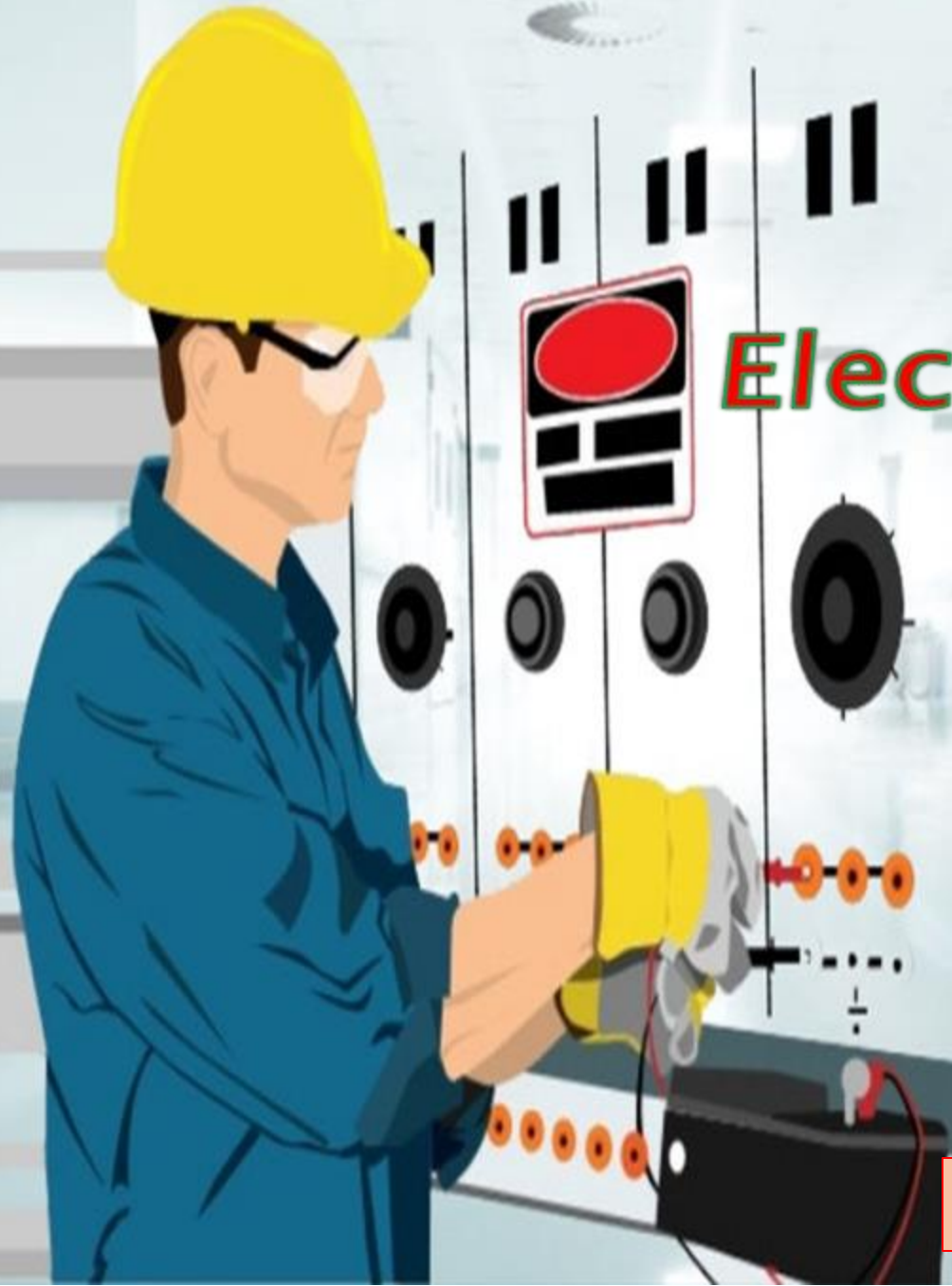




Electrical Safety

Awareness Training

Md .Iktear Uddin Gazi
Engineer-EHS (Industrial)

Introduction

Electricity –Movement of the free electrons between atoms;

–Related terms :

Current : the movement of electric charge.

Resistance : opposition to current flow.

Voltage : a measurement of electrical force.

Conductor : Substances , such as metals ,that have little resistance to electricity.

Insulators: Substance ,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.

Take Electricity Seriously

- Electricity is the second leading cause of death in construction.
- Electrocutions make up 12% of construction fatalities annually.
- Over 30,000 non-fatal shocks occur each year.
- Over 600 deaths occur annually due to electrocution.



