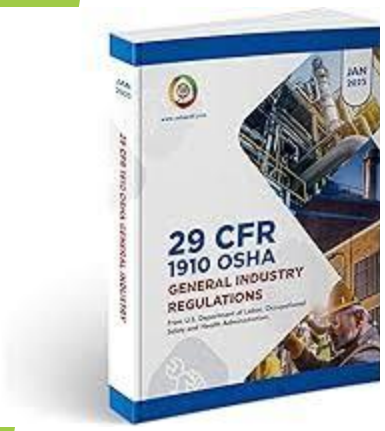
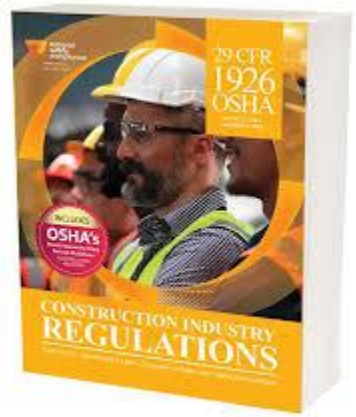
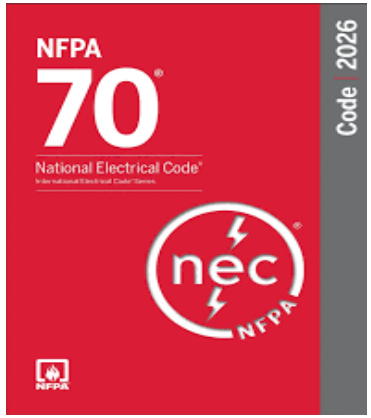
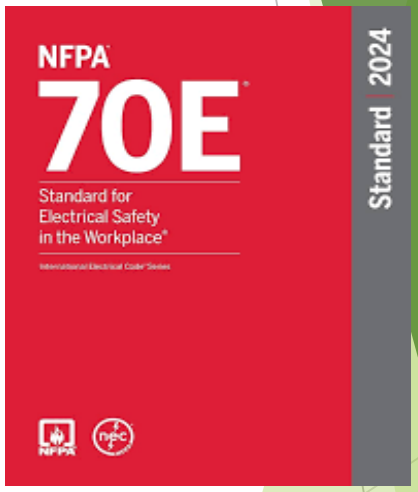
Electrical Safety in the Workplace



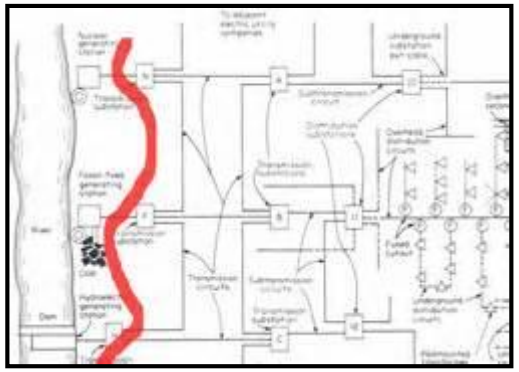






Presenter: Ray Struffolino, COSS, NFPA-70e EHS Trainer

Electrical Safety



Introduction

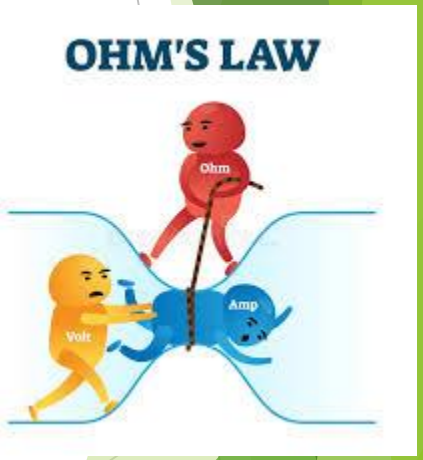
Lesson objectives:

1. Identify major electrical hazards
2. Describe types of electrical hazards
3. Describe electrical protection methods
4. Lockout/Tagout
5. Recognize employer requirements to protect workers from electrical hazards

Introduction

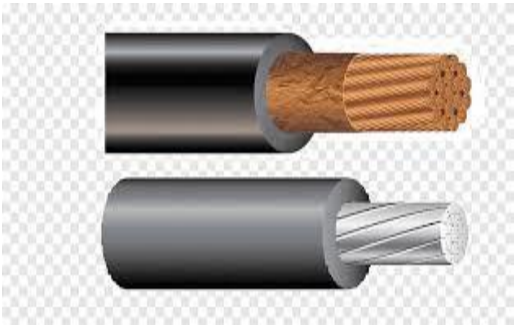
Definitions:

- Electricity – movement of the free electrons between atoms;
  - Related terms:
    - Current – the movement of electrical charge
    - Resistance – opposition to current flow
    - Voltage – a measurement of electrical force



Introduction

- Conductors – substances, such as metals, that have little resistance to electricity
- Insulators – substances, such as **dry** wood, rubber, glass and Bakelite, that have high resistance to electricity
- Grounding – a conductive connection to the earth which acts as a protective measure



Electrical Hazards

Serious injuries and death can be caused by electrical hazards such as arc flash, shocks, burns, falls, and fires. Source of graphics: OSHA

Electrical Hazards

BE SAFE:

- Burns
- Electrocution
- Shock
- Arc flash/arc blast
- Fire
- Explosions

Electrical Hazards

Burns:

- Most common shock-related injury
- Three types of electrical burns:
  - Electrical
  - Arc flash
  - Thermal contact

Electrical Hazards

Electrocution:

- Is fatal
- Meaning: to kill with electrical shock
- Results when a human is exposed to a lethal amount of electrical energy

Electrical Hazards

Shock:

- Body becomes part of electrical circuit
- Reflex response to passage of electric current through the body

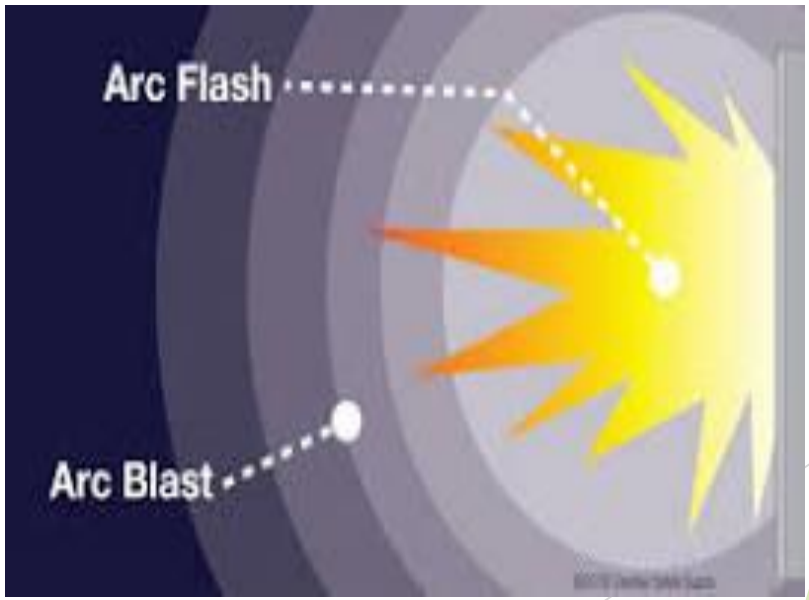
Electrical Hazards

Arc Flash/Arc Blast

- Arc flash
  - Sudden release of electrical energy through air when a high-voltage gap exists and there is a breakdown between conductors
  - Gives off thermal radiation (heat) and bright, intense light that can cause burns
  - Temperatures as high as 35,000°F (Four times hotter than the surface of the sun)

Electrical Hazards

- Arc blast – high-voltage arcs can also produce considerable pressure waves by rapidly heating the air and creating a blast



Electrical Hazards

Fire:

- Most result from problems with "fixed wiring"
- Problems with cords, plugs, receptacles, and switches also cause electrical fires

Electrical Hazards

Explosions:

- Occur when electricity ignites explosive mixture of material in the air
- Note:
  - Electricity is source of these hazards
  - All hazards are of equal importance
  - Lesson focuses on eliminating electrical hazards

Electrical Hazards (Statistics)

