Federation of Myanmar Engineering Societies

Electrical Safety in the Workplace

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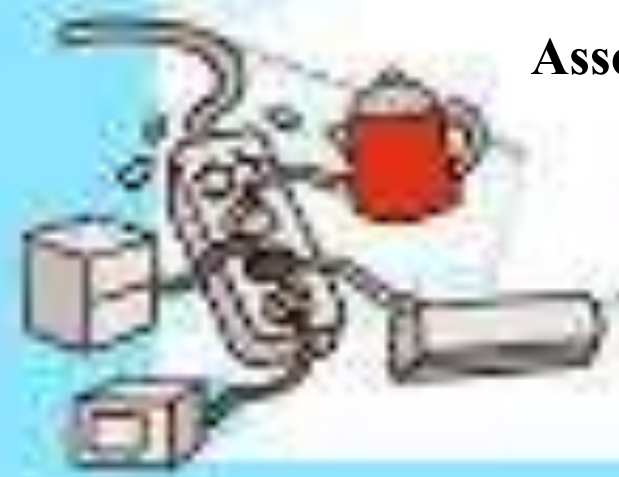
Date-17-1-2026



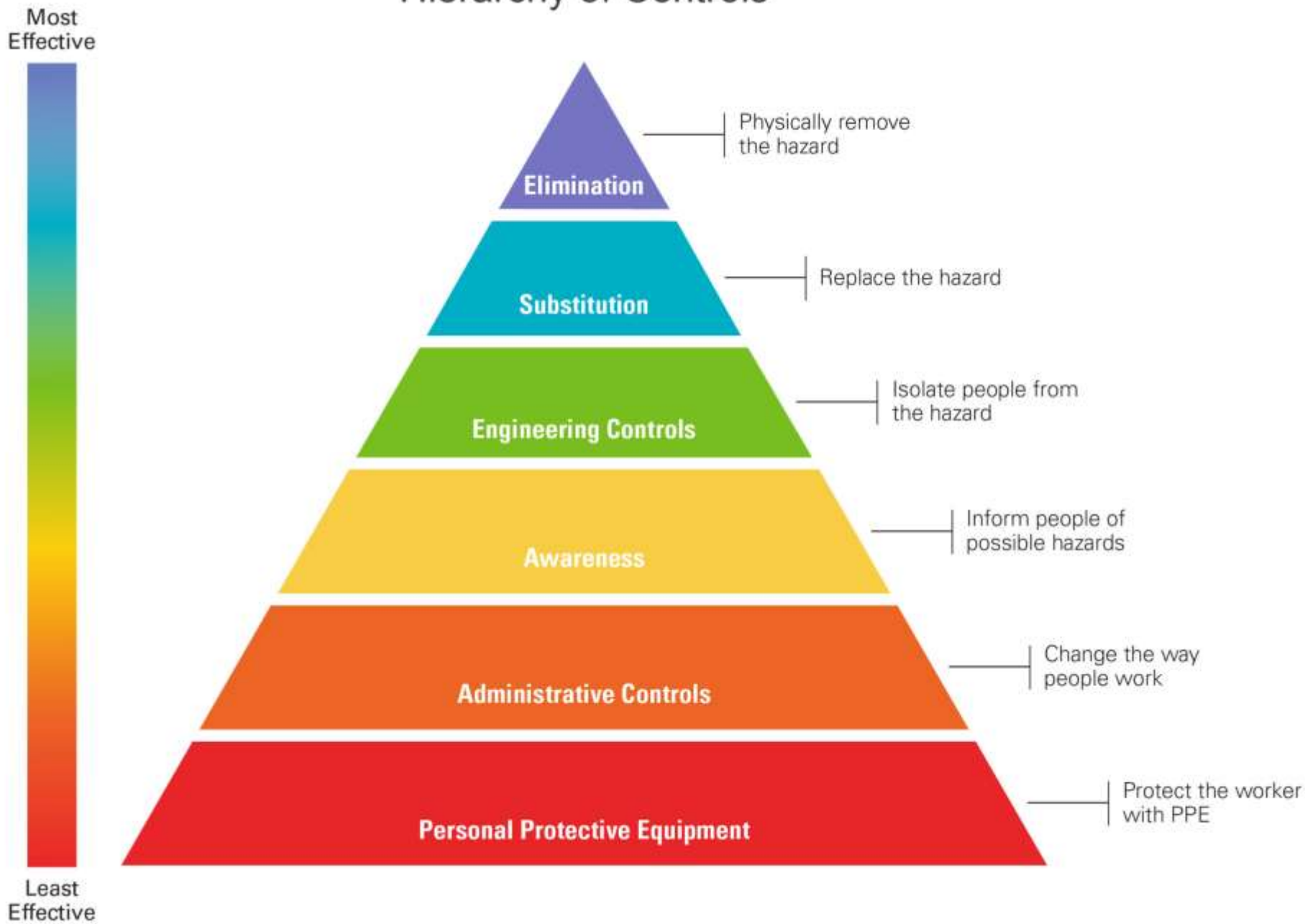
Outlines of presentation

- Introduction
- Electrical Hazards in the Workplace
- Electrical Safety Concepts
- Risk Assessment
- Personal Protective Equipment (PPE)
- Safe Work Practices
- Lockout/Tagout (LOTO) Procedures
- Causes of Electrical Accidents
- Standards and Regulations
- Case Studies
- Safety Culture and Training
- Responsibilities of Engineers
- Conclusion

Introduction

- Importance of electrical safety
- High-risk areas in engineering
- Objectives
  - Identify electrical hazards
  - Understand safety practices and codes
  - Apply control measures

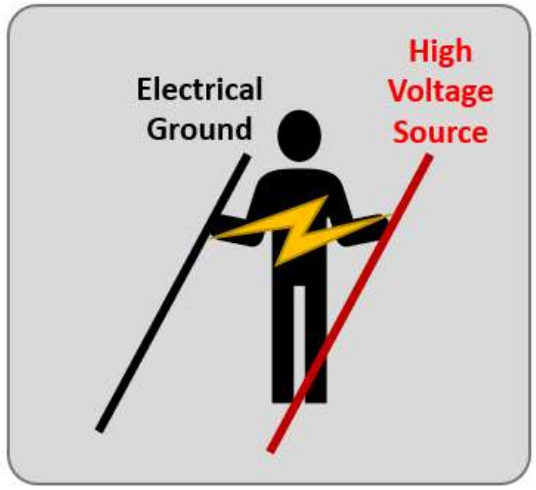
Hierarchy of Controls



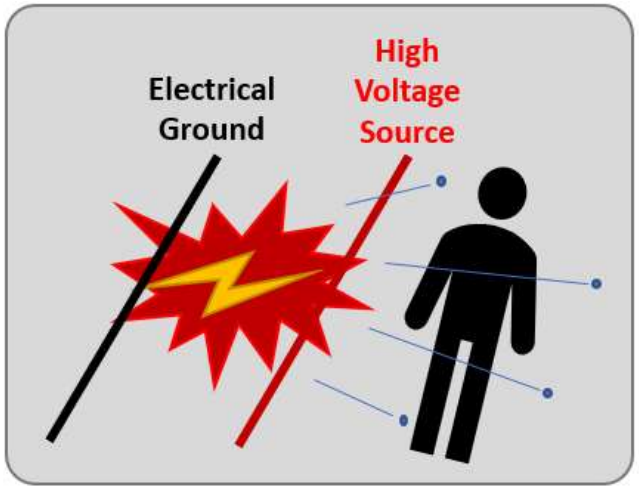
Electrical Hazards in the Workplace

❖ Types of Hazards:

- ➢ Electric shock
- ➢ Arc flash
- ➢ Burns and fires



Electrical Shock



Arc Flash and Arc Blast

❖ Causes:

- ➢ Faulty wiring, exposed conductors
- ➢ Inadequate PPE
- ➢ Unsafe equipment or practices

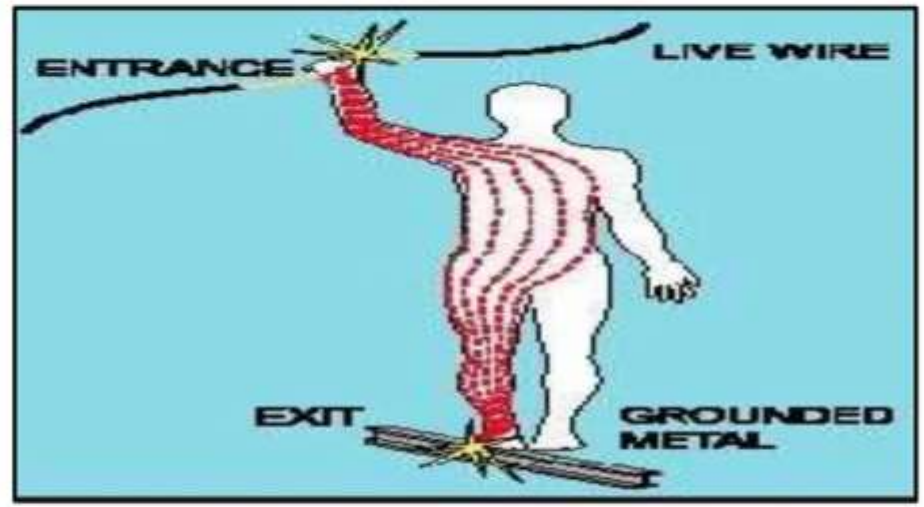
Electrical Hazards

Contact with overhead power lines:

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

Contact with energized source:

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



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

SAFETY FIRST

Godrej | PROPERTIES

Contact with Power Lines: Overhead and buried power lines carry high voltage that can cause instant electrocution.

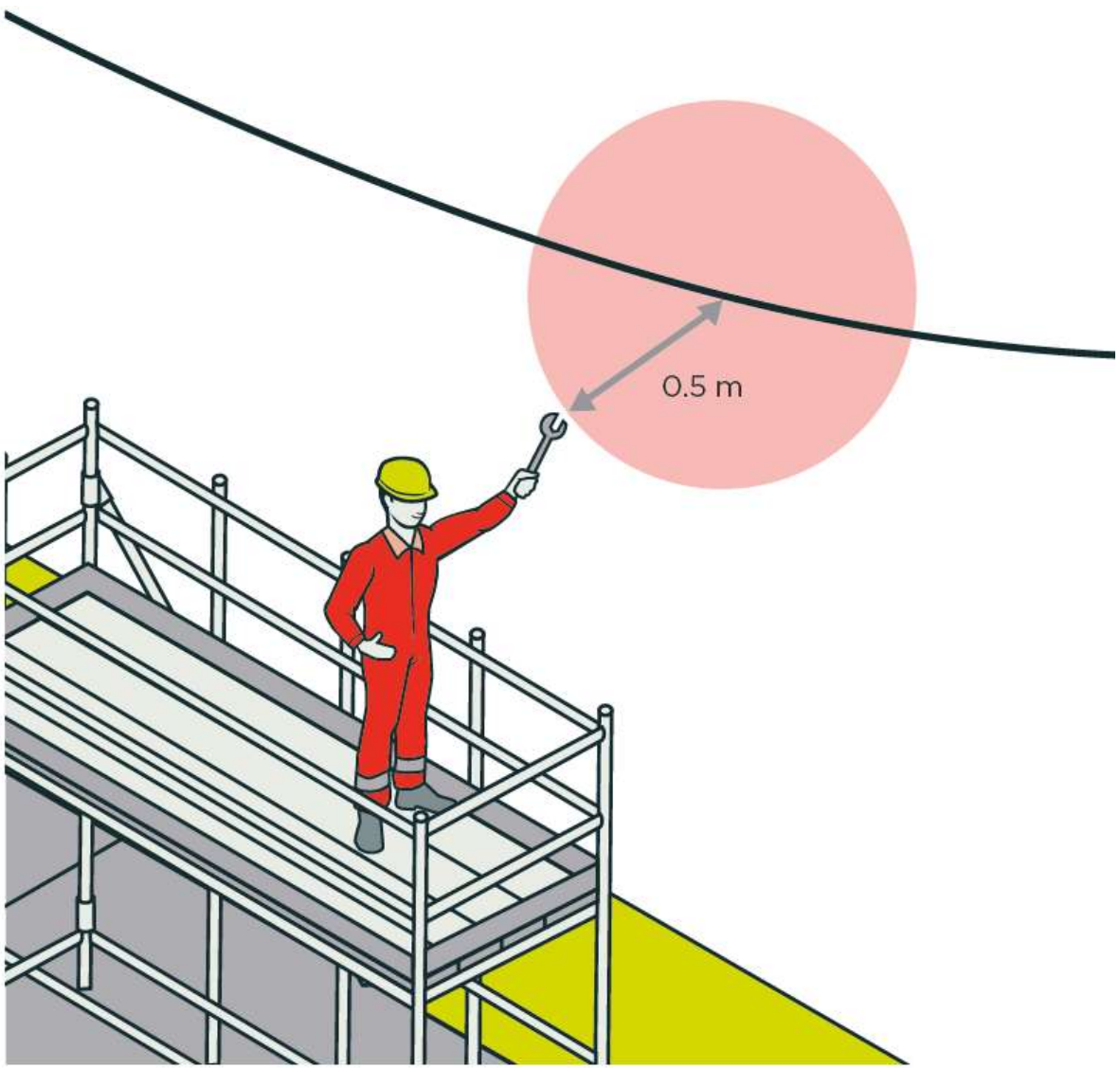
Damaged Equipment: Frayed cords, cracked tool casings, and broken plugs expose "live" parts.

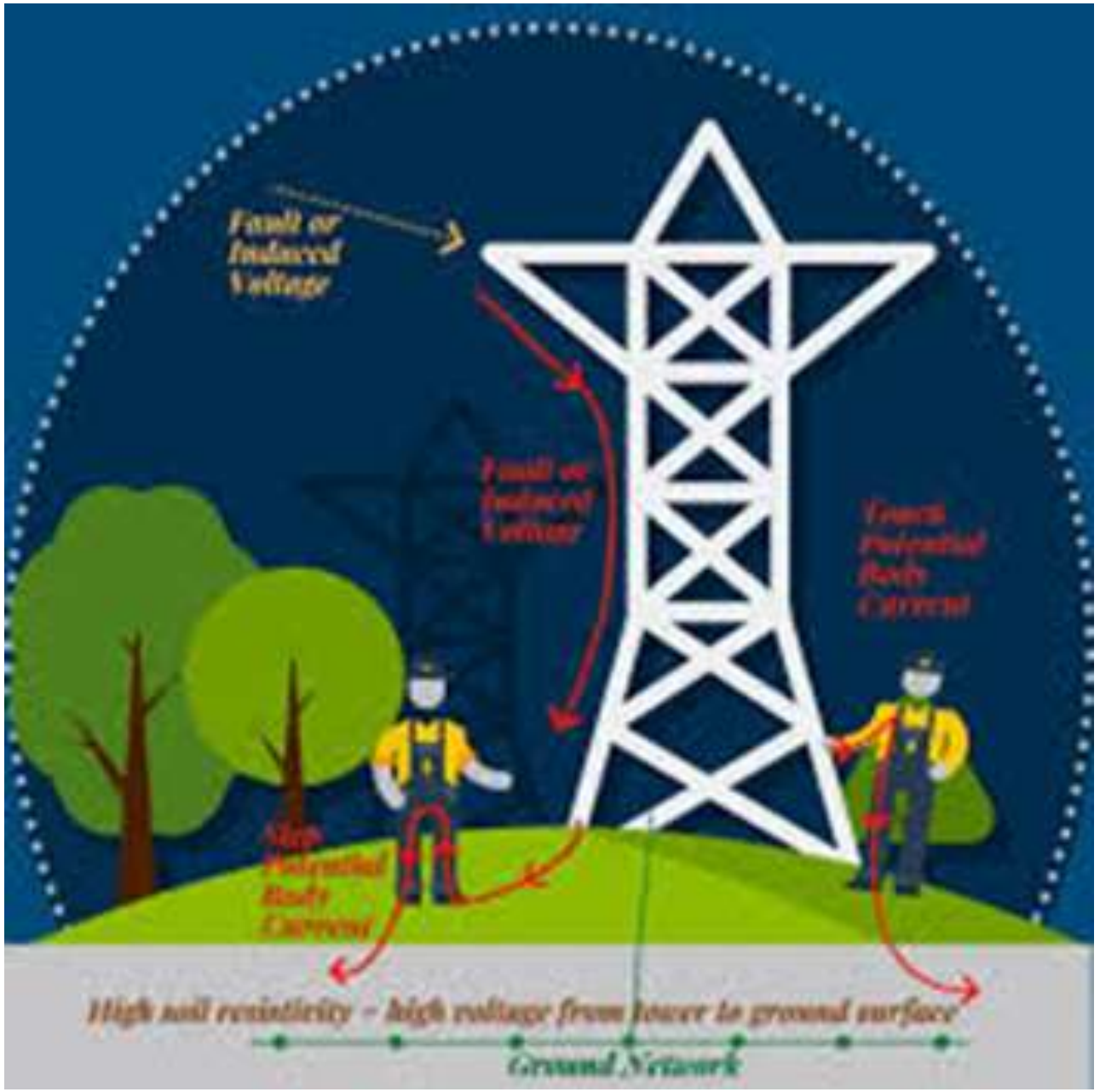
Improper Grounding: A missing or discontinuous ground path prevents a safe exit for current during a fault.

Overloaded Circuits: Plugging too many devices into a single outlet or daisy-chaining extension cords can cause overheating and fires.

Wet Conditions: Water greatly reduces skin resistance, increasing the severity of a shock.

Arc Flash/Blast: A sudden release of electrical energy through the air that can reach temperatures up to 35,000°F, causing severe burns and pressure waves.


