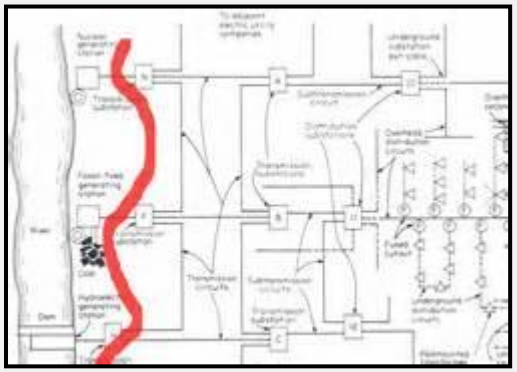
1910 General Industry Electrical Hazards

Electrical



Source of photos: OSHA

Introduction

Lesson objectives:

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

Source: OSHA

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

Source: NIOSH

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

Examples of electrical hazards that could cause workers to be electrocuted:

- https://www.osha.gov/video/shipyard_accidents/08_welder_electrocuted.html

- https://www.osha.gov/video/shipyard_accidents/15_lockout_tagout_failure.html

Electrical Hazards

BE SAFE:

- **B**urns
- **E**lectrocution
- **S**hock
- **A**rc flash/arc blast
- **F**ire
- **E**xplosions

Electrical Hazards

Burns:

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

Source: OSHA

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

Source: OSHA

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

Electrical Hazards

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

Common Causes of Arc Flash

Common causes include:

- Dust
- Dropping tools
- Accidental touching
- Condensation
- Material failure
- Corrosion
- Faulty installation
- Wiring errors

Arc Flash Prevention

Preventing an arc flash incident starts by following up-to-date safe work practices and procedures. The National Fire Protection Association, or NFPA, publishes current safe work practices that will enable you to recognize and avoid arc flash hazards.

Almost all arc flash accidents happen when workers are untrained or ignore safe work practices.

Never work on an electrical task without being properly *qualified* for the work being performed.

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

Examples of fatal accidents:

- Case #1: Worker electrocuted when the ladder came in contact with overhead power lines
- Case #2: Worker electrocuted when mast came in contact with high voltage overhead lines

Electrical Hazards

- Case #3: Worker changing energized ballast on light fixture was electrocuted and fell to the concrete floor while working from an 8' fiberglass stepladder.

Electrical Hazards

U.S. Bureau of Labor Statistics:

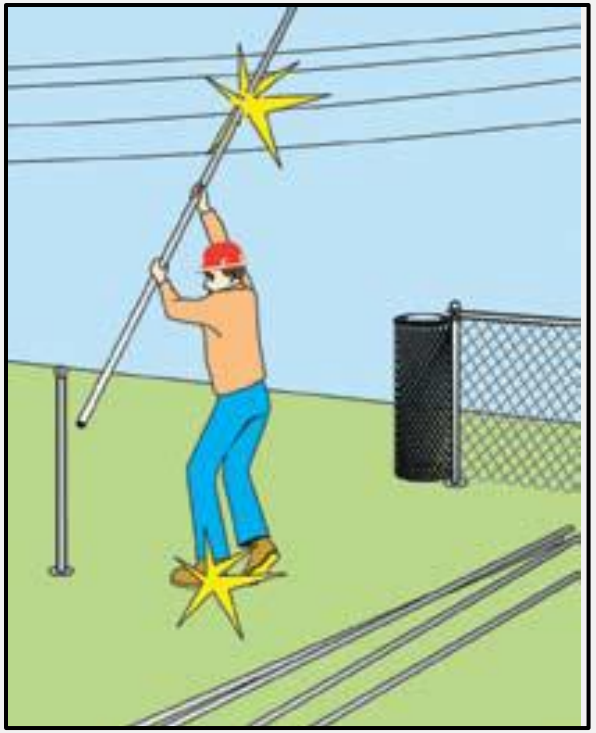
- 156 electrocutions for 2014
- Up from 141 in 2013