Electrical Hazards

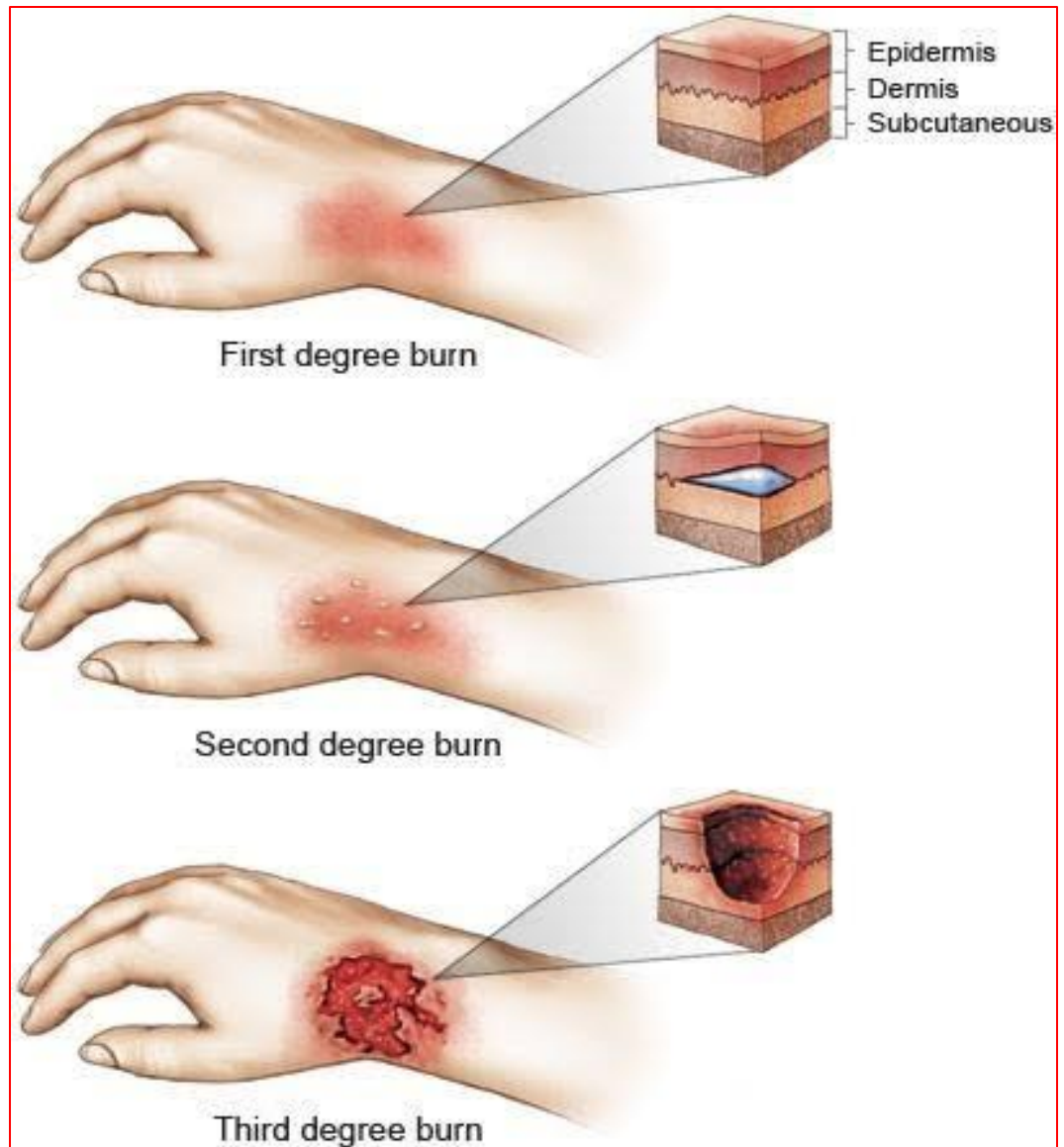
BE SAFE:

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



Types of Burn

An electrical burn is a skin burn that happens when electricity comes in contact with your body. When electricity comes in contact with your body, it can travel through your body. When this happens, the electricity can damage tissues and organs.



Effects of Current Flow



Electrocution

Electrocution:

- ▶ Is fatal
- ▶ Meaning: to kill with electrical shock

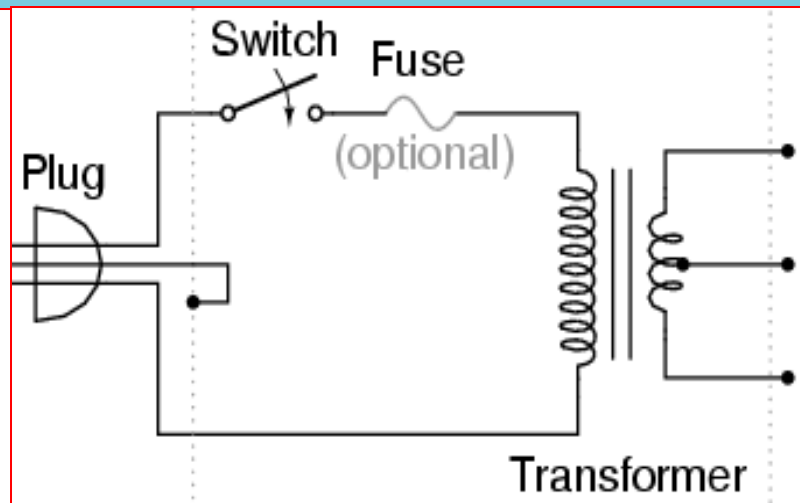
Electric current can cause injury in four ways:

- Cardiac arrest due to the electrical effect on the heart.
- Muscle, nerve, and tissue destruction from a current passing through the body.
- Thermal burns from contact with the electrical source.
- Falling or injury after contact with electricity.



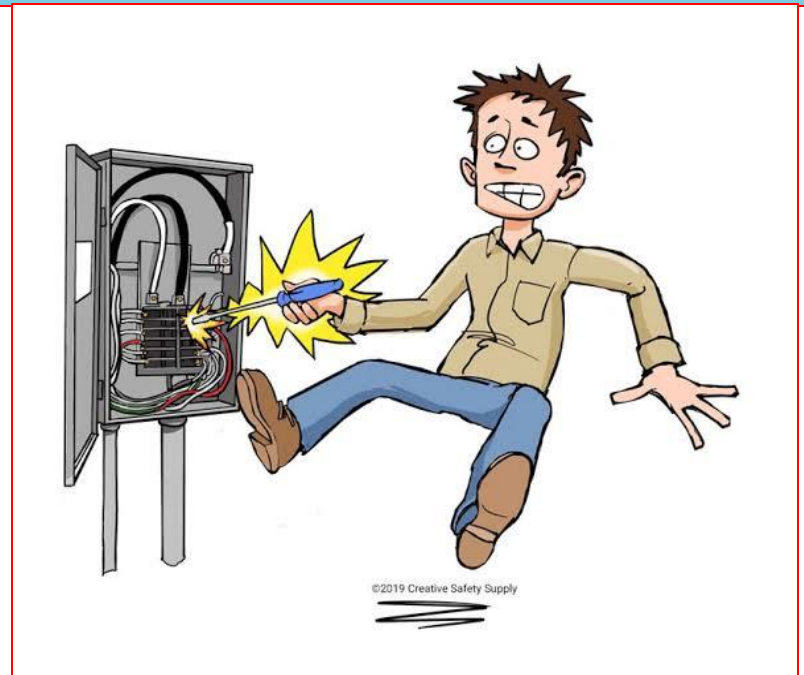
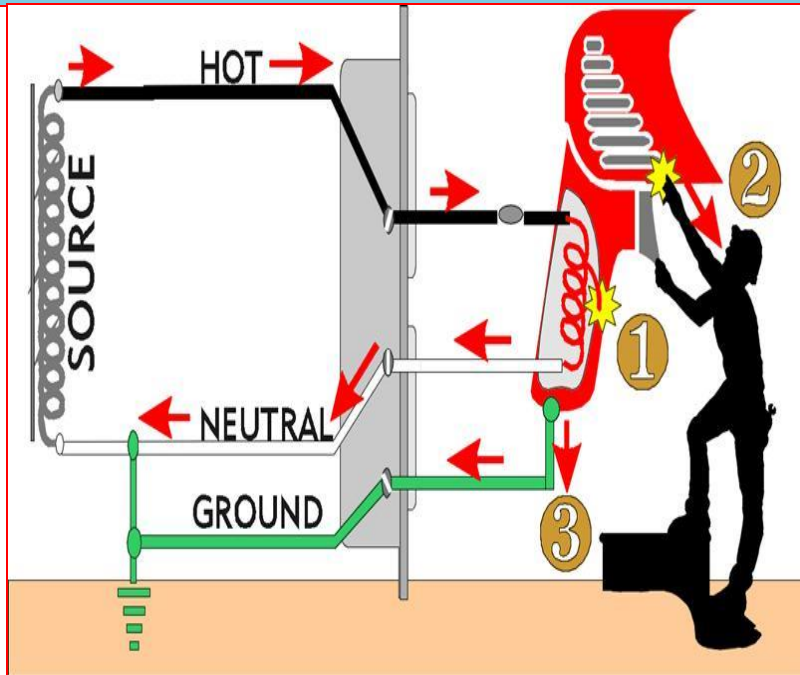
How Shocks Occur

- Shock occurs when the body becomes a part of the circuit.
- Current enters at one point & leaves at another.