0.5 m


Fault or
Induced
Voltage
Fault or
Induced
Voltage
Ground Network

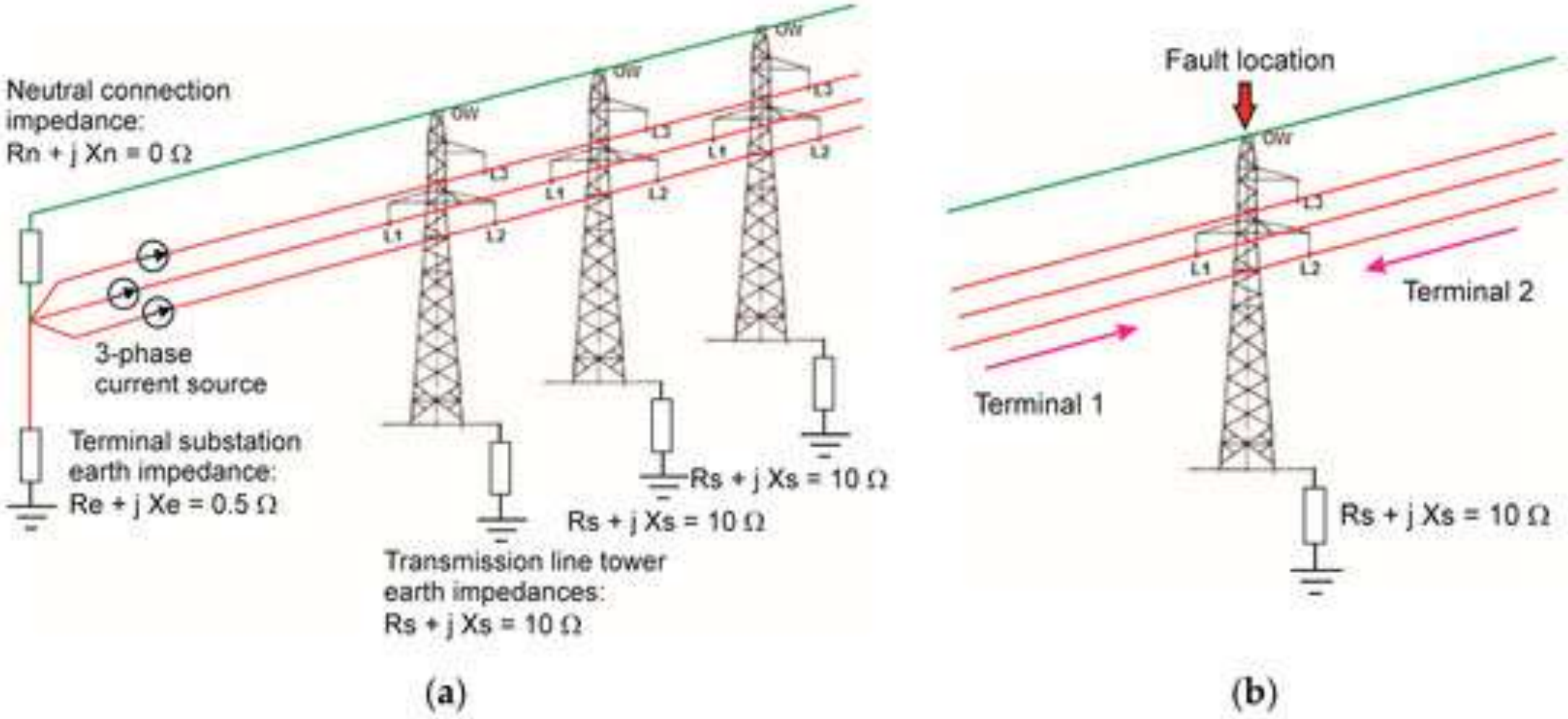
DANGER

Electrocution Hazard

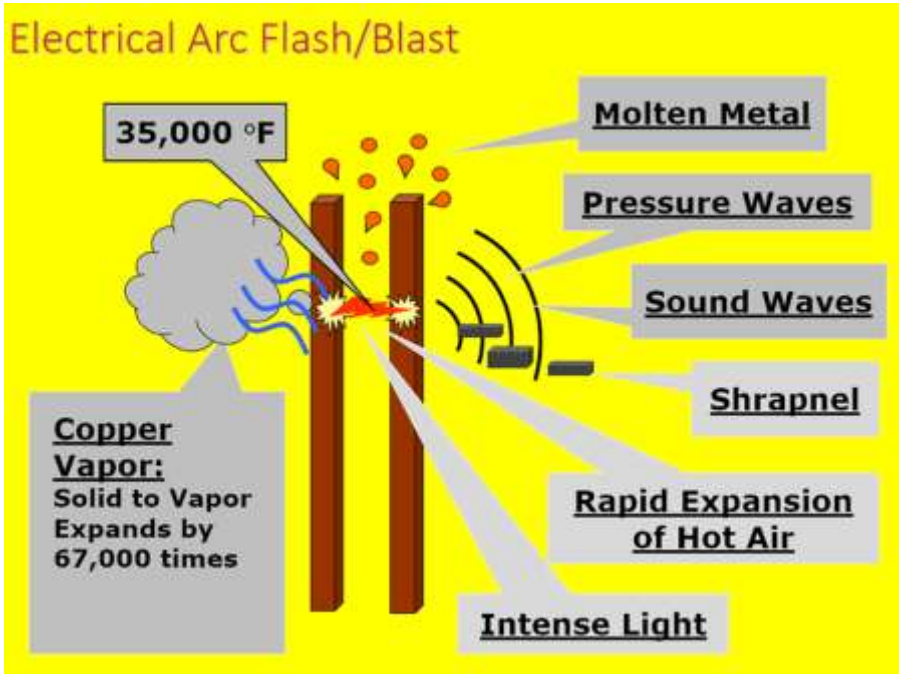
- This machine is not insulated.
- Maintain a clearance of at least 10 ft. (3m) between any part of machine or load and any electrical lines or apparatus.

Failure to follow instructions will result in death or serious injury.

CREATIVE safety supply | creativesafetysupply.com | 866-777-1360 # WS29522-24



Modeling (a) the HV transmission line and the terminal substation; (b) the fault-to-ground condition at one of the HV line towers.


Electrical Arc Flash/Blast
35,000 °F
Molten Metal
Pressure Waves
Sound Waves
Shrapnel
Rapid Expansion of Hot Air
Intense Light
Copper Vapor:
Solid to Vapor Expands by 67,000 times

Burns:

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

Source: OSHA

BE SAFE:

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

TOP 4 ELECTRICAL HAZARDS IN THE WORKPLACE

Exposed Wires & Cables

Risk: Shocks, burns, and fires.

Fix: Insulate & enclose wires; inspect regularly; keep electrical panels accessible.

Faulty Equipment & Tools

Risk: Shocks & fires from damaged tools.

Fix: Inspect before use; replace damaged equipment; avoid quick fixes with tape.

Overloaded Circuits & Outlets

Risk: Overheating & fire.

Fix: Avoid overloading; use power strips with protection; distribute the load; inspect for overheating.

Wet Conditions & Electrical Equipment

Risk: Increased shock hazard.

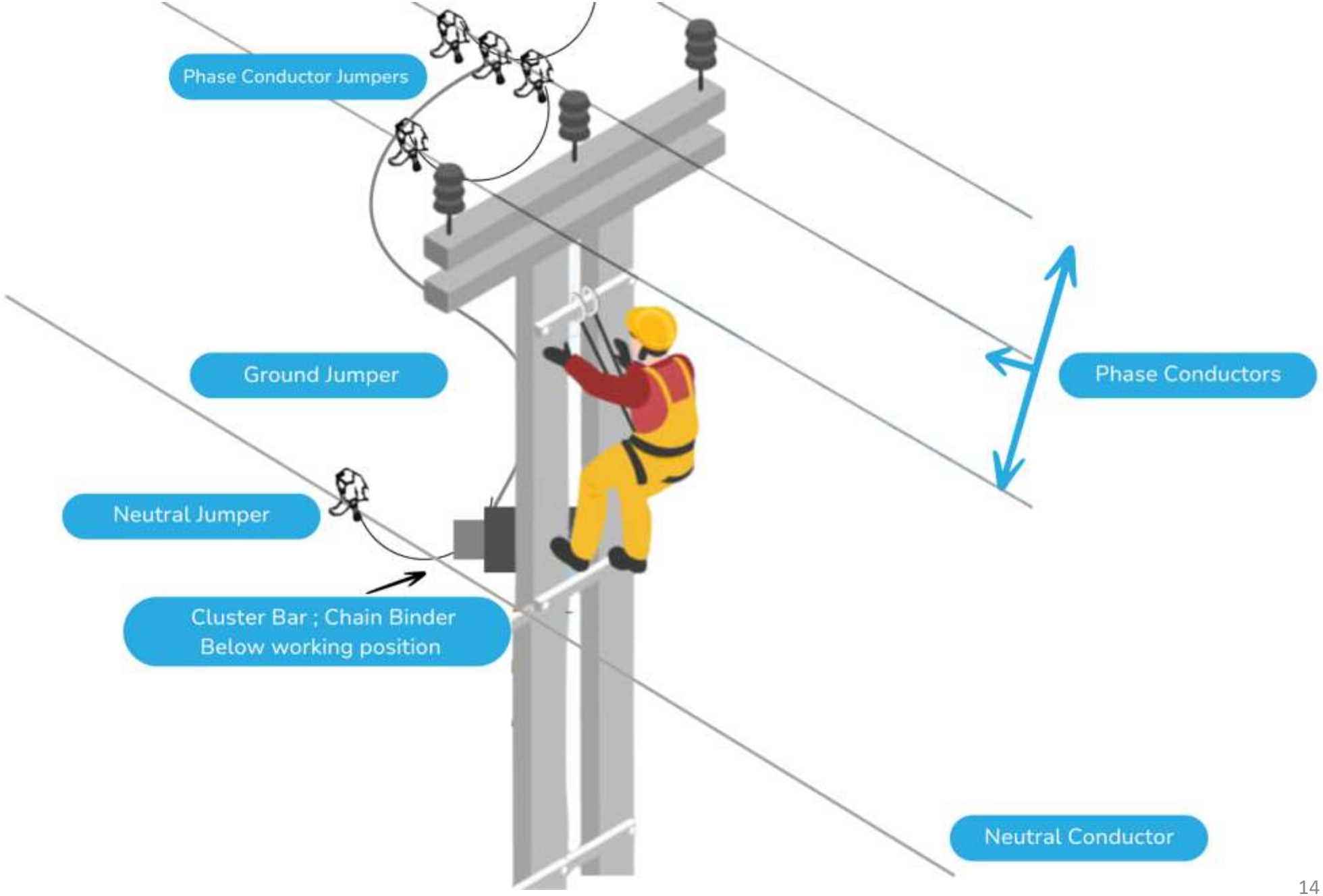
Fix: Use equipment designed for wet conditions; dry hands; use Ground Fault Circuit Interrupters (GFCIs).

Stay Safe

Recognize & address these hazards to prevent injuries & create a safer workplace!

HAZWOPER OSHA

www.hazwoper-osha.com


Phase Conductor Jumpers
Ground Jumper
Neutral Jumper
Cluster Bar ; Chain Binder
Below working position
Phase Conductors
Neutral Conductor

Electrical Hazards: Understanding Dangers and Safety

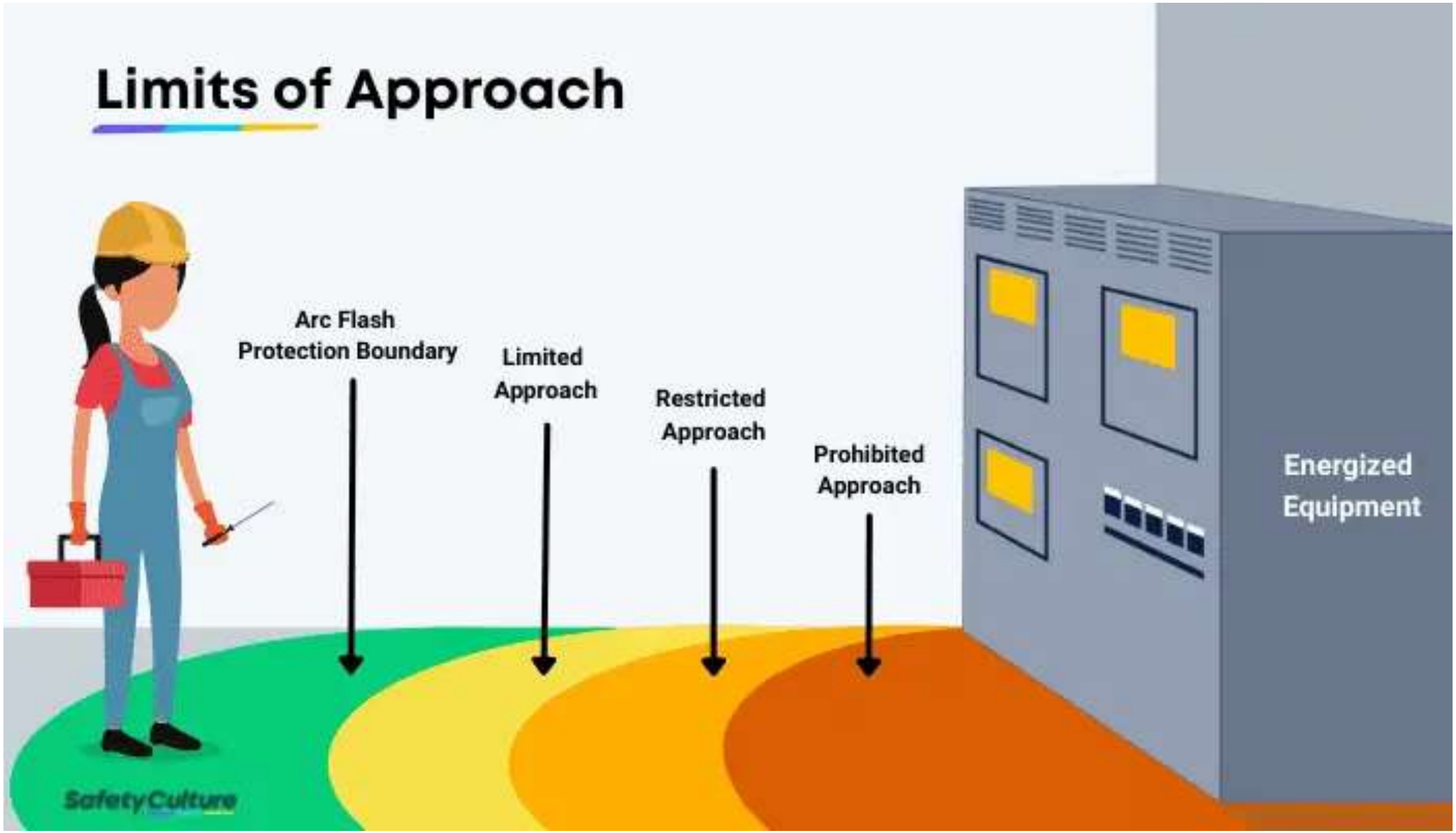
Hazards

- Damaged or worn-out electrical cords or cables
- Overloaded outlets or extension cords
- Wet or damp areas near electrical equipment
- Poorly maintained electrical equipment
- Exposure to live wires or circuits
- Use of electrical equipment in hazardous or flammable areas

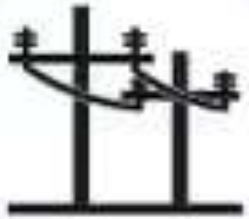
Injuries

- Electric shock
- Electrical burns
- Arc flash

AUSTRALIAWIDE FIRST AID


Limits of Approach
Arc Flash
Protection Boundary
Limited
Approach
Restricted
Approach
Prohibited
Approach
Energized
Equipment
SafetyCulture

Examples of Electrical Hazards



Overhead Power Lines

Damaged/Faulty Tools & Equipment

Inadequate Wiring & Overloaded Circuits

Exposed Electrical Parts

Improper Grounding

Damaged Insulation

Wet Conditions

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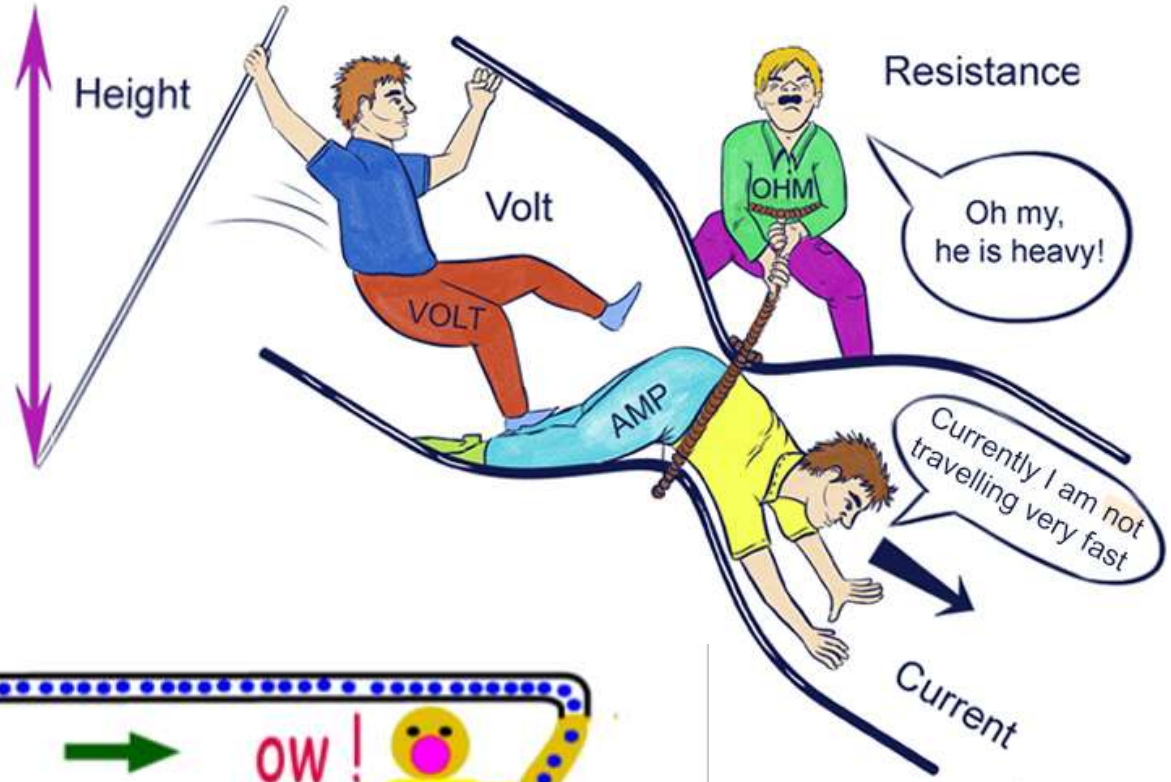
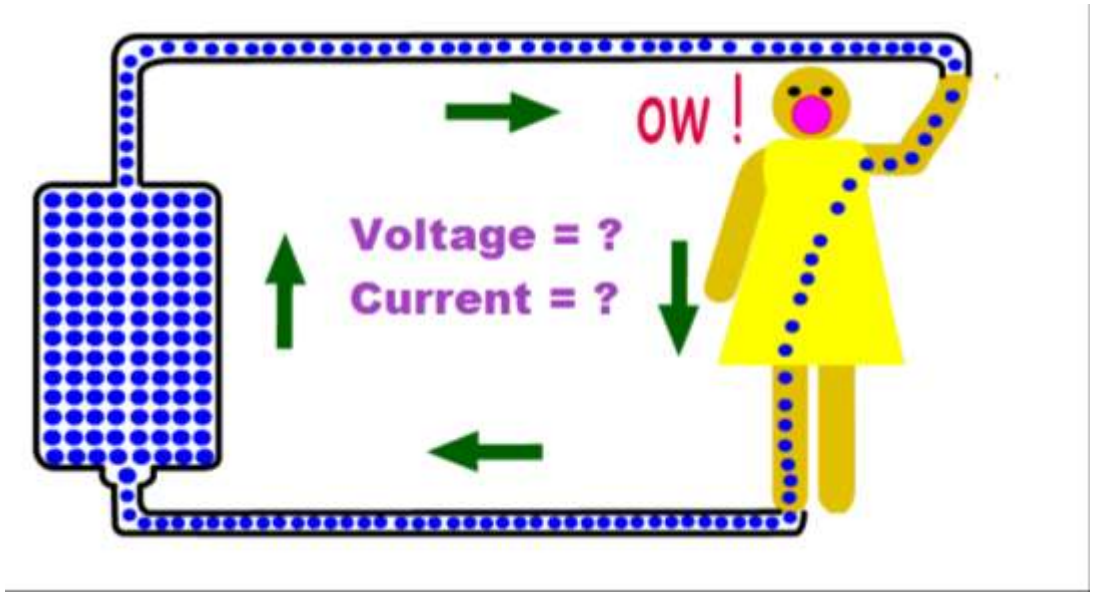
Electrical Safety Concepts

- A critical area of workplace safety, encompassing several key concepts to protect people and equipment from electrical hazards
- . The core concepts listed are fundamental to understanding and mitigating these risk



- Voltage, current, resistance, and power
- Grounding and bonding
- Overcurrent protection
- Lockout/Tagout (LOTO)



•**Voltage** : the electrical pressure or force that causes current to flow.

