

Construction Focus Four: Electrocution Hazards Student Handouts

- “Construction Focus Four: Electrocution, Safety Tips for Workers” tri-fold brochure format
- Focus Four Toolbox Talks 1, 2, and 3 produced by IUOE National Training Fund under OSHA grant number SH-16591-07-06-F-11
- OSHA Quick Card™ “Electrical Safety”

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General Rules for Construction Electrical Safety

MAJOR PROTECTIVE METHODS FROM ELECTRICAL HAZARDS

Protection from electrical hazards generally includes the following methods:

1. **DISTANCE:** Commonly used with regard to power lines.
2. **ISOLATION AND GUARDING:** Restricting access, commonly used with high voltage power distribution equipment.
3. **ENCLOSURE OF ELECTRICAL PARTS:** A major concept of electrical wiring in general, e.g., all connections are made in a box.
4. **GROUNDING:** Required for all non-current carrying exposed metal parts, unless isolated or guarded as above. (However, corded tools may be either *grounded* OR be *double-insulated*.)
5. **INSULATION:** Inact insulation allows safe handling of everyday electrical equipment, including corded tools. Category also includes insulated mats and sleeves.
6. **DE-ENERGIZING AND GROUNDING:** Protective method used by electrical utilities and also in conjunction with electrical lockout/tagout.
7. **PERSONAL PROTECTIVE EQUIPMENT (PPE):** Using insulated gloves and other apparel to work on energized equipment, limited to qualified and trained personnel working under very limited circumstances.



Effects of Electric Current in the Human Body

Current / Reaction (1,000 milliamperes = 1 amp; therefore, 15,000 milliamperes = 15 amp circuit)
Below 1 milliampere Generally not perceptible
1 milliampere Faint tingle
5 milliampere 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



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Construction Focus Four: Electrocution Safety Tips for Workers

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- Electrical Safety Overview
- General Rules for Electrical Work
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- General Rules for Construction Electrical Safety
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Electrical Safety Overview

- 1. CORD AND PLUG OPERATED** electric tools with exposed metal parts must have a three-prong grounding plug - **AND** be grounded - or else be double-insulated.
- 2. EQUIPMENT GROUNDING** only works when there is a permanent and continuous electrical connection between the metal shell of a tool and the earth.
- 3. PROPER POLARITY IN ELECTRICAL WIRING IS IMPORTANT:** hot to hot, neutral to neutral, equipment ground to equipment ground. Polarized plugs have a wider neutral blade to maintain correct polarity. **Reversed polarity can kill.**
- 4. CIRCUITS MUST BE EQUIPPED WITH FUSES OR CIRCUIT BREAKERS** to protect against dangerous overloads. Fuses melt, while circuit breakers trip to turn off current like a switch. **Overcurrent protection devices protect wiring and equipment from overheating and fires. They may, or may not, protect you.**
- 5. MOST 120 VOLT CIRCUITS** are wired to deliver up to 15 or 20 amps of current. Currents of 50 - 100 milliamperes can kill you. ($1 \text{ mA} = 1/1,000 \text{ of } 1 \text{ amp}$.)
- 6. WET CONDITIONS LOWER SKIN RESISTANCE**, allowing more current to flow through your body. Currents above 75 milliamperes can cause ventricular fibrillation, which may be fatal. Severity of a shock depends on: path of current, amount of current, duration of current, voltage level, moisture and your general health.
- 7. A GROUND FAULT CIRCUIT INTERRUPTER (GFCI)** protects from a ground-fault, the most common electrical hazard. GFCIs detect differences in current flow between hot and neutral. They trip when there is current leakage - such as through a person - of about 5 milliamperes and they act within 1/40 of a second. Test a GFCI every time you use it. It must "Trip" and it must "Reset."
- 8. EXTENSION CORD WIRES MUST BE HEAVY ENOUGH** for the amount of current they will carry. For construction, they must be UL approved, have strain relief and a 3-prong grounding plug, be durable, and be rated for hard or extra-hard usage.
- 9. OVERHEAD POWER LINES CAN KILL.** The three major methods of protection are: maintaining a safe distance, de-energizing **AND** grounding lines, having the power company install insulating sleeves. Have a power company rep on the site.
- 10. UNDERGROUND POWER LINES CAN KILL.** Call before you dig to locate all underground cables. Hand dig within three feet of cable location!