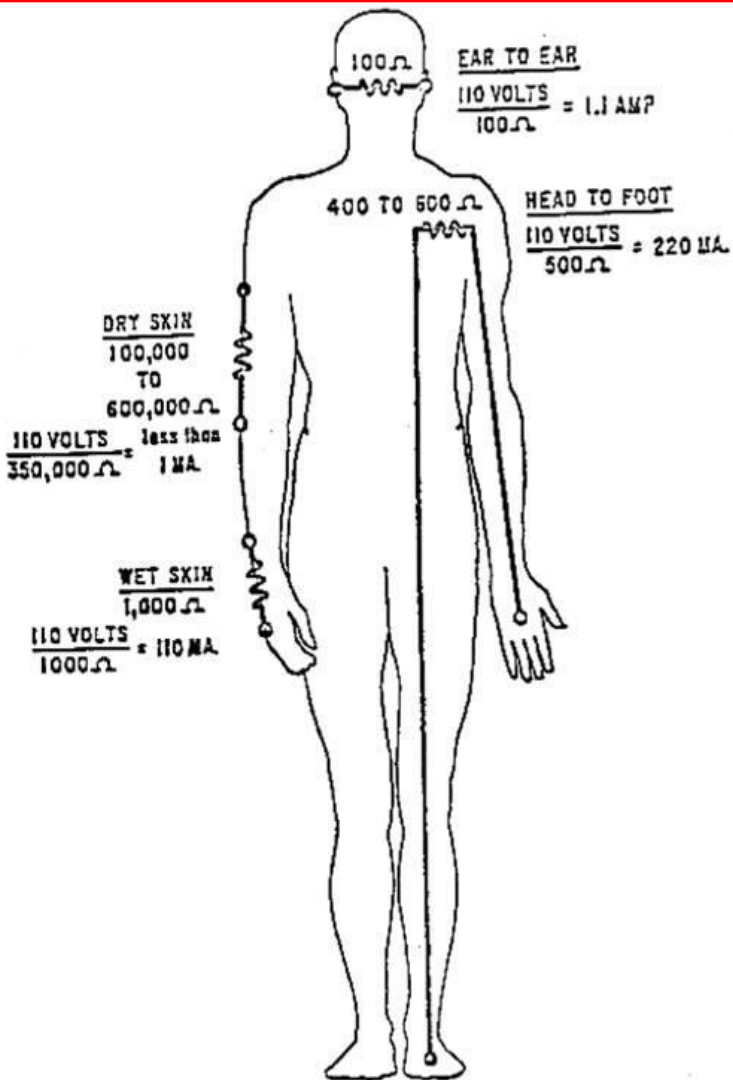


Shocks Occur in Two Ways

- Contact with both conductors
- Contact with one conductor and ground



Using a 120 volt circuit and resistance for wet & dry skin:



Typical Body Resistance and Currents

E=IR: Voltage=Current x Resistance
(Volts) (Amps) (Ohms)

So: **I=E/R**

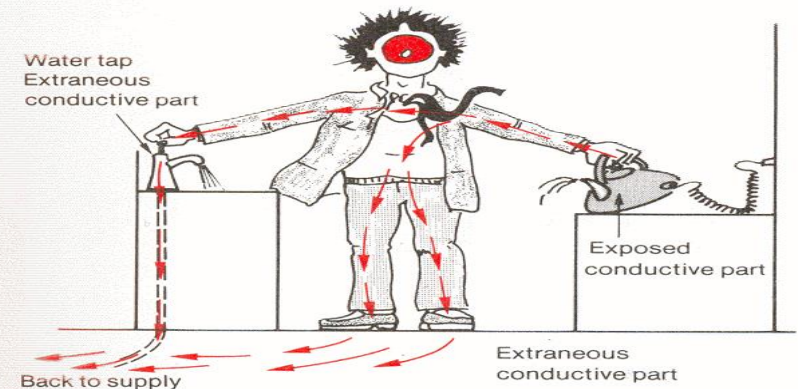
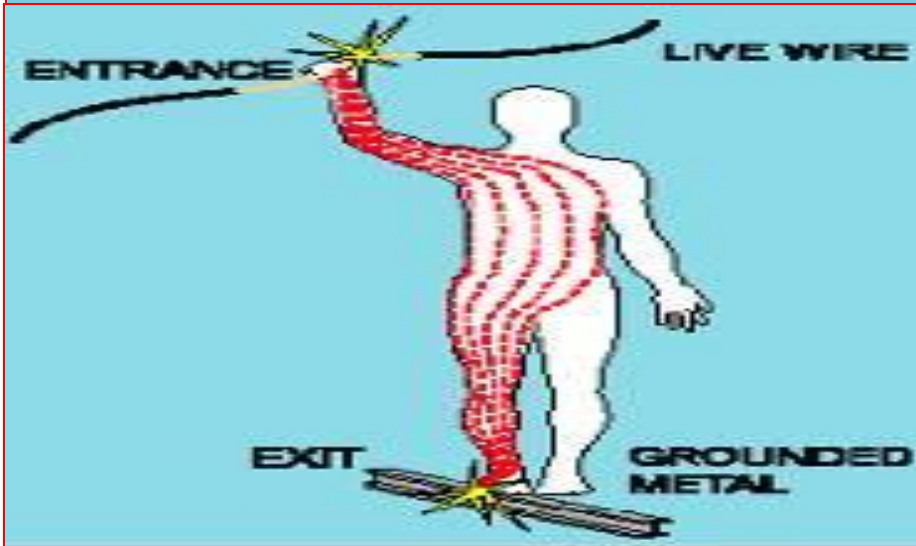
Dry Skin = $120/100,000 = .0012$ amps
= **1.2ma** flowing through
body to ground

