Ohio | Bureau of Workers' Compensation

Electrical Safety

Steven Roth, PE
Division of Safety & Hygiene

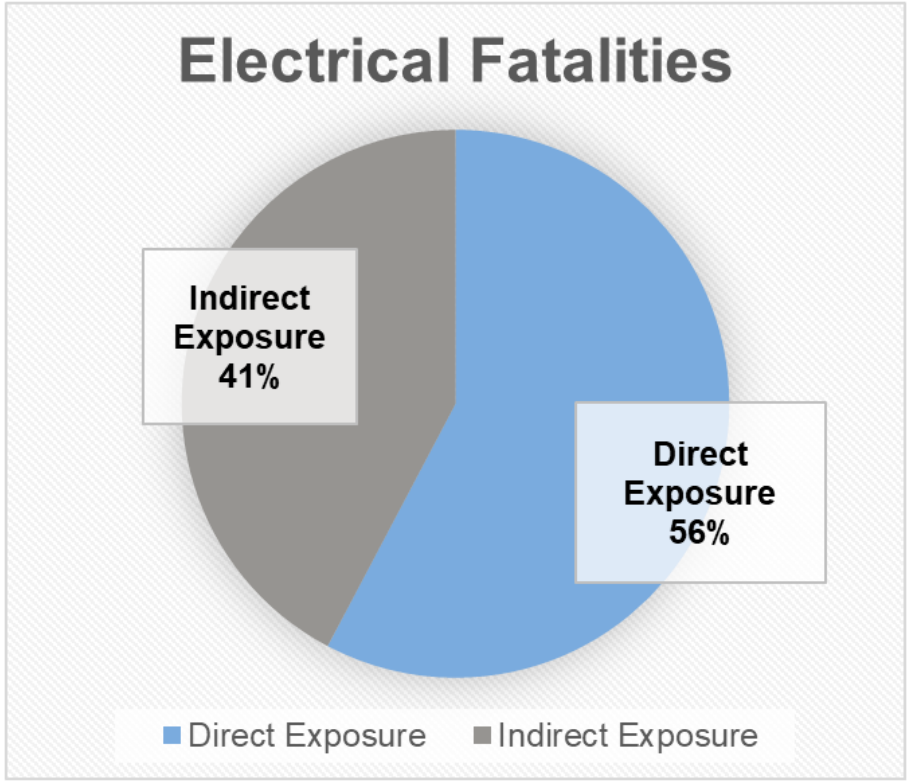
WHY IT'S IMPORTANT

739 Fatalities

56% due to direct exposure (414)

41% due to indirect exposure (303)

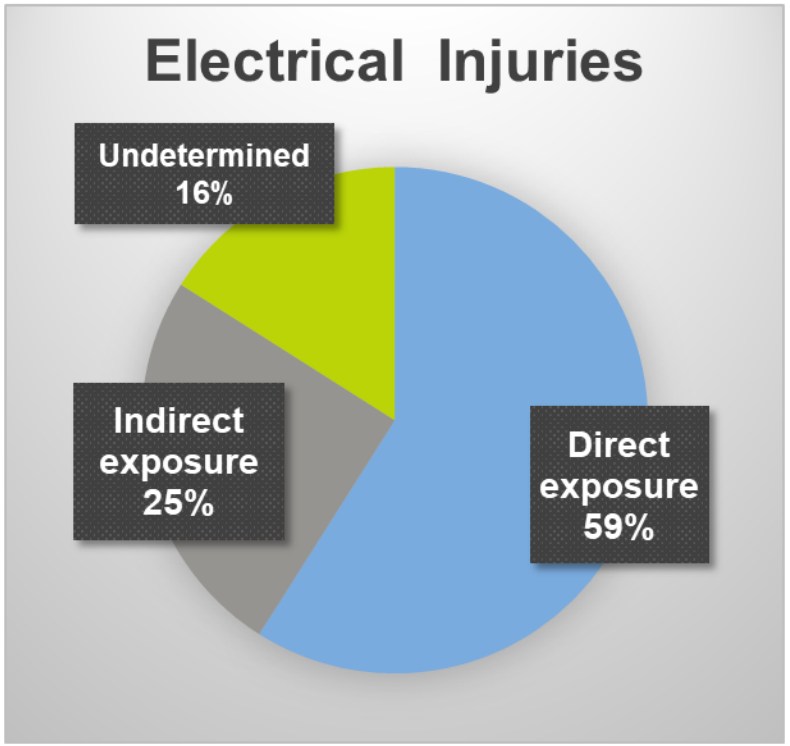
51% 25-44 yrs. age group (377)



Data from NFPA Non-Fatal Electrical Injuries at Work-2012-2016

WHY IT'S IMPORTANT

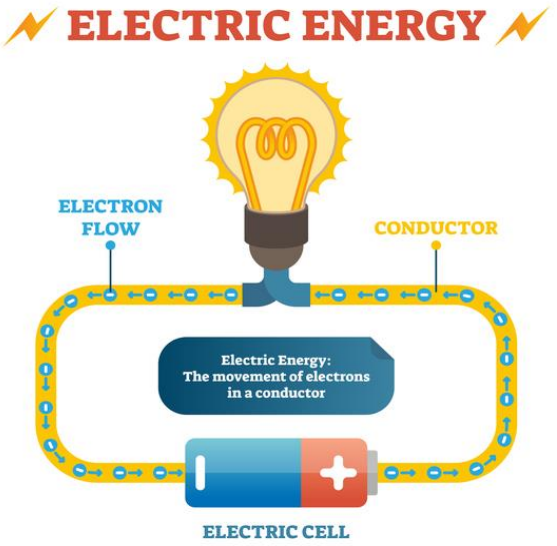
- 9,760 workers injured
- 59% due to direct exposure (5,758)
- 25% due to indirect exposure (2,440)
- 28% resulted with more than 30 days away from work



Data from NFPA Non-Fatal Electrical Injuries at Work-2012-2016

Electricity – How it Works

- Electricity is the flow of electrons from one place to another
- Requires a source of power: usually a generating station
- Travels in a closed circuit



Electrical Terms

Voltage (V):