•**Current** :the flow of electrical charge. The amount of current passing through the body is a primary factor in the severity of an electric shock.

•**Resistance** : the opposition to the flow of current. Materials with low resistance are conductors (e.g., metals), while those with high resistance are insulators (e.g., rubber, glass).

•**Power** is the rate at which electrical energy is transferred or used (measured in watts, P=V*I).

•**Grounding** provides a safe, low-resistance path for fault current to the earth, which helps prevent electric shock and fires. A properly grounded system minimizes the risk of a dangerous voltage build-up on equipment enclosures.

•**Bonding** connects various pieces of conductive equipment to keep them at the same electrical potential. This prevents static sparking between objects and ensures that grounding systems work effectively.

•**Fuses** and **circuit breakers** are essential overcurrent protection devices.

•They automatically interrupt the flow of current when it exceeds a safe level (due to an overload or short circuit), thus preventing damage to equipment and reducing the risk of fire.

•**LOTO** is a safety procedure used to ensure that equipment is completely shut off, de-energized, and rendered inoperable before maintenance or servicing work begins.

•The procedure involves placing **locks** on energy-isolating devices (like circuit breakers or valves) and attaching **tags** to warn others that the equipment must not be operated.

•This prevents the unexpected energization or start-up of machinery and the accidental release of hazardous energy (electrical, mechanical, etc.), which could cause severe injury or death.

Electrical resistance

Table 8.1 Normal Resistance Values of Various Materials

Materials	Resistance (Ohms)
Most metals	>0 to 50
Dry wood	100,000
Wet wood	1,000
Dry Concrete on Grade	200,000 – 1,000,000
Wet Concrete on Grade	1,000 – 5,000
Leather Sole, dry, including foot	100,000 – 500,000
Leather Sole, damp, including foot	5,000 – 20,000
Rubber Gloves or soles	> 20,000,000

Source: Electrical Safety Handbook

Table 8.2 Human Resistance to Electric Current

Body Area	Resistance (Ohms)
Human body, Internal (wet, ear to ear)	100
Human body , Internal (damp, hand to foot)	400 to 600
Human body (wet skin)	1,000
Human body (dry skin)	100,000 to 600,000

Source: Accident Prevention Manual

Hazards of electricity:

- Electric Shock
- Burns
- Fire

Electric shock occurrence

Electrical shock is a common hazard encountered by people involved in the installation, maintenance, and operation of electrical equipment. Electric shock occurs once the worker' body becomes part of an electrical circuit when it comes in contact with a live internal conductor at the point of insulator breakdown.

Table 8.3 Effect of current on the human body

Current	Effect
0 – 1mA	No sensation, not felt
1mA	Shock perceptible, reflex action to jump away. No direct danger from shock but sudden motion may cause an accident.
> 3mA	Painful Shock
6 mA	Let go current for women
9 mA	Let go current for Men
>10mA	Local muscle contractions, sufficient to cause freezing to the circuit for 2.5% of the population
>15mA	Local muscle contractions, sufficient to cause "freezing" to the circuit for 50% of the population
>30mA	Breathing difficulty; can cause unconsciousness
50 – 100 mA	Possible ventricular fibrillation of the heart
100 – 200mA	Certain ventricular fibrillation of the heart
> 200mA	Severe burns and muscular contractions; heart more apt to stop than fibrillate
> 1A	Irreparable damage to body tissue

Source: Occupational and Environmental Safety Engineering and Management

S.A.F.E.T.Y.

THE FOUNDATION OF WORKPLACE SAFETY

S – Set the Standard
Establish clear safety rules, procedures, d expectations for all employees. Leadership must define what "safe work"

A – Act Safely
Implement safe practices consistently, Safety is not just a rule – it's a behavior and a culture in daily tasks.

F – Follow Up
Regularly inspect, monitor, and verity that controls are working. Correct unsafe acts or conditions immediately.

E – Educate & Engage
Provide continuous safety training, awareness sessions. and engage employees in building a proactive safety culture.

T – Test the Controls
Evaluate the effectiveness of safety systems, emergency preparedness, and equipment functionality.

Y – Yes or No
Always ask; "Is it safe?" If the answer is **YES** → proceed. If **NO** → stop, correct, and improve.

- ✓ **SAFETY is not a choice — it's a commitment.**
- ✓ **When we educate, act, and take responsibility, we ensure everyone goes home safe.**

#SAFETY #WorkplaceSafety #HSE #SafetyFirst #SafetyCulture #Empus

ELETRICAL SAFETY

ELECTRICITY CAN KILL YOU

- Each year about 1000 accidents at work involving electrical shocks Or burns are reported to health & safety executive
- Around 30 of these are fatal.
- Shocks from voltages over 50 volts ac or 120 volts dc are hazardous.
- Even non-fatal shocks can cause severe and permanent injury.

WHAT DO THE REGULATIONS REQUIRE

The Health And Safety At Work Act 1974 States That:
Employers Are Responsible For Ensuring The Safety And Health Of Their Employees And The Public, If They Are At Risk From Work Activities.

The Electricity At Work Regulations 1989 States That:
Electrical Systems Must Be Constructed In A Way That Prevents Danger.
Employers, Employees And The Self - Employed Must Work On use Of Electrical Systems Carried Out In A Way That Prevent Danger.

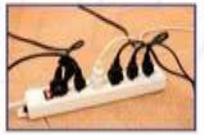
Electrical Equipment Used In Hazardous Environments Must Be Constructed Or Protected To Prevent It Becoming Dangerous. Only Those With Competent Knowledge Or Experience Or Under Adequate Supervision Should Work With, Or, On, Electrical Equipment That Could Cause Danger Or Injury.

The Reporting Of Injuries, Diseases And Dangerous Occurrences Regulations 1995 States That:

The Enforcing Authority Must Be Notified Immediately By Telephone Using The Incident Reporting Line 08453009923 Or Via The Health And Safety Executive's Incident Report Page.

ASSESSING THE RISK

Health and safety risk assessment should take into account the risks associated with electricity.



1. Identifying the hazards.
2. Deciding who might be harmed and how.
3. Evaluating the risks and deciding on precautions.
4. Recording your finding and implementing them .
5. Reviewing your risk assessment and updating it if necessary.

Most common risks come from

- Contact with live parts.
- Electrical fault and the risks are greatest where the equipment contains heat source.
- Flammable of explosive atmospheres.
- Harsh conditions where unsuitable equipment can easily become live and can make its surroundings live and dangerous.
- Confined spaces where if an electrical fault develops it will be very difficult to avoid a shock.
- Some of the equipment such as extension leads and flexible leads which are particularly laible to damage.

For further guidance please see HSE's website (www.hse.gov.ukrisk)

REDUCING THE RISK FOR EMPLOYERS

Ensure people working on or with electrical equipment or system are 'competent' for the task.

Ensure the electrical installation:
Complies to BS 7671 Requirements for electrical installations.
Is maintained in a safe condition.
There are enough socket outlets provided.

Provide safe suitable equipment:
Equipment must be suitable for its working environment.
Consider using air, hydraulic or hand-powered tools in harsh conditions.
Provide a switch near each fixed machine to cut off power in an emergency.
Replace damaged sections of cable completely.
Special electrical equipment should be used in potentially flammable or explosive atmospheres.
Consider asking for specialist advice.

Reduce the voltage
Temporary lighting can be run at lower voltages.
Battery-operated tools are safest.
Portable tools designed to be run from a 110 volt center-tapped-to-earth supply are available.
Provide a safety device (an RCD) if equipment operating at 230 volts or higher is used. An RCD is a device which detects some faults in the electrical system and rapidly switches off the supply.

REDUCING THE RISKS FOR EMPLOYEES

Visual inspection should also be done by employees.
Work Safety

- Suspect or fault equipment must be taken out of use, labeled 'DO NOT USE' and kept secure until examined by a competent person.
- If possible, tools and power socket outlets should be switched off before plugging in or unplugging.
- Equipment should be switched off and / or unplugged before cleaning of making adjustments.

Always expect cables will be present and live when digging in the street, pavement or near buildings.

Have overhead electric lines switched off if possible or maintain safe working distance from the lines.

The line of track operating company must be consulted before starting work near electrified railways or tramways.

Risk Assessment

- Steps:
  - ❖ Identify electrical sources
  - ❖ Evaluate risk severity and likelihood
  - ❖ Control or mitigate risks
- Tools:
  - ❖ Job Safety Analysis (JSA), Hazard Matrix

identifying sources (wiring, tools),

evaluating risks (severity/likelihood) using tools like a **Hazard Matrix**, and

controlling them (elimination, PPE) following the hierarchy of controls,

often documented via a **Job Safety Analysis** **(JSA)** that breaks tasks into steps, identifies hazards, and outlines safety measures for each step.

The core process includes identifying hazards, assessing risks, implementing controls, documenting findings, and reviewing them regularly

Risk Assessment Steps (Electrical Context)

1.Identify Electrical Hazards: Locate exposed wires, overloaded circuits, faulty equipment, wet conditions near power sources, and potential for arc flash.

2.Assess Risks: Determine the **severity** (how bad the harm could be) and **likelihood** (how often it might happen) for each hazard, often using a hazard matrix.

3.Control Risks: Apply the hierarchy of controls:

Eliminate the hazard (e.g., remove the faulty tool).

Substitute with safer alternatives.

Engineering Controls (e.g., guards, RCDs).

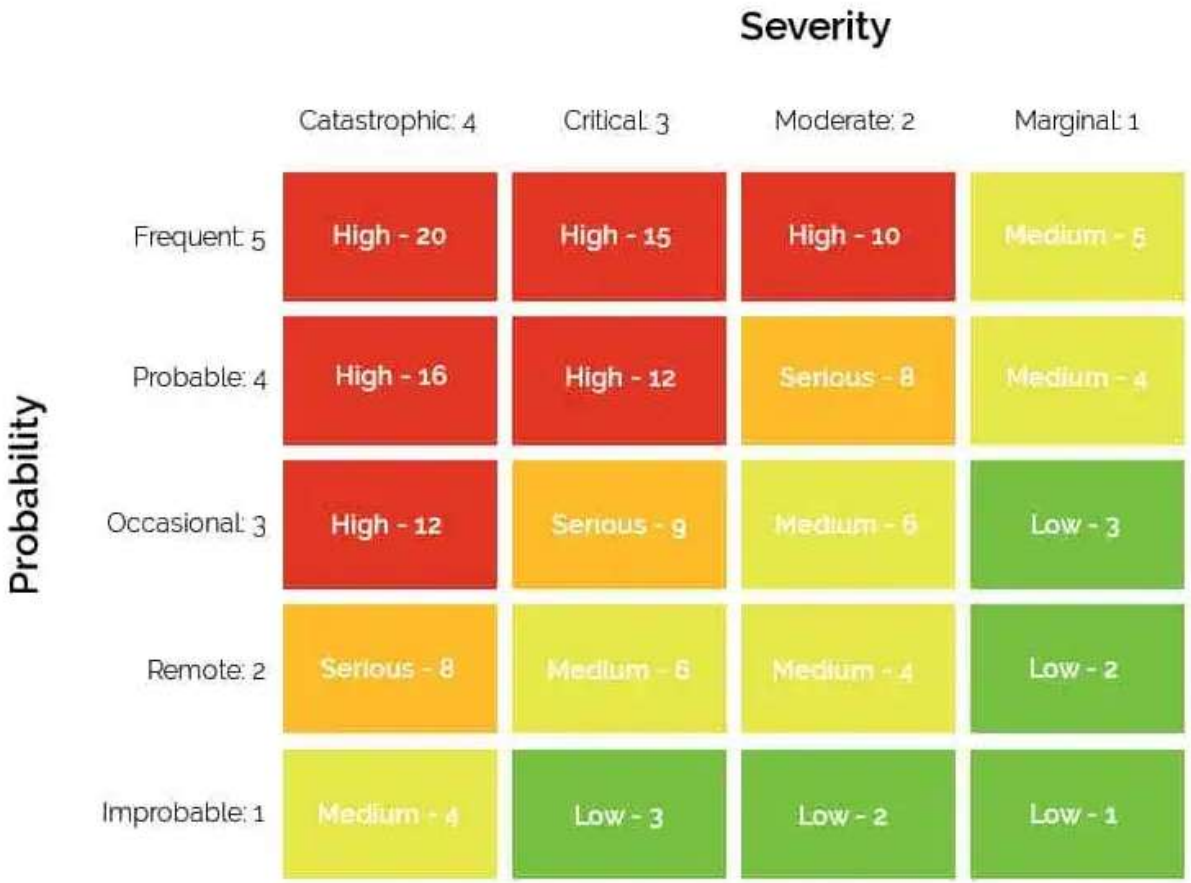
Administrative Controls (e.g., procedures, training).

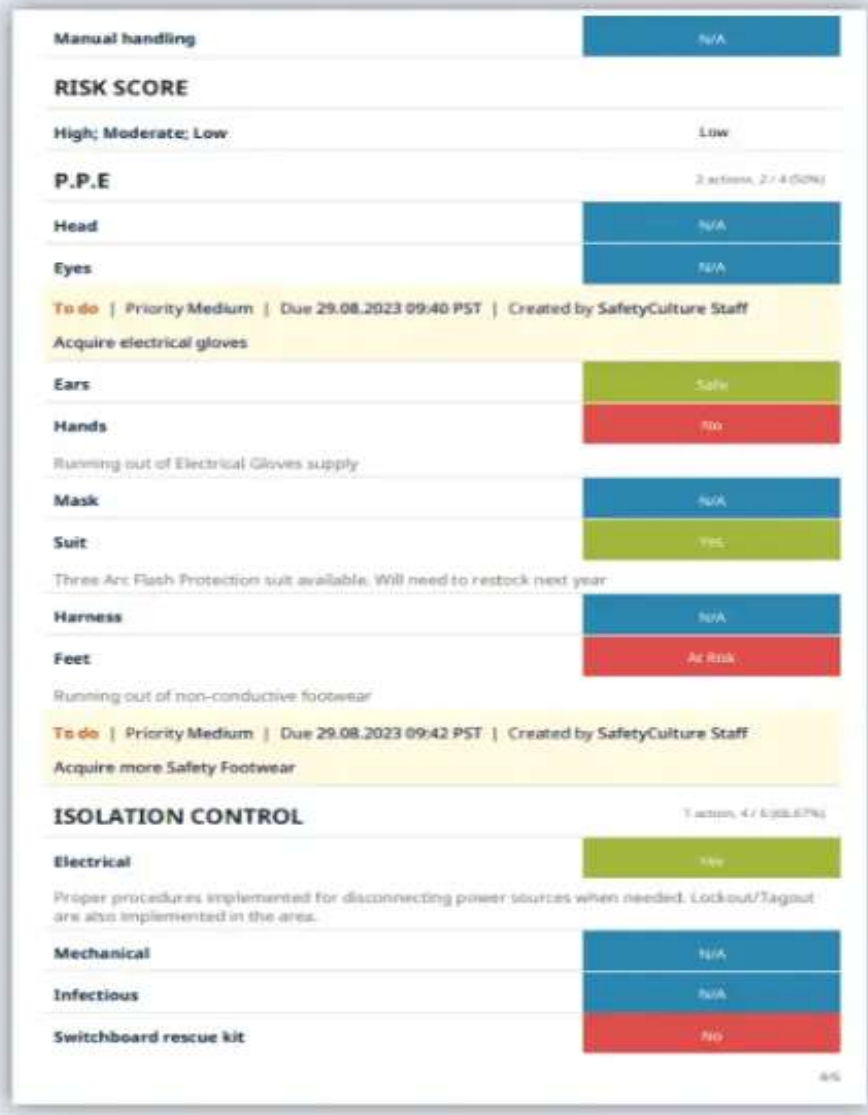
Personal Protective Equipment (PPE) (e.g., insulated gloves) as a last resort.

4.Document Findings: Record the identified hazards, risk levels, and control measures, often within a JSA.

