
Electrical
Safety
1910 Subpart S

Introduction

- An average of one worker is electrocuted on the job every day
- There are four main types of electrical injuries:
  - Electrocution (death due to electrical shock)
  - Electrical shock
  - Burns
  - Falls

Electrical Terminology

- **Current** – the movement of electrical charge
- **Resistance** – opposition to current flow
- **Voltage** – a measure of electrical force
- **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
- **Grounding** – a conductive connection to the earth which acts as a protective measure

Consider a Freeway

Current = Traffic direction

Resistance = Traffic

Voltage = Amount of Traffic

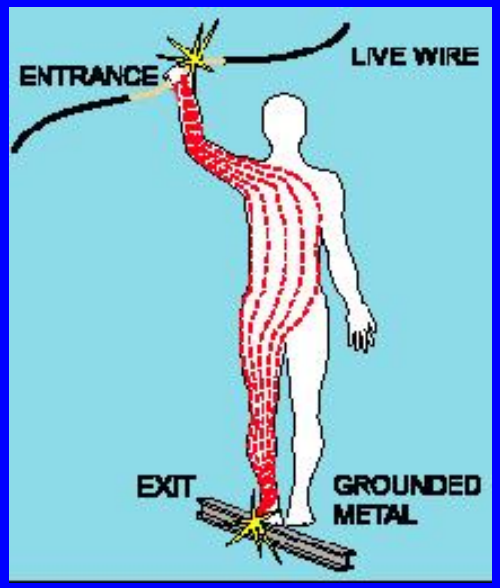
Conductors = Highway surface

Insulators = Highway shoulder and Traffic Containment Barriers

Grounding = On and Off Ramps

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



Dangers of Electrical Shock

- Currents greater than 75 mA* can cause ventricular fibrillation (rapid, ineffective heartbeat)
- Will cause death in a few minutes unless a defibrillator is used
- 75 mA is not much current – a small power drill uses 30 times as much

Defibrillator in use

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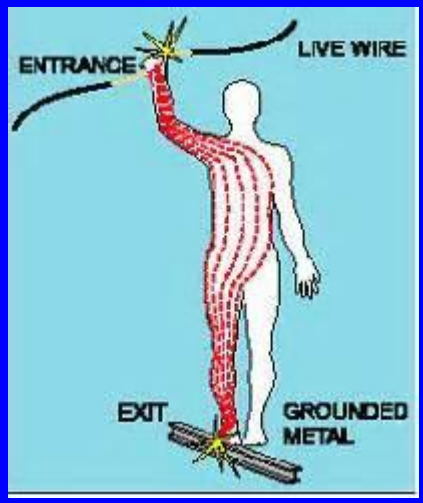
* mA = milliampere = 1/1,000 of an ampere

How is an electrical shock received?

- When two wires have different potential differences (voltages), current will flow if they are connected together
  - In most household wiring, the black wires are at 110 volts relative to ground
  - The white wires are at zero volts because they are connected to ground
- If you come into contact with an energized (live) black wire, and you are also in contact with the white grounded wire, current will pass through your body and YOU WILL RECEIVE A SHOCK

How is an electrical shock received? (cont'd)

- If you are in contact with an energized wire or any energized electrical component, and also with any grounded object, YOU WILL RECEIVE A SHOCK
- You can even receive a shock when you are not in contact with a ground
  - If you contact both wires of a 240-volt cable, YOU WILL RECEIVE A SHOCK and possibly be electrocuted