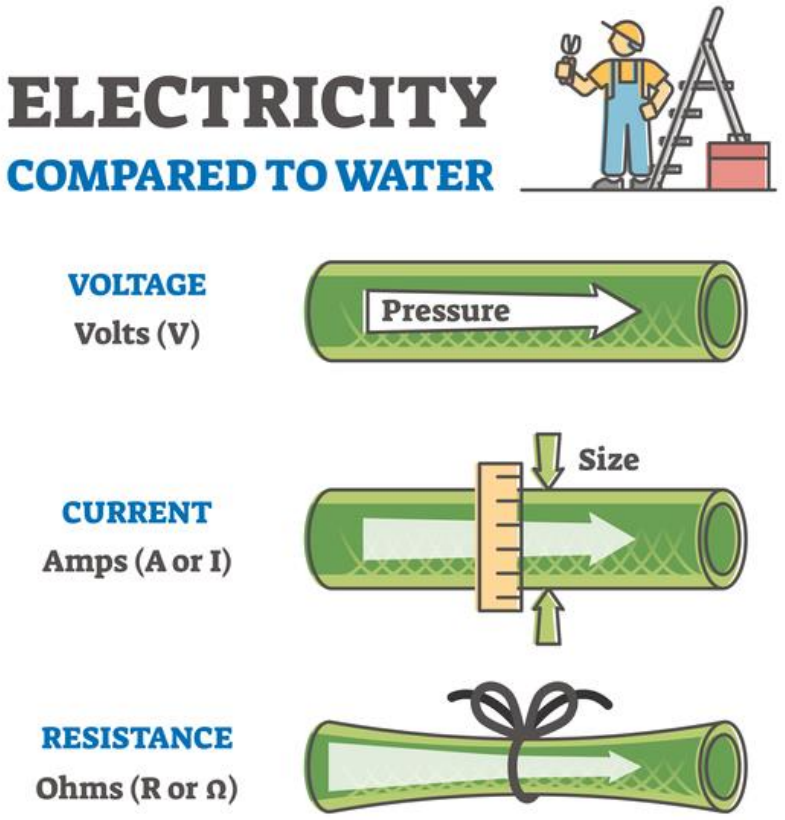
Force that causes electrons to move. Measured in Volts (V).

Current (I):

Flow of electric charge over a period. Measured in Amps (A).

Resistance (R):

Impedes electrical flow. Measured in Ohms (Ω)



Electricity-type of Materials

Conductive (Conductor):

- Material which permits the flow of electrical energy.

  Examples: copper, aluminum, gold, and silver, graphite, and the human body

Non-Conductive (Insulators):

- Material that impedes the flow of current, electrons or energy.

  Examples: glass, air, plastic, rubber, and wood

Fun Equations

Ohm's Law

$V = I \times R$

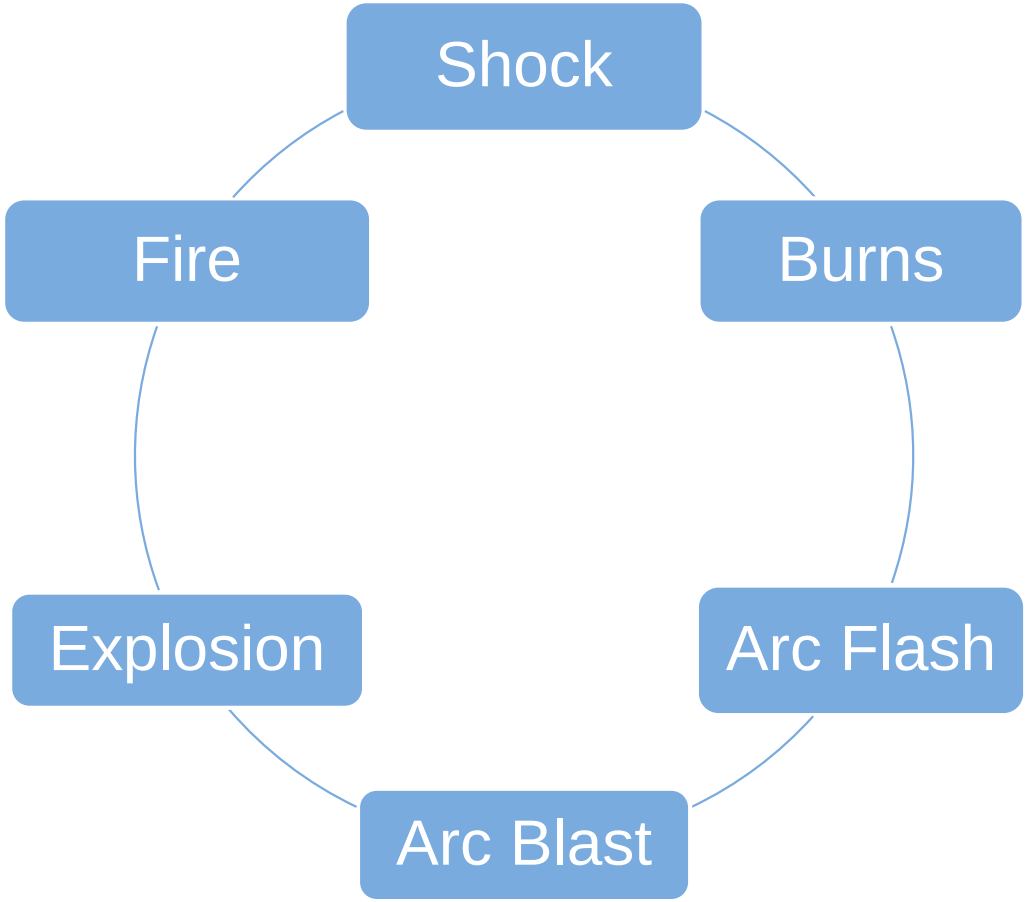
V = Voltage in volts
I = Current in amps
R = Resistance in ohms