5.Review & Update: Periodically check controls to ensure they remain effective and update the assessment as needed

Electrical Risk Assessment Template Sample Report




Manual handling
N/A
RISK SCORE
High; Moderate; Low
Low
P.P.E
Head
N/A
Eyes
N/A
To do | Priority Medium | Due 29.08.2023 09:40 PST | Created by SafetyCulture Staff
Acquire electrical gloves
Ears
Safe
Hands
No
Running out of Electrical Gloves supply
Mask
N/A
Suit
Yes
Three Arc Flash Protection suit available. Will need to restock next year
Harness
N/A
Feet
At Risk
Running out of non-conductive footwear
To do | Priority Medium | Due 29.08.2023 09:42 PST | Created by SafetyCulture Staff
Acquire more Safety Footwear
ISOLATION CONTROL
Electrical
Yes
Proper procedures implemented for disconnecting power sources when needed. Lockout/Tagout are also implemented in the area.
Mechanical
N/A
Infectious
N/A
Switchboard rescue kit
No

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WHAT IS RISK ASSESSMENT?

Risk assessment is the process of finding hazards, determining how likely they are to cause harm, how severe that harm could be, and deciding what actions are needed to control or eliminate the risk.

STEPS IN RISK ASSESSMENT

1 IDENTIFY HAZARDS

Look for anything that could cause harm (machinery, chemicals, work at height, electricity, fire, etc.)

2 DETERMINE WHO COULD BE HARMED & HOW

Workers, contractors, visitors, public – consider direct and indirect harm

3 EVALUATE RISKS

Decide how likely it is to happen and how severe the consequences would be. Often done using a RISK MATRIX

4 DECIDE ON CONTROLS (MITIGATION)

Eliminate hazard if possible, or reduce risk with engineering controls, PPE, safe work procedures

5 DOCUMENT FINDINGS

Keep a written record of hazards, risks, and controls

6 REVIEW & UPDATE REGULARLY

Update whenever there is a change in process, equipment, or after an incident

Risk Analysis

JOB SAFETY ANALYSIS (JSA) & RISK ASSESSMENT TRAINING

JOB STEPS IDENTIFICATTION

Breaking down task into sequential steps

HAZARD RECOGNITION

Identifying potential hazards and risks

RISK EVALUATION

Assessing risk levels and prioritizing actions

IMPLEMENTING CONTROLS

Applying mitigation measures and controls

Elion

Personal Protective Equipment (PPE)

- PPE for Electrical Work:
  - Insulated gloves and boots
  - Arc-rated clothing
  - Face shields and goggles
- PPE Selection: Based on voltage level and risk category

Electrical PPE protects against shock and arc flash using insulated gloves/boots, arc-rated (AR) clothing, and face shields/goggles, selected based on the task's voltage and Hazard Risk Category (HRC) or incident energy level, with higher categories requiring more robust gear like full AR suits and specialized head/hand/foot protection for extreme hazards.Electrical PPE Components

- **Insulated Gloves & Boots:** Provide shock protection, often rubber insulating gloves with leather protectors. Boots are insulated and AR-rated.
- **Arc-Rated (AR) Clothing:** Flame-resistant materials (shirts, pants, coveralls, hoods) that prevent burns by blocking flames and absorbing heat.
- **Face & Eye Protection:** AR face shields, goggles, or full hoods, plus safety glasses, protect eyes and face from heat, sparks, and debris.
- **Head Protection:** Hard hats, often with AR liners, for impact and flash protection.
- **Hearing Protection:** Earplugs or muffs for noise and arc blast protection.

PPE Selection: Voltage & Risk Category

- **Voltage Level:** Determines the necessary insulation class for gloves and footwear (e.g., Class 00 for 500V, Class 2 for 17kV).
- **Arc Flash Hazard (HRC/Incident Energy):**
  - **Lower Risk (e.g., HRC 1-2):** Basic AR clothing (shirt/pants or coverall), AR face shield/hood, safety glasses, gloves/protectors, hard hat, leather boots.
  - **Higher Risk (e.g., HRC 3-4):** Full AR suit (jacket, pants, hood), heavy-duty AR gloves/protectors, AR footwear, hard hat, hearing protection, goggles.
- **Method:** Use the incident energy method (preferred) or the category method, referencing equipment labels and NFPA 70E guidelines for selection.

Essential PPE for Linemen

Full-body harness

Keeps safe from falls by distributing force across the body & securing to lifelines or bucket trucks.

EH-rated boots

Provide insulation against live circuits and protect feet from shocks, slips, and heavy impacts.

Class E hard hat

These helmets are tested for up to 20,000 volts, shielding the head from electrical contact and falling objects.

Eye & Ear Gear

Safety glasses guard against flying debris, while ear protection reduces long-term hearing damage.

FR shirts/pants

Flame-resistant clothing won't ignite or melt, giving linemen critical protection against arc flashes and sparks.

Rubber insulating gloves

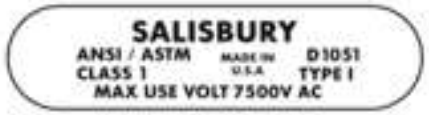
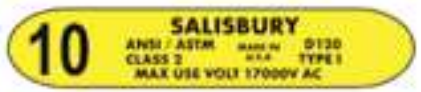
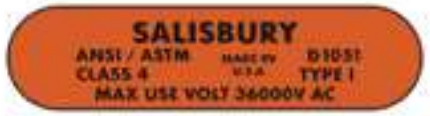
Designed to stop electrical current from reaching the skin, these gloves are often paired with leather protectors for durability.

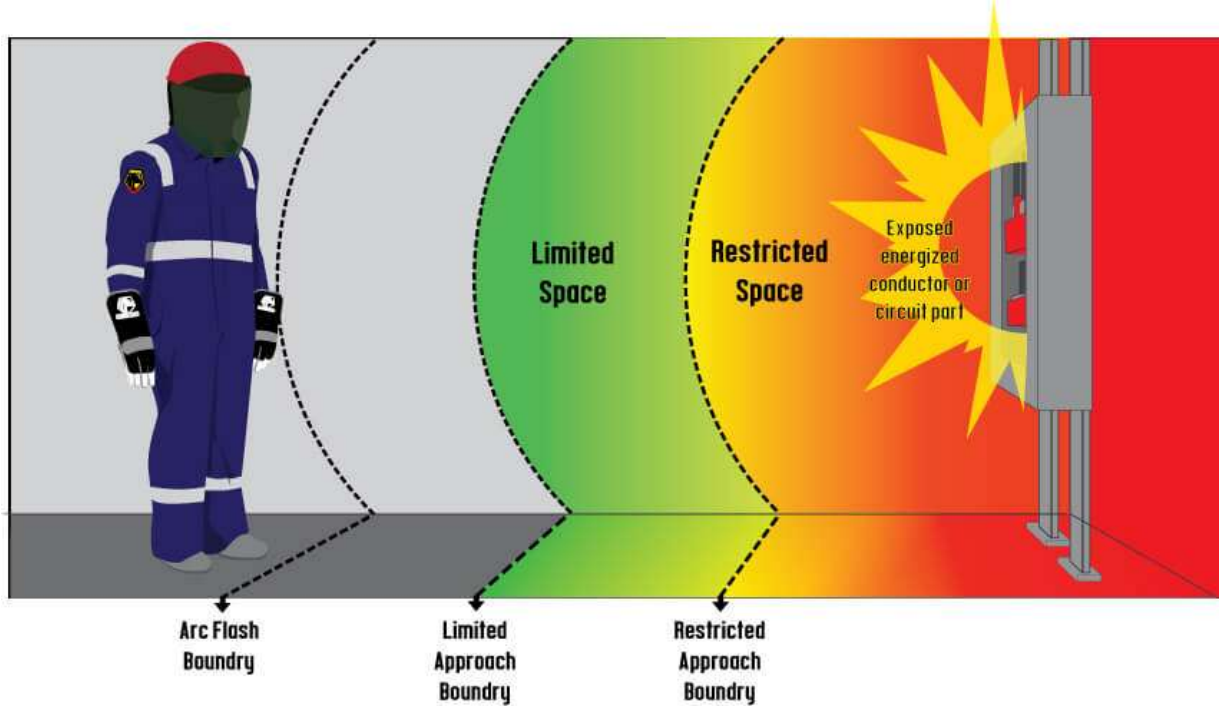

1 PPE CATEGORY
MINIMUM ARC RATING OF 4 cal/cm²
Arc Rated Clothing
AR long-sleeve shirt and pants, or AR coverall
AR face shield, or AR flash suit hood
AR jacket, parka, rainwear, or hard hat liner (as needed)
Protective Equipment
Hard hat
Safety glasses or safety goggles
Hearing protection (with inserts)
Heavy-duty leather gloves
Leather footwear (as needed)
2 PPE CATEGORY
MINIMUM ARC RATING OF 8 cal/cm²
Arc Rated Clothing
AR long-sleeve shirt and pants, or AR coverall
AR flash suit hood, or AR face shield and AR balaclava
AR jacket, parka, rainwear, or hard hat liner (as needed)
Protective Equipment
Hard hat
Safety glasses or safety goggles
Hearing protection (with inserts)
Heavy-duty leather gloves
Leather footwear
3 PPE CATEGORY
MINIMUM ARC RATING OF 25 cal/cm²
Arc Rated Clothing
As required: AR long-sleeve shirt, AR pants, AR coverall, AR flash suit jacket, and/or AR flash suit pants
AR flash suit hood
AR gloves
AR jacket, parka, rainwear, or hard hat liner (as needed)
Protective Equipment
Hard hat
Safety glasses or safety goggles
Hearing protection (with inserts)
Leather footwear (as needed)
4 PPE CATEGORY
MINIMUM ARC RATING OF 40 cal/cm²
Arc Rated Clothing
As required: AR long-sleeve shirt, AR pants, AR coverall, AR flash suit jacket, and/or AR flash suit pants
AR flash suit hood
AR gloves
AR jacket, parka, rainwear, or hard hat liner (as needed)
Protective Equipment
Hard hat
Safety glasses or safety goggles
Hearing protection (with inserts)
Leather footwear (as needed)

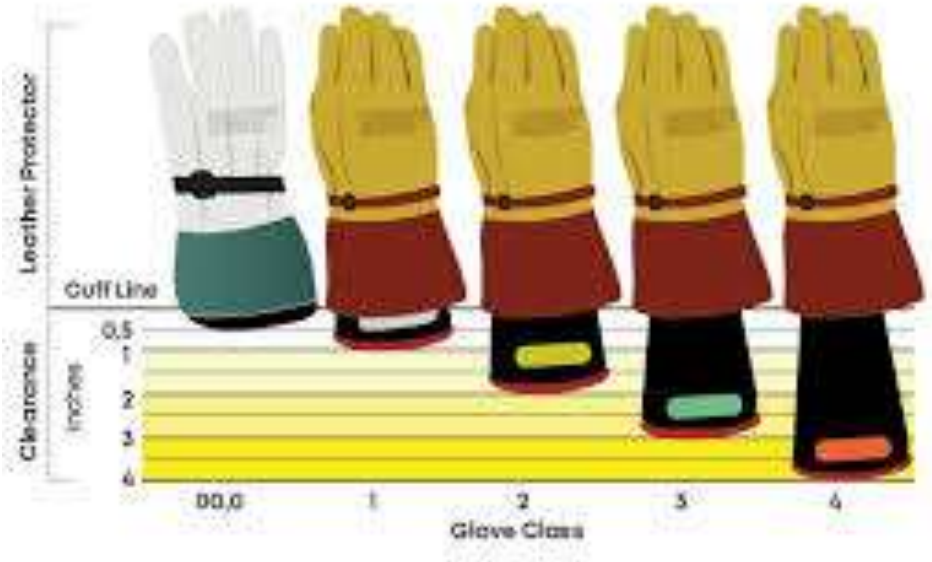
ELECTRICAL INSULATED GLOVES

ASTM Labeling Chart

Class Colour	Proof Test Voltage AC/DC	Max Use Voltage AC/DC	Insulating Rubber Glove Label Colour
00 Beige	2,500 / 10,00	500 / 750	
0 Red	5,000 / 20,00	1,000 / 1,500	
1 White	10,000 / 40,000	7,500 / 11,250	
2 Yellow	20,000 / 50,000	17,000 / 25,500	
3 Green	30,000 / 60,000	26,500 / 39,750	
4 Orange	40,000 / 70,000	36,000 / 54,000	

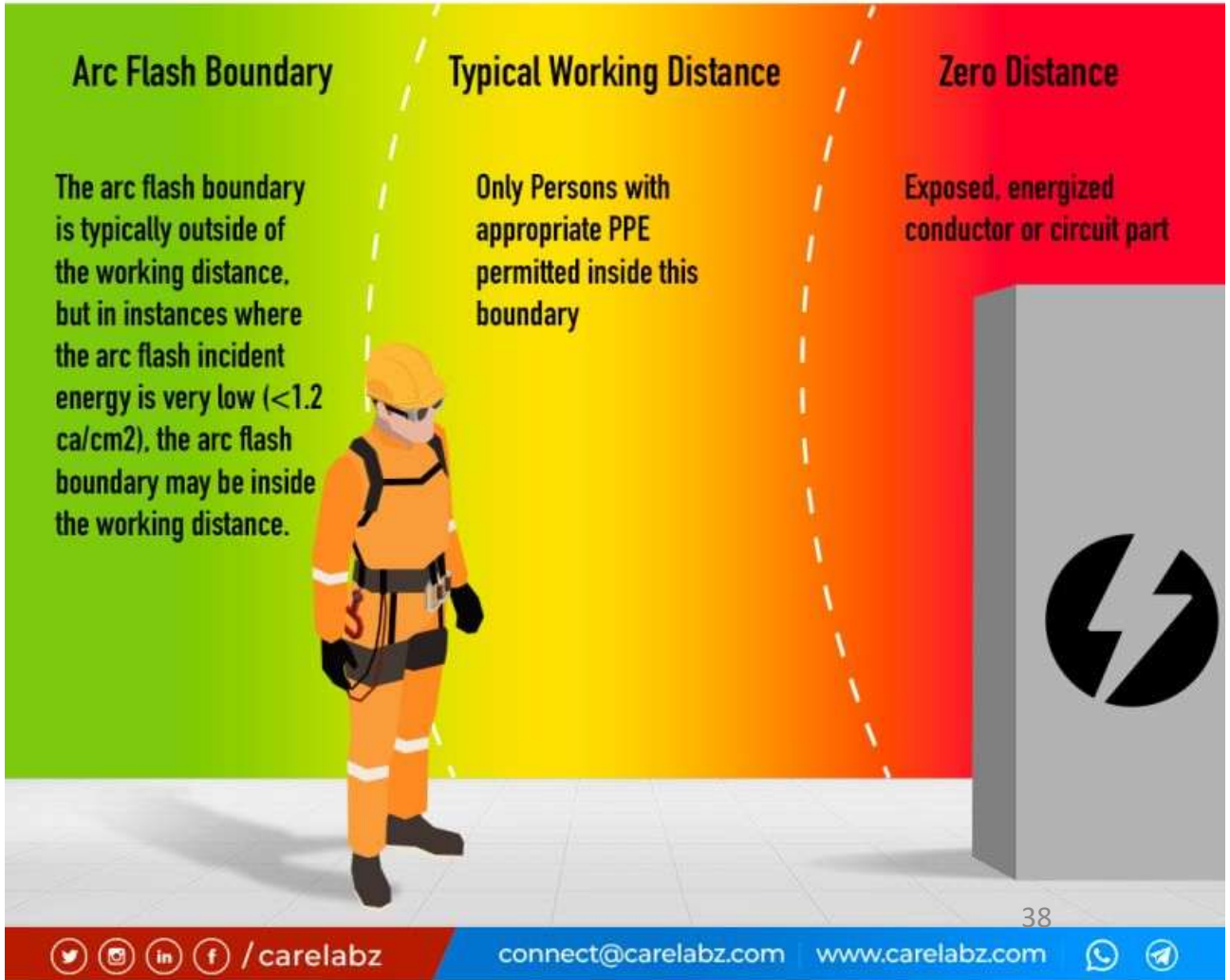
Class Color	Proof Test Voltage AC / DC	Max. Use Voltage* AC / DC	Rubber Molded Products Label	Insulating Rubber Glove Label	Insulating Rubber Dipped Sleeve Label
00 Beige	2,500 / 10,000	500 / 750			
0 Red	5,000 / 20,000	1,000 / 1,500			
1 White	10,000 / 40,000	7,500 / 11,250			
2 Yellow	20,000 / 50,000	17,000 / 25,500			
3 Green	30,000 / 60,000	26,500 / 39,750			
4 Orange	40,000 / 70,000	36,000 / 54,000			





carelabs
Test | Calibrate | Inspect | Certify

Understanding Arc Flash Boundary



/carelabz connect@carelabz.com www.carelabz.com

Various Types of Electrical PPE

Head Protection

Eye and Face Protection

Hearing Protection

Hand and Arm Protection

Foot and Leg Protection

Body Protection

SafetyCulture

Safe Work Practices

Essential for preventing electrical shocks, burns, and fatalities. They form the basis of "electrically safe work conditions.

Never Bypass Safety Devices: Safety interlocks, ground pins, and fuses are designed to protect personnel. Bypassing them can lead to equipment failure, serious injury, or fire.

Use Insulated Tools: When working near electrical circuits, use tools specially designed with non-conductive, certified, and tested insulation (such as VDE-rated). This reduces the risk of accidental short circuits and electric shocks if the tool contacts a live wire.

Maintain Safe Distances: Always keep a safe distance from overhead power lines (at least 10 feet) and other live components to prevent accidental contact, especially when carrying ladders, pipes, or operating equipment.

Use GFCIs in Damp Locations: Ground Fault Circuit Interrupters (GFCIs) must be used in damp or wet locations (e.g., outdoors, kitchens, basements) to instantly break the circuit if electricity leaks, protecting against fatal shock.

Always Test Before Touch (Verify De-energization): Never assume a circuit is off. Before starting work, use a trusted, calibrated voltage tester to confirm that the equipment is truly de-energised, even after turning off the breaker

- **de-energizing** equipment via Lockout/Tagout (LOTO) to prevent accidental startup,
- using **insulated tools** and gear for protection,
- avoiding **wet conditions**, and
- respecting **clearance distances** from live parts like overhead lines, all to prevent shocks, burns, and electrocution by isolating hazards and creating safe work zones

Don’t do this at Home….

