Lab Electrical Safety

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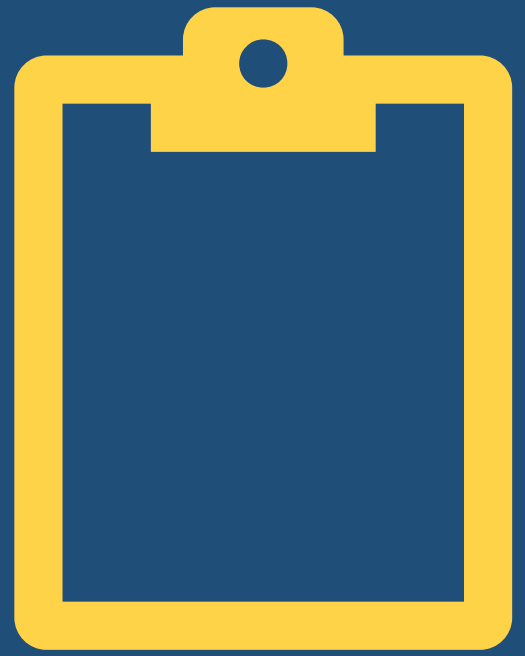
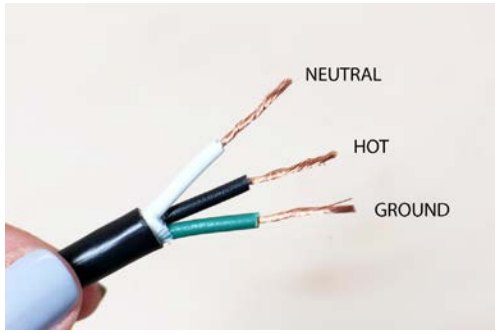
Electrical Terminology

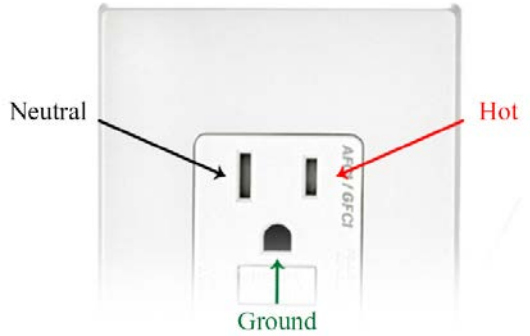
- **Current** –the movement of electrical charge
- **Voltage** – a measure of electrical force-pressure
- **Resistance** – opposition to current flow
- **Conductors** – substances, such as metals, that have little resistance to electricity
- **Insulators** – substances, such as wood, rubber, glass, and Bakelite, that have high resistance to electricity



Electrical Terminology

- **Grounding** – a conductive connection to the earth
- **Wire or Conductor Terminology**
  - HOT-black wire-ungrounded conductor
  - NEUTRAL-white wire-grounded conductor
  - GROUND-green or bare wire-grounding conductor





Relationship between power, current, voltage and resistance:

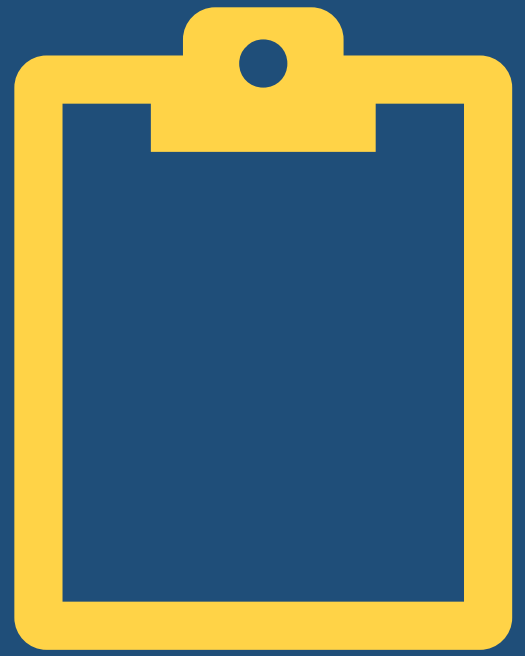
$$V = I \times R$$

$$P = I \times V$$

$$P = I^2 \times R$$

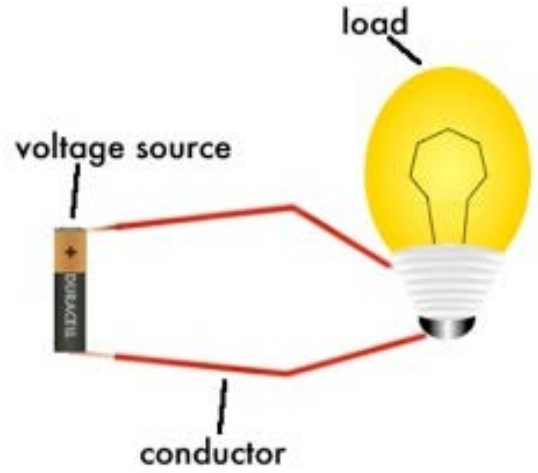
P = power (watts)
I = current (amperes)
V = voltage (volts)
R = resistance (ohms)

Example:
Heating tape uses 5 amps at 120 volts.
Power dissipated by this device is 600 watts.