U.S. Bureau of Labor Statistics, OSHA and ESFI

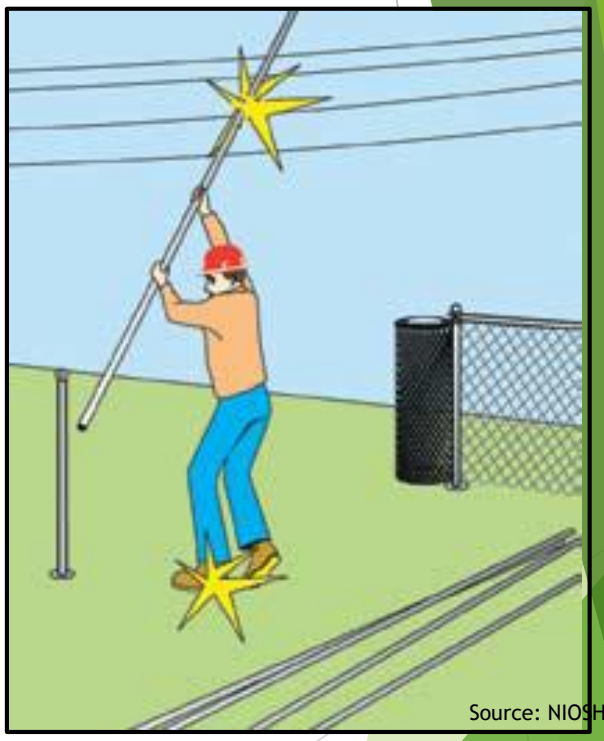
- In 2024, there were **1738** fatal injuries from direct contact with electric current.
- **10** to **1** Ratio: For every one fatality there are approximately ten non fatal electrical injures.

Source of graphics:
OSHA

Types of Electrical Hazards

Contact with overhead power lines:

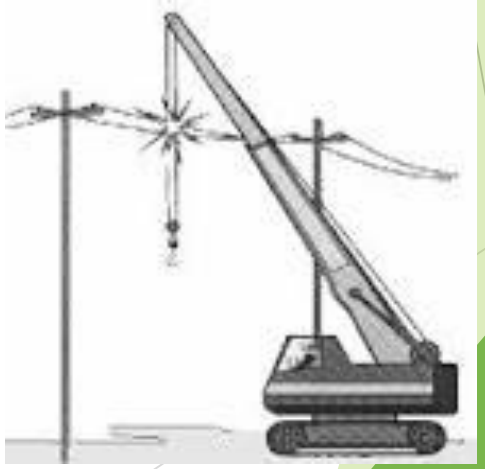
- Overhead and buried power lines carry extremely high voltage
- Risks
  - Electrocution (main risk)
  - Burns and falls



Types of Electrical Hazards

- Cranes are not the only equipment that can reach overhead power lines.
- Use of ladders or suspension in a man-basket under or near power lines are risks.

Source: OSHA



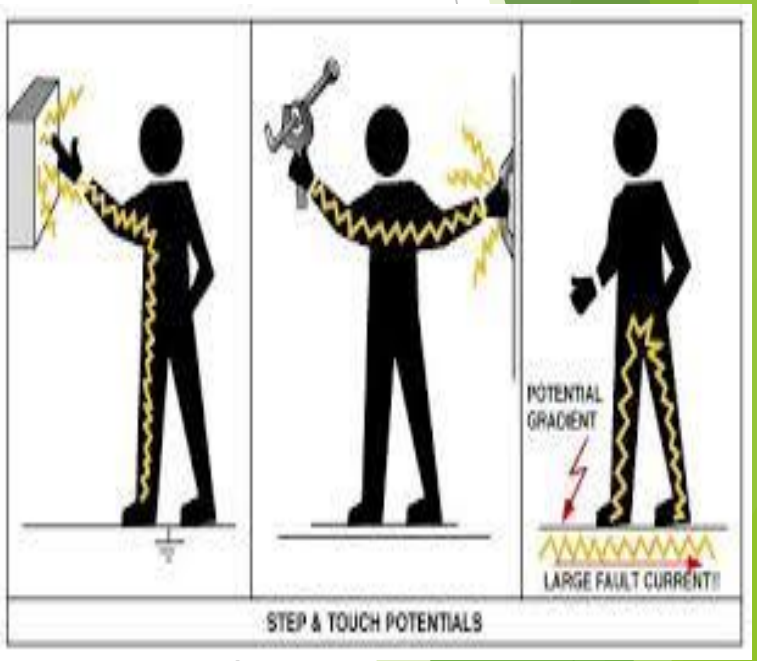
Types of Electrical Hazards

- **Important**: the covering on an overhead power line is primarily for weather protection; therefore, workers need to know that if they touch a power line, covered or bare, death is probable.