Practices Explained:

- **De-energize Equipment Before Work (Lockout/Tagout):** This is critical; before any maintenance or repair, the power source must be completely turned off, locked out, and tagged to prevent accidental re-energisation, which is often done using LOTO procedures.
- **Use Proper Tools and Insulation:** Always use tools with insulated handles, rated for the voltage, and ensure you wear appropriate insulating gloves and gear, keeping them in good condition to prevent current transfer.
- **Avoid Wet Locations:** Water conducts electricity, so keep all electrical equipment, cords, and connections dry and away from damp or wet environments, using rubber mats and boots if necessary.
- **Maintain Clearance Distances:** Stay a safe distance from overhead power lines (often 10 feet or more) and establish exclusion zones around energized equipment to prevent accidental contact with live parts

Additional Safety Measures:

- **Inspect Equipment:** Regularly check cords, tools, and equipment for damage (cracks, frayed wires) and don't use anything defective.
- **Ground Equipment:** Use properly grounded (3-prong) cords and equipment.
- **Awareness:** Always assume lines are live; look up for overhead lines and stay aware of your surroundings.
- **Training:** Ensure all workers are trained in electrical safety and PPE usage

AT HOME LEARNING
ELECTRICAL SAFETY

Attending school at home? Follow these electrical safety tips to keep you, your family, and home safe from electrical hazards.

1. Avoid overloading outlets.
2. Unplug appliances when not in use to save energy and minimize the risk of shock and fire.
3. Regularly inspect electrical cords and extension cords for damage.
4. Extension cords should only be used on a temporary basis.
5. Never plug a space heater or fan into an extension cord or power strip.
6. Never run cords under rugs / carpets, doors, or windows.
7. Plug in smartly. Make sure cords do not become tripping hazards.
8. Keep papers and other potential combustibles at least three feet away from space heaters and other heat sources.
9. Make sure you use proper wattage for lamps / lighting.
10. Make sure your home has smoke alarms. Test them monthly, change batteries yearly, and replace the unit every 10 years.

Wherever you are learning, it's always important to be safe.

Please share this free resource to save lives

ESFI.org www.facebook.com/ESFI.org www.twitter.com/ESFIdotorg www.youtube.com/ESFIdotorg

WORKPLACE SAFETY

KNOW WHEN TO SAY WHEN – KNOW WHEN TO STOP WORK

While qualified electrical line workers and electricians are often willing to go above and beyond the call, some jobs require specific knowledge and experience. That's why it's important to stop and reassess a situation if there is ever doubt about a job's task or a procedure's requirement. As qualified electrical workers, it is our jobs to ensure all trades are aware of danger related to unqualified electrical work.

ALWAYS ASK YOURSELF:

1. *Have I been properly trained to safely complete this job task?*

2. *Have I worked on this task before, and do I have the right training and experience?*

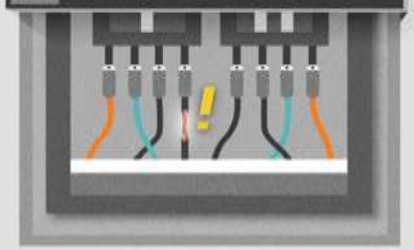
3. *Do I have the proper tools for this job?*

4. *Is the hierarchy of risk controls being followed to ensure that preventive and protective risk controls are being implemented?*

5. *Has a proper risk assessment been performed?*

6. *Are all conductors and circuit parts in an electrically safe working condition?*

7. *Are these parts properly guarded to reduce the likelihood of electrical contact or arcing faults?*



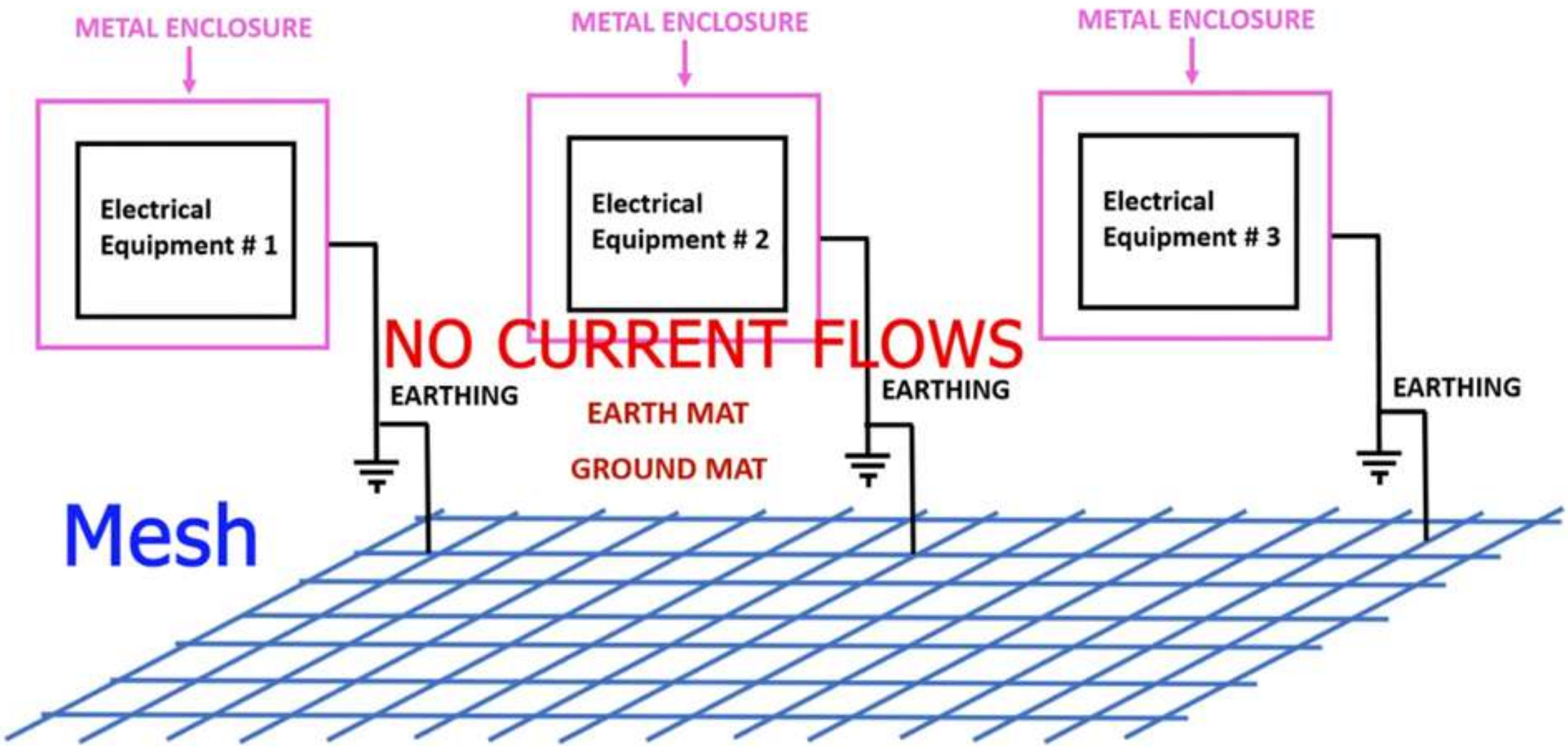
8. *Are all applicable procedures and job planning procedures completed?*

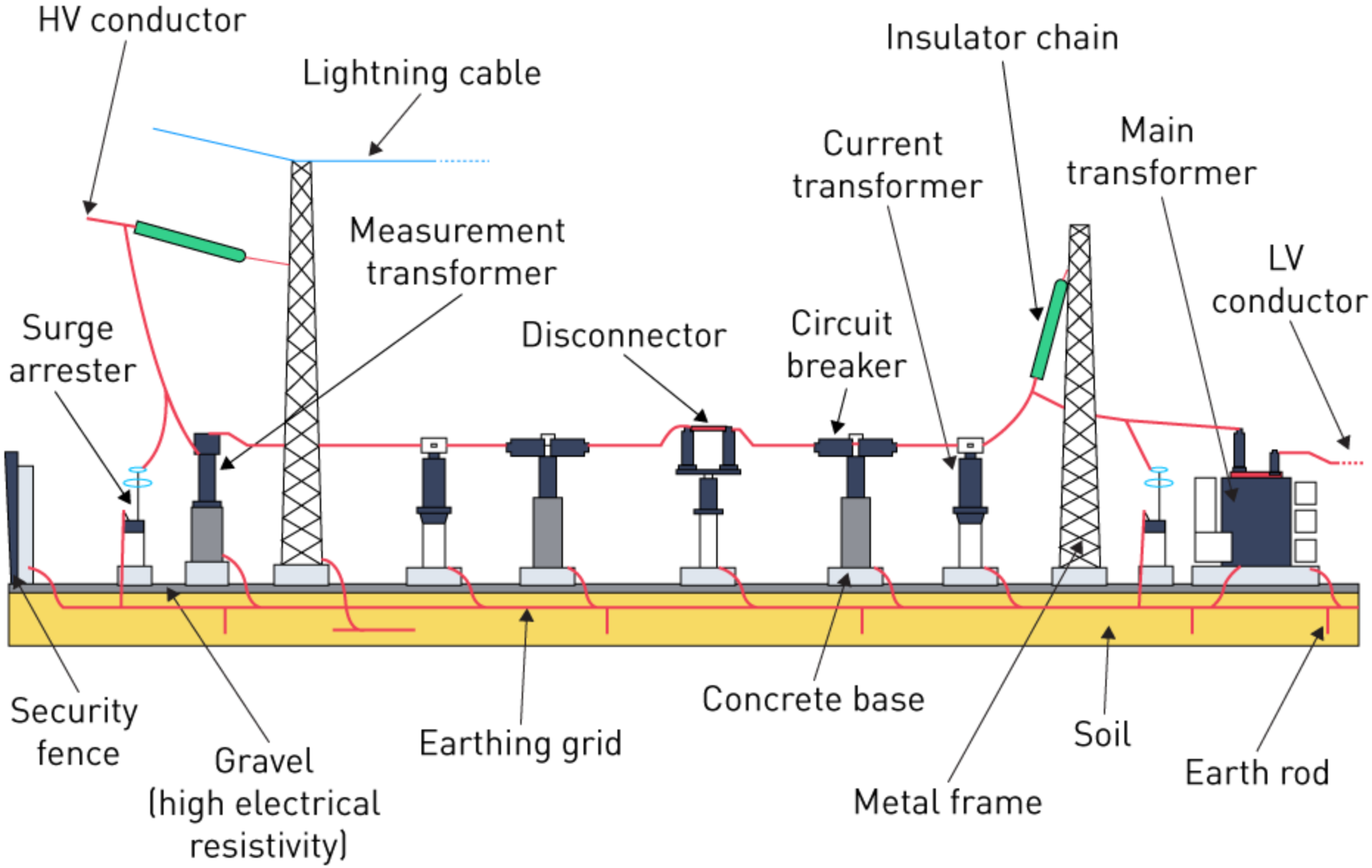
9. *Am I confident about completing this job without risk or putting others at risk?*

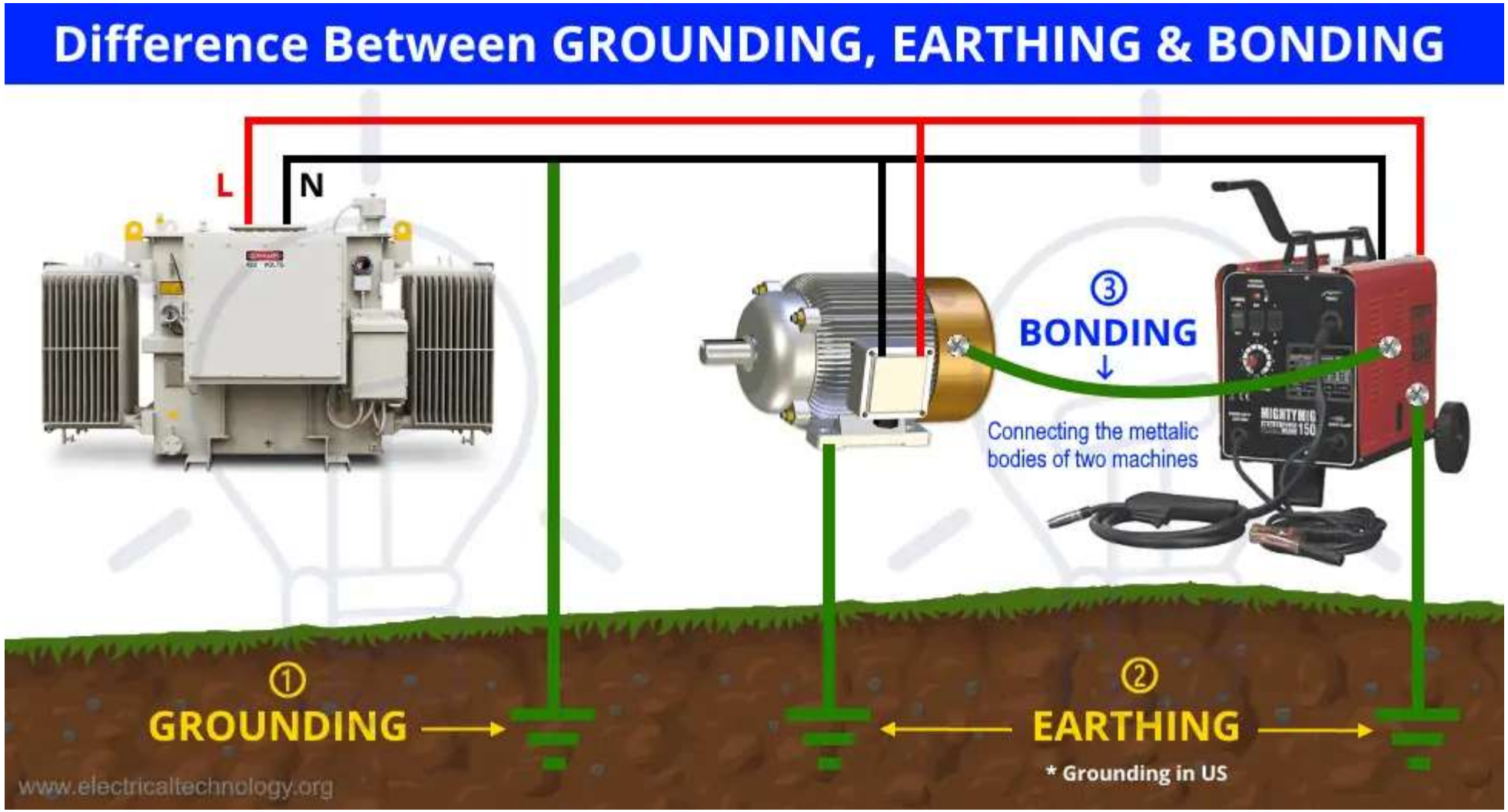
KNOW WHEN TO SAY WHEN – IT CAN SAVE YOUR LIFE, AND THE LIVES OF THOSE WORKING WITH YOU.

Please share this free resouce to save lives

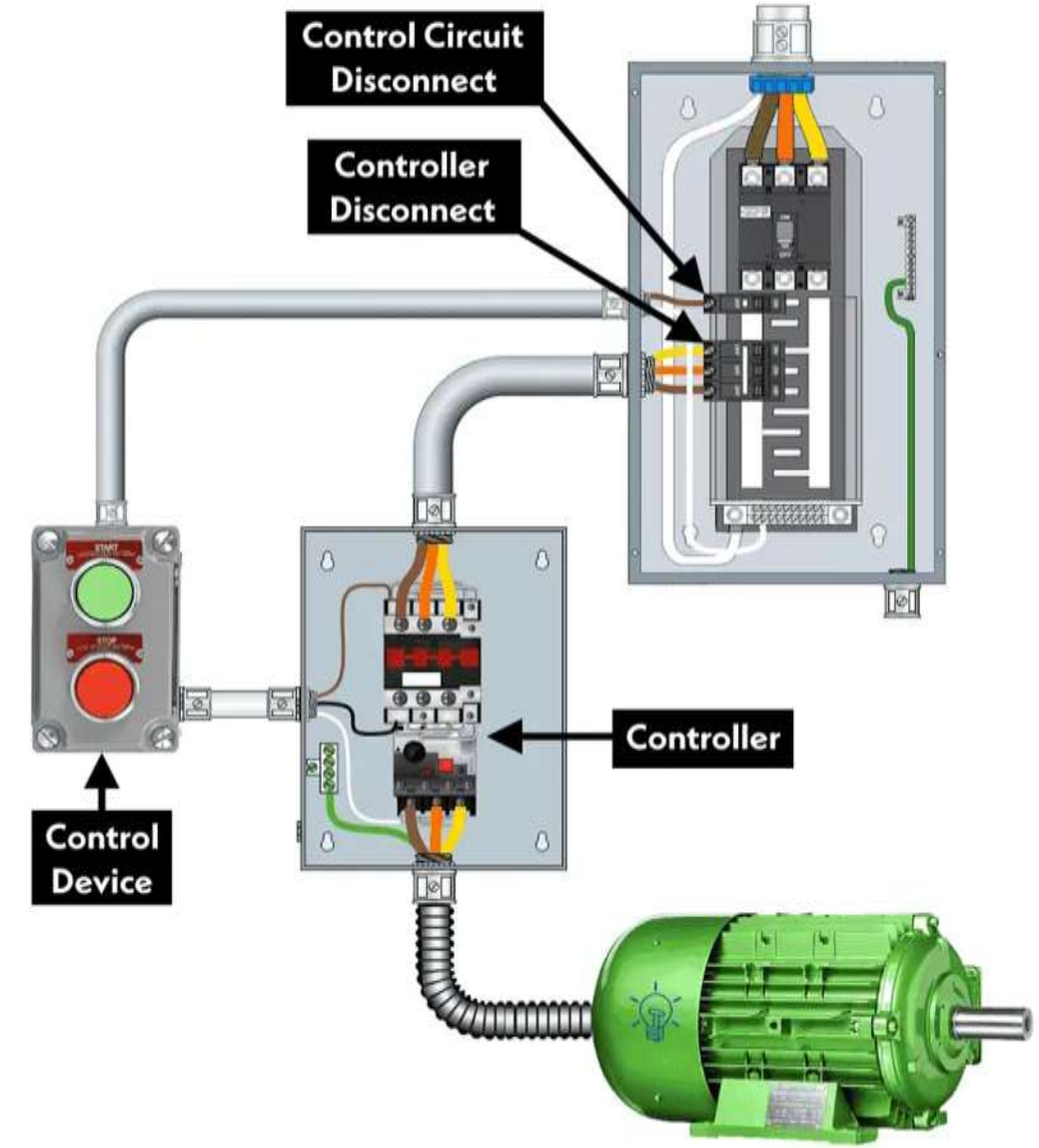
ESFI.org www.facebook.com/ESFI.org www.twitter.com/ESFIdotorg www.youtube.com/ESFIdotorg