Watt's Law

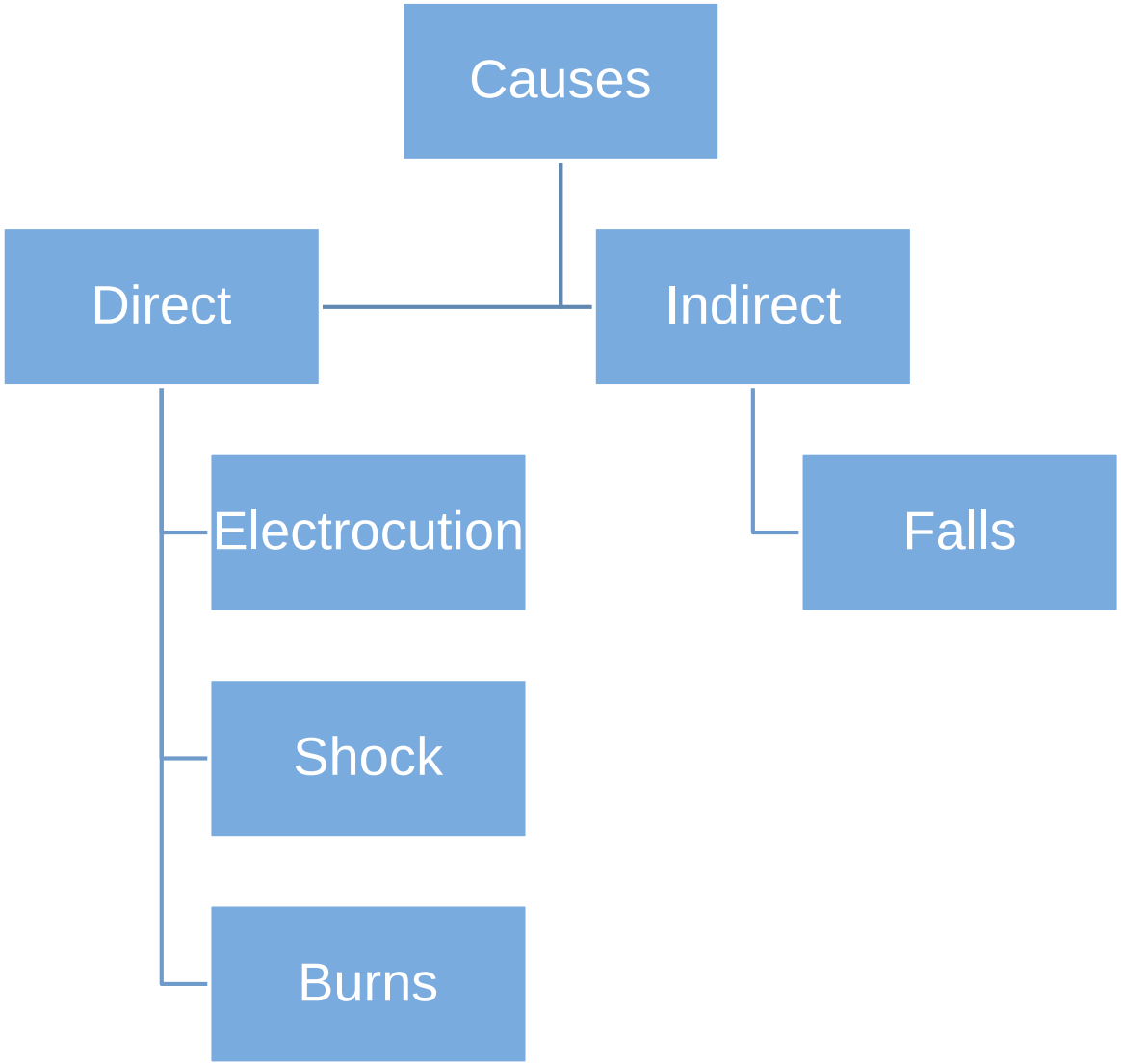
$P = V \times I$

P = Power in watts
V = Voltage in volts
I = Current in amps

Hazards of Electricity



Electrical Injuries



Electrical Shock

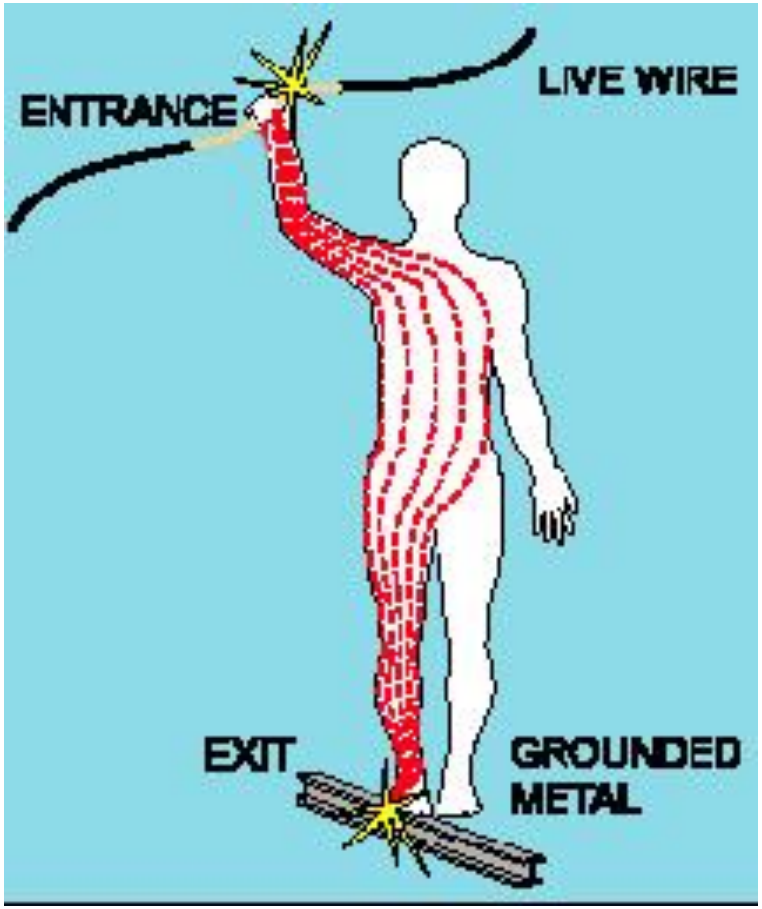
An electrical shock is received when electrical current passes through the body

You will get an electrical shock if a part of your body completes an electrical circuit by:

- Touching a live wire and an electrical ground, or
- Touching a live wire and another wire at a different voltage

Shock Severity

- **Severity depends on:**
  - **Path**
  - **Amount of current**
  - **Duration**
- **Low voltage does not mean low hazard**



Effects of Electricity

More than 3 mA	→	Painful Shock
More than 10 mA	→	No Let Go Threshold
More than 30 mA	→	Breathing Stops
More than 75 mA	→	Heart Fibrillation
More than 4 Amps	→	Heart Stops
More than 5 Amps	→	Tissue Burns
More than 20 Amps	→	Tissue & Organ Damage

Dangers of Electrical Shock

- Currents more than 75 mA can cause a rapid, ineffective heartbeat -- death will occur in a few minutes unless a defibrillator is used
- 75 mA is not much current – a 100 watt light bulb uses 830 mA, 11 times as much.