Types of Electrical Hazards

Contact with energized sources:

- Live parts
  - The major hazards
    - Electrical shock and burns
    - Electrical shock occurs when the body becomes part of the electric circuit



Types of Electrical Hazards

- **Severity and effects of an electrical shock depend on a number of factors**
  - Pathway through the body
  - Amount of current
  - Length of time of the exposure
  - Whether skin is wet or dry
- **Water**
  - Great conductor
  - Allows current to flow more easily in wet conditions and through wet skin

(1,000 milliamperes = 1 amp; therefore, 15,000 milliamperes = 15 amp circuit)	
Current	**Reaction**
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 milliampres	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
1,000-4,300 milliamperes (1 to 4 Amperes)	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely
10,000 milliamperes (10 Amperes)	Cardiac arrest, severe burns; death probable

This table shows the body's reaction when exposed to various levels of current. Source: OSHA

Types of Electrical Hazards

- **Damaged or bare wires**
  - Fault current may travel through a body, causing electrical burns or death, if
    - Power supply is not grounded
    - Path has been broken
    - There are live parts or bare wires
  - Extreme conditions and rough treatment can change electrical equipment from safe to hazardous

ARC FLASH Labeling of Equipment

Types of Personal Protection Equipment

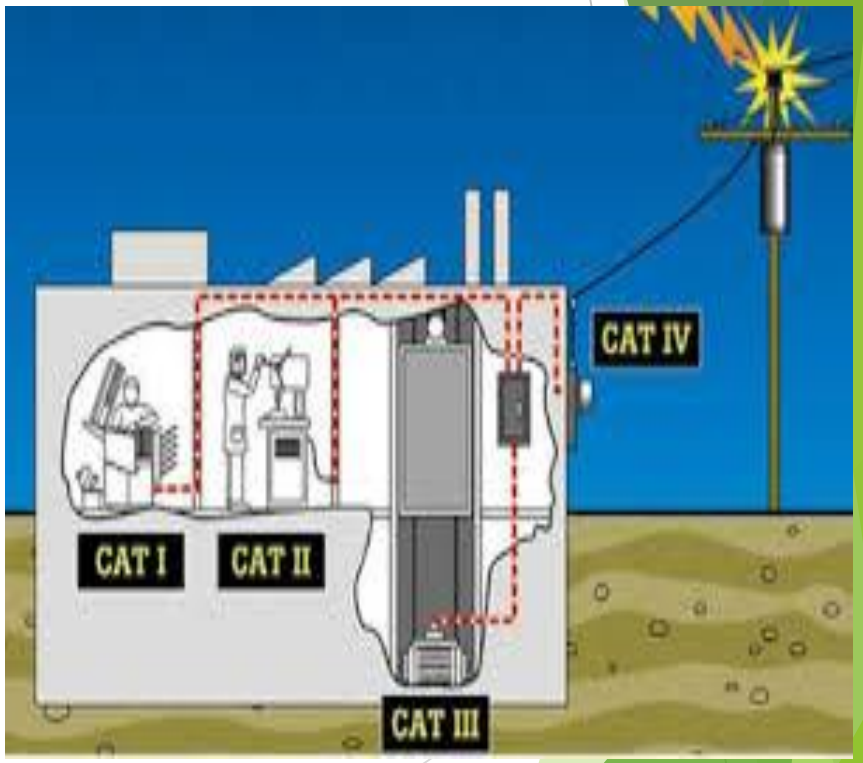
New Type of Personal Protection Equipment.

Types of Personal Protection Equipment

CLASS	TEST AC VOLTS	USE AC VOLTS	USE DC VOLTS	LABEL COLOR	LABEL IMAGE
00	2,500	500	750	Beige	
0	5,000	1,000	1,500	Red	
1	10,000	7,500	11,250	White	
2	20,000	17,000	25,500	Yellow	
3	30,000	26,500	39,750	Green	
4	40,000	36,000	54,000	Orange	

Voltage Rated Tools

Test Instruments



Test Instruments "continued."

- NFPA-70e, 110.4(A)(1)(e), 110.6(A)

1. Employees shall be trained to select an appropriate test instrument and shall demonstrate how to use a device to verify the absence of voltage
2. Only qualified persons shall perform tasks such as testing, troubleshooting, and voltage measuring on electrical equipment where an electrical hazard exists
3. Test instruments within an organization should be standardized to facilitate their use.