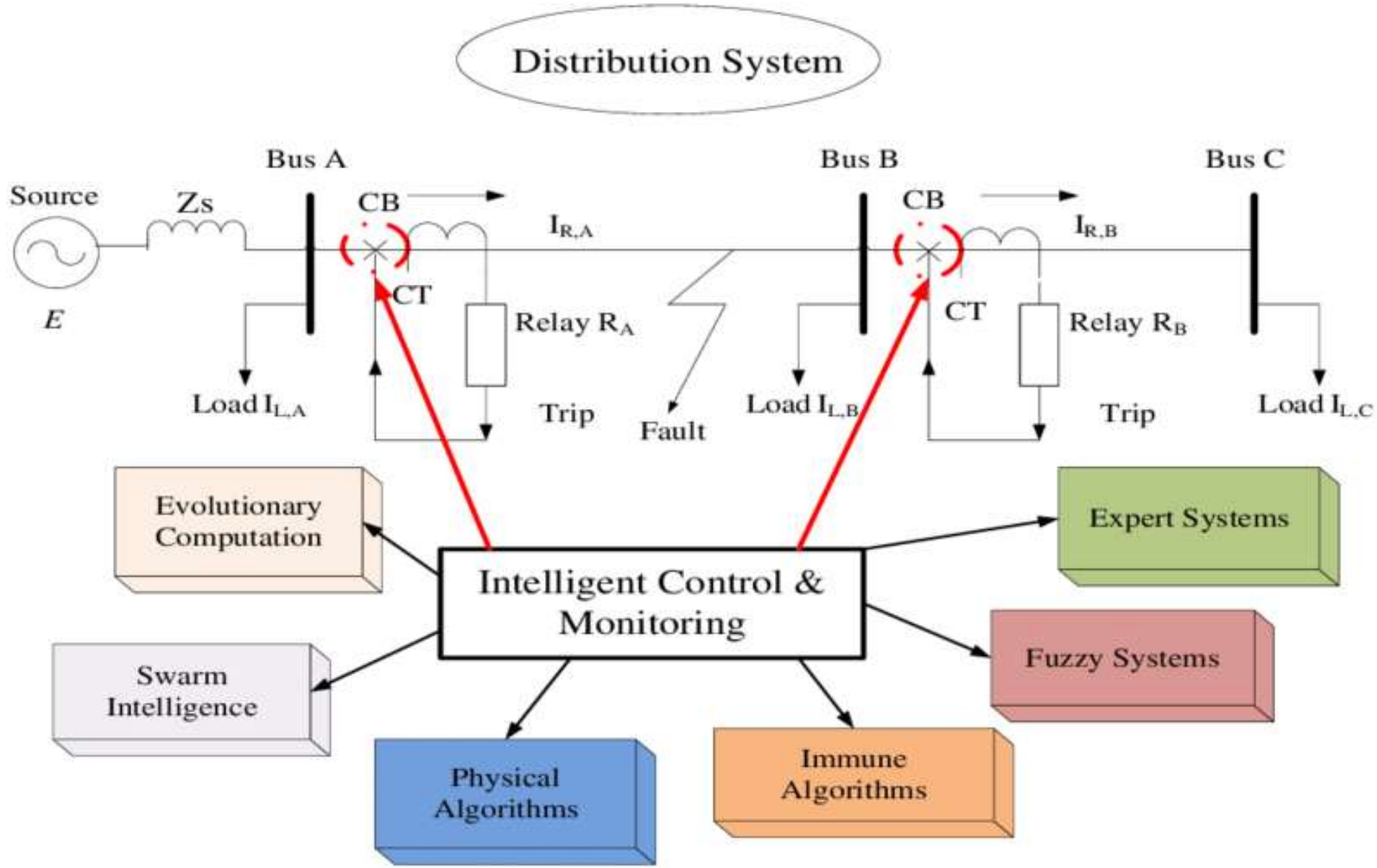

METAL ENCLOSURE
METAL ENCLOSURE
METAL ENCLOSURE
Electrical Equipment # 1
Electrical Equipment # 2
Electrical Equipment # 3
NO CURRENT FLOWS
EARTHING
EARTHING
EARTHING
EARTH MAT
GROUND MAT
Mesh


HV conductor
Lightning cable
Insulator chain
Current transformer
Main transformer
Measurement transformer
LV conductor
Surge arrester
Disconnector
Circuit breaker
Security fence
Gravel (high electrical resistivity)
Earthing grid
Concrete base
Soil
Earth rod
Metal frame


Difference Between GROUNDING, EARTHING & BONDING
L
N
③
BONDING
Connecting the mettalic bodies of two machines
①
GROUNDING
②
EARTHING
* Grounding in US
www.electricaltechnology.org

Part 10 - Overcurrent Protection for Motor Control Circuits




Distribution System
Bus A
Bus B
Bus C
Source
Zs
CB
CB
$I_{R,A}$
$I_{R,B}$
CT
CT
E
Relay R_A
Relay R_B
Load $I_{L,A}$
Trip
Fault
Load $I_{L,B}$
Trip
Load $I_{L,C}$
Evolutionary Computation
Expert Systems
Intelligent Control & Monitoring
Swarm Intelligence
Fuzzy Systems
Physical Algorithms
Immune Algorithms

Contact Rozel for your Electrical Safety Training Needs

ELECTRICAL HAZARD BOUNDARIES

Rozel
www.70eConsultants.com

FLASH PROTECTION

(for when an increased likelihood of injury from an arc flash hazard exists i.e. "not normal operation" or high incident energy equipment)

ARC FLASH BOUNDARY

The energy (cal/cm²) available at the working distance is indicated on the label. Use this value to choose flash PPE. The above pictures are examples.

WORKING DISTANCE (NORMALLY 18")

The energy (cal/cm²) available inside the working distance is greater than indicated on the label.

Electrical Equipment

2nd or 3rd degree burns are possible inside the arc flash boundary

SHOCK PROTECTION

(for *exposed & energized* conductors)

All parts of your body in this boundary must be protected from shock. Only qualified persons allowed.

VOLTAGE RATED TOOLS ONLY

RESTRICTED APPROACH BOUNDARY

NO un-qualified persons unless continuously escorted by a qualified person.

LIMITED APPROACH BOUNDARY

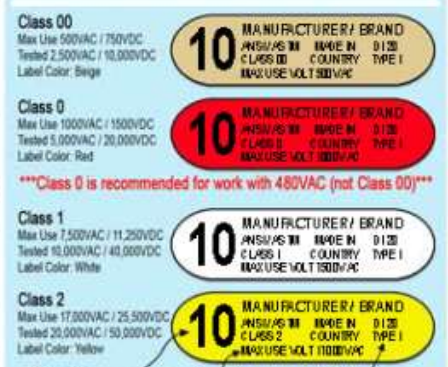
Approach Boundaries

Nominal Voltage	Limited (exposed fixed circuit part)	Restricted
50 VAC - 150 VAC	42 inches (3'-6")	Avoid Contact
151 VAC - 750 VAC	42 inches (3'-6")	12 inches (1')
751 VAC - 15,000 VAC	60 inches (5')	26 inches (2'-2")

Operating a circuit breaker or switch for the first time after installation or completion of maintenance in equipment requires additional protective measures i.e. appropriate PPE

cal/cm²	RECOMMENDED PPE FOR FLASH & SHOCK
less than 1.2	Long Sleeve Natural Fiber, i.e. 100% cotton Shirt and Pants, Safety Glasses or Goggles, Hard Hat, Hearing Protection, Rubber Insulating Gloves as Required, Leather Gloves (as needed), Leather Footwear (EH).
1.2 and greater up to 8.0	Clothing with an arc rating greater than the incident energy, i.e. Long-Sleeve Shirt and Pants, Hard Hat with **Face Shield & Balaclava (or hood)**, Safety Glasses or Goggles, Hearing Protection, Rubber Insulating Gloves with Leather Protectors, Leather Footwear (EH).
8.0 and greater up to 40.0	Clothing with an arc rating greater than the incident energy. i.e. **Arc Flash Suit, Hood**, Hard Hat, Safety Glasses or Goggles, Hearing Protection, Rubber Insulating Gloves with Leather Protectors, Leather Footwear (EH).
greater than 40.0	Danger! Wear PPE rated for the available incident energy at the corresponding working distance. There is an increased likelihood of injury from an arc flash while working on this equipment.

GLOVE CLASSES FOR COMMON VOLTAGES



WARNING

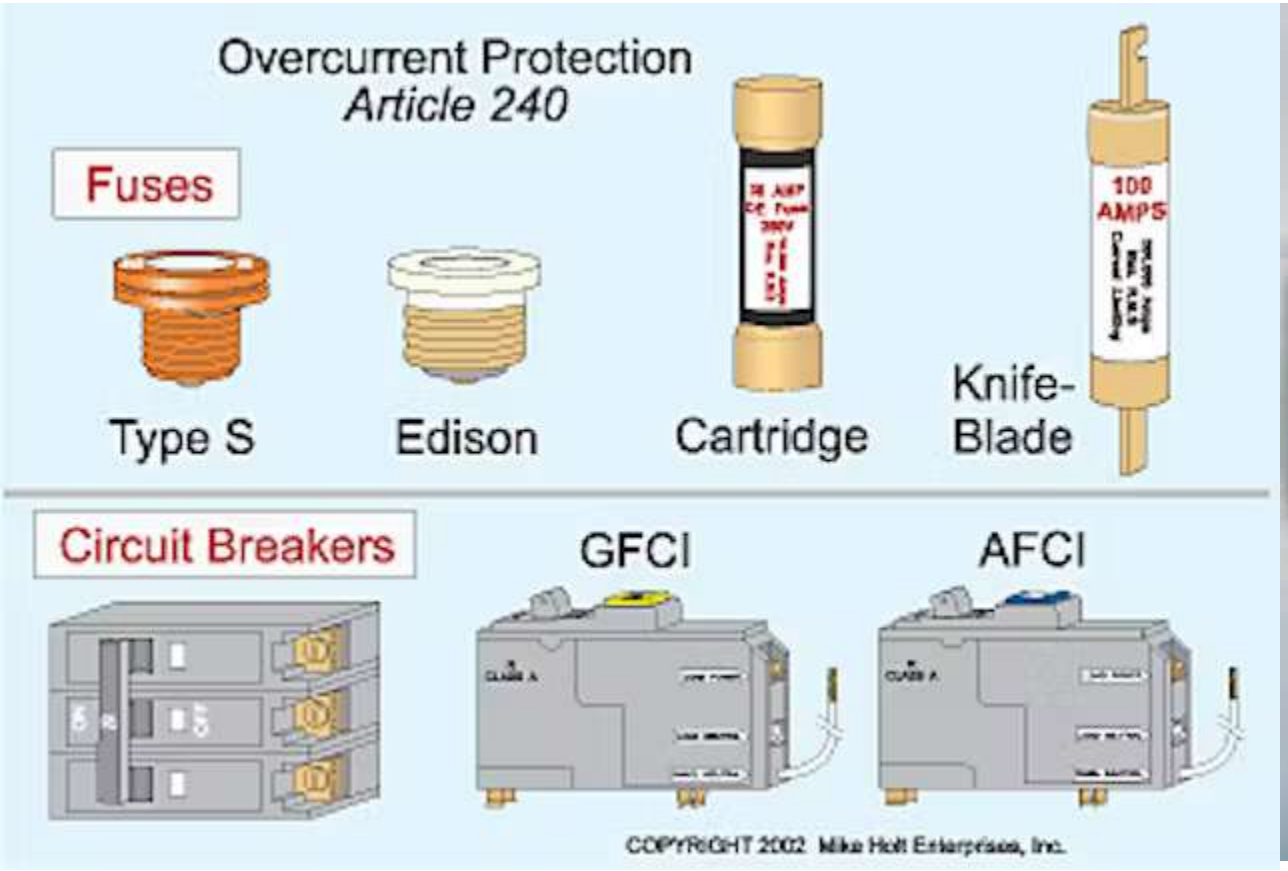
ARC FLASH AND SHOCK HAZARD

FLASH PROTECTION		SHOCK PROTECTION	
<1.2	cal/cm^2 Flash Hazard at 18 inches	480 VAC	
Arc Flash Boundary	18 inches	Glove Class	0
Available Fault Current	29.62 kA	Limited Aprch. Boundary	42 inches
		Restricted Aprch. Boundary	12 inches
(FOR WHEN AN INCREASED LIKELIHOOD OF INJURY FROM AN ARC FLASH HAZARD EXISTS)		(FOR EXPOSED ENERGIZED CONDUCTORS)	

Recommended PPE for Flash and Shock:
Long Sleeve Natural Fiber, i.e. 100% cotton Shirt and Pants, Safety Glasses or Goggles, Hard Hat, Hearing Protection, Rubber Insulating Gloves as Required, Leather Gloves (as needed), Leather Footwear (EH).

February 7, 2023

Contact Rozel for arc flash evaluation report and electrical hazard label questions or when major modification or renovation takes place. **Evaluations should be reviewed periodically, at intervals not to exceed 5 years.**


Overcurrent Protection
Article 240
Fuses
Type S
Edison
Cartridge
100 AMPS
Knife-Blade
Circuit Breakers
GFCI
AFCI
COPYRIGHT 2002 Mike Holt Enterprises, Inc.


C16
C16
C16
C16
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C16
C16
C10
C6
C6

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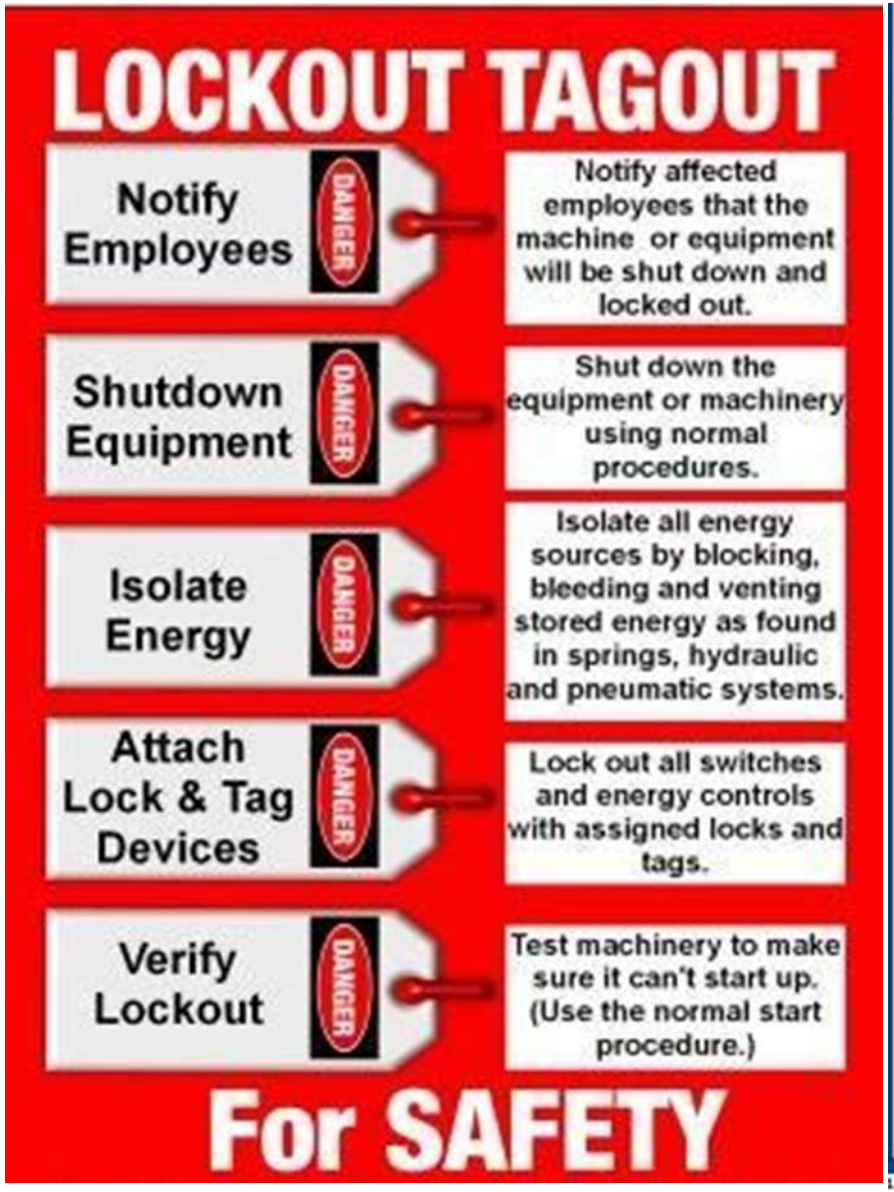
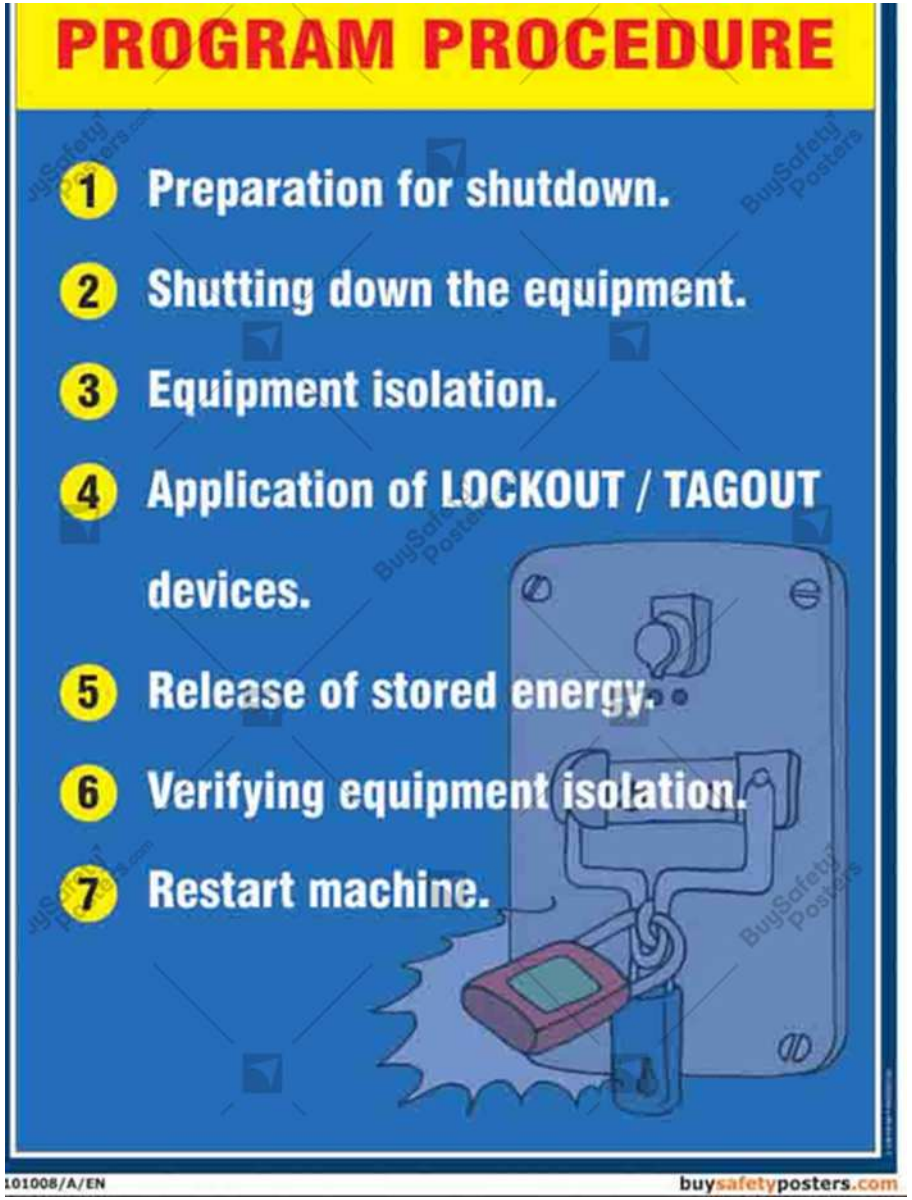
Lockout/Tagout (LOTO) Procedures