Defibrillator in use

* mA = milliampere = 1/1,000 of an ampere

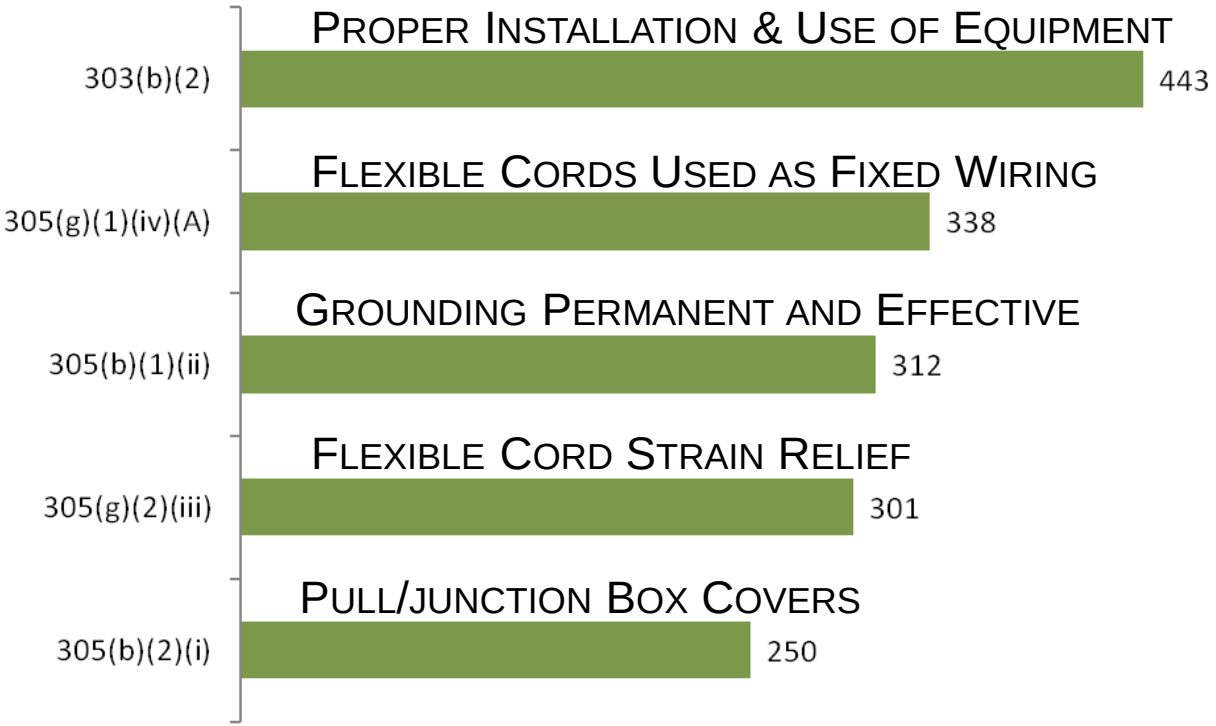
Electrical Burns

- Most common shock-related, nonfatal injury
- Occurs when you touch electrical wiring or damaged/faulty equipment
- Typically occurs on the hands
- Very serious injury that needs immediate attention

Falls

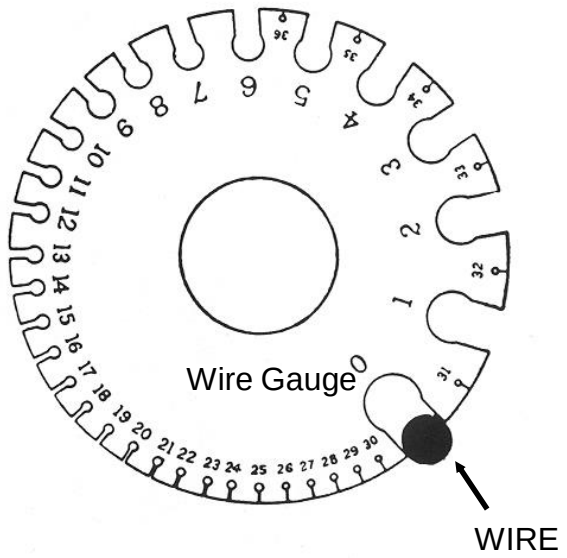
- Electric shock can also cause indirect or secondary injuries
- Workers in elevated locations who experience a shock can fall, resulting in serious injury or death

Electrical [1910.301 – .399]