Electrical Burns

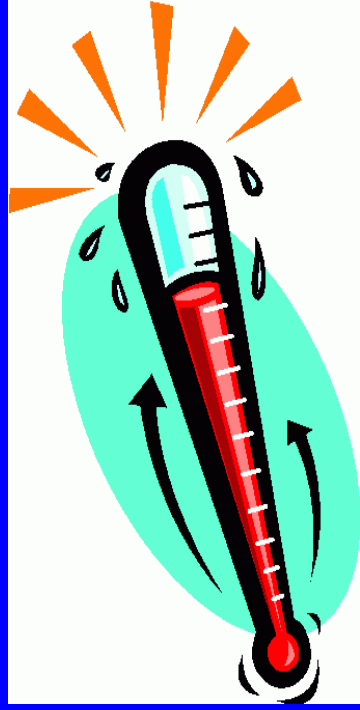
- Most common shock-related, nonfatal injury
- Occurs when you touch electrical wiring or equipment that is improperly used or maintained
- Typically occurs on the hands
- Very serious injury that needs immediate attention

Arc Flash

- An arc flash is an electric arc supplied with sufficient electrical energy to cause substantial damage, harm, fire or injury. This is caused when a controlled electric current is diverted from its path and heats the air or any objects causing an explosion. Lightning is an example of Arc Flash.

- **One of the most common causes of arc flash injuries happens when switching on electrical circuits and, especially, tripped circuit breakers.** A tripped circuit breaker often indicates a fault has occurred somewhere down the line from the panel. The fault must usually be isolated before switching the power on, or an arc flash can easily be generated. Small arcs usually form in switches when the contacts first touch, and can provide a place for an arc flash to develop. If the voltage is high enough, and the wires leading to the fault are large enough to allow a substantial amount of current, an arc flash can form within the panel when the breaker is turned on. Generally, either an electric motor with shorted windings or a shorted power transformer are the culprits, being capable of drawing the energy needed to sustain a dangerous arc-flash. Motors over two horsepower usually have magnetic starters, to both isolate the operator from the high-energy contacts and to allow disengagement of the contactor if the breaker trips.
- *Source: http://en.wikipedia.org*

Damage



- The onset of a second degree burn is 180 F
- Skin cell death occurs at 201 F
- Cotton burns at 700 F
- Aluminum melts at 1200 F
- Copper melts at 1981 F
- Carbon steel melts at 2700 F
- **The sun's surface is about 9000 F**
- **An Electrical Arc Flash can reach 35,000 F!!**

Did you know that...

- In addition to the intense heat, an arc flash blast can contain as much as 2100 pounds per square inch (PSI) of pressure instantly!
- Just a sudden change in 20 psi can create a wind speed of about 470 mph!

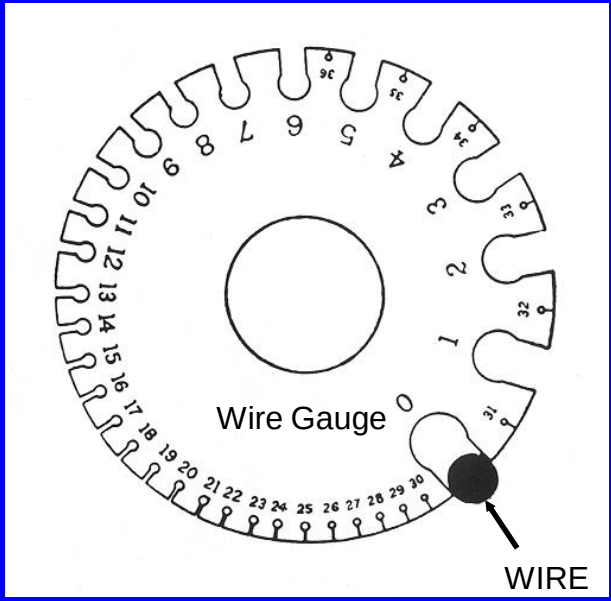
- Injuries from an arc flash can be fatal. Over 2000 people a year are admitted to burn centers with severe arc flash burns.