Parts of an Electric Circuit

- Power source - Either electrical or battery, provides the power to the load
- Conducting path - The wires, carry the power from the power source to the load
- Load - The device using the electricity such as a computer, light bulb, power saw, etc. More complicated circuits use switches, such as light switches, to control the flow of electricity

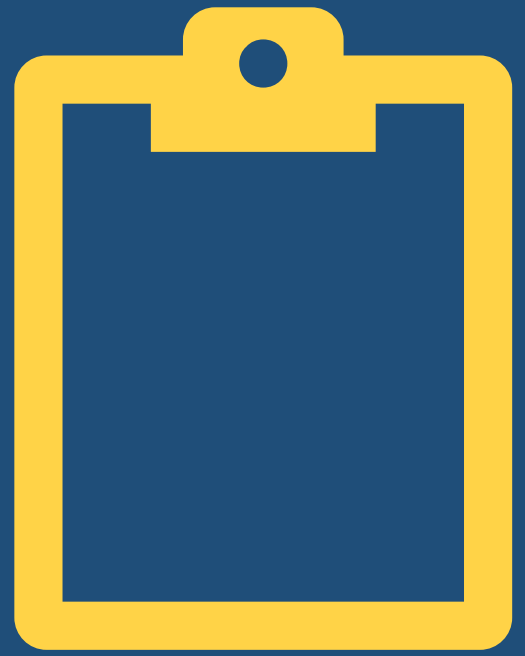


Hazards of Electricity

- Chart below assumes 1 second hand to foot exposure to 120 volt, 60 cycle AC power supply

Current	Reaction
1 mA	Perception
5 mA	Slight shock felt; not painful but disturbing
6-30 mA	Painful shock; "let-go" range
50-150 mA	Extreme pain, respiratory arrest, severe muscular contraction
1,000-4,300 mA	Ventricular fibrillation
10,000+ mA	Cardiac arrest, severe burns and probable death

Laboratory wall outlets provide 20,000 mA !!