Wet skin = $120/1000 = .120$ amps
= **120ma** flowing through
body to ground

Remember: 1 Amp = 1000 milliamps

Severity of the Shock

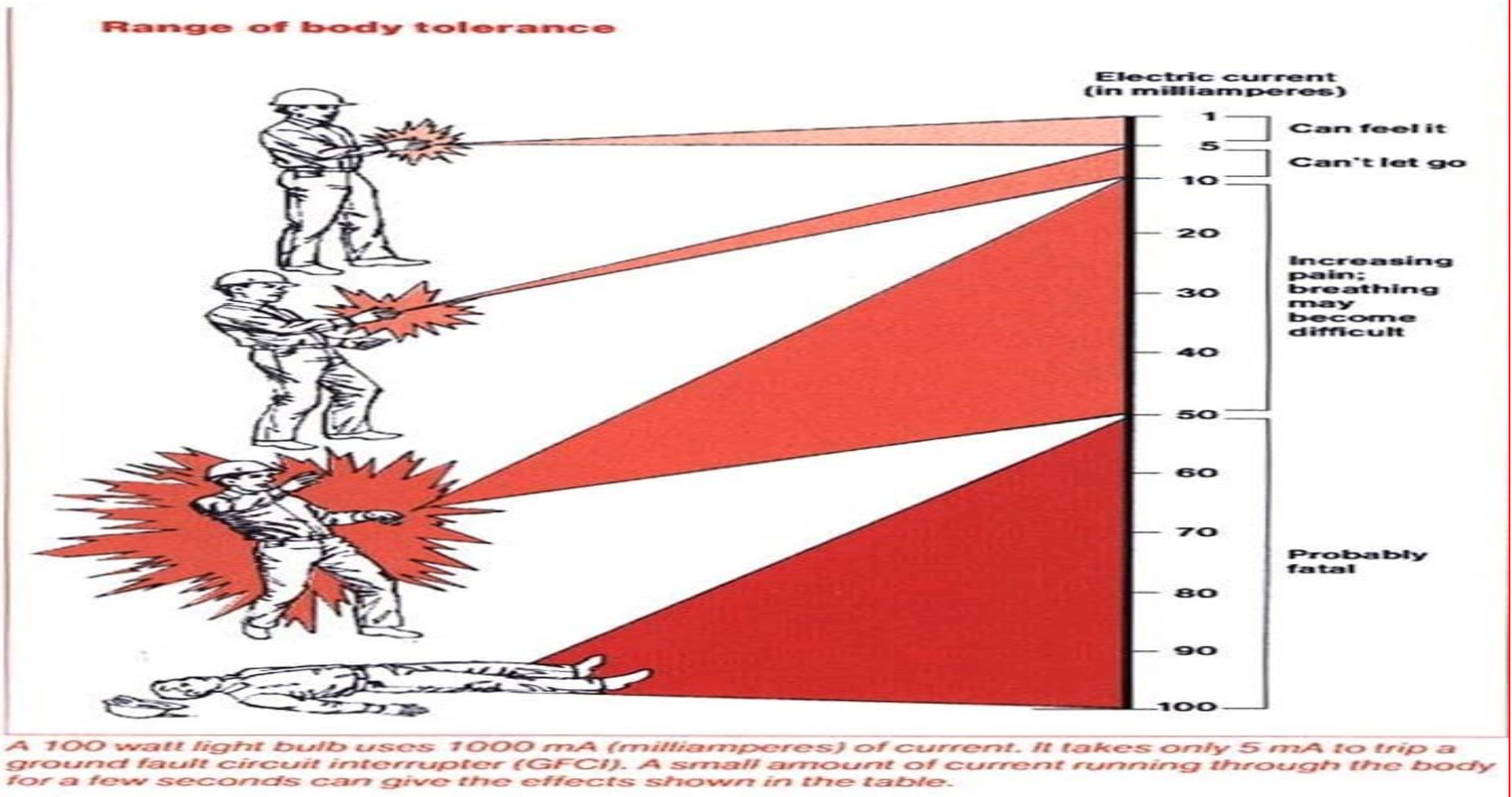
- Severity of the Shock depends on:
 - Amount of current
 - Path through the body
 - Duration of flow through the body



Depend on Electric Shock

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

Current Reaction Chart



Current Reaction Chart

(1,000 milliamperes = 1 amp; therefore, 15,000 milliamperes = 15 amp circuit)

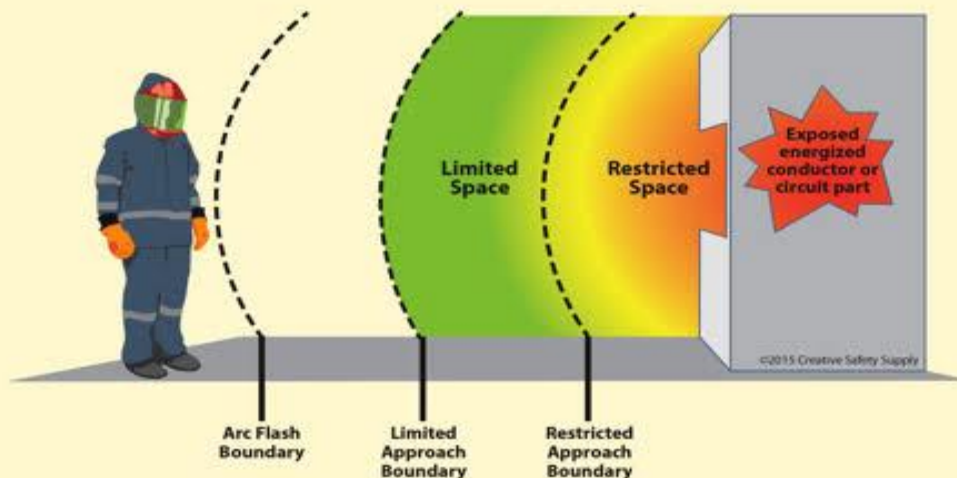
Current	Reaction
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliampere	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries
6-25 milliamperes (women)	Painful shock, loss of muscular control
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

Arc Flash / Arc Blast

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 Light.
- Temperatures as high as 35,000°F



Arc Flash Injuries



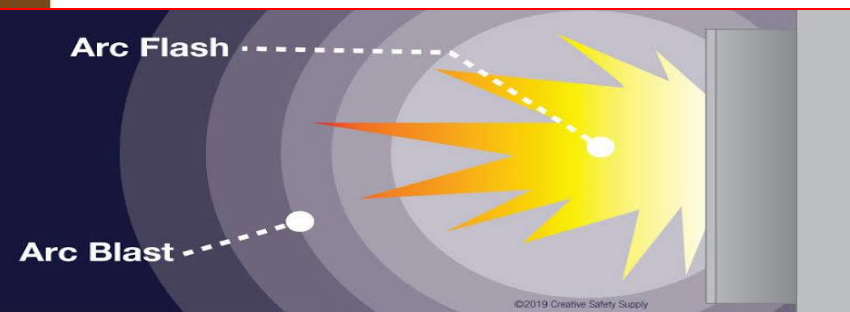
- Electric shock
- Severe burns
- Blindness
- Blast injuries
 - Shrapnel wounds
 - Lung blast injuries
 - Ruptured eardrums
 - Pressure wave injuries



14

Arc Flash Hazards -- Construction Safety Association of Ontario

PB/RH -- March 3, 2009



Arc Blast and Hazard of an Arc Flash/Blast

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

Hazards of an Arc Flash/Blast

- 1. Shrapnel** – Arc Flash/Blasts spray droplets of molten metal at speeds that exceed 700 MPH that can easily penetrate standard Personal Protective Equipment (PPE).
- 2. Extreme Temperatures** – Arcs produce some of the highest temperatures recorded on earth; up to 35,000° F which is three times the temperature of the Sun.
- 3. Sudden Air Expansion** – All known materials are vaporized at this temperature. The rate of expansion is comparable to a pea sized piece of copper expanding to the size of a boxcar. Blast pressure waves have thrown workers across the room.
- 4. Fatal Burns** – Fatal burns can occur even when the worker is several feet away from the arc. Clothing can ignite from 10 feet away unless proper PPE is used.
- 5. Hearing Loss** – An Arc Blast can have a sound magnitude of 140 dB two feet from the arc and can cause permanent hearing loss.

Fire

Fire:

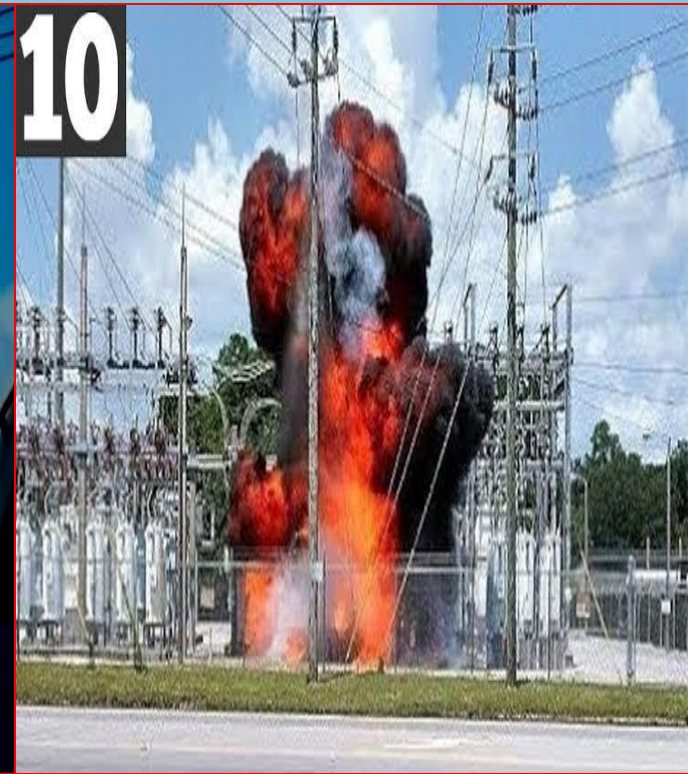
- ▶ Most result from problems with "fixed wiring"
- ▶ Problems with cords, plugs, receptacles, and switches also cause electrical fires



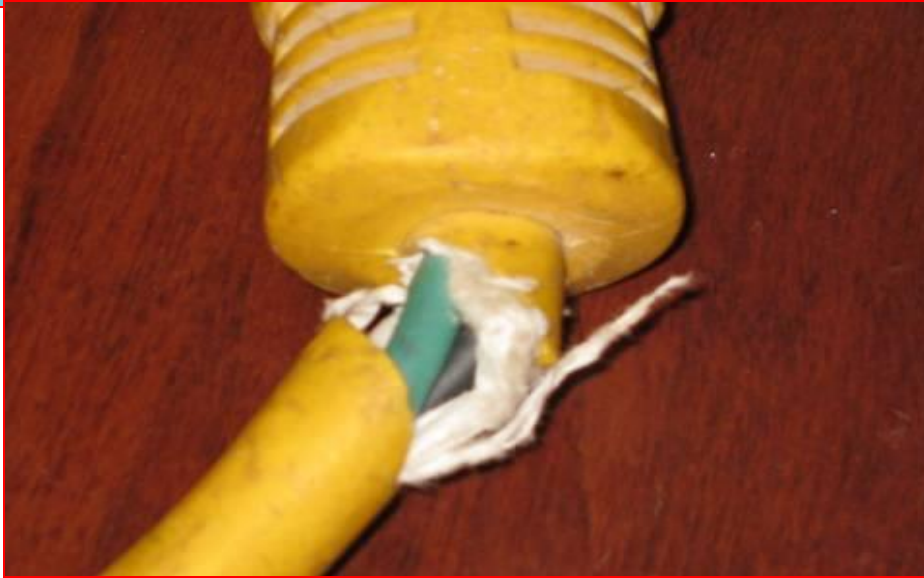
Explosions

Explosions:

- ▶ Occur when electricity ignites explosive mixture of material in the air(যখন বিদ্যুৎ বাতাসে উপাদানের বিস্ফোরক মিশ্রণ জ্বালায় তখন ঘটে)



Defective Extension Cords



Unsafe Behavior



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Electrical Protection Methods

Inspect portable tools and extension cords:

- ▶ Electric hand tools that are old, damaged, or misused may have damaged insulation inside.

Use power tools and equipment as designed:

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

Electrical Protection Methods

Tool safety tips

- ▶ Never carry a tool by the cord.
 - ▶ Keep cords away from heat, oil, and sharp edges.
 - ▶ Disconnect when not in use and when changing accessories such as blades and bits.
- ✗ 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.
 - ✗ Use gloves and appropriate footwear.
 - ✗ Store in dry a place when not using.

Electrical Protection Methods

Employer requirements to protect workers:

- ✖ Ensure overhead power line safety
 - ✖ Isolate electrical parts
 - ✖ Supply ground-fault circuit interrupters (GFCI) protection
 - ✖ Ensure power tools are maintained in a safe condition
 - ✖ Ensure proper guarding
 - ✖ Provide training
 - ✖ Enforce LOTO safety related work practices
 - ✖ Ensure proper use of flexible cords .
 - ✖ Ensure proper identification of power sources
- 

Electrical Protection Methods

Safe Work Practices

Lock out & Tag out
Replace damaged cords or plugs.

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

Manpower/Workers

Qualified electrician, preferably B License holders.
Identification of the electrician –Example (Red Helmet)

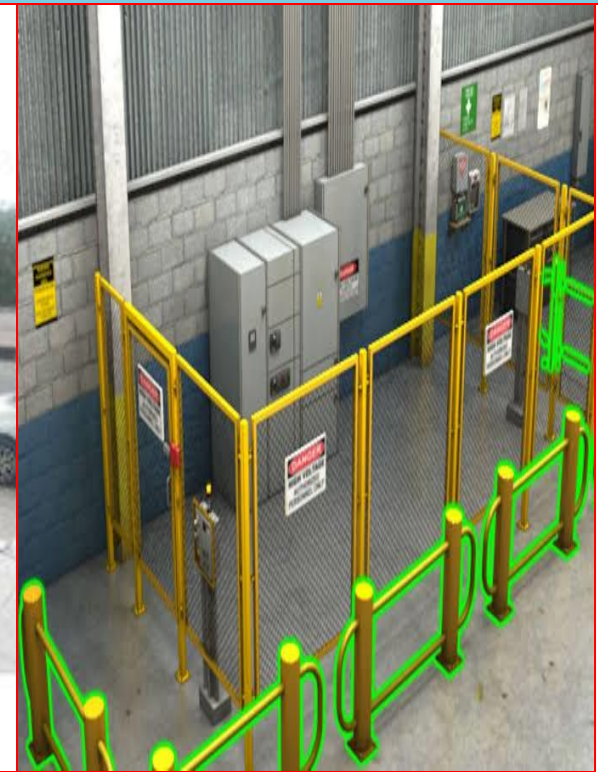
Isolation(Examples)

- ✓Panel boards, generators ,large motors, should be enclosed.
- ✓The switch should be connected in phase only
- ✓The switches should be easy and free to operate.
- ✓Body of the metallic switches should be earthed.
- ✓Every DB should be provided with a on/off switch.



Guarding(Electrical Device)

- ✓Any parts of electrical equipment at 50 volts or more must be Guarded.
- ✓At least eight feet above the floor of the work area.
- ✓Grounding .
- ✓Looking Machines & equipments entry accessible permission only to qualified personnel.



Electrical Protective Devices (Safety Device)

- ✓ Fuses
- ✓ Circuit Breakers / overloaded trippers.
- ✓ ELCB ,GFCI,MCB

Earth-leakage circuit breaker

একটি আর্থ-লিকেজ সার্কিট ব্রেকার (ELCB) হল একটি নিরাপত্তা ডিভাইস যা শক প্রতিরোধ করতে উচ্চ আর্থ ইম্পিডেন্স সহ বৈদ্যুতিক ইনস্টলেশনে ব্যবহৃত হয়

Miniature Circuit Breaker

এটি স্বয়ংক্রিয়ভাবে বৈদ্যুতিক নেটওয়ার্কের যেকোনো অস্বাভাবিক অবস্থা যেমন ওভারলোড এবং শর্ট সার্কিট অবস্থার সময় বৈদ্যুতিক সার্কিট বন্ধ করে দেয়।

ELCB (Earth Leakage Circuit Breaker)



Miniature Circuit Breakers

Types, Working and Trip Curves



Ground-fault circuit interrupters(GFCI)

Use Ground-fault circuit interrupters(GFCI)

- ✓ Designed to protect people from electrical shock.

- ✓ Limits duration of electrical shock.



Ground-fault circuit interrupters(GFCI)

Three types of GFCI:

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



Receptacle GFCI : Often found on contraction work sites, outdoor areas and other locations where damp conditions do or could exist.

Temporary or portable GFCIs : Temporary or portable GFCIs are frequently used in construction and in outdoor settings with electric tools, mowers, trimmers, and similar devices.

Circuit Breaker GFCI : If a person's body starts to receive a shock, the GFCI senses this and cuts off the power before he/she can get injured.

Maintain safe distance from overhead power lines

Contact with overhead power lines:

- ❖ Overhead power lines carry extremely high voltage .
- ❖ Risks: Electrocution
Burns and falls



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

Summary – Hazards & Protections

Hazards

- Unsafe 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 power lines
- All hazards are made worse in wet conditions
- Damaged extension cords
- Unqualified workers doing electrical work

Protective Measures

- ◆ Proper grounding
- ◆ Use GFCI's
- ◆ Use fuses and circuit breakers
- ◆