- Purpose: Prevent accidental energization
- Steps:
  - Shut down the equipment
  - Isolate the energy source
  - Lock and tag
  - Verify zero energy state

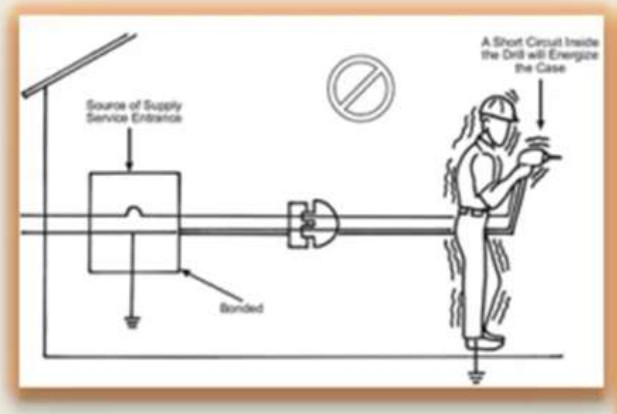

LOCKOUT
TAGOUT
CABINET
DANGER
DO NOT
OPERATE

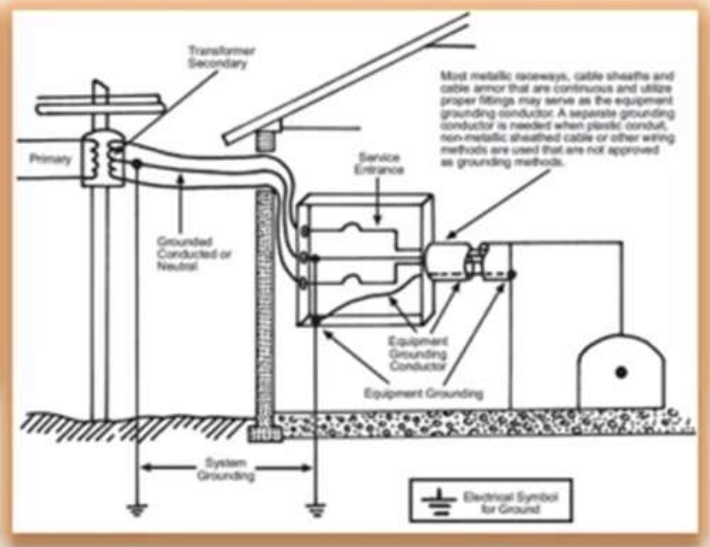

LOCKOUT TAGOUT
Notify Employees
DANGER
Notify affected employees that the machine or equipment will be shut down and locked out.
Shutdown Equipment
DANGER
Shut down the equipment or machinery using normal procedures.
Isolate Energy
DANGER
Isolate all energy sources by blocking, bleeding and venting stored energy as found in springs, hydraulic and pneumatic systems.
Attach Lock & Tag Devices
DANGER
Lock out all switches and energy controls with assigned locks and tags.
Verify Lockout
DANGER
Test machinery to make sure it can't start up. (Use the normal start procedure.)
For SAFETY

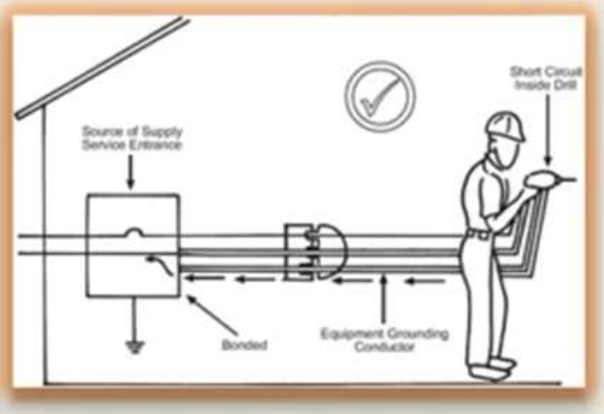

PROGRAM PROCEDURE
1 Preparation for shutdown.
2 Shutting down the equipment.
3 Equipment isolation.
4 Application of LOCKOUT / TAGOUT devices.
5 Release of stored energy.
6 Verifying equipment isolation.
7 Restart machine.
101008/A/EN
buysafetyposters.com

Causes of Electrical Accidents

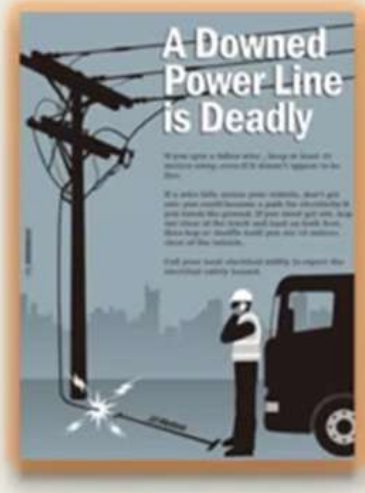
Working with Electricity Electrical Accidents Guide for Electrical Workers

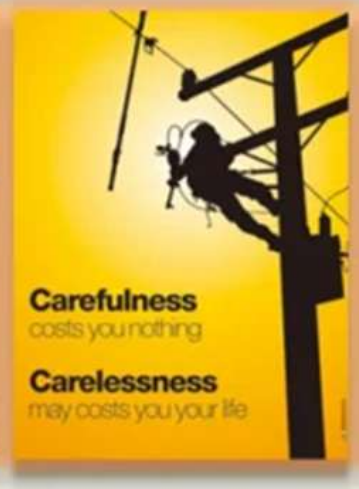


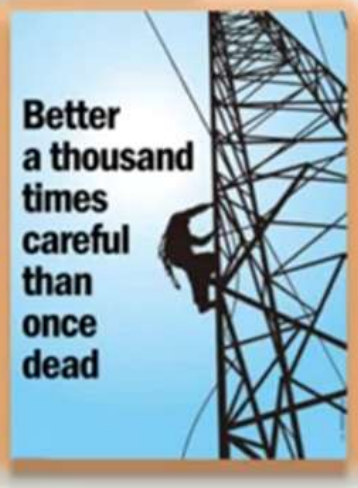


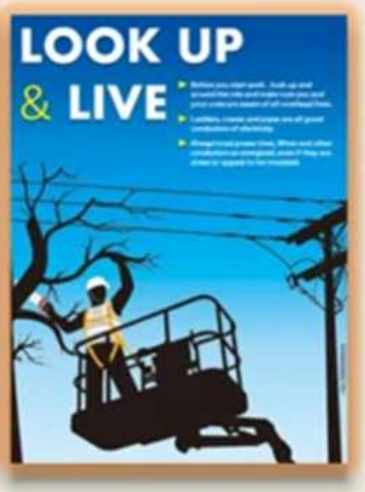


HSSEWORLD.COM
Health, Safety ,Security and Environment





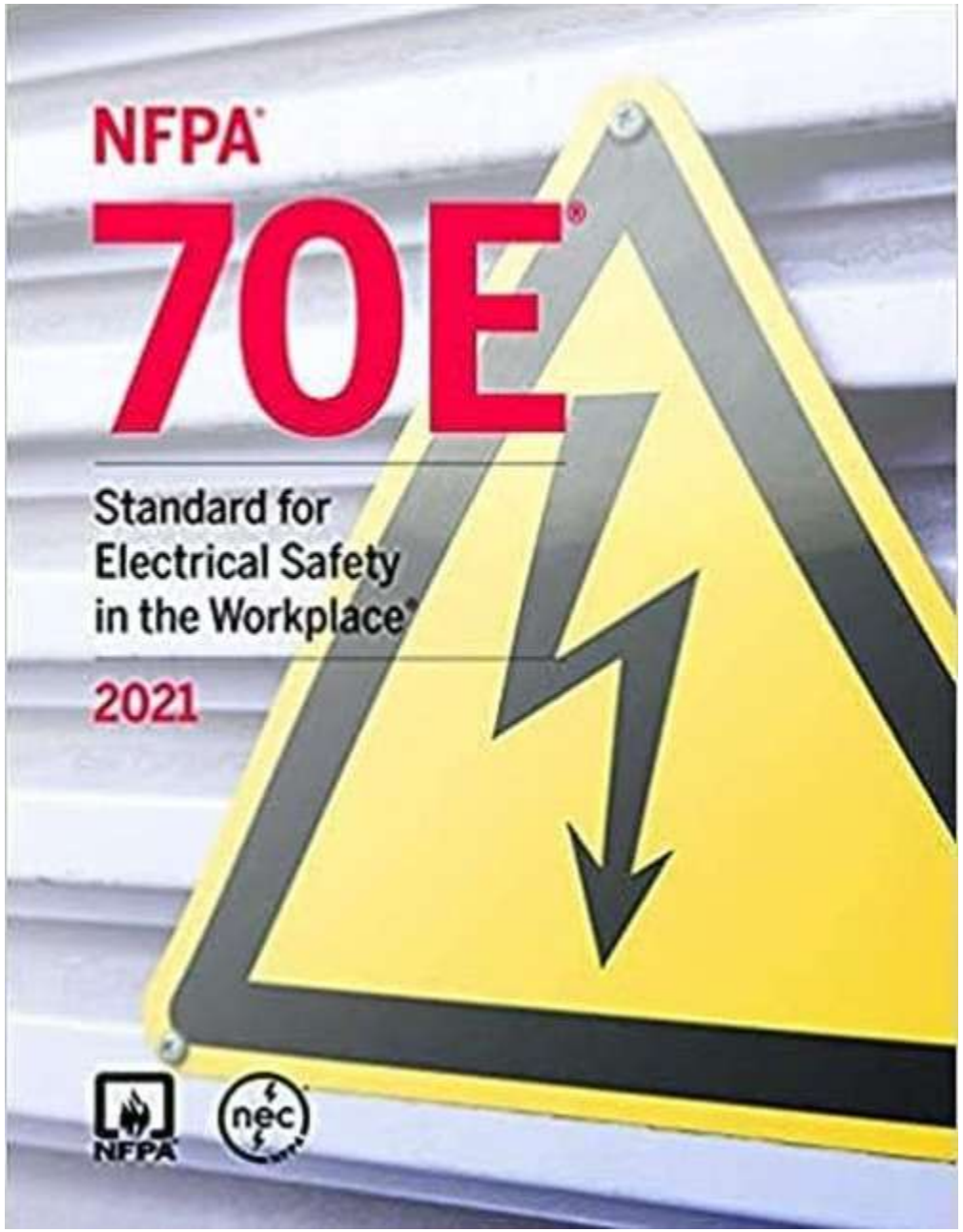




Standards and Regulations

- Applicable Standards:
  - IEC, IEEE, NFPA 70E
  - OSHA electrical safety regulations
  - MNBC, EI
- Importance of Compliance

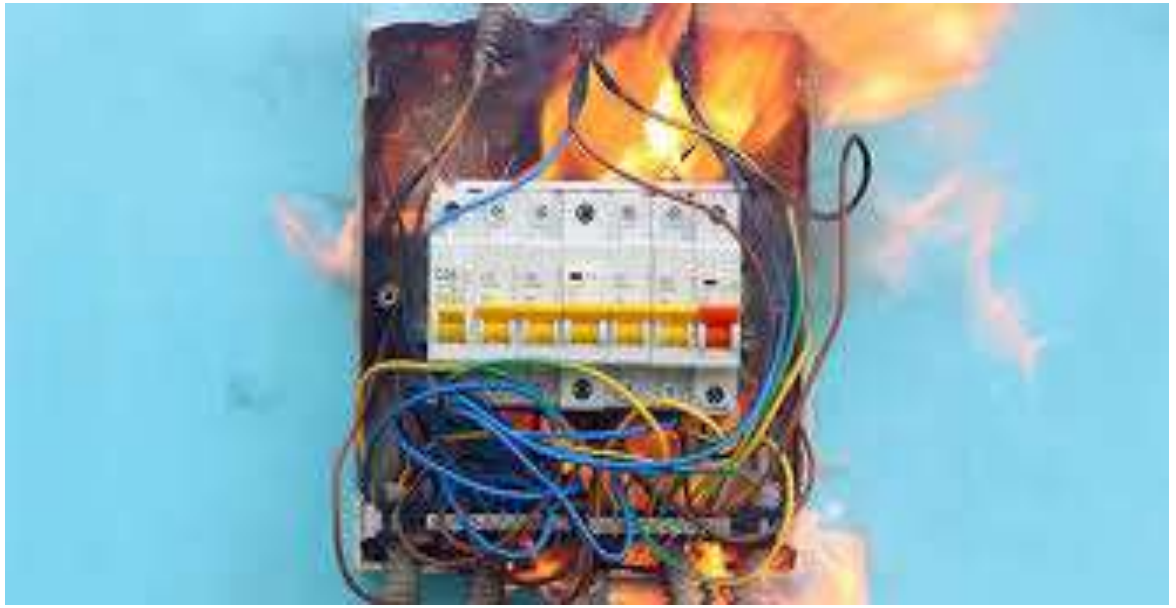

DANGER
DANGER
CAUTION
CAUTION
SAFETY
SAFETY
NOTICE
NOTICE
QUALITY
QUALITY
AWAITING INSPECTION
ACCEPTED
CCTV in operation
Toilets
Parking
VACUUM
OXYGEN
NITROGEN
AIR SUPPLY
ELECTRICAL
SLOW

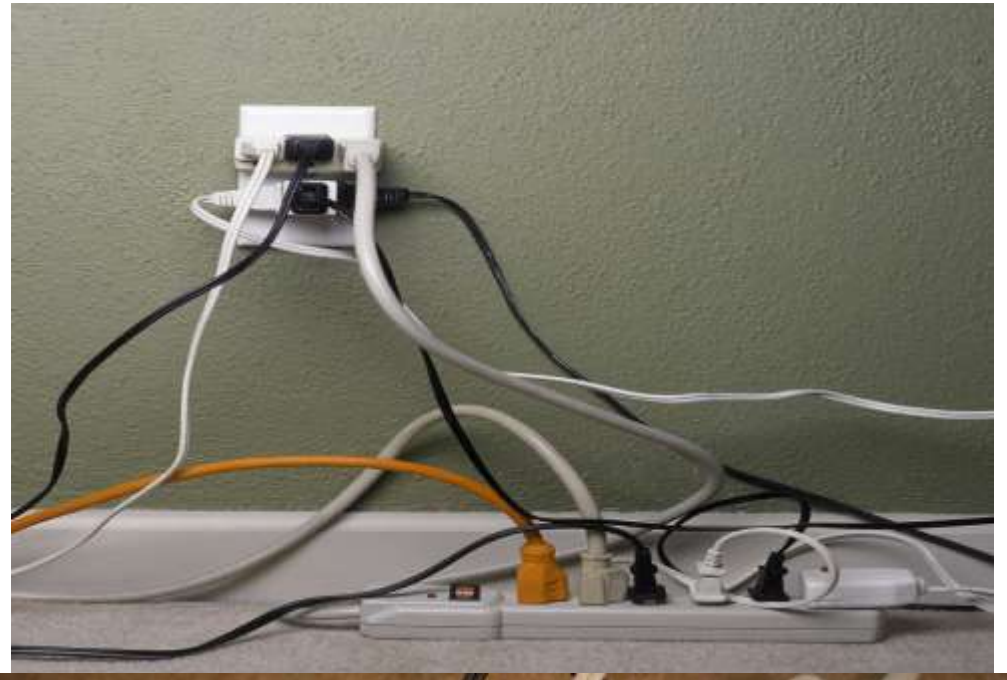

NFPA
70E
Standard for
Electrical Safety
in the Workplace
2021
NFPA
nec

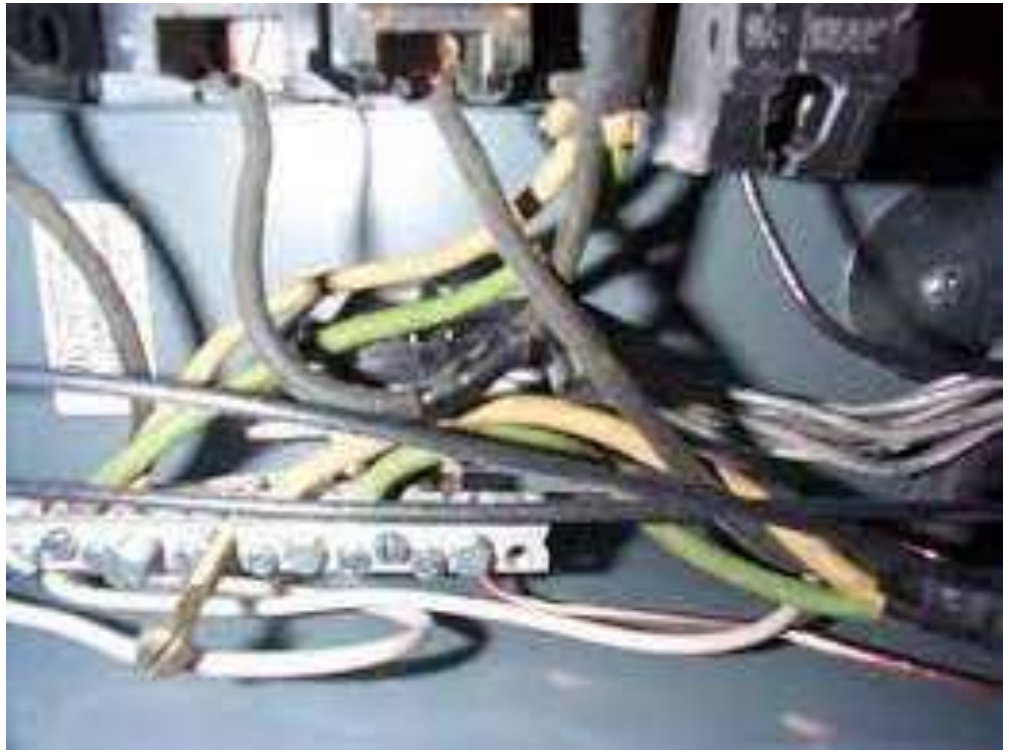

SAFETY
RULES
1 You are responsible for your own safety and safety of others.
2 Wear personal protective equipment nesessary for the job.
3 Always use equipment/tools/ machinery safely and properly.
4 Lift properly using your legs and not your back.
5 Keep your work area clean.
6 Wear appropriate and safe work clothing and footwear.
7 Report any unsafe conditions.
8 Clean up spills immediately.
9 Report all injuries.
10 No alcohol or drugs to be used or allowed on company property.