Types of Overcurrent Devices (Circuit Breaker)

Overcurrent Devices High Voltage

Overcurrent Devices (Fuses)

Types of Electrical Hazards

- Defective equipment or tools

Types of Electrical Hazards

- Temporary Lighting

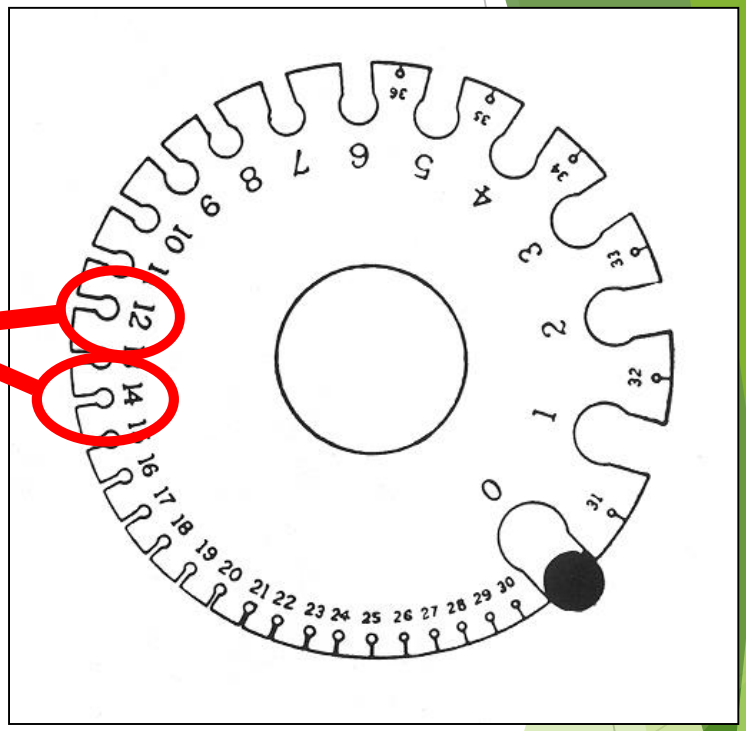
Types of Electrical Hazards

Improper use:

- Extension and flexible cords
  - Care
  - Connection
  - Capacity

Types of Electrical Hazards

- Capacity affected by
  - Size of wire
    - 14 gauge = 15 amps
    - 12 gauge = 20 amps
  - Length of the cord
    - UL tag capacity
    - In general any cord over 100 ft. requires one size larger cord (14 gauge to 12 gauge)



Source: OSHA

Conductor (wire) Color code

Black-Red-Blue

120/208 Volts

Brown-Orange-Yellow

277/480 Volts

White/Natural Gray (Neutral)

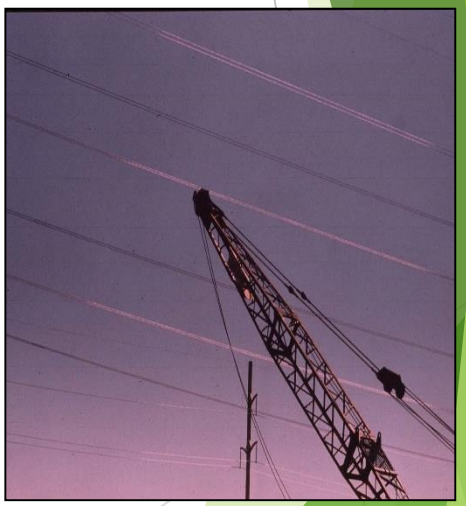
Green/Green with **Yellow**

(Earth Ground)

Electrical Protection Methods

Maintain safe distance from overhead power lines:

- Staying away
- Following table shows the safe power line clearance distance for various line voltages.
- https://youtu.be/Y2MwX738e1Y



Source of graphics: OSHA

Electrical Protection Methods

Voltage (nominal, kV, alternating current)	Minimum Clearance Distance (feet)
Up to 50	10
Over 50 to 200	15
Over 200 to 350	20
Over 350 to 500	25
Over 500 to 750	35
Over 750 to 1000	45
Over 1000 (Remember to check Relative Humidity)	(As established by the power line owner/operator or registered professional engineer who is a qualified person with respect to electrical transmission and distribution)

Electrical Protection Methods

Use ground-fault circuit interrupters (GFCI):

- Designed to protect people from electrical shock
- Detects ground faults and interrupts electric current
- Limits duration of electrical shock

Source: OSHA

Electrical Protection Methods

Three types of GFCI:

- Receptacle GFCI
- Temporary/portable GFCI
- Circuit Breaker GFCI

Electrical Protection Methods

Inspect portable tools and extension cords:

- Workers need to inspect extension cords prior to their use for any cuts or abrasion.
- Electric hand tools that are old, damaged, or misused may have damaged insulation inside.

