connecting and Disconnecting

- Make sure that your hands are dry before connecting or disconnecting equipment
- Use electrical safety gloves if there is a chance of shock
- Check to make sure connections are an appropriate fit and are secure
- Only switches or circuit breakers should be used to de-energize running equipment

Personal Protective Equipment

- Any areas of the body that may contact electrical hazards must be protected
- The equipment used must be rated higher than the system voltage
- Always check to make sure that the PPE is electrically rated
- PPE must be kept in a safe and reliable condition, and must be periodically tested or inspected

Electrical Safety Gloves

- Electrical safety gloves must be inspected each day prior to use
- Check for tears, punctures, holes, or cuts
- Check for foreign objects stuck in the material
- Make sure the texture of the gloves has not changed
  - Swelling, cracking, softening, or hardening are all signs of damage

Warning Employees

- Employees must be warned of electrical hazards
- Safety signs and tags should be used to alert employees to hazards
- Non-conductive barriers should be used to prevent access to exposed electrical parts
- If barriers or signs are not enough protection, an attendant must be posted to alert employees of the hazard

Fires

- Class C fires are electrical fires
- The quickest way to put out the fire is to shut off the power
- DO NOT use water to put out electrical fires
- Use a class C extinguisher

Fire Prevention Plans

- Every employer must have a fire prevention plan which includes:
  - List of all major fire hazards
  - HAZMAT handling and storage procedures
  - Potential ignition sources and control measures
  - Type of fire protection required for each hazard
  - Control procedures for flammable or combustible materials
  - Safeguard maintenance procedures
  - Assign employee responsibility

In Case of Fire

- TURN OFF CIRCUIT
- Put fire out with dry chemical or CO2 extinguisher

Treatment of Electrical Shock

- DO NOT TOUCH THE PERSON IN CONTACT WITH ENERGIZED EQUIPMENT
- Do not try to pry them off
- TURN OFF THE CIRCUIT
- If unconscious or unresponsive, start CPR
- Run burned limb under cold water to slow the burning process
- Call 911

Summary

- Electricity will flow to the path of least resistance
- The four main hazards of electricity are:
  - Shocks and burns
  - Falls
  - Arc flash burns
  - Arc flash blast impacts

Summary

- Only qualified electrical workers can work on energized equipment, and only as a last resort. Lab staff should call for biomedical technicians
- Inspect power tools and cords prior to every use
- If there is any chance of contacting live electrical parts with any part of the body, electrical PPE must be used

OSHA Electrical Safety

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