Lunch Box Safety Webinar
Safety Over Sandwiches

JUNE: Basic Electrical Safety/Arc Flash

Presented by Joe Mlynek, Progressive Safety Services LLC
Discussion Outline

Qualified Persons/Training

Electricity/Electrical Hazards

Protection Against Electrical Hazards

Safe Work Practices/PPE
What makes an employee qualified to perform electrical work?
Qualified Persons

- Definitions found in several locations:
  - NFPA 70 – National Electric Code
    - NFPA 70B  Recommended Practice for Electrical Equipment Maintenance.
    - NFPA 70E  Electrical Safety in the Workplace
  - OSHA 1910 Subpart S – Electrical
    - 1910.303 General Requirements
    - 1910.334 Selection and Use of Work Practices
    - 1910.335 Safeguards for Personal Protection
Qualified Person – National Electric Code (NEC)/NFPA 70E

“One who has skills and knowledge related to construction and operation of electrical equipment and installations and has received safety training on the hazards involved.”
OSHA – Training

- Apply to employees who face a risk of electrical shock that is not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308

- Employees shall be trained in and familiar with the safety-related work practices required by 1910.331–1910.335 that pertain to their respective jobs.
OSHA – Content of Training

- Qualified persons shall at a minimum, be trained in and familiar with the following:

  - Skills and techniques to distinguish exposed live parts from other parts of electric equipment.
  - The skills and techniques to determine the nominal voltage of exposed live parts.
  - Clearance distances specified in 1910.333 and the corresponding voltages to which the qualified person will be exposed.
  - Proper use of personal protective equipment, insulating and shielding materials, and insulated tools.
Electrical Incidents

- Most commonly caused by:
  - Unsafe Equipment or Installation
  - Unsafe Environment
  - Unsafe Work Practices
Electricity

Characteristics
The Flow of Electricity

- Some materials such as metal offer little resistance to the flow of electric current.

- These materials are called conductors.
The Flow of Electricity

- There are materials that slow or stop the flow of electricity. Examples include:
  - Plastic
  - Porcelain
  - Glass
  - Dry Wood
  - Rubber

- These materials are called insulators.
Electrical Hazards

Shock
Conditions And Shock

- Dry skin acts as an insulator even when higher voltages are present.

- If skin is wet from perspiration, broken or the surrounding conditions are damp then the resistance drops and it becomes a conductor.

- Real Life Example
What Causes Shock

- Electricity travels in a closed circuit, normally through a conductor.
- Sometimes a person's body becomes part of the electrical circuit.
Effects of Shock on the Body

- Electrical shock can vary a slight tingling sensation to cardiac arrest. The severity depends on the following:
  - Amount of current
  - Current’s path through the body
  - Length of time the body remains part of the circuit
  - The currents frequency
Current passing through the heart and lungs is the most serious
Effects of Current on the Body

Ohm’s Law
Ohm's Law

- Ohm's Law  \( I = \frac{V}{R} \)
  - \( I = \) Current (Current Flow, Amps)
  - \( V = \) Voltage (Electrical Potential Between Two Points)
  - \( R = \) Resistance (Ohms)
Resistance

- Person working with 120 volts.
- Person Is Perspiring
- Average Resistance Is 1000 Ohms From Hand To Hand
Example: 120 volts and 1000 ohms of resistance

- $I = \frac{V}{R}$
- $I = \frac{120}{1000}$
- $I = 0.120$ AMPS OR $I = 120$ MA
## Current Values And Effects

<table>
<thead>
<tr>
<th>Current (mA)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mA</td>
<td>Tingling Sensations</td>
</tr>
<tr>
<td>5 mA</td>
<td>Slight shock felt, not painful but disturbing. Average individual can let go.</td>
</tr>
<tr>
<td>9 – 30 mA</td>
<td>Individual can not let go. Can be thrown away from circuit if extensor muscles are stimulated.</td>
</tr>
<tr>
<td>50–150 mA</td>
<td>Extreme pain, respiratory arrest, severe muscle contractions. Death possible.</td>
</tr>
<tr>
<td>1000 –4,300 mA</td>
<td>Rhythmic pumping action of heart ceases, nerve damage, death likely.</td>
</tr>
<tr>
<td>10,000 mA</td>
<td>Cardiac arrest, severe burns, death probable.</td>
</tr>
</tbody>
</table>
The longer the exposure, the greater the risk of serious injury.