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



Source: NIOSH

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

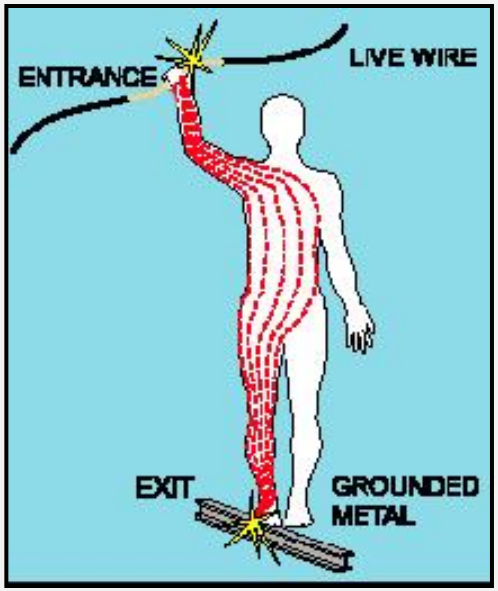
Types of Electrical Hazards

- **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.
- https://www.osha.gov/dts/vtools/construction/ladder_powerline_fnl_eng_web.html

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



Source: OSHA

Elevator Industry-Related Electrical Hazards

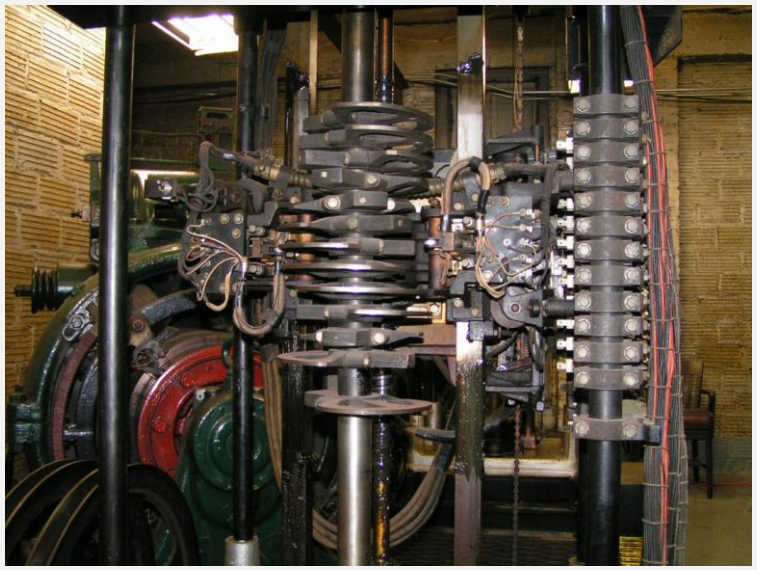
Control cabinet doors should be closed any time work is not being done. This will eliminate accidental contact with any live components. The controller may be located inside the hoistway, and only accessible from the car top. Whenever possible, perform LOTO procedures before doing any work inside the control panel. Always follow your company's LOTO and live work processes.

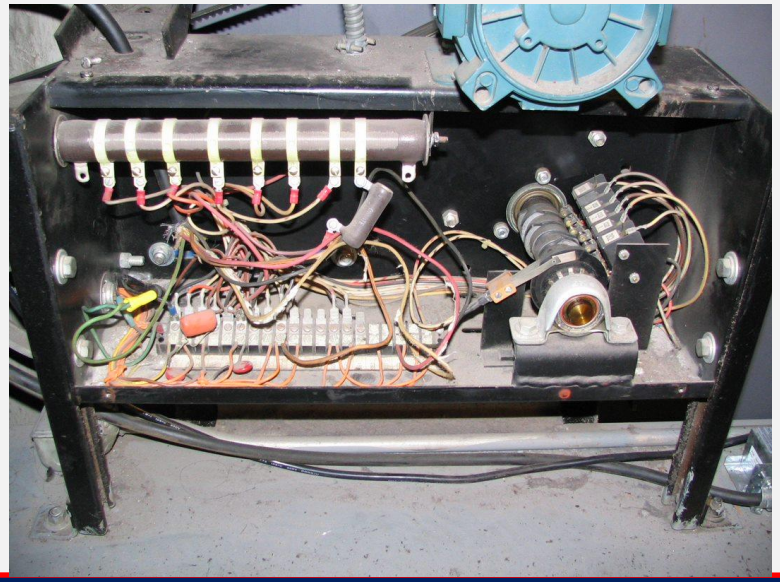
Elevator Industry-Related Electrical Hazards

Unguarded electrical equipment in the machine room can be dangerous. This selector has exposed electrical connections.

When you remove the cover on any equipment, such as this door operator, you expose yourself to the risk of shock.

Always perform LOTO whenever possible and follow your companies electrical safe work practices.