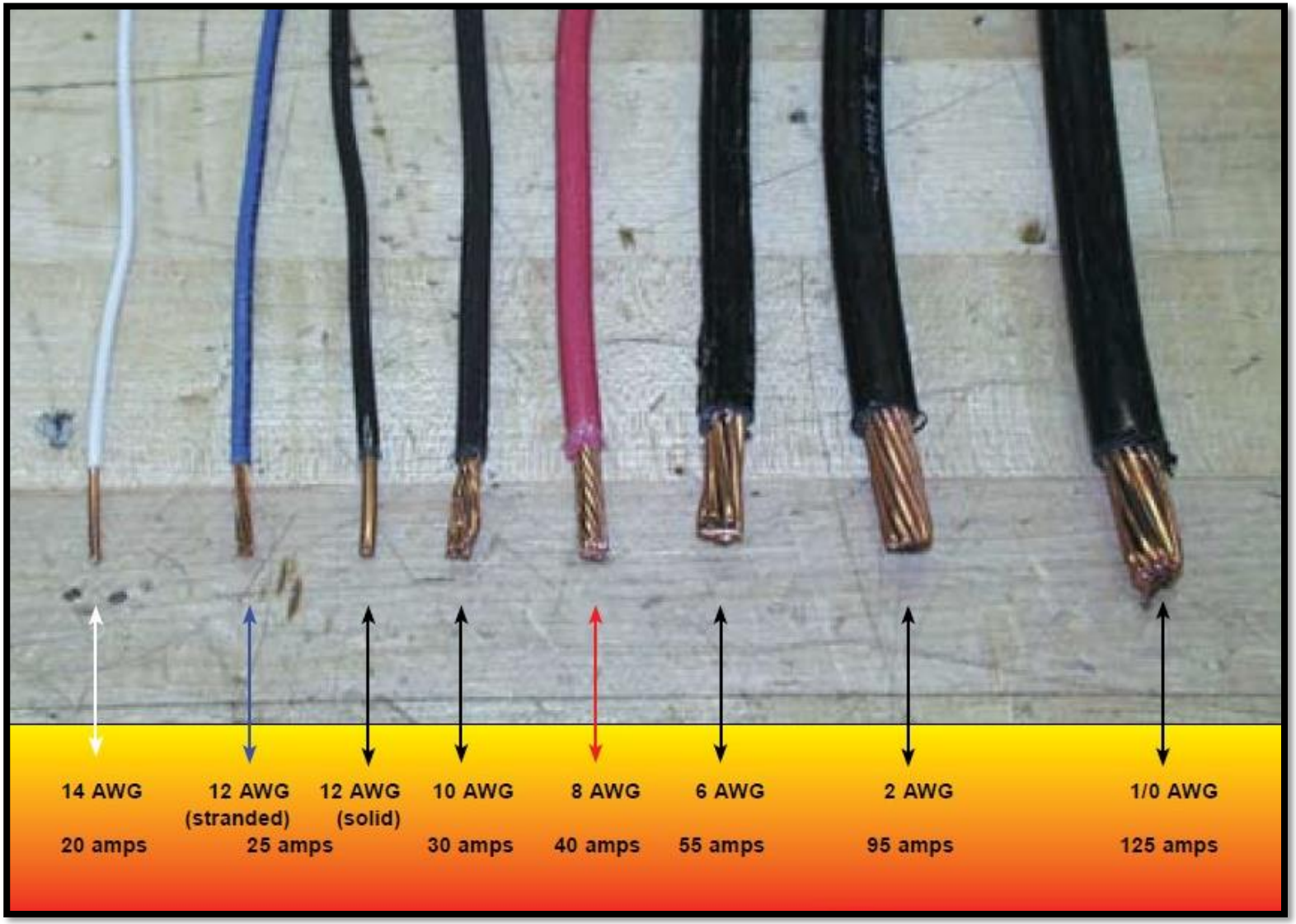
Inadequate Wiring Hazards

- A fire hazard exists when the conductor is too small to safely carry the current
- A portable tool with an extension cord that has a wire too small for the power draw
  - The tool will draw more current than the cord can handle, causing overheating and a possible fire without tripping the circuit breaker



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

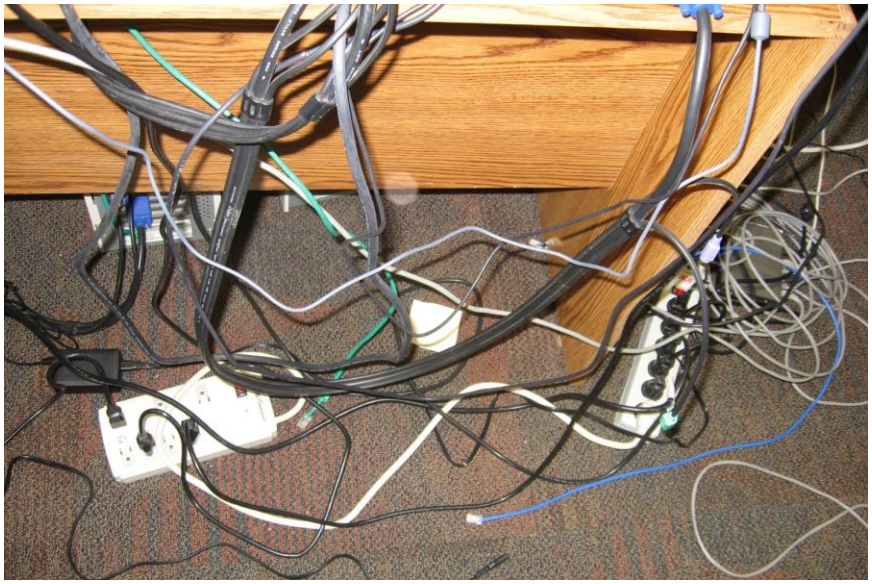
Equipment/Installation



Hazard – Overloaded Circuits

Hazards may result from:

- Too many devices, leading to heat and fire;
- Damaged tools overheating;
- Lack of overcurrent protection;
- Wire insulation melting, which may cause arcing and a fire



Electrical Protective Devices

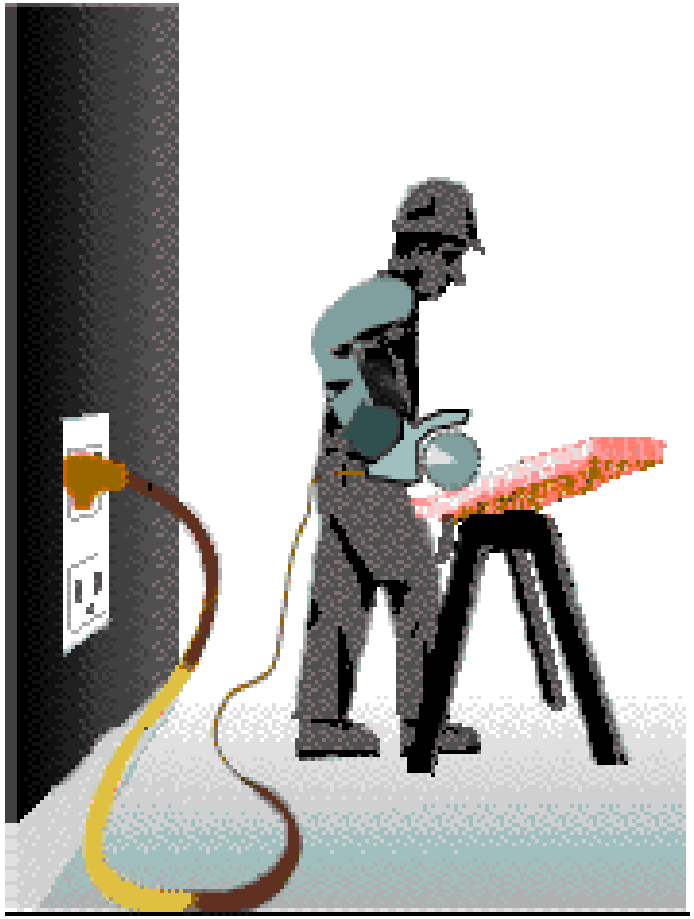
- Shut off electricity flow in the event of an overload or ground-fault in the circuit
  - Fuses
  - Circuit Breakers
  - Ground-fault circuit interrupters (GFCI)
- Fuses and circuit breakers are overcurrent devices
  - Fuses melt
  - Circuit breakers trip open