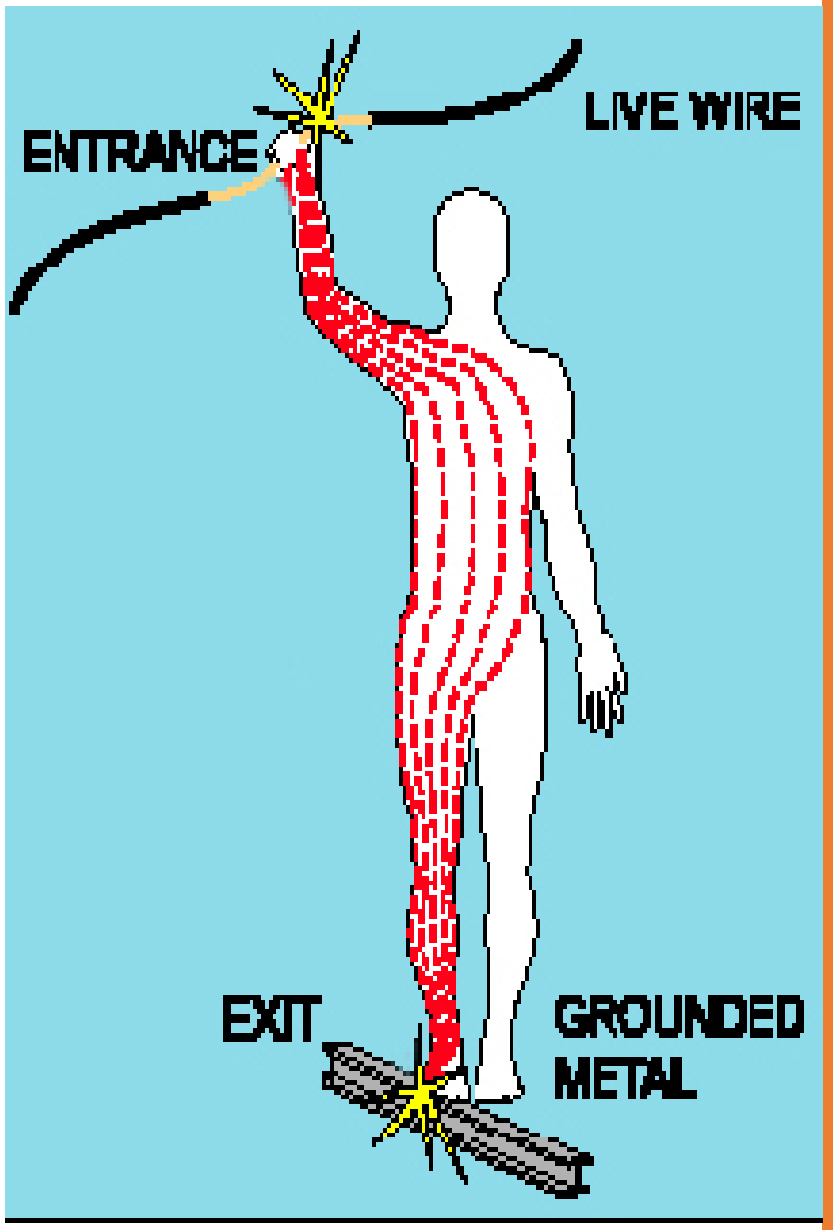


Electrical Shock

- Received when current passes through the body

- Severity of the shock depends on:
  - ***Path*** *of current through the body*
  - ***Amount of current*** *flowing through the body*
  - ***Length of time*** *the body is in the circuit*

- LOW VOLTAGE DOES NOT MEAN LOW HAZARD



How to Respond to Electric Shock

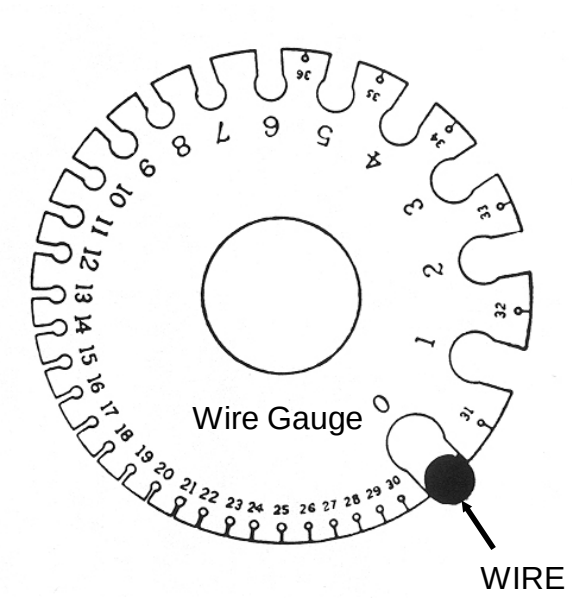
- Do not touch the victim
- Call 9-1-1 for assistance
- If victim is “locked on” to the power source, switch off the power if it is safe to do so.
- If power cannot be switched off, do not touch the victim directly. If there is a piece of wood or confirmed non-conductive item nearby it can be used to attempt to knock the victim away from the power source.

Electrical Hazards - Wiring Hazards

A hazard exists when a conductor is too small to safely carry the current.

A portable tool with an extension cord that has a wire too small for the tool

- The tool will draw more current than the cord can handle
- Overheats without tripping the circuit breaker
- The circuit breaker could be the right size for the circuit but not for the smaller-wire extension cord



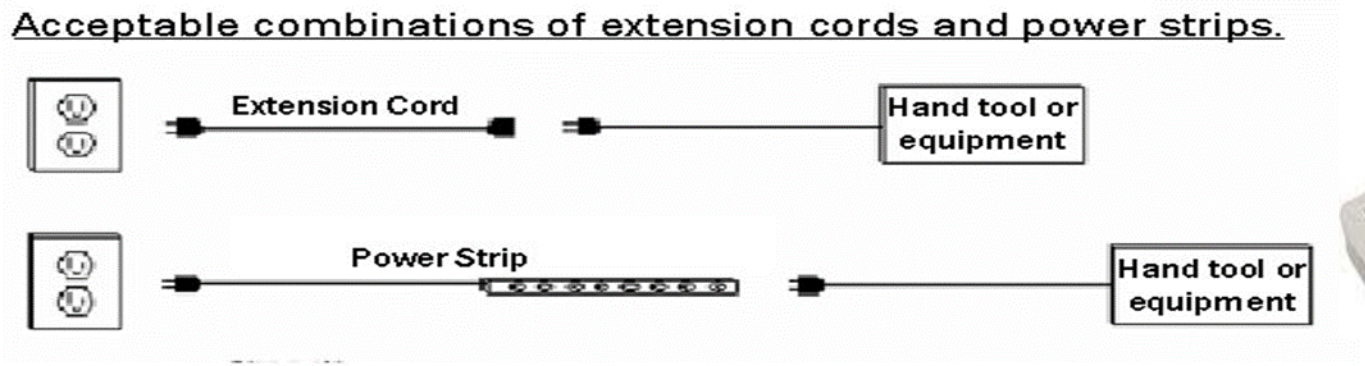
Wire gauge measures wires ranging in size from number 36 to 0 American wire gauge (AWG)