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

Inadequate Wiring Hazards

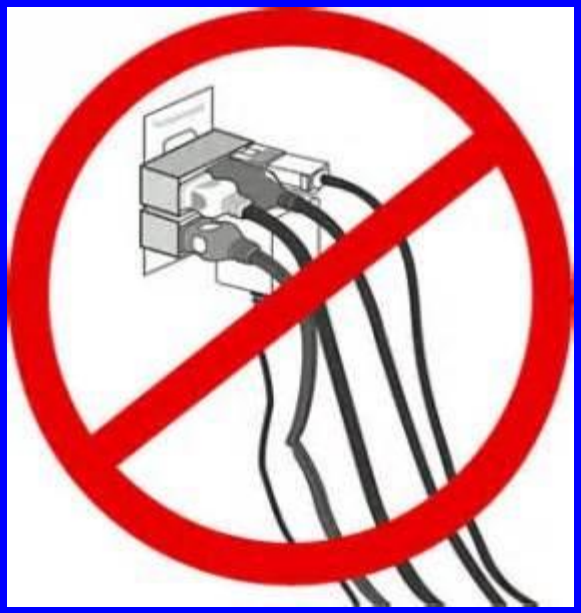
- A hazard exists when a conductor is too small to safely carry the current
- *Example:* using a portable tool with an extension cord that has a wire too small for the tool
  - The tool will draw more current than the cord can handle, causing overheating and a possible fire without tripping the circuit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

Overload Hazards

- If too many devices are plugged into a circuit, the 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 Protective Devices

- These devices shut off electricity flow in the event of an overload or ground-fault in the circuit
- Include fuses, circuit breakers, and ground-fault circuit-interrupters (GFCI's)
- Fuses and circuit breakers are overcurrent devices
  - When there is too much current:
    - Fuses melt
    - Circuit breakers trip open

Ground-Fault Circuit Interrupter

- This device protects you from dangerous shock
- The GFCI detects a difference in current between the black and white circuit wires

  (This could happen when electrical equipment is not working correctly, causing current “leakage” – known as a *ground fault.*)
- If 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 Hazards

- Some of the most frequently violated OSHA standards
- Metal parts of an electrical wiring system that we touch (switch plates, ceiling light fixtures, conduit, etc.) should be at zero volts relative to ground
- Housings of motors, appliances or tools that are plugged into improperly grounded circuits may become energized
- If you come into contact with an improperly grounded electrical device, YOU WILL BE SHOCKED

Overhead Powerline Hazards

- Most people don't realize that overhead powerlines are usually not insulated
- Powerline workers need special training and personal protective equipment (PPE) to work safely
- Do not use metal ladders – instead, use fiberglass ladders
- Beware of powerlines when you work with ladders and scaffolding

Electrical Safety Awareness for Non-electrical Workers

Some Examples of OSHA Electrical Requirements . . . .

Grounding Path

- The path to ground from circuits, equipment, and enclosures must be permanent and continuous
- Violation shown here is an extension cord with a missing grounding prong

Hand-Held Electric Tools

- 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

Guarding of Live Parts

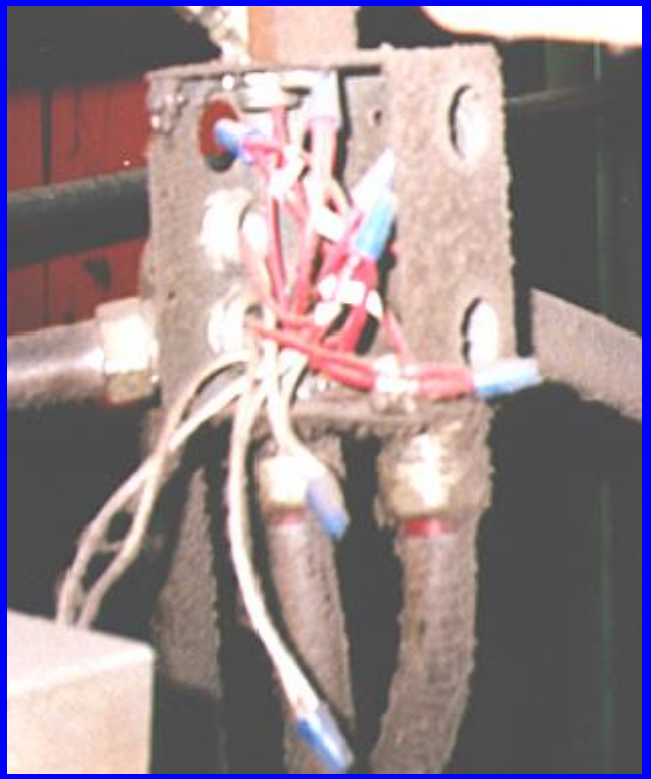
- Must guard live parts of electric equipment operating at 50 volts or more against accidental contact by:
  - Approved cabinets/enclosures, or
  - Location or permanent partitions making them accessible only to qualified persons, or
  - Elevation of 8 ft. or more above the floor or working surface
-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