Ground-Fault Circuit Interrupter

- Protects you from dangerous shock
- Detects a difference in current between the black and white wires
- When a ground fault is detected, the GFCI can shut off electricity flow in as little as 1/40 of a second, protecting you from a dangerous shock

Grounding

- Grounding creates a low-resistance path from a tool to the earth to disperse unwanted current.
- When a short occurs, energy flows to the ground, protecting you from electrical shock, injury and death.

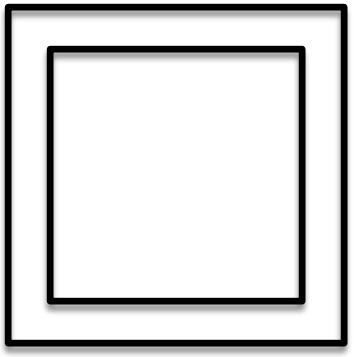


Hazard – Improper Grounding

- The path to ground from circuits, equipment, and enclosures must be permanent and continuous
- Tools plugged into improperly grounded circuits may become energized
- Broken wire or plug on extension cord
- One of the most frequently violated OSHA standards

Hand-Held Electric Tools

- Pose a potential danger because they make continuous good contact with the hand
- To protect you from shock, burns, and electrocution, tools must:
  - Have a three-wire cord with ground and be plugged into a grounded receptacle, or
  - Be double insulated, or
  - Be powered by a low-voltage isolation transformer



Double Insulated

Hazard - Overhead Power Lines

- Usually not insulated
- Examples of equipment that can contact power lines:
  - Crane
  - Ladder
  - Scaffold
  - Backhoe
  - Scissors lift
  - Raised dump truck bed
  - Aluminum paint roller

Control - Overhead Power Lines

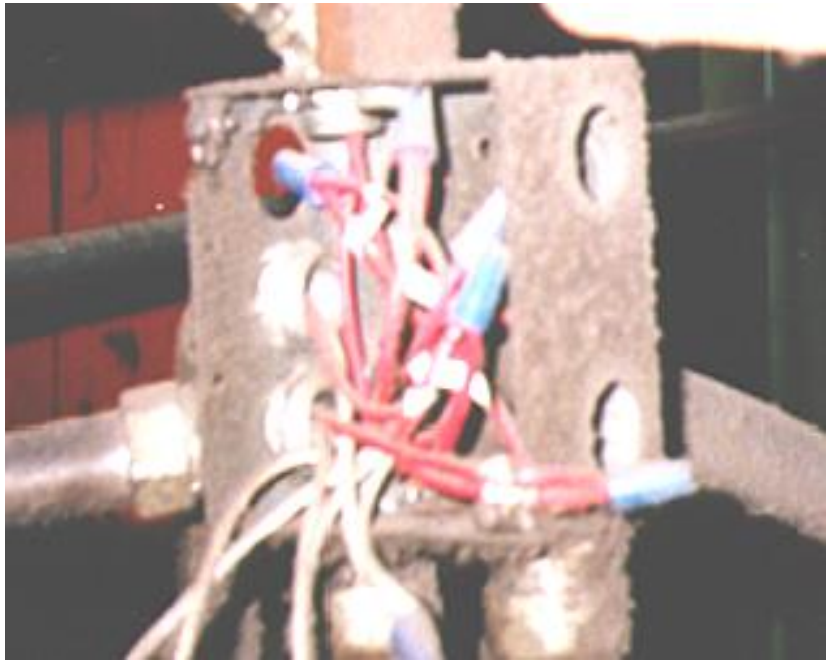
- Stay at least 10 feet away
- Post warning signs
- Assume that lines are energized
- Use fiberglass ladders, not metal
- Power line workers need special training and PPE

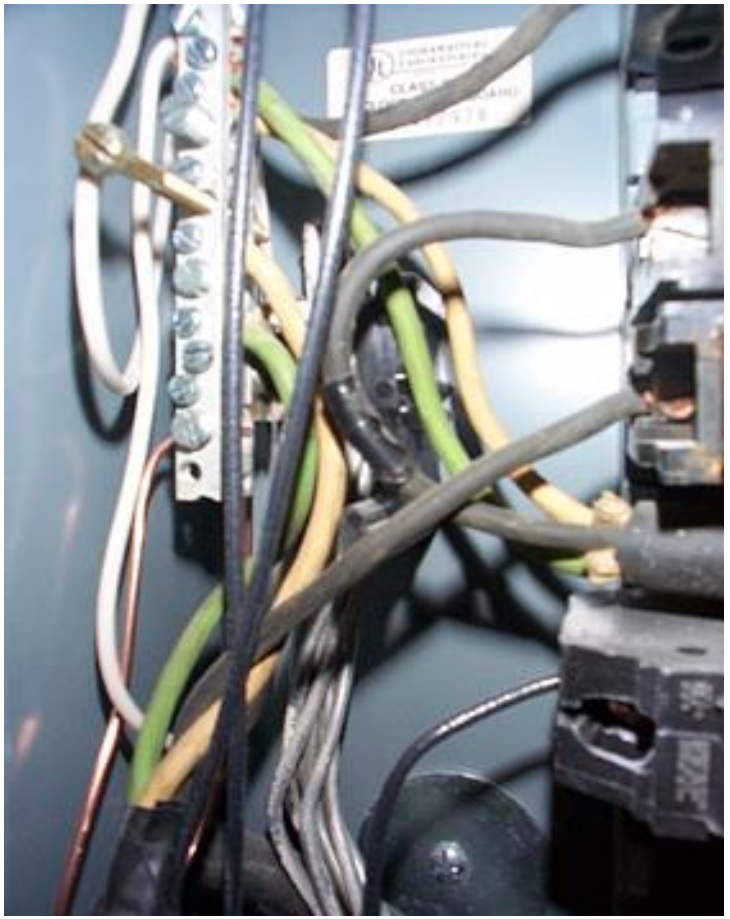
Guarding of Live Parts

- At ≥ 50 volts, must guard all live parts of electric equipment against accidental contact by:
  - Approved cabinets/enclosures, or
  - Location or permanent partitions making them accessible only to qualified persons, or
  - Elevation of 8 ft. or more above the floor or working surface
- Mark entrances to guarded locations with conspicuous warning signs