General Rules for Electrical Work

- **Non-conductive PPE is essential for electricians. NO METAL PPE!** Class B hard hats provide the highest level of protection against electrical hazards, with high-voltage shock and burn protection (up to 20,000 volts). Electrical hazard, safety-toe shoes are non-conductive and will prevent the wearers' feet from completing an electrical circuit to the ground.
 - **Be alert to electrical hazards**, especially when working with ladders, scaffolds and other platforms.
 - **Never bypass electrical protective systems or devices.**
 - **Disconnect cord tools** when not in use and when changing blades, bits or other accessories.
 - **Inspect all tools** before use.
 - **Use only grounded extension cords.**
 - **Remove damaged tools and damaged extension cords** from use.
 - **Keep working spaces and walkways clear** of electrical cords.
- RULES FOR TEMPORARY WIRING AND LIGHTING**
- **Use Ground Fault Circuit Interrupters (GFCIs)** on all 15-Amp and 20-Amp temporary wiring circuits.
 - **Protect temporary lights** from contact and damage.
 - **Don't suspend temporary lights by cords**, unless the temporary light is so designed.



Condensed Electrical Glossary

AMPERE OR AMP: The unit of electrical current (flow of electrons). • One milliamper (mA) = 1/1,000 of 1 Amp.

CONDUCTORS: Materials, such as metals, in which electrical current can flow.

ELECTRICAL HAZARDS can result in various effects on the body, including: • **SHOCK** - The physical effects caused by electric current flowing in the body. • **ELECTROCUTION** - Electrical shock or related electrical effects resulting in death. • **BURNS** - Often occurring on the hands, thermal damage to tissue can be caused by the flow of current in the body, by overheating of improper or damaged electrical components, or by an arc flash. • **FALLS** - A common effect, sometimes caused by the body's reaction to an electrical current. A non-fatal shock may sometimes result in a fatal fall when a person is working on an elevated surface.

EXPOSED LIVE PARTS: Energized electrical components not properly enclosed in a box or otherwise isolated, such that workers can touch them and be shocked or killed. Some of the common hazards include: missing knockouts, unused openings in cabinets and missing covers. Covers must not be removed from wiring or breaker boxes. Any missing covers must be replaced with approved covers.

INSULATORS: Materials with high electrical resistance, so electrical current can't flow.

LOCKOUT/TAGOUT: The common name for an OSHA standard, "The control of hazardous energy (lockout/tagout)." Lockout is a means of controlling energy during repairs and maintenance of equipment, whereby energy sources are de-energized, isolated, and then locked out to prevent unsafe start-up of equipment which would endanger workers. Lockout includes - but is not limited to - the control of electrical energy. Tagout means the placing of warning tags to alert other workers to the presence of equipment that has been locked out. Tags alone **DO NOT LOCK OUT** equipment. *Tagout is most effective when done in addition to lockout.*

OHM or Ω : The unit of electrical resistance (opposition to current flow).

OHM'S LAW: A mathematical expression of the relationship among voltage (volts), current (amps) and resistance (ohms). This is often expressed as: $E = I \times R$. In this case, E = volts, I = amps and R = ohms. (The equation, Amps = Volts/Ohms, as used in this curriculum, is one form of Ohm's Law.)

VOLT: The unit of electromotive force (emf) caused by a difference in electrical charge or electrical potential between one point and another point. The presence of voltage is necessary before current can flow in a circuit (in which current flows from a source to a load - the equipment using the electricity - and then back to its source).

WET CONDITIONS: Rain, sweat, standing in a puddle - all will decrease the skin's electrical resistance and increase current flow through the body in the event of a shock. Have a qualified electrician inspect any electrical equipment that has gotten wet before energizing it.

Focus Four [Electrocution] Toolbox Talks 1:

What increases your risk of electrocution?

[Ask the following questions and give time for answers.]

What are the hazards? Bodily contact with electricity

What are the results? Shock, fire, burns, falls or death

What should we look for? Damaged equipment, faulty wiring, improper cord use, no GFCIs, wet conditions, reverse polarity, potential arc flash areas, lack of assured equipment grounding conductor program

[Relate this incident or, better, one you know.]

Actual Incident: A 40-year-old male plumber died after lying on his work light while installing plumbing under a house being remodeled. The victim was crawling under the house carrying the work light with him. The wire inside the work light's conduit became bare and energized the light's housing. Investigation of the incident showed a damaged work light was used with no GFCI. Also, the home's electrical system was not properly grounded.

[Ask the following question and ensure every item is covered.]

How do we prevent these results?

- Inspect all electrical equipment before use.
- Use GFCI with all power tools.
- Use intact and properly rated cords (i.e. correct AWG).
- Do not use damaged equipment - take it out of service.
- Institute an assured equipment grounding conductor program.
- Do not work in wet conditions with electricity.

[Ask the following questions about this site and ensure every item is covered.]

Let's talk about this site now.

- What factors increase your chance of being electrocuted?
- Can someone demonstrate how to inspect this tool for electrical safety? (If possible, provide a tool)
- What are some areas on the site that could use attention pertaining to electrical hazards?

[Record questions below that you want to ask about this site.]



What are the hazards shown in these photos?

Focus Four [Electrocution] Toolbox Talks 2:

What protective devices and procedures can you use to prevent electrocution?

[Ask the following questions and give time for answers.]

What are the hazards? Bodily contact with electricity due to faulty equipment, ungrounded or damaged equipment, wet conditions, etc.

What are the results? Shock, fire, burns, falls or death

What should we look for? Proper training in using engineering controls (e.g. GFCIs, proper cords), assured equipment grounding conductor written program, electrical testing meters

[Relate this incident or, better, one you know.]

Actual Incident: A 29-year-old male welder was electrocuted and died when he contacted an energized receptacle end of an extension cord. It was found that the welding unit and cord were incompatible; however, both the welding cord and extension cord were damaged allowing them to be used together. The result was an ungrounded system that killed a worker.

American Wire Gauge (AWG)	
Cord Size	Handles Up To
#10 AWG	30 amps
#12 AWG	25 amps
#14 AWG	18 amps
#16 AWG	13 amps

[Ask the following question and ensure every item is covered.]

How do we prevent these results?

- ☐ Inspect all electrical equipment before use.
- ☐ Use GFCI with all power tools.
- ☐ Use intact and properly-rated cords (i.e. correct AWG).
- ☐ Do not use damaged equipment - take it out of service.
- ☐ Institute an assured equipment grounding conductor program.
- ☐ Use testing meters, where appropriate, if you are trained to do so.

[Ask the following questions about this site and ensure every item is covered.]

Let's talk about this site now.

- ☐ Can someone explain how a GFCI works? (If possible, provide a GFCI to use).
- ☐ Who has read this site's assured equipment grounding conductor program?
- ☐ What are some of the requirements?



[Record questions below that you want to ask about this site.]

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Focus Four [Electrocution] Toolbox Talks 3:

How can we prevent electrocutions while using power tools?

[Ask the following questions and give time for answers.]

What are the hazards? Bodily contact with electricity

What are the results? Shock, fire, burns, falls or death

What should we look for? Tools that aren't double-insulated, damaged tools and cords, incorrect cords, wet conditions, tools used improperly

[Relate this incident or, better, one you know.]

Actual Incident: A 45-year-old male electrician was electrocuted when he contacted an energized 1/2" electric drill casing. The victim was working in wet conditions and using a single insulated drill attached to damaged extensions cords run through water.

[Ask the following question and ensure every item is covered.]

How do we prevent these results?

- ☐ Get proper training on manufacturers' tool use and specs.
- ☐ Inspect tool before each use according to manufacturers' instructions.
- ☐ Do not use damaged tools, remove them from service.
- ☐ Use only battery-powered tools in wet conditions.
- ☐ Use with GFCI.
- ☐ Use with properly sized and intact cords.



[Ask the following questions about this site and ensure every item is covered.]

Let's talk about this site now.

- ☐ What can lead to an electrocution while using power tools? *Non double-insulated tools, damaged cord, wet conditions*
- ☐ Have you seen or used any defective power tool?
- ☐ What should you do if you find a defective power tool?

[Record questions below that you want to ask about this site.]



Electrical Safety

Electrical hazards can cause burns, shocks and electrocution (death).

Safety Tips

- Assume that all overhead wires are energized at lethal voltages. Never assume that a wire is safe to touch even if it is down or appears to be insulated.
- Never touch a fallen overhead power line. Call the electric utility company to report fallen electrical lines.
- Stay at least 10 feet (3 meters) away from overhead wires during cleanup and other activities. If working at heights or handling long objects, survey the area before starting work for the presence of overhead wires.
- If an overhead wire falls across your vehicle while you are driving, stay inside the vehicle and continue to drive away from the line. If the engine stalls, do not leave your vehicle. Warn people not to touch the vehicle or the wire. Call or ask someone to call the local electric utility company and emergency services.
- Never operate electrical equipment while you are standing in water.
- Never repair electrical cords or equipment unless qualified and authorized.
- Have a qualified electrician inspect electrical equipment that has gotten wet before energizing it.
- If working in damp locations, inspect electric cords and equipment to ensure that they are in good condition and free of defects, and use a ground-fault circuit interrupter (GFCI).
- Always use caution when working near electricity.

For more complete information:

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Safety and Health
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U.S. Department of Labor
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OSHA 3210-10-10