Guarding of Live Parts

- Must enclose or guard electric equipment in locations where it would be exposed to physical damage
- Violation shown here is physical damage to conduit

Cabinets, Boxes, and Fittings

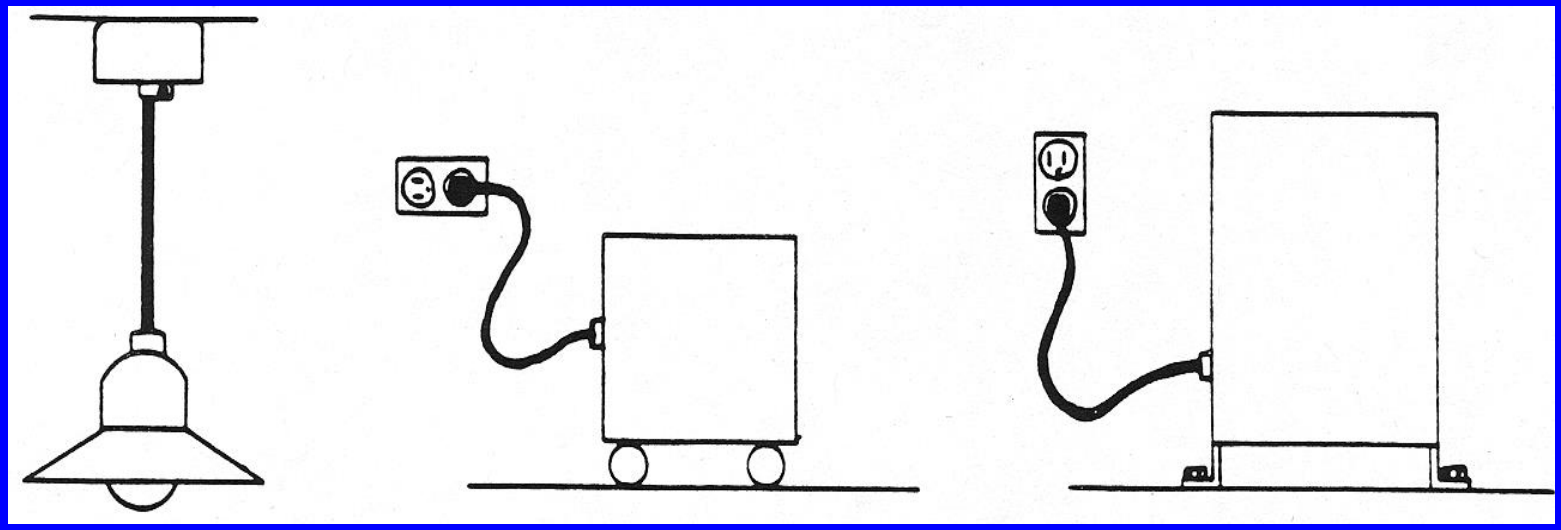
- Junction boxes, pull boxes and fittings must have approved covers
- Unused openings in cabinets, boxes and fittings must be closed (no missing knockouts)
- Photo shows violations of these two requirements