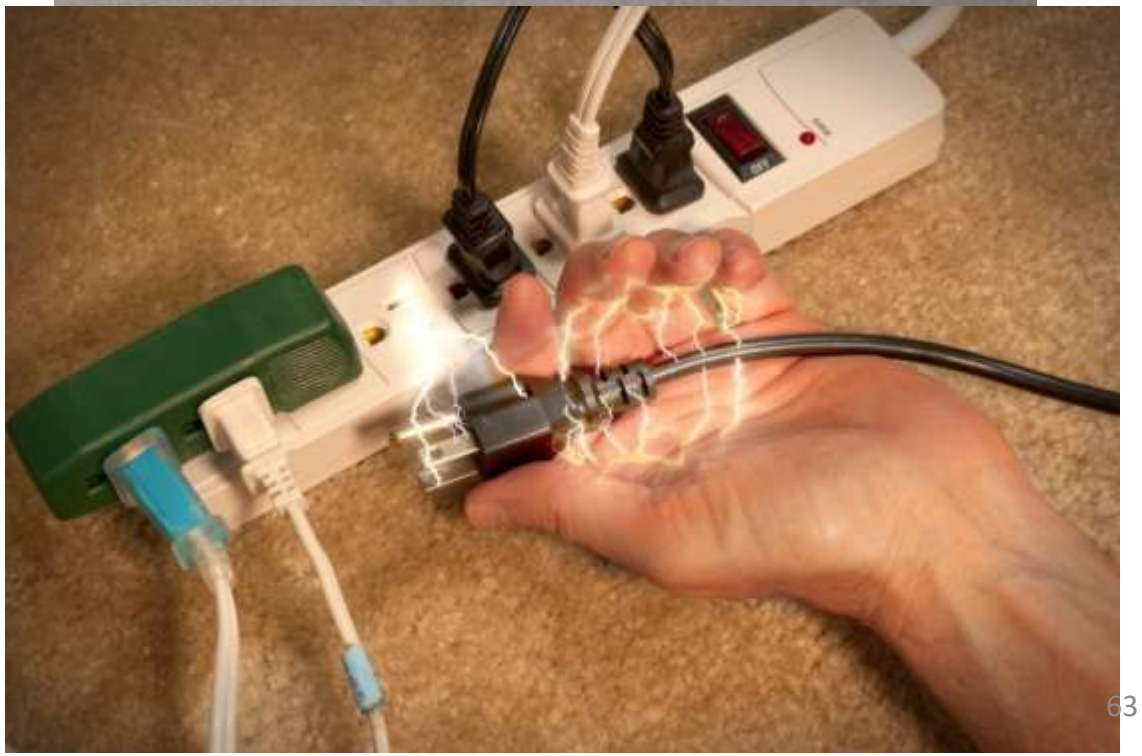
Case Studies

- Short example of an electrical accident
- Analysis of what went wrong
- Lessons learned









Safety Culture and Training

- Encourage reporting of hazards
- Continuous safety training
- Safety audits and toolbox talks

PPIS
Forging Clean Energy Future

Electrical Safety Culture


TRADESAFE


ELECTRICAL
SAFETY
DON'T WORK LIVE
Don't work without permit to work, risk assessment
Ensure isolation has been proven
Ensure you work safely and by the rules


Electrical
Safety
Reminders
Unplug equipment before maintenance or repair.
Only use extension cords temporarily.
Do not overload electrical outlets.
Report electrical hazards.
Use GFCIs when required.
Make sure cords and cables do not create tripping hazards.

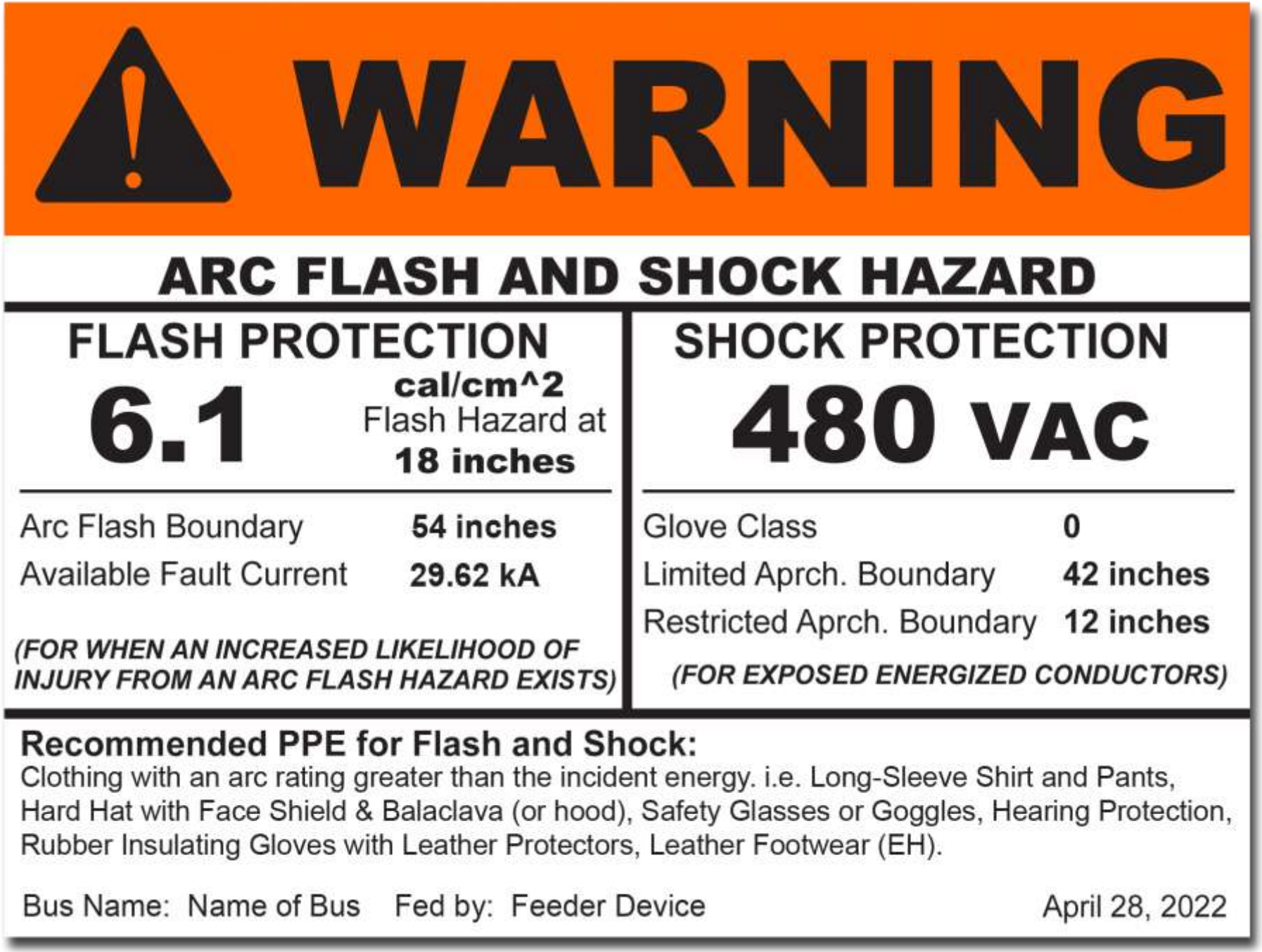
AGS

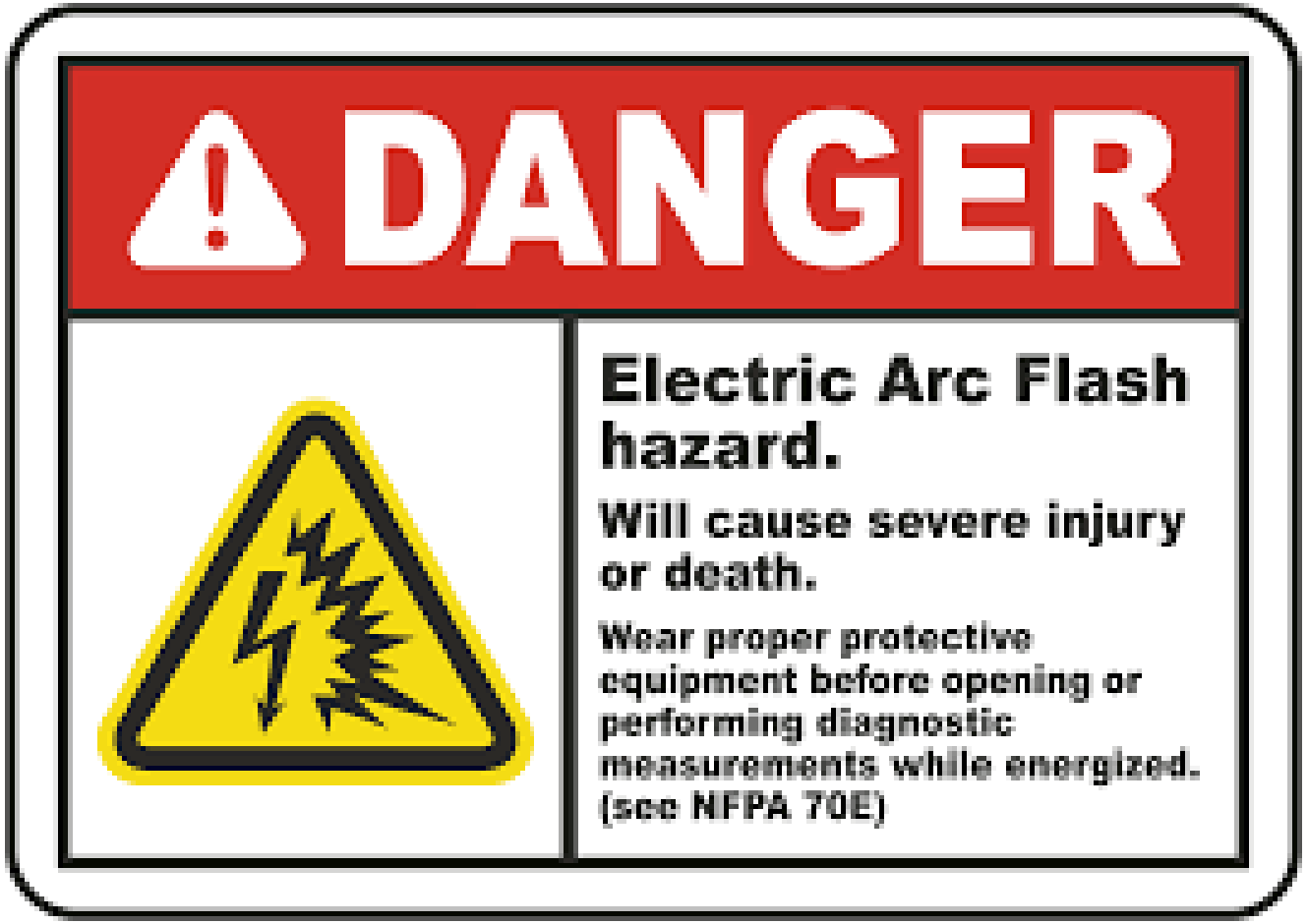
Safety Signs for Electricals

www.safety-decals.com

Responsibilities of Engineers

- Design for safety
- Conduct inspections
- Supervise and train teams
- Stay updated with codes and standards


WARNING
ARC FLASH AND SHOCK HAZARD
FLASH PROTECTION
6.1
cal/cm^2
Flash Hazard at
18 inches
Arc Flash Boundary 54 inches
Available Fault Current 29.62 kA
(FOR WHEN AN INCREASED LIKELIHOOD OF INJURY FROM AN ARC FLASH HAZARD EXISTS)
SHOCK PROTECTION
480 VAC
Glove Class 0
Limited Aprch. Boundary 42 inches
Restricted Aprch. Boundary 12 inches
(FOR EXPOSED ENERGIZED CONDUCTORS)
Recommended PPE for Flash and Shock:
Clothing with an arc rating greater than the incident energy. i.e. Long-Sleeve Shirt and Pants, Hard Hat with Face Shield & Balaclava (or hood), Safety Glasses or Goggles, Hearing Protection, Rubber Insulating Gloves with Leather Protectors, Leather Footwear (EH).
Bus Name: Name of Bus Fed by: Feeder Device April 28, 2022


DANGER
Electric Arc Flash hazard.
Will cause severe injury or death.
Wear proper protective equipment before opening or performing diagnostic measurements while energized. (see NFPA 70E)

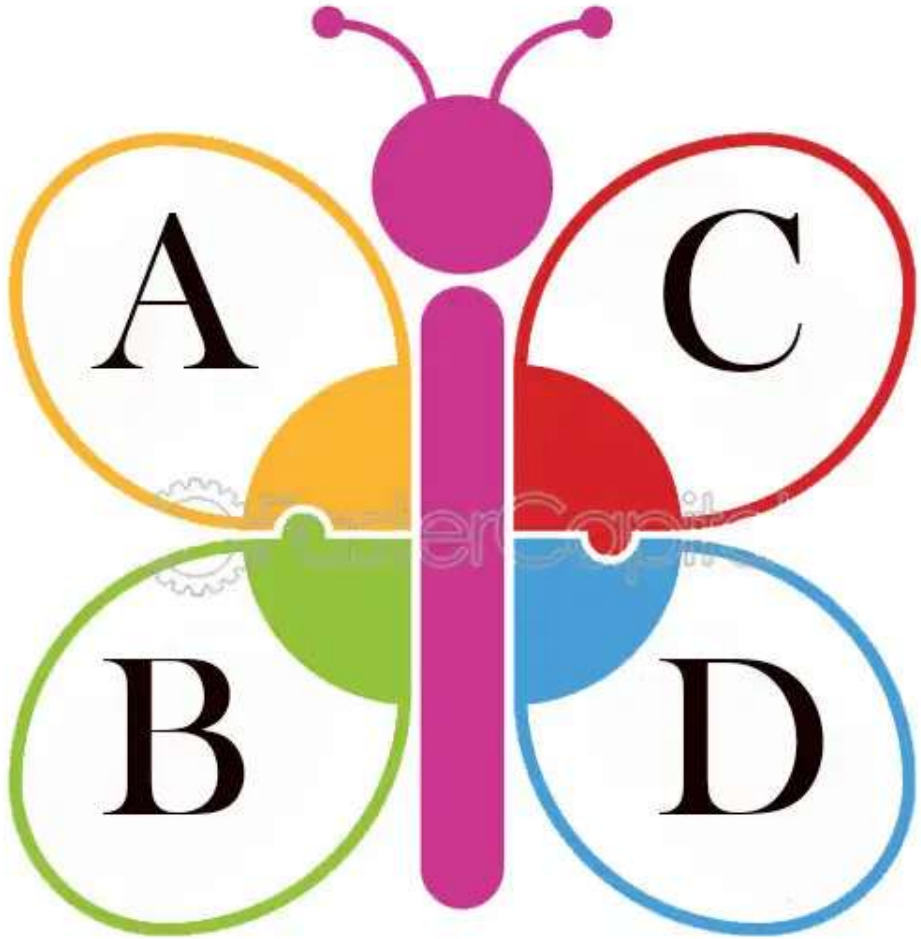

Did you know?
According to Industrial Safety & Hygiene news, an average of 30,000 arc flash incidents every year. With 7,000 burn injuries, 2,000 hospitalizations, and 400 fatalities per year.
FRONTLINE

Conclusion

- identify, assess, and mitigate electrical hazards
- Follow best practices and use PPE
- Promote a culture of safety

Conclusion and Final Thoughts on Electrical Safety

Always ensure that the electrical products you purchase are tested and certified by a reputable organization



Be aware of the potential electrical hazards in your home or workplace

It is crucial to follow the manufacturer's instructions when using electrical products

In case of an electrical emergency, it is important to know what to do

References:

Cleango, 6th March 2024, 54 Electrical Accidents & Workplace Injury Statistics, https://www.bookcleango.com/blog/electrical-injury-statistics

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OSHA Guidelines

NFPA 70E

IEC Standards

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6. https://www.youtube.com/watch?v=vhtQGQbuq6w


Thank You