Longer exposures to low voltages can be just as dangerous as short exposures to higher voltages.
Electrical Burns

- Most common shock related injury.

- Occur when electric current flows through:
  - Internal organs
  - Tissue
  - Bone

- Generate heat that causes tissue damage.
What should you do if someone “freezes” to a live electrical contact?

- Shut off current immediately.
- Use non-conducting material to push or pull the person away from the contact point.
- Always protect yourself from becoming part of the circuit.
Protection Against Electrical Hazards

Insulation, Guarding, Grounding, and Circuit Protection
Insulation

- Used to coat metals and other conductors to help stop or reduce the flow of electric current.

- Must be suitable to the voltage used.

- Must withstand the work environment:
  - Corrosives
  - Moisture
  - Others
Insulation

- Often Color Coded:
  - Grounding conductors
    - Green
    - Green with yellow stripes
  - Insulation covering grounded conductors is generally:
    - White
    - Grey
  - Ungrounded conductors (hot wires)
    - Red or black
Insulation

- Always check insulation for exposed wires or defects.

- Insulation in non-construction applications is regulated by OSHA:
    - Requires insulation on circuit conductors
  - Subpart K of 29CFR1926.402 through 1926.408
Guarding

- Enclosing live electrical equipment to make sure that people don’t make accidental contact.

- Equipment with exposed parts operating at 50 volts or more to be placed where accessible only to authorized people to work with it.
Guarding

- Signage posted at entrances to electrical rooms and similarly guarded locations to alert people to electrical hazards.

- Language on Signs
  - Danger
  - Warning
  - Caution

- Instructions such as “Danger/High Voltage/Keep Out” or similar.
Grounding

- Intentionally creating a low resistance path that connects to the earth.

- Usually a secondary protective measure to protect against electrical shock.

- Doesn’t always guarantee elimination of shock potential but will reduce the risk.
Grounding

- A “service” or “system” ground is designed to protect machines, tools, and insulation against damage.

- The neutral or grounded conductor is grounded.

- An equipment ground helps protect the equipment operator by furnishing a second path for the current to pass from the tool or machine to ground.
Circuit Protection Devices

- Limit or stop the flow of current automatically in the event of a ground fault, overload, or short circuit in the wiring system. Examples:
  - Circuit Breaker
  - Fuse
  - Ground Fault Circuit Interrupter
  - Arc Fault Circuit Interrupters
Circuit Protection Devices

- When too much current flow through them:
  - Fuses melt
  - Circuit breakers trip

- Fuses and circuit breakers are designed to protect conductors and equipment from overheating.
Ground Fault Circuit Interrupters (GFCI)

- Used in wet locations, construction sites, and other high risk areas.
- Interrupt the flow of electricity in as little as 1/40th of a second to prevent electrocutions.
- Compare the amount of current going into the electric equipment with the amount of current returning.
- If the difference exceeds 5 mA, the device automatically shuts off the electric power.
Safe Work Practices

Protecting yourself from electrical hazards.
Safe Work Practices

- Electrical incidents can be prevented by using safe work practices such as:
  - De-energizing electrical equipment before inspection or repair.
  - Keeping electric tools properly maintained.
  - Exercising caution when working near energized lines.
  - Using appropriate protective equipment.