Electrical Protection Methods

Use power tools and equipment as designed:

- Follow tool safety tips to avoid misusing equipment
- Follow manufacturer's instructions

Electrical Protection Methods

- Common examples of misused equipment

Source of photos: OSHA

These photos show examples of equipment misuse.

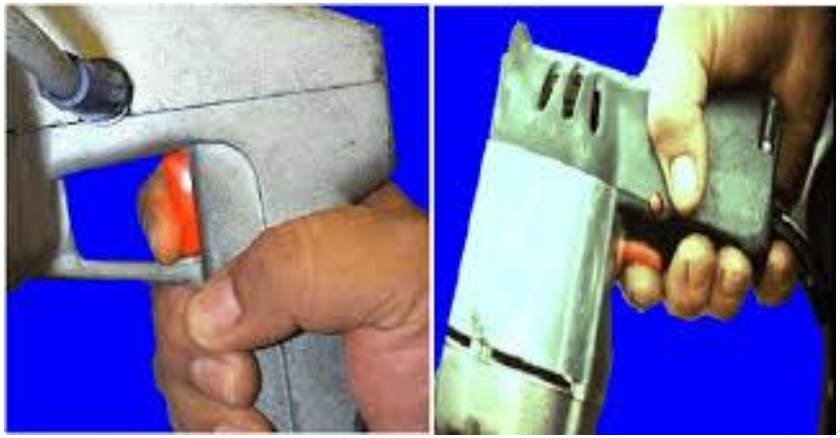
Electrical Protection Methods

Tool safety tips

- Never carry a tool by the cord.
- Never yank the cord to disconnect it.
- Keep cords away from heat, oil, and sharp edges.
- Disconnect when not in use and when changing accessories such as blades and bits.

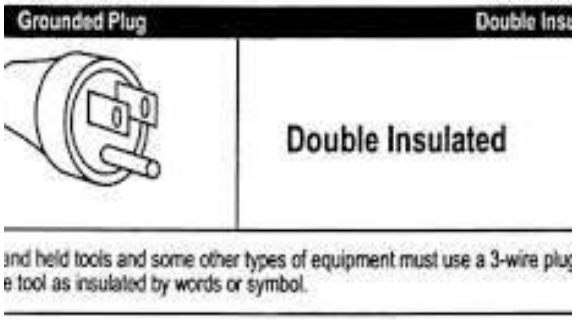
Electrical Protection Methods

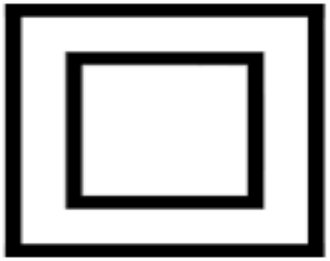
- Avoid accidental starting. Do not hold fingers on the switch button while carrying a plugged-in tool.
- Use gloves and appropriate footwear.
- Store in dry a place when not using.



Electrical Protection Methods

- Don’t use in wet/damp environments.
- Keep working areas well lit.
- Ensure that cords do not cause a tripping hazard.
- Remove damaged tools from use.
- Use double-insulated tools.





Electrical Protection Methods

Follow lockout/tagout (LOTO) procedures:

- Lockout/tagout
  - Essential safety procedure
  - Protects workers from injury while working on or near electrical circuits and equipment
  - Prevents contact with operating equipment parts such as, blades, gears, shafts, etc.

Electrical Protection Methods

- LOTO prevents the unexpected release of hazardous gases, fluids, or solid matter in areas where workers are present.