Control – Isolate Electrical Parts

- Replace covers
- Use guards or barriers

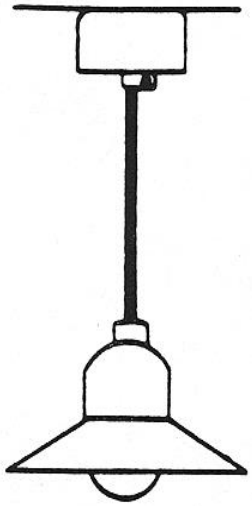




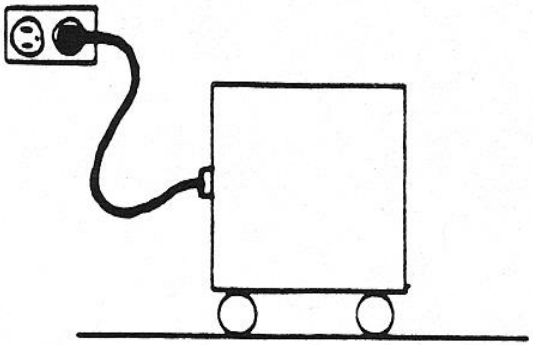
Use of Flexible Cords

- More vulnerable than fixed wiring
- Do not use if one of the recognized wiring methods can be used instead
- Flexible cords can be damaged by:
  - Aging
  - Door or window edges
  - Staples or fastenings
  - Abrasion from adjacent materials
  - Activities in the area
- Improper use of flexible cords can cause shocks, burns or fire