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	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely
10,000 milliamperes	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

Types of Electrical Hazards

- Defective equipment or tools

These photos show examples of defective equipment/tools. Source of photos: OSHA

Types of Electrical Hazards

- Improper repairs
  - Examples of incidents:
    - Ballast strap not replaced after repair = Electrocution of 11-year-old boy
    - Cutting off bleed resistor on capacitor= causes 370-volt shock
    - Removing and leaving off terminal insulator on capacitor = causes 440-volt shock

Types of Electrical Hazards

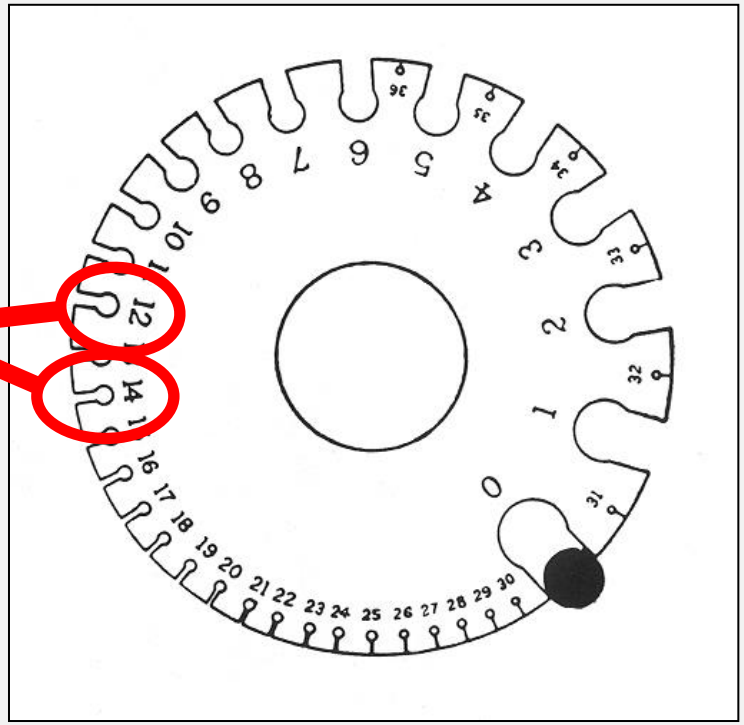
Improper use:

- Extension and flexible cords
  - Care
  - Connection
  - Capacity

Source: TEEX SH 46F1-HT06

Types of Electrical Hazards

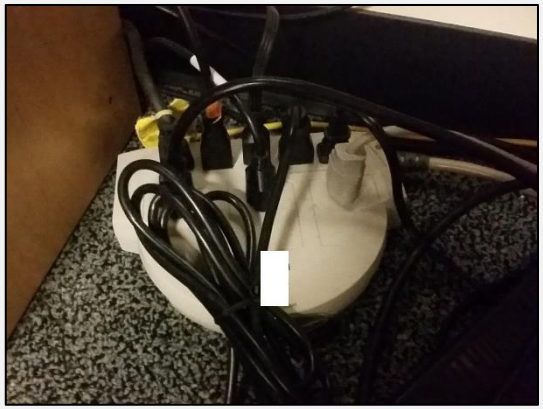
- Capacity affected by
  - Size of wire
    - 14 gauge = 15 amps
    - 12 gauge = 20 amps
  - Length of the cord
    - UL tag capacity
    - In general any cord over 100 ft. requires one size larger cord (14 gauge to 12 gauge)



Source: OSHA

Types of Electrical Hazards

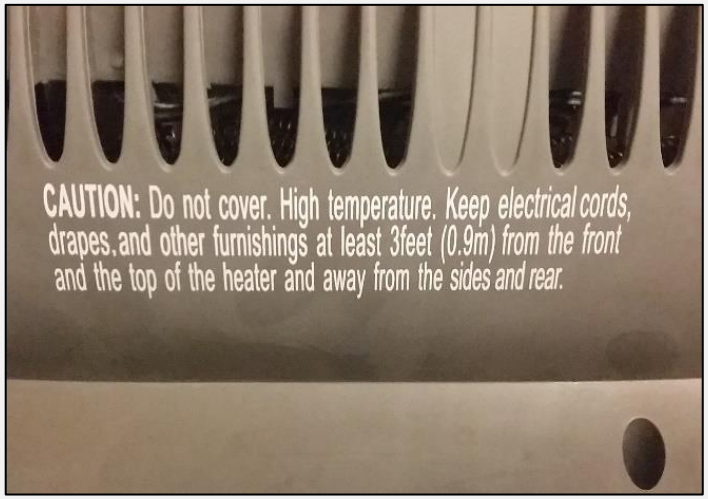
- Power strips:
  - Can be overloaded because of multiple plug arrangement
  - Most have overload protection but often malfunction causing fire
  - Use fixed wiring when possible



Source: UBATC

Types of Electrical Hazards

- Portable heaters and appliances:
  - Dangerous if manufacturer recommendations not followed
  - Do not plug into a power strip! This causes overloads and fires.