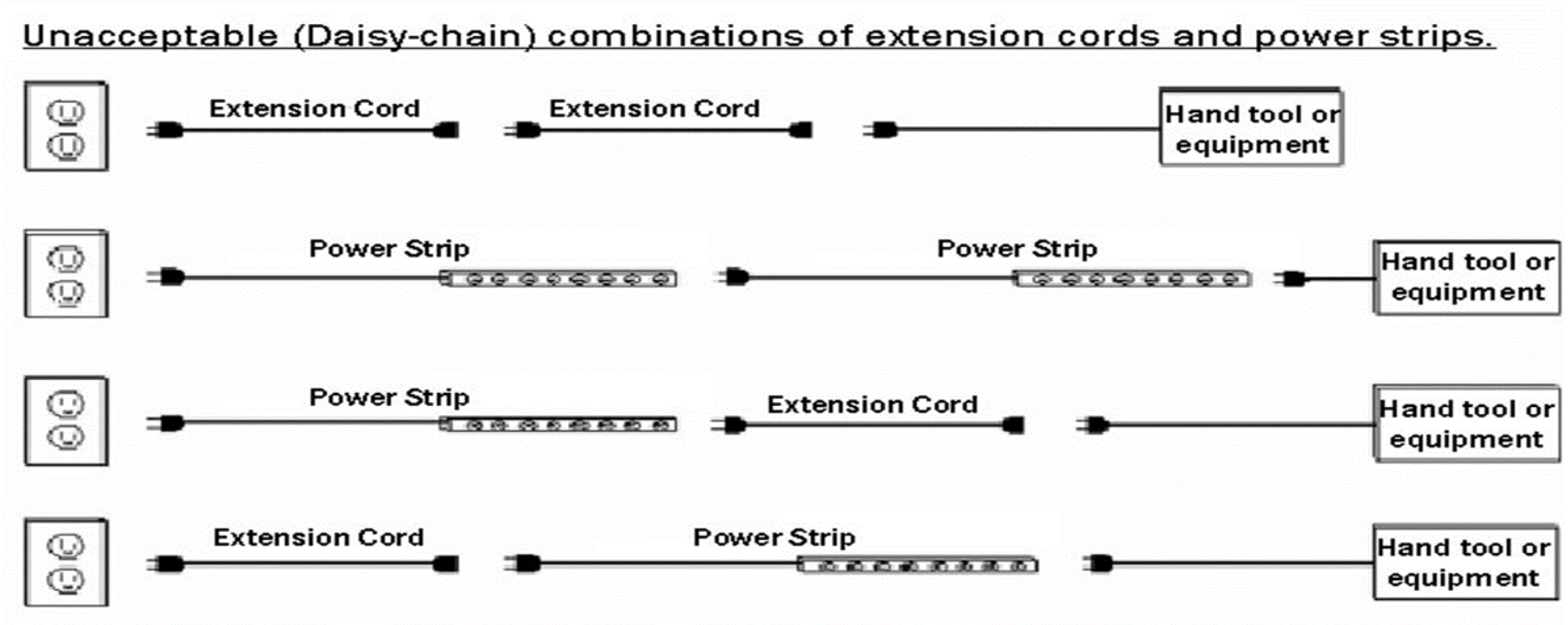
Electrical Hazards - Overloading

If too many devices are plugged into a circuit, current will heat the wires to a very high temperature, which may cause a fire

If the wire insulation melts, arcing may occur and cause a fire in the area where the overload exists, even inside a wall

Electrical Hazards - Extension Cords and Power Strips





Do Not Overload Power Strips

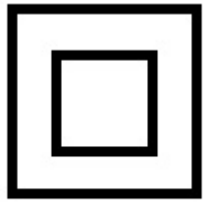
Electrical Hazards - Extension Cords

- Extension cords must be visually inspected before each use on any shift. Examine the cord for
  - Damaged other jacket (tear in insulation)
  - Possible internal damage (pinched cord)
  - Missing grounding pin