Electrical Protection Methods

- The Eight steps to lockout/tagout (LOTO)

1. Preparation
2. Notification
3. Shutdown
4. Lockout/Tagout
5. Check (stored energy)
6. Verification (truly de-energized)
7. Service Equipment
8. Equipment back into service

Electrical Protection Methods

Power source identification:

- Mark all breakers accordingly for the circuits they protect
- Mark all disconnect means accordingly for the equipment they service
- Identify all voltages with proper labeling

Employer Requirements

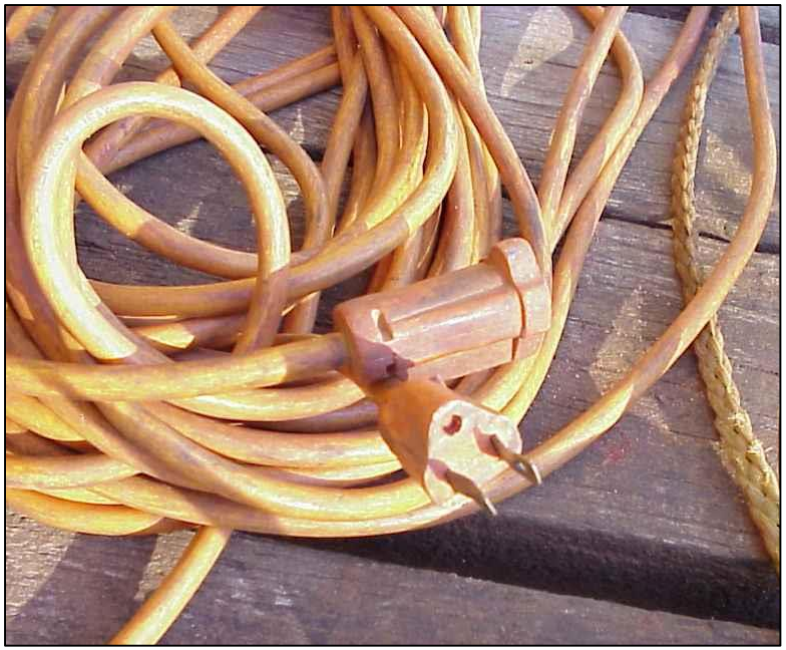
Employer requirements to protect workers:

- Ensure overhead power line safety
- Isolate electrical parts
- Supply ground-fault circuit interrupters (GFCI) protection
- Establish and implement an AEGCP (Assured Equipment Grounding Conductor Program)
- Ensure power tools are maintained in a safe condition

Employer Requirements

- Ensure proper guarding
- Provide training
- Enforce LOTO safety related work practices
- Ensure proper use of flexible cords and power strips
- Ensure proper identification of power sources

What's Wrong?



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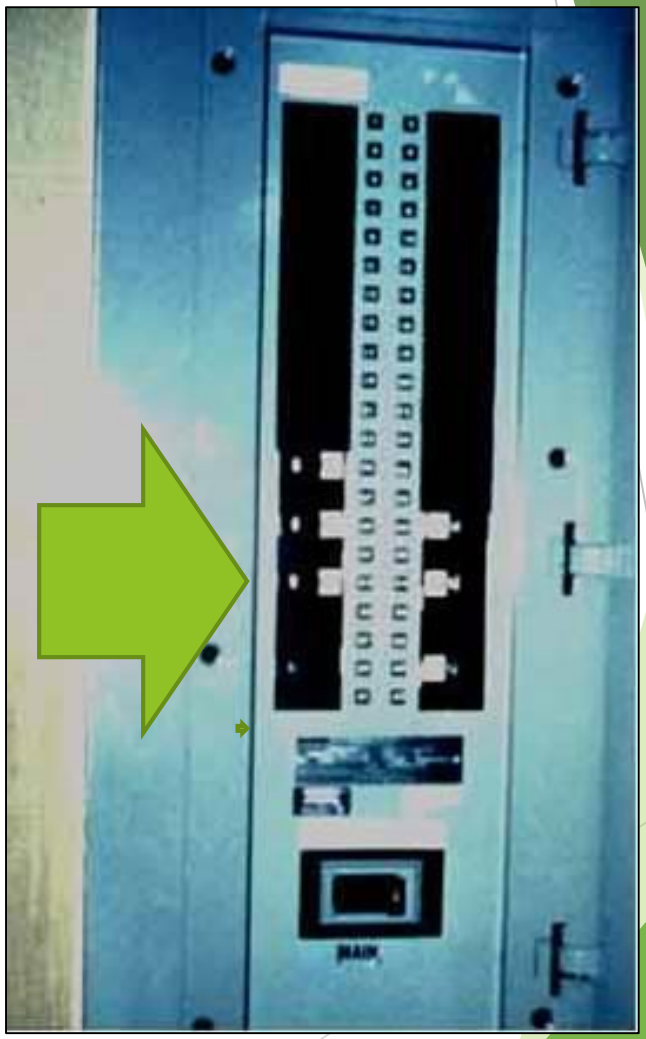

Questions