Electrical Safety for Non-Electrical Workers

Module 1: Electrical Fundamentals

- Objective
  - Define electricity
  - Identify mechanisms for distributing electricity (how it travels)
  - Identify required actions to take following an electric shock.

What is Electricity?

- Electricity is a source of energy to power devices (e.g., lights, electrical drill, or a computer)
- If you compare electricity to water, voltage is the water pressure and current is the rate of flow
  - Just as with water, the higher the voltage (pressure) or greater the current (flow rate), the more dangerous electricity becomes

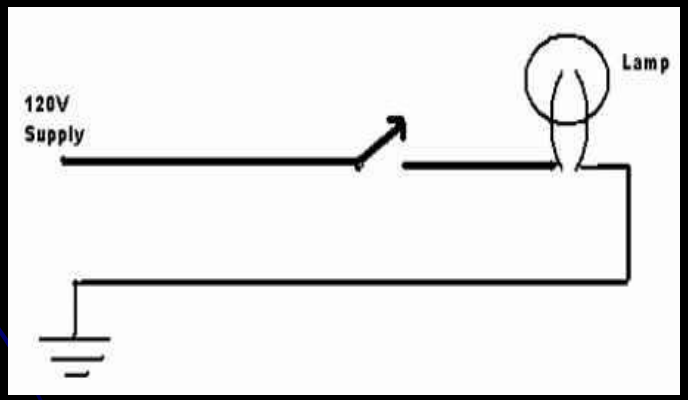
Two Basic Types of Electrical Energy

- Alternating Current (AC)
  - Power sources are generally supplied by generators found at hydroelectric, coal fired, or nuclear power plants
  - AC energy is distributed by above or underground power lines for end use in home, commercial, and industrial applications

- Direct Current (DC)
  - Power sources are generally supplied by batteries
  - Batteries in cell phones, lap tops, flashlights, Uninterruptable Power Supplies (UPS) or vehicles are sources of direct current (DC)

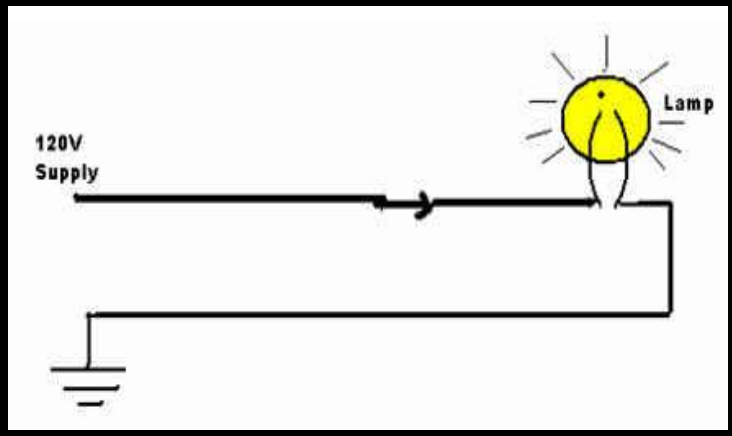
How does electricity travel?

- Consider a light switch circuit:
  - There is a source, typically 120 volts alternating current (VAC)
  - There is a switch controlling the source, a light bulb, and a return (typically at zero volts) or ground



How does electricity travel?

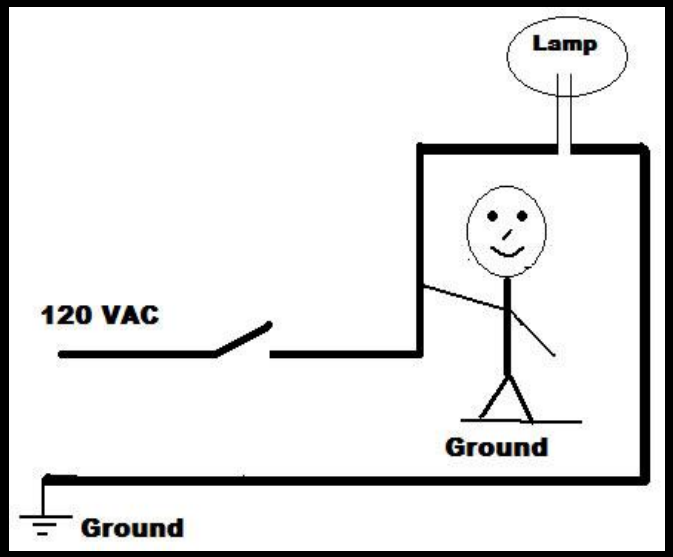
- In the light switch, current will only flow through the circuit if the switch is closed, creating a place for the energy to go
- This is created by a difference in voltage between the source (120 VAC) and the return (0 Volts)
- If there isn't a complete path in the circuit, current will not flow
- Once the switch is closed current flows and the lamp produces energy in the form of light



Electrical Shock

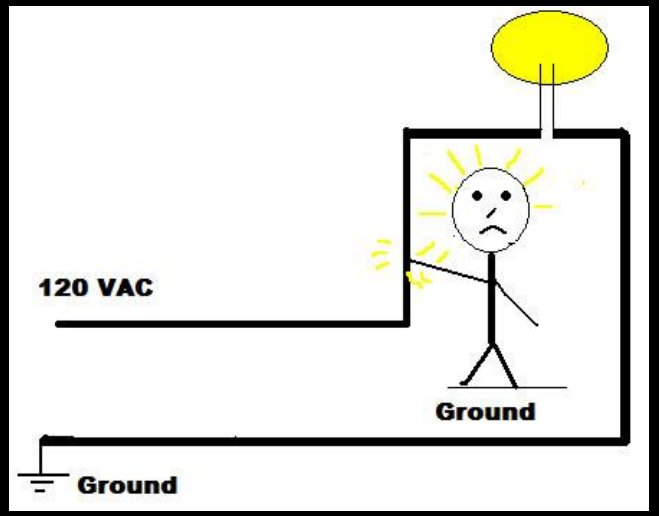
- Electric shock occurs when the human body becomes a conductor, completing the path for current to flow
- Basic electrical safety is that if a path is not complete, current will not flow, and shock will not occur
- Like water, electricity will take the path of least resistance. Current will most likely flow through a circuit instead of a human body unless the body presents a path of lower resistance.

Electrical Shock



Open circuit with worker grounded

Worker receiving electrical shock from lighting circuit



Effects of Shock

- Effects of electrical shock range from mild tingling to heart failure, depending on the amount of current
- Current as low as 50 milliamps can cause heart fibrillation
  - Heart fibrillation is where the ability of the heart to pump in a regular rhythm is disrupted
  - Given enough time in this state, it is usually fatal

Effects of Shock

- Severity of a shock is determined by amount of current and the path through the body
- If the current path is through the heart, there is a much greater chance of death than if the current passes from one finger to another
- At lower currents, respiratory paralysis can occur, also potentially fatal

Effects of Shock

- Direct effects include pain, paralysis, heart fibrillation, or tissue burn
- Indirect effects include confusion, amnesia, headaches, or breathing and heart irregularities
- Problems may last several days and progress into vision abnormalities and swelling of affected areas
- Over a victim's lifetime, long range effects may include paralysis, speech/writing impairment, loss of taste, and other disorders

What To Do When A Person Is Shocked

If victim is still engaged with or attached to the circuit:

- De-energize the circuit, if possible
- Remove victim from the circuit using non-conductive material (i.e., length of dry rope, dry broomstick, or leather belt)
- Call 6911 (cells phones at UAH call 824-6911) for help immediately
- Apply artificial respiration and CPR, if necessary

If victim is conscious, they still need medical treatment as soon as possible.

Electrical Shocks at UAH

Report all electric shocks to the Major Professor, Supervisor, Principal Investigator or other appropriate person to ensure that equipment is in a safe condition and an investigation can be completed, corrective actions performed, and lessons learned can be shared to help prevent a recurrence of the incident.

OEHS should be notified by the supervisor.

Arc Flash/Blast

- Arc Flash/Blast occurs when an energized source comes in contact with a grounded source creating an unexpected release of energy in the form of noise and pressure.

- Effects of Arc Flash/Blast - may cause severe burns, eye and hearing damage

Module 1 - Review Questions

1. What is the correct sequence of events to follow if you observe someone receive a serious electrical shock?
   a) Call 6911, de-energize the circuit, go home
   b) Call 6911, give first aid as needed
   c) Call 6911, de-energize the circuit, remove victim, acquire medical treatment for victim, report the incident

2. Electric Arc Flash/Blast occurs when:
   a) An electrical system is over-loaded
   b) An energized source comes in contact with a grounded source
   c) When an person's hand comes in contact with exposed energized conductors

Module 1 - Review Questions

3. If you discover an unconscious person, clearly a victim of electric shock, and are unable to de-energize the electrical circuit, how do you remove the victim from the circuit?

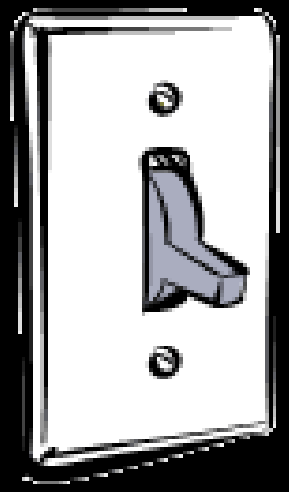
   a) Grab the person, pull them off the energized line, render CPR.
   b) Do nothing. There's nothing you can do to help him.
   c) Wait for EMS to arrive because they are trained to deal with this kind of problem.
   d) Use non-conductive broom handle or belt to move him off the energized line, render CPR.

Module 2: Engineering Controls

- Objective:
  - Identify the purpose of various engineering controls designed for electrical safety
  - The preferred method to control electrical hazards is to engineer controls into the design of equipment

Engineering Safeguards

Engineered safeguards can be as simple as a light switch cover or a door on the breaker panel.



What If Engineering Safeguards Are Removed?

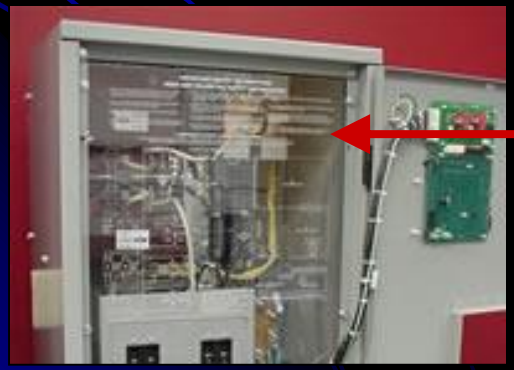
- A missing cover screw caused this cover to fall onto the plug, which was not fully inserted, & resulted in a short circuit and damaged outlet.

- The outlet cover is metal. Metal is still used in many areas. It is safe if the cover is installed correctly.

- The plug would be safe if it was installed correctly.
- Engineering controls require proper installation to ensure safety. In this case, improper installation caused the short.

Internal Barriers

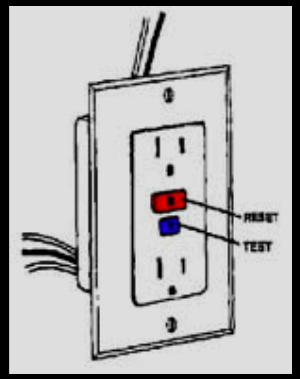
- Internal barriers on some equipment ensure workers are not exposed to energized parts
- Barriers may be as simple as covers over terminal posts or Plexiglas® panels
- UAH requires Nationally Recognized Testing Laboratory (NRTL) certified equipment and components (e.g. UL)
- Purchase of non-NRTL equipment, when certified equipment is available, is not permissible



Plexiglas cover over energized doors is an engineered control.

Internal Barriers

At UAH, Ground Fault Circuit Interrupters (GFCIs) are required under the following conditions:



- Damp or wet location
- Within 6 feet of exterior door
- Within 6 feet of signs
- Outdoors
- Rooftops

- If a GFCI outlet is not available, portable GFCIs are an alternative.

Module 2 - Review Questions

1. Portable GFCI-protected extension cords should be used when using portable tools outdoors or in any damp or wet location.

   a) True

   b) False

2. A light switch in your office has a missing cover. It is an unsafe condition because the cover is an engineering control and designed to work only if installed properly.

   a) True

   b) False

Module 3: Administrative Controls

- Objective
  - Identify administrative controls that UAH employs to prevent electric shock

What is an Administrative Control?

- Administrative controls relate to organization and management, procedures, record keeping, assessment, and reporting necessary to ensure safe operation of a facility

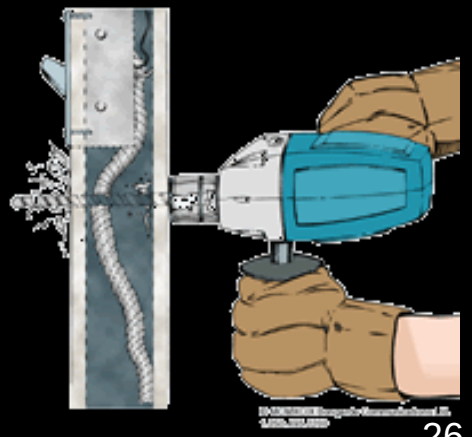
- Examples:
  - Work planning/control documents
  - Work-related training and certifications
  - Warning signs, labels, and tags

National Fire Protection Association (NFPA) 70E Requirements

- NFPA 70E (Electrical Safety in the Workplace) identifies requirements to maintain a safe electrical workplace
- NFPA 70E has two categories for electrical hazards:
    1. Shock hazards
    2. Arc flash hazards
- Unqualified personnel must be escorted by a qualified person to enter a shock or arc flash boundary
- Qualified person must ensure unqualified person has required PPE & understands hazards/required controls
- Qualification requires employees to have knowledge about the work and equipment they will be working on

Excavation/Penetration Permits

- Hidden hazards are sources of energy that are not visibly apparent, such as underground electrical conduit or wiring inside walls
- There are specific requirements for excavation and drilling into walls
  - Obtain Excavation or Penetration Permit from UAH Facilities & Operations: Call 824-6490



Electrical Lockout/Tagout (LOTO)

- The most important administrative control is Lockout/Tagout
- If you see a lock on an electrical circuit, do not attempt to operate the circuit.
- To gain access to a locked & tagged out circuit, contact the person named on the tag. Do not remove the tag or restore the circuit without approval. If and when possible, a qualified worker will restore the circuit in accordance with the LOTO procedure.
- Electrical locking devices may be installed on a cord, switch, breaker, or disconnect device: look before you operate the equipment.
- Be sure to follow your departmental LOTO program.

Pre-Work Briefings

- A pre-work briefing is the best way to identify hazards, answer questions, and plan work.
- They improve productivity, reduce accidents/injuries, and improve communications between all levels of the organization
- Work practices has the potential to affect more people, and can have more serious consequences if safe procedures are not followed.

Module 3 - Review Questions

1. What are the requirements for performing electrical work?
    a) You must be trained and qualified
    b) You must know the controls & have the appropriate PPE
    c) You must understand the electrical hazard
    d) All the above
2. What are some common electrical hazards that cause concerns for workers?
    a) Sand trap and rough hazards
    b) Hidden and overhead hazards
    c) Tripping and lifting hazards
3. Who installs the LOTO on an electrical circuit?
    a) A qualified electrician
    b) Person requesting the work
    c) LOTO authorized worker exposed to electrical hazard

Module 4 – Hazard Recognition & Avoidance

- Objective
  - Identify hazards associated with electrical systems and equipment
  - Discuss electrical accident prevention through increased awareness of surrounding conditions

- Accident prevention is a deliberate, planned series of events that includes training, awareness, design considerations, procedures, and management support

- NFPA70E requires electrical safety programs to instill safety principles in employees. Safety, particularly electrical safety, is a mind set. Since electricity is part of everyday life, it is easy to overlook potential hazards.