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
Examples

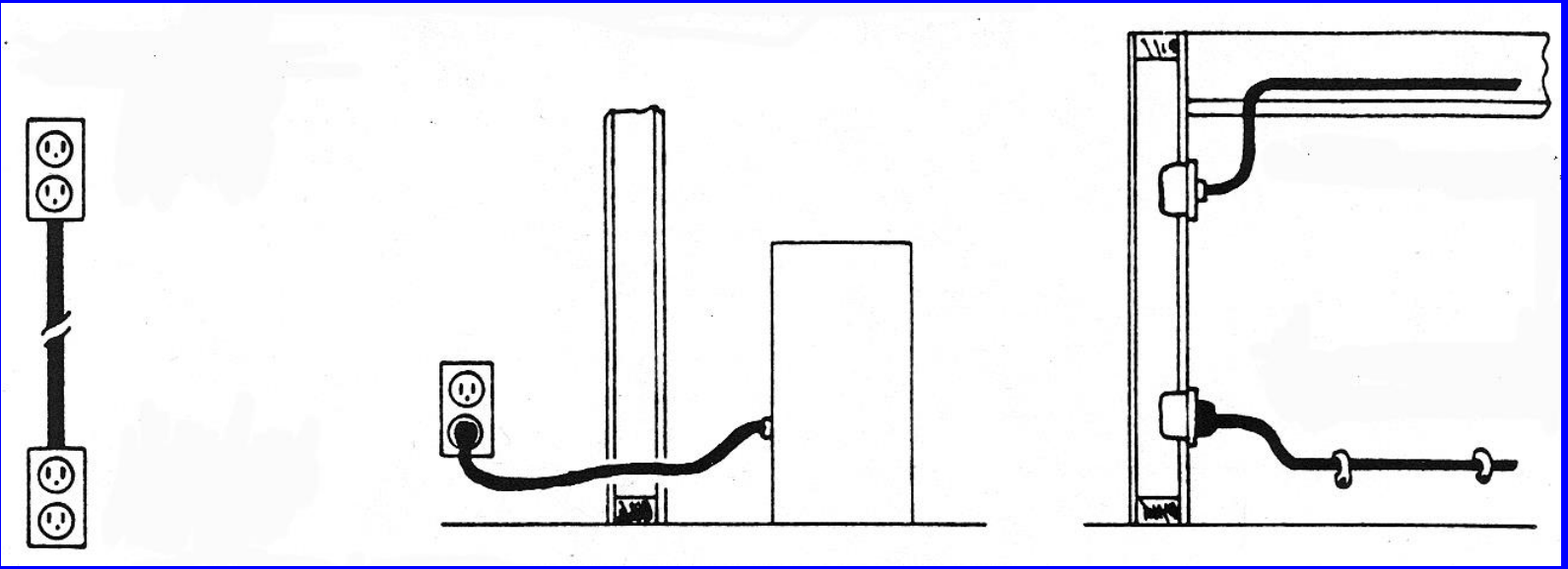


Pendant, or Fixture Wiring

Portable lamps, tools or appliances

Stationary equipment- to facilitate interchange

Prohibited Uses of Flexible Cords
Examples



Substitute for fixed wiring

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

Concealed behind or attached to building surfaces

Clues that Electrical Hazards Exist

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

Training

Train employees working with electric equipment in safe work practices, including:

- De-energizing electric equipment before inspecting or making repairs
- Using electric tools that are in good repair
- Using good judgment when working near energized lines
- Using appropriate protective equipment

Lock Out/Tag Out

- Ensure an electrically safe working condition by implementing a lock-out and tag-out protocol on all energized sources to create an absence of electrical energy.

Refer to OSHA Standard 1970.147

Summary

Hazards

- Inadequate wiring
- Exposed electrical parts
- Wires with bad insulation
- Ungrounded electrical systems and tools
- Overloaded circuits
- Damaged power tools and equipment
- Using the wrong PPE and tools
- Overhead powerlines
- Wet conditions

Protective Measures

- Proper grounding
- Using GFCI's
- Using fuses and circuit breakers
- Guarding live parts
- Proper use of flexible cords
- Training
- PPE

LUNCH TIME
Please be back by 12:30