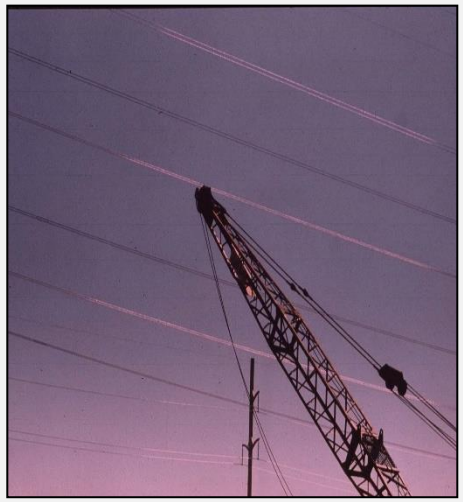


Source of photos: UBATC

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	(As established by the power line owner/operator or registered professional engineer who is a qualified person with respect to electrical transmission and distribution)

This table shows the minimum clearance distances, in feet, for different power line voltages. Source: OSHA

Electrical Protection Methods

Use ground fault circuit interrupters (GFCIs):

- 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 GFCIs:

- Receptacle GFCIs
- Temporary/portable GFCIs
- Circuit Breaker GFCIs

These photos show examples of the three types of GFCI. Source of photos: OSHA

Electrical Protection Methods

Inspect portable tools and extension cords:

- Workers need to inspect extension cords and power cords prior to their use for any cuts, abrasions, or any other damage
- Electric hand tools that are old, damaged, or misused may have damaged insulation inside

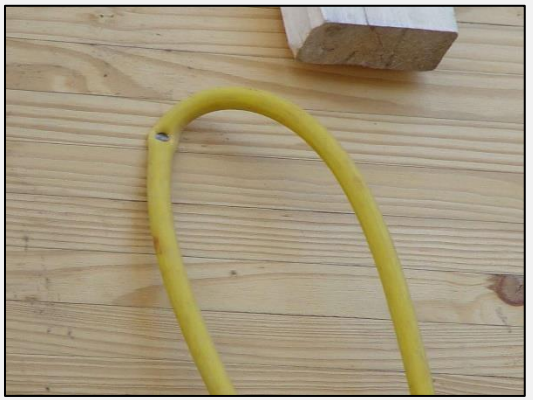
Electrical Protection Methods

Use power tools and equipment as designed:

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

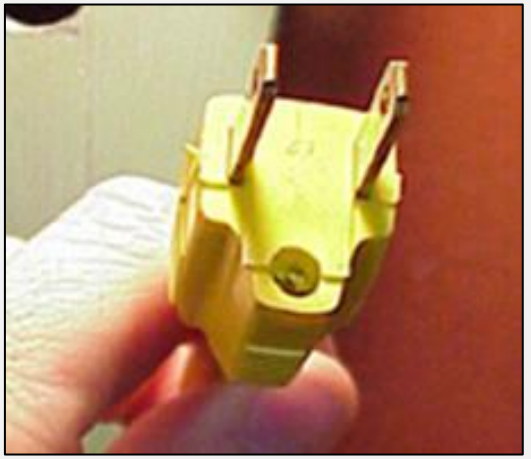
Electrical Protection Methods

- Common examples of misused equipment



Source: TEEX SH 46F1-HT06

Source of photos: OSHA



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.

Source: OSHA

Electrical Protection Methods

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

Source of photos: OSHA

Lockout/Tagout

LOTO equipment must be identifiable as LOTO specific.

LOTO for power tools or equipment with a plug

LOTO for circuit breakers

LOTO for multiple locks

Lockout/Tagout

Following is a general step by step process for performing LOTO. Always follow your company's policies & procedures.