Inspect All Electrical Equipment Before Use

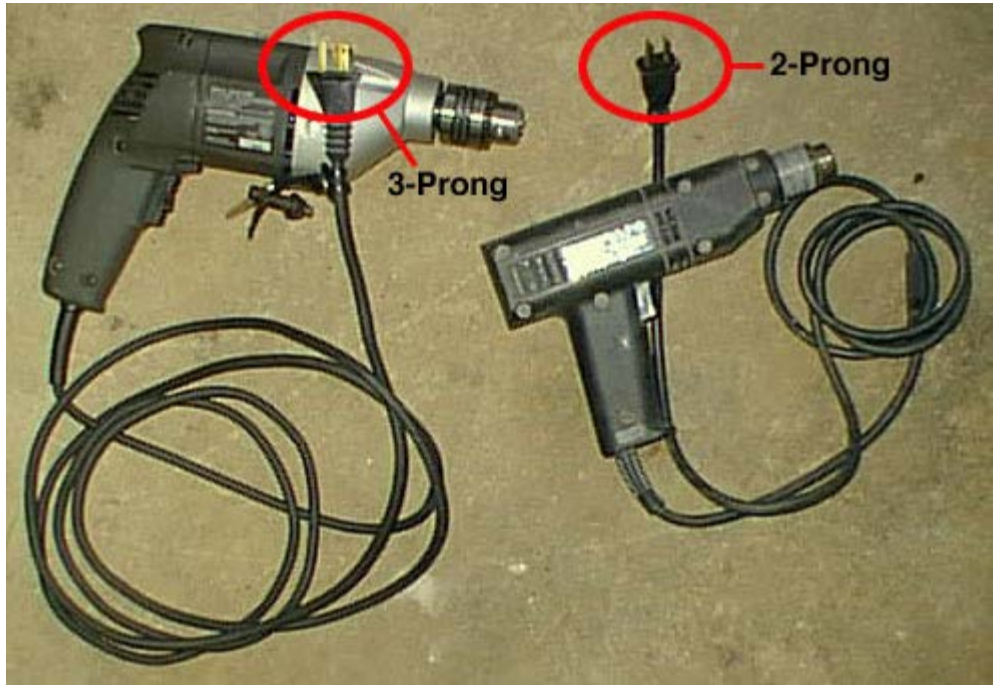
- Damaged wires or plugs
- Signs of electrical hazards
- Overheating
- Smoke
- Sparks

Double Insulation



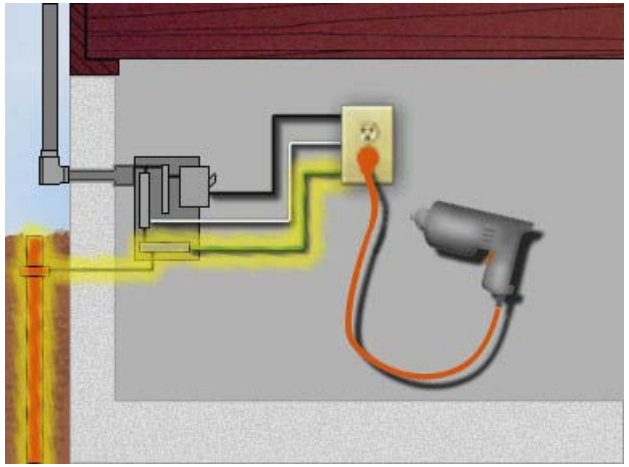
Double insulated symbol

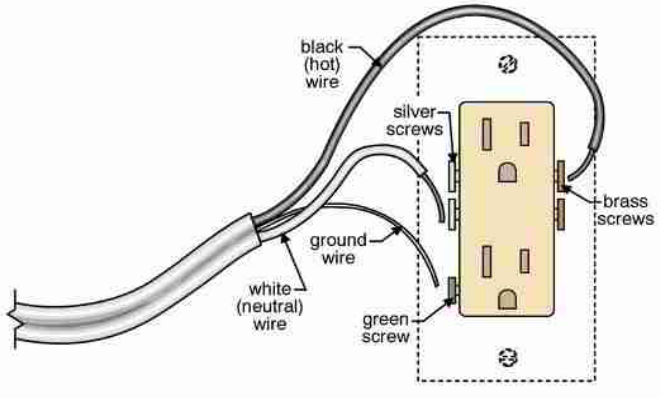
- 2 prong plug
- Double insulated symbol on label
- Two levels of insulating materials between the electrical parts of the appliance and any parts on the outside that you touch.