- Electrical safety related work practice requirements for general industry are detailed in:
Safe Work Practices

- Ensure that cord and plug equipment has a three prong plug or is double insulated.
- Utilize lockout/tagout to de-energize systems being repaired or inspected.
Safe Work Practices

- Maintain safe distances from overhead power lines.
  - Other opportunities – de-energize or insulate lines.
  - Maintain at least 10 foot of clearance.
  - Avoid contact with equipment being operated near overhead power lines.
Safe Work Practices

- Always have underground utilities indentified prior to excavating.
Personal Protective Equipment

Protect yourself
Safe Work Practices PPE

- Utilize Electrical PPE:
  - Insulated gloves
  - Leather Protective Gloves
  - Sleeves
  - Blankets
  - Class E hardhats
Personal Protective Equipment

- Must be maintained in a safe and reliable condition.
- Inspected and tested in accordance with 1910.137.
HAND PROTECTION

- Inner rubber insulated glove
- Protective leather outer gloves
- Rubber insulated gloves tested every 6 months
# HAND PROTECTION

<table>
<thead>
<tr>
<th>ID Tag</th>
<th>Class</th>
<th>AC Proof Test Voltage</th>
<th>AC Max Use Voltage</th>
<th>DC Proof Test Voltage</th>
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</thead>
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<td>Beige</td>
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<td>2,500</td>
<td>500</td>
<td>10,000</td>
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<tr>
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<td>1,000</td>
<td>20,000</td>
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<td>Orange</td>
<td>4</td>
<td>40,000</td>
<td>36,000</td>
<td>70,000</td>
</tr>
</tbody>
</table>
Hand Protection

- OSHA Requirements for Gloves:
  - 1910.137(b)(2)(vii)
    - Protector gloves shall be worn over insulating gloves except as follows:
      - Protector gloves need not be used with Class 0 gloves, under limited use conditions, where small equipment and parts manipulation necessitate unusually high finger dexterity.
  - Always follow your Company guidelines.
Hand Protection

- OSHA Requirements
  - 1910.137 (b)(2)(vii)(B)
  - Any other class of gloves may be used for similar work without protector gloves if the employer can demonstrate that the possibility of physical damage to the gloves is small and if the class of glove is one higher than that required for the voltage involved.

- Always follow your Company’s guidelines.
Head Protection

- 1910.335

- Head protection shall be worn whenever there is a danger of head injury from shock or burns due to contact with exposed electrical parts.
Head Protection

- Hardhat Classifications
  - Class G – 2,200 volts
  - Class E – 20,000 volts
Face Protection

- 1910.335

- Employees shall wear protective equipment for the eyes wherever there is a danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from explosion.
Tools

1910.335

When working near exposed conductors or circuits, each employee shall use insulated tools or handling equipment if the tools might make contact with conductors.
INSULATED TOOLS

- Symbol of overlapped triangle (double delta)
- Labeled “Ac1000v”
- SOME TOOLS MAY LOOK INSULATED BUT ARE IN FACT NOT!
INSULATED TOOLS

- 1910.335

- Fuse handling equipment, insulated for circuit voltage, shall be used to remove or install fuses when terminals are energized.
Other Protective Measures

- **1910.335**
  - Shields
  - Barriers

  - Must restrict access to exposed live parts during maintenance and repair.

  - Protect unqualified persons from contact with live parts.
Safety Signs

- 1910.335

- Safety signs, symbols, or tags shall be used where necessary to warn employees about electrical hazards that may endanger them.
Apparel

- Use non-conductive apparel
- Natural Fibered or FR clothing
- No synthetic clothing
Electrical PPE

- Maintained in a safe and reliable condition.
- Free of defects
  - Holes
  - Tears
  - Punctures
  - Cuts
  - Embedded object
Electrical PPE

- Store in an area to protect from:
  - Light
  - Temperature Extremes
  - Excessive Humidity
  - Hazardous Chemicals
Other considerations

- One hand work
- Working in pairs
- Fiberglass ladders
Questions???

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