Lockout/Tagout (LOTO) –Sequence of Steps

1. Gain control of the conveyance and ensure that it is secured from public access. Make sure all necessary PPE and diagnostic hardware is readily available prior to commencing energy shut down.

2. Identify and locate the specific circuit or conveyance and corresponding disconnect you intend to de-energize. Stand to the side and face away while switching off the disconnect.

Lockout/Tagout

Lockout and Tagout (LOTO) –Sequence of Steps cont.

3. Place the appropriate lock to isolate the equipment.
NOTE: If more than one employee is working on the equipment that is locked out, each employee shall place his/her personal lock on the disconnect.

4. Place a "Danger: Do Not Operate" tag with the following four items: company name, employee name, date and a contact number.

Lockout/Tagout

Lockout and Tagout (LOTO) –Sequence of Steps cont.

5. Identify a known, (LIVE), voltage source and test the functionality of the multimeter or non-contact voltage detector against this source.

Lockout/Tagout

Lockout and Tagout (LOTO) –Sequence of Steps cont.

6. Test and verify that the voltage has been disconnected (DEAD) with a non-contact voltage detector or a multimeter. Check each leg to ground, and on ungrounded or above ground system check leg to leg to complete verification of absence of energy.

NOTE: If only de-energizing the mainline, be aware that the controller may still have live 110/120-volt circuit for cab lighting and fan. Also, verify that voltage has been dissipated from capacitors and AC drive units.

Lockout/Tagout

Lockout and Tagout (LOTO) –Sequence of Steps cont.

7. Re-verify that the functionality of the multimeter or non-contact voltage detector worked properly before and after the measurement. Check against a known (LIVE) voltage source**.**

8. Ensure that all potentially hazardous stored energy is relieved, disconnected, restrained, and otherwise rendered safe. Hydraulic elevator units must be landed on buffers, pipe stands, or have rail blocks installed when working on the pressurized system. Mechanical safeguarding of escalators and moving walks shall be put in place to protect from stored energy.

Lockout/Tagout

Lockout and Tagout (LOTO) –Sequence of Steps cont.

9. Perform work.

10. Re-energize the conveyance following these steps:

- Replace all guards and remove all tools
- Recheck to ensure control of the conveyance and that is secure from public access
- The employee(s) who applied personal locks shall remove their own lock and tag
- Make sure all workers are safe and accounted for before equipment and circuits are unlocked and turned back on.
- Stand to the side and face away, announce "power going on" when powering the disconnect on
- Check that the conveyance has been properly returned to 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

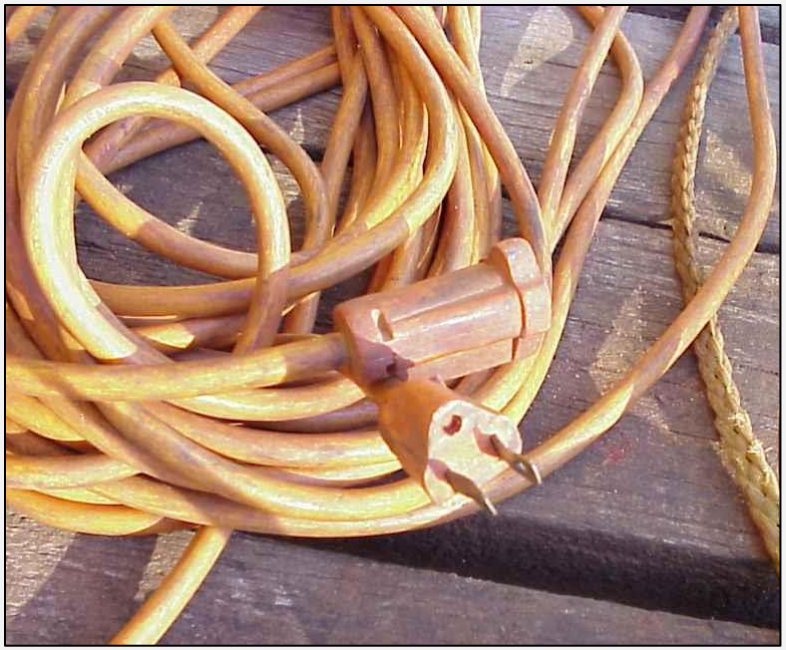
Employer requirements to protect workers:

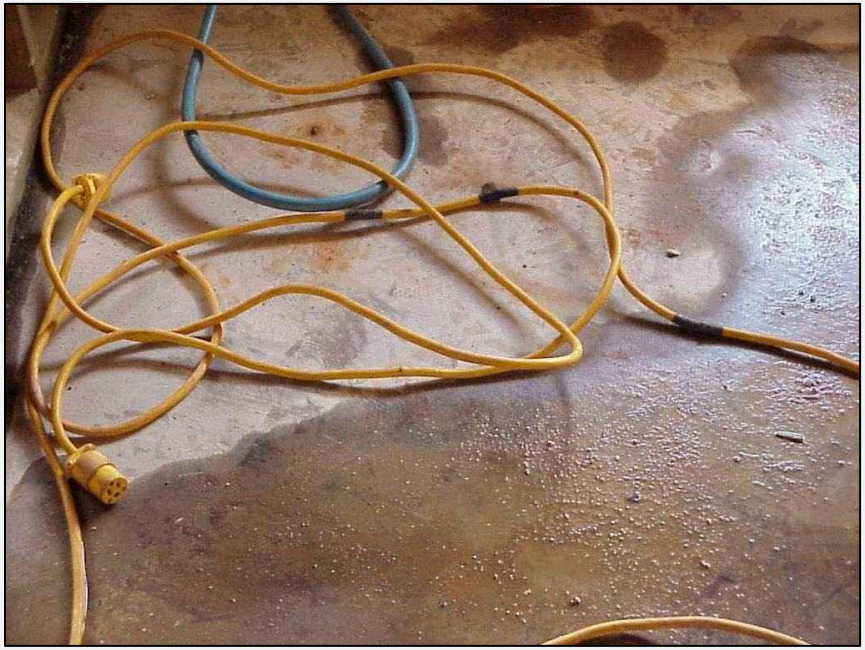
- Ensure overhead power line safety
- Isolate electrical parts
- Supply ground-fault circuit interrupters (GFCI) protection
- Establish and implement an AEGCP
- Ensure power tools are maintained in a safe condition

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?





Identify the hazards in these photos. Source of photos: TEEX SH 46F1-HT06

What's Wrong?

Identify the hazards in these photos. Source of photos: OSHA

Knowledge Check

1. What is electricity?
   a. The movement of atoms within an object
   b. The movement of free electrons between atoms
   c. Solid mass
   d. Movement within the nucleus of an atom

Answer: b. The movement of free electrons between atoms

Knowledge Check

2. "Electrocution" means ___.
   a. received a mild electrical shock
   b. killed by electrical shock
   c. exposed to electrical current
   d. any accident involving electricity

Answer: b. killed by electrical shock

Knowledge Check

3. True or false: Arc flash/arc blast can reach maximum temperatures up to 350˚F.
   a. True
   b. False

Answer: b. False - temperatures can reach up to 35,000˚F

Knowledge Check

4. Which gauge of wire will carry the most current?
   a. 14 gauge
   b. 12 gauge
   c. 10 gauge
   d. 00 gauge

Answer: d. 00 gauge – the lower the wire gauge number, the more current it can carry

Knowledge Check

5. What does GFCI stand for?
   a. Ground Flexible Conduit Insulator
   b. Ground Flow Current Interceptor
   c. Ground Fault Circuit Interrupter
   d. Ground Floor Connection Intersector

Answer: c. Ground Fault Circuit Interrupter

Knowledge Check

6. Which of the following is a safe practice?
   a. Carrying a power tool by the cord
   b. Holding fingers on switch button while carrying a plugged-in tool
   c. Keeping cords away from heat, oil, and sharp edges
   d. Yanking cord to disconnect plug from outlet

Answer: c. Keeping cords away from heat, oil, and sharp edges

Knowledge Check

7. Who is responsible for ensuring that overhead power lines are de-energized?
   a. Power company
   b. Employer
   c. Employee
   d. Municipality

Answer: b. Employer

Through the Alliance between OSHA's 10 Regional Offices and the Elevator Contractors of America (ECA), Elevator Industry Work Preservation Fund (EIWPF), International Union of Elevator Constructors (IUEC), National Association of Elevator Contractors (NAEC), National Elevator Industry Educational Program (NEIEP), and National Elevator Industry Inc. (NEII), collectively known as The Elevator Industry Safety Partners, developed this Fall Hazard Industry Specific Training for informational purposes only. It does not necessarily reflect the official views of OSHA or the U.S. Department of Labor. May 2021

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Any questions?