Grounding

- The "ground" wire is a safety wire that has intentionally been connected to earth.
  - The grounding wire does not carry electricity under normal circuit operations.
  - It's purpose is to carry electrical current only under short circuit or other conditions that would be potentially dangerous.
  - Grounding wires serve as an alternate path for the current to flow back to the source, rather than go through anyone touching a dangerous appliance or electrical box.





Electrical Protection

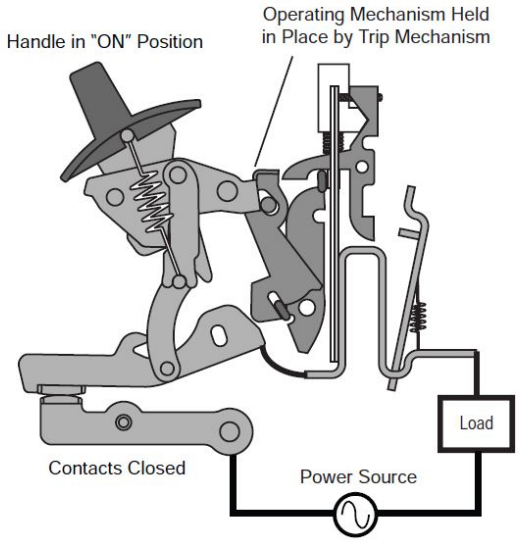
Disconnects electrical flow in the event of an overload or ground-fault in the circuit

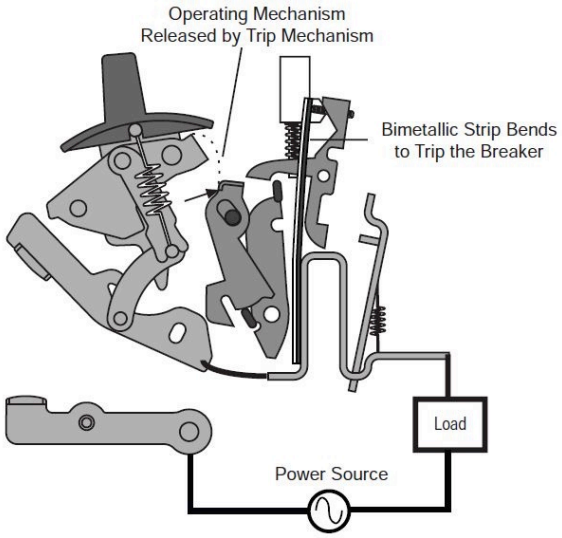
- Fuses
- Circuit breakers
- Ground Fault Circuit Interrupters (GFCIs)

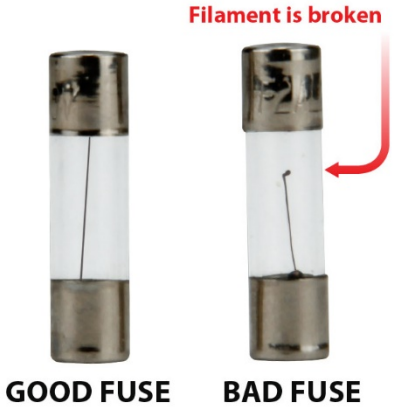
Fuses and circuit breakers are **overcurrent** devices

Electrical Protection

- Circuit Breakers and Fuses
  - Provided to protect EQUIPMENT not people
  - Do not reset breakers with a line voltage higher than 120V and only reset if you know why it tripped
  - Circuit breakers and fuses should be sized 125% of the continuous load. (If max load is 12 amps then the correct fuse/breaker is 15 amps)