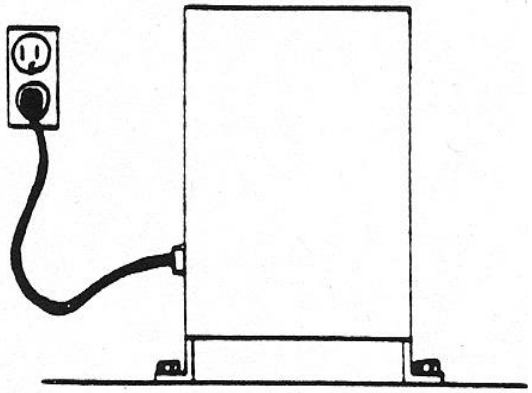
Permissible Uses of Flexible Cords



Pendant, or Fixture Wiring

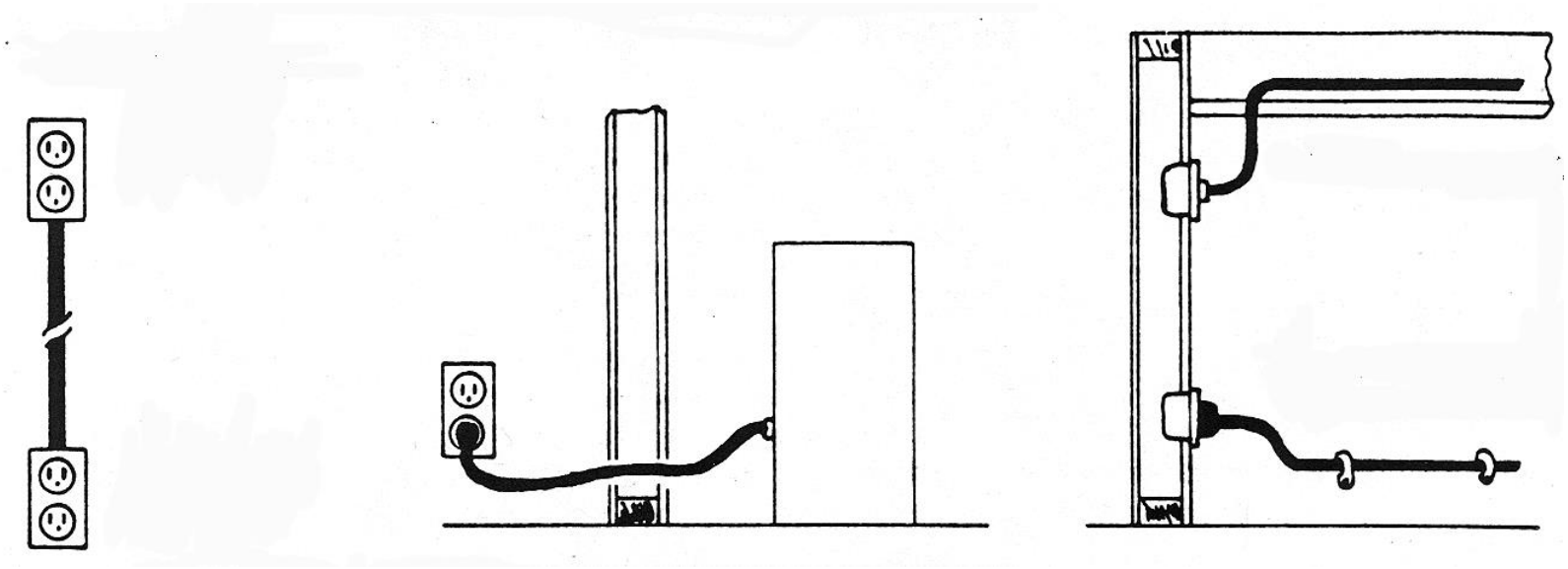


Portable lamps, tools or appliances



Stationary equipment- to facilitate interchange

Prohibited Uses of Flexible Cords



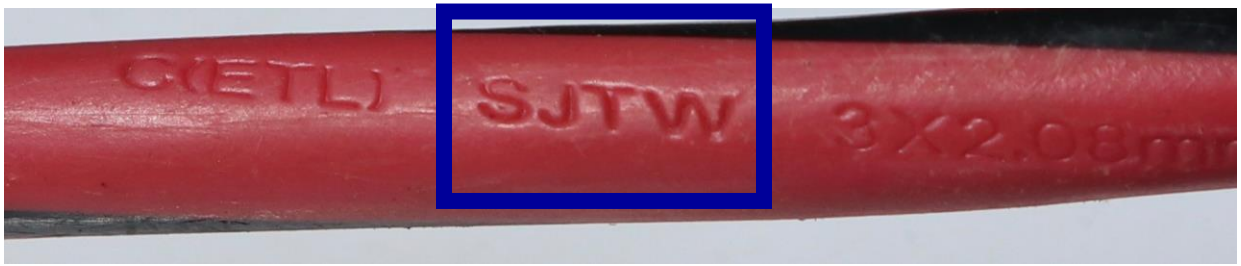
Substitute for fixed wiring

Run through walls, ceilings, floors, doors, or windows

Concealed behind or attached to building surfaces

Control – Cords and Wires

- Check before use
- Use only cords that are 3-wire types
- Use only cords marked for hard (SJ) or extra-hard (S) usage
- Use only cords, connection devices, and fittings equipped with strain relief
- Remove cords by pulling on the plugs, not the cords

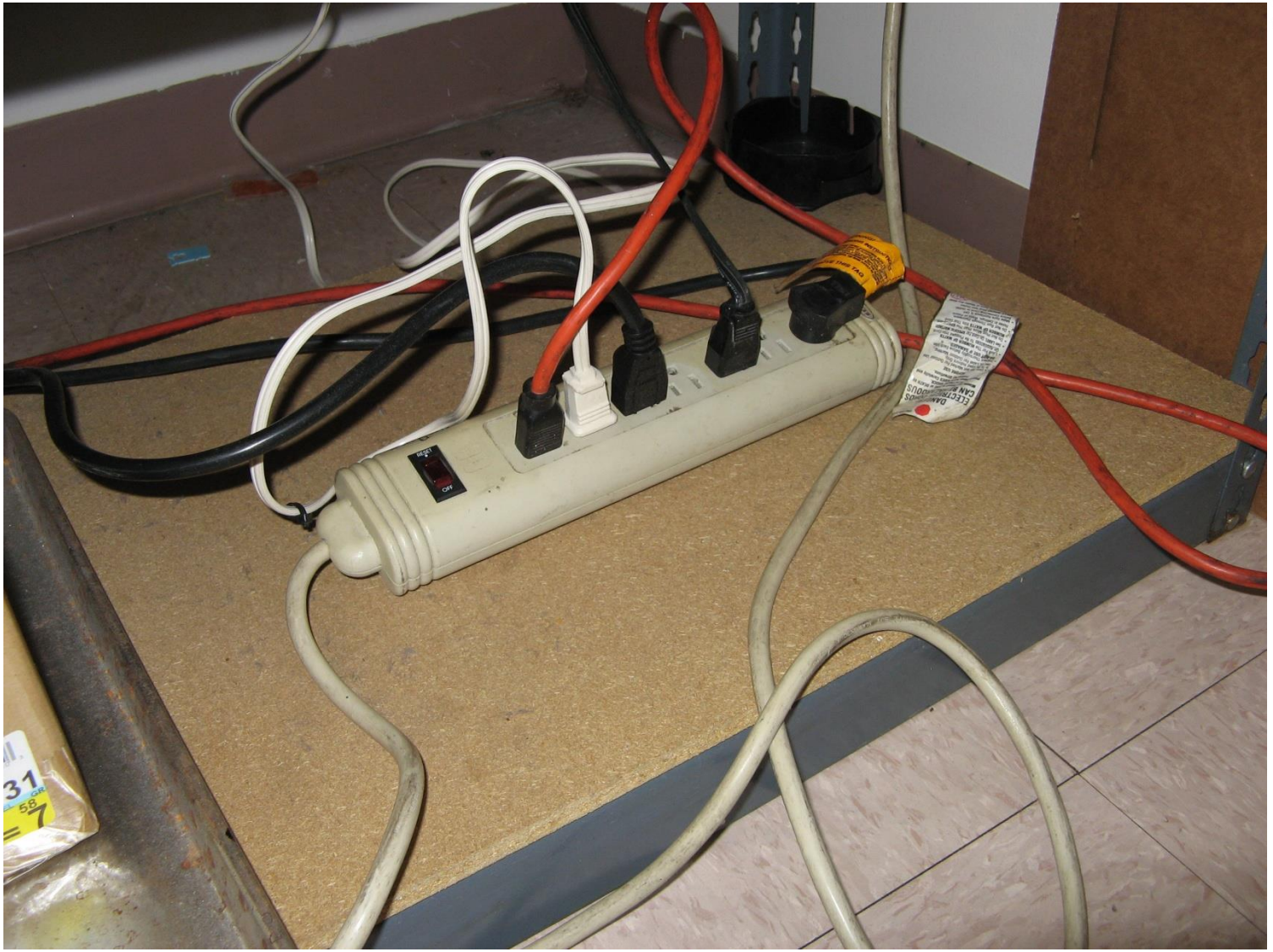


Clues that Electrical Hazards Exist

- Tripped circuit breakers or blown fuses
- Warm tools, wires, cords, connections, or junction boxes
- Worn or frayed insulation around wire or connection
- GFCI that shuts off a circuit

Common Examples of Misused Equipment

- Using multi-receptacle boxes designed to be *mounted,* with a power cord and placing them on the floor.
- Fabricating extension cords with ROMEX® wire.
- Using indoor equipment outdoors.
- Attaching ungrounded, two-prong adapter plugs to three-prong cords and tools.




WARNING
Arc Flash Hazard
Appropriate PPE Required
DANGER


improved design

Ohio Bureau of Workers' Compensation

Summary

- Listed and Labeled
- No exposed electrical parts
- Ground permanent and continuous

Ohio | Bureau of Workers' Compensation

Steven Roth, PE
Ergonomist
Division of Safety & Hygiene
Steven.R.1@bwc.state.oh.us
513-889-8413