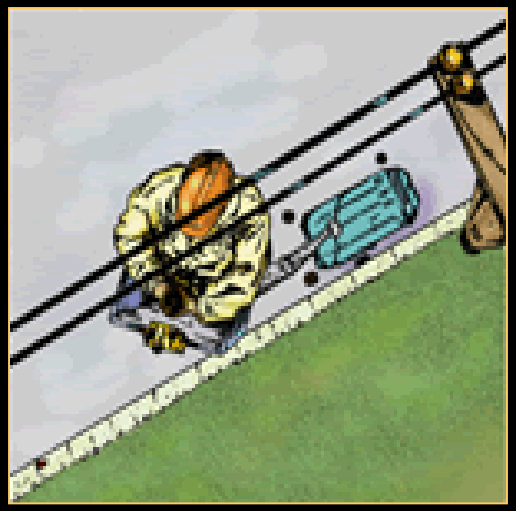
Overhead Hazards

- Specific requirements for working in the vicinity of overhead power lines:
  - Transit: Equipment not performing its primary function (i.e., traveling under power lines) may not come within 4’ of energized overhead lines.
  - Standoff Distance: Operating equipment may not approach energized power lines closer than 10’. This distance increases if the voltage in the lines is greater than 50,000 volts.
  - Trained Operators: Anyone working near energized power lines must be trained on the specific hazards associated with working on those lines.

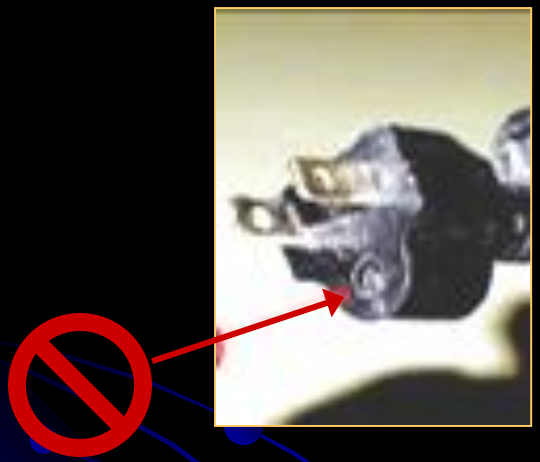
Overhead Hazards

- Every year several accidents across the U.S. were caused by inadvertent contact with overhead power lines.

- The Department of Labor reports that more than 100 workers are killed every year due to contact with overhead power lines.



Missing Ground Pin



The ground pin is missing in this picture. You might say no problem – the plug still fits in the outlet. Is this plug safe?

With no engineered ground, you and the tool could easily become the path to ground for current.

If the tool experienced an internal short circuit or made contact with a hidden, energized wire, the metallic housing and anyone touching it would become energized.

In a case like this, a fatal shock could be delivered.

Burned Insulation

In this picture, a section of insulation is burned and missing. If you were using this in your office, and the exposed portions contacted the metal chair you are sitting on, you would probably receive a shock.

CAUTION

Inspect all equipment, prior to use. DO NOT use damaged equipment!

Shorted Nightlight

Tired of looking at a night light, and believing the easiest way to remove it from the wall was to pry it loose with a butter knife, a woman quickly found out that the butter knife was not the right tool to use. The results are evident.

When the conductive knife contacted the energized blades of the night light, the knife shorted across the energized blades, creating a short circuit.

The woman using the knife was okay. However, this short circuit could have been avoided had she planned the job and applied safe work practices.

Integrated Safety Management System (ISMS)

Appling these ISMS principles to all the work that you do will help create a safe working environment for you and the people you work with and around:

- Plan Work
- Analyze Hazards
- Control Hazards
- Perform Work
- Feedback and Improve

Module 4 Review Questions

1. Using a three-pronged cord with the round ground pin broken is a bad idea because:
   a) You might scratch yourself on the broken pin
   b) If equipment fails internally, the connection to ground could be through your body, causing an electric shock.
   c) It's not a bad idea. I do it all the time.

2. You request electrical support to identify potential electrical hazards. You observe the electrician reaching into an electrical distribution panel without PPE. You should:
   a) Not worry - the electrician knows what he's doing
   b) Suspend work and ask the electrician if PPE is required for the task (always look out for each other)
   c) Move up next to the electrician to get a better view

Module 4 –SUMMARY

There are four facts to remember about electricity:

1. Water and electricity do not mix.

2. Inspect all equipment prior to use and do not use damaged equipment.

3. Employ ISMS principles: Plan work; analyze hazards; control hazards (with PPE, correct tools etc.); perform work; and feedback & improve.

4. Use common sense - ask questions if you do not understand, and, if not satisfied with the answer, shut down unsafe work practices.

Remember . . . Be Careful Out There!

Electrical Safety Quiz

Test your knowledge of electrical safety