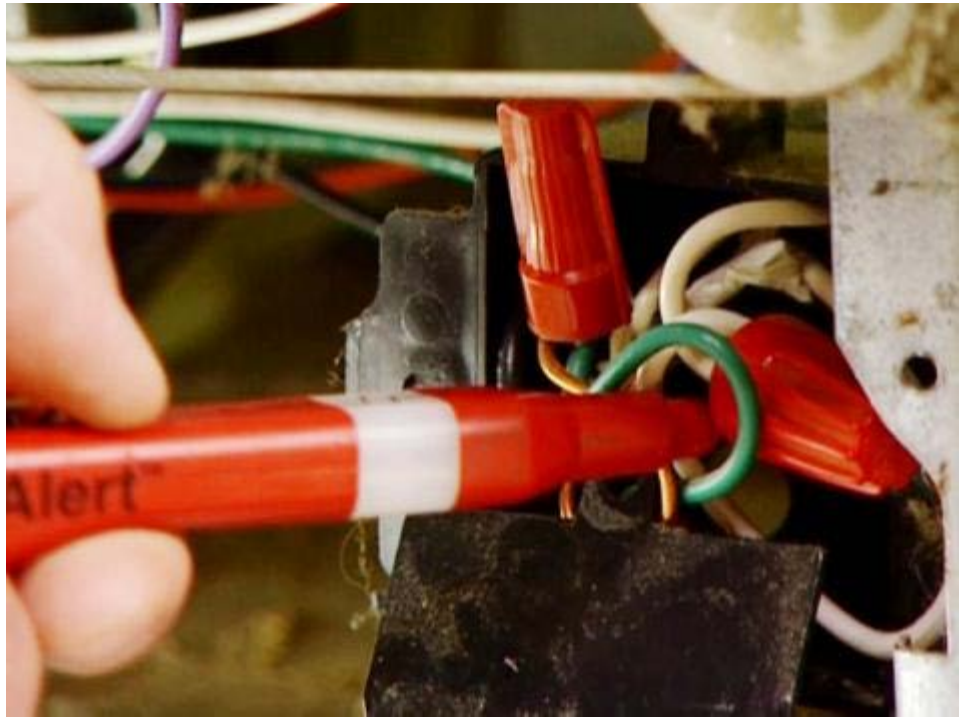


Electrical Protection

Electrical Work

ALWAYS de-energize equipment before exposing wiring or working on it.

All electrical over 50 volts AC and DC must be guarded against accidental contact.

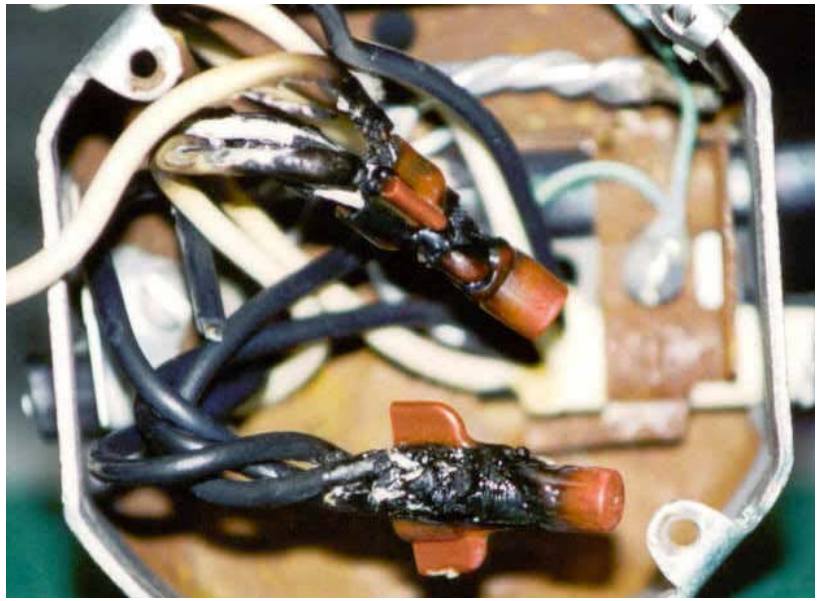


Electrical Protection

Lockout/Tag Out should be used to prevent someone from energizing a system that is being worked on or is in an unfinished state.

Electrical Fires

Electrical fires can occur with little to no warning



Classifications of Fire

- Fires are classified according to the material burning. The classifications of fire:

➢ Class A - Ordinary Combustibles

Paper, cloth, wood, and some plastics

➢ Class B - Flammable Liquids or Gasses

Liquids: Gasoline, Oil, Grease, Solvents

Gases: Acetylene, Methane, Hydrogen

➢ Class C - Energized Electrical Equipment

Equipment Connected to Electrical Source

➢ Class D- Combustible Metals

Metals: Magnesium, Potassium, Sodium, Powdered Aluminum

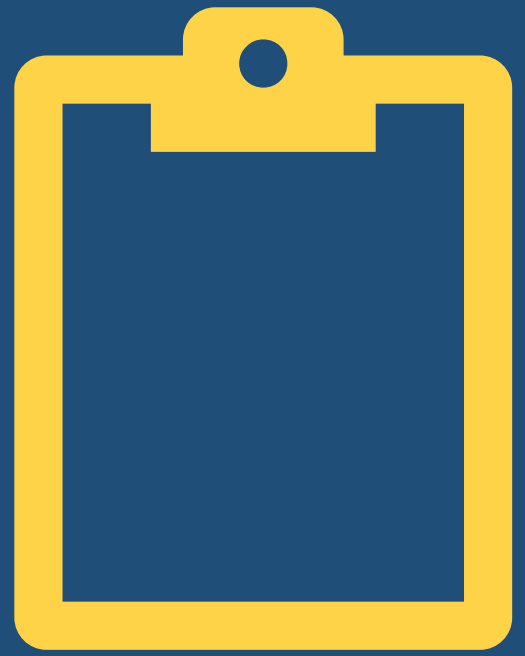
How to Use Fire Extinguishers

- Know where fire extinguishers are located
- Use proper extinguisher for type of fire
- Most extinguishers on Campus are multipurpose dry chemical extinguishers
- The **P-A-S-S** technique for fire extinguisher use:
  - P - Pull the pin. This will also break the tamper seal
  - A - Aim low at the base of the fire
  - S - Squeeze the handle to release the extinguishing agent
  - S - Sweep from side to side at the base of the fire until it appears to be out

If you have the slightest doubt about your ability to fight a fire….EVACUATE IMMEDIATELY!

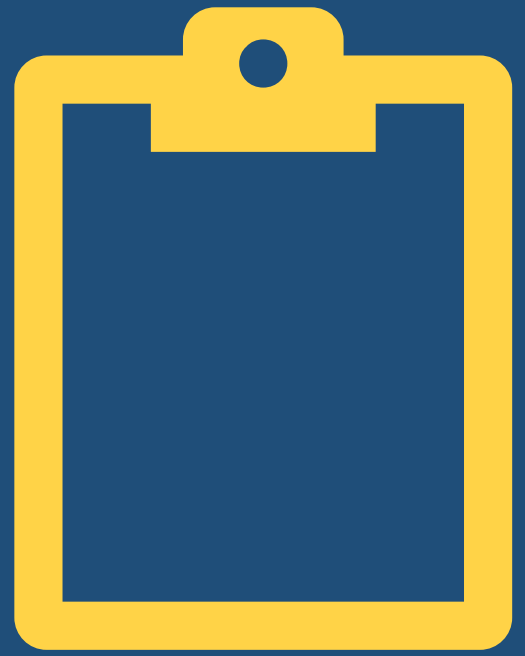
Electrical Safety Guidelines

- ✓ Be familiar with the electrical hazards associated with your work area.
- ✓ Unplug electrical equipment before repairing or servicing it.
- ✓ If a prong breaks off inside an outlet, do not attempt to remove it yourself. Call Facilities Services for assistance.
- ✓ Ensure that outlets are firmly mounted. Report loose outlets to Facilities Services.
- ✓ Report all electrical problems, including tripped breakers, broken switches, and flickering lights, to Facilities Services.
- ✓ All appliances used on campus must be UL (Underwriter's Laboratory) or FM (Factory Mutual) labeled. Contact EH&S with questions.
- ✓ Do not use an appliance that sparks, smokes, or becomes excessively hot, unless the appliance is specifically designed to exhibit these characteristics.
- ✓ Portable electrical heaters must be placed to avoid causing a trip hazard and must be kept away from combustible material. Never leave a heater unattended. Unplug the heater at the end of the day or when not in use.
- ✓ Keep electrical equipment away from water, unless the appliance is specifically designed for use around water, such as a wet-dry shop vacuum.
- ✓ Use Ground Fault Interrupter Circuits (GFCI) whenever possible.



Electrical Plug and Cord Safety Guidelines

- ✓ Do not remove the prongs of an electrical plug. If plug prongs are missing, loose, or bent, replace the entire plug
- ✓ Do not use an adapter or extension cord to defeat a standard grounding device. (e.g., only place three-prong plugs in three-prong outlets; do not alter them to fit in a two-prong outlet). No ground lifters.
- ✓ Use extension cords only when necessary and only on a temporary basis. Do not use extension cords in place of permanent wiring. Request new outlets if your work requires equipment in an area without an outlet.
- ✓ Use extension cords that are the correct size or rating for the equipment in use. The diameter of the extension cord should be the same or greater than the cord of the equipment in use.
- ✓ Do not run electrical cords above ceiling tiles or through walls, windows, or doors.
- ✓ Keep electrical cords away from areas where they may be pinched and areas where they may pose a tripping or fire hazard (e.g., doorways, walkways, under carpet, etc.)
- ✓ Avoid plugging more than one appliance in each outlet. If multiple appliances are necessary, use an approved power strip with surge protector and circuit breaker. Do not overload the circuit.
- ✓ Discard damaged cords, cords that become hot, or cords with exposed wiring.
- ✓ Never unplug an appliance by pulling on the cord; pull on the plug.



Remember…
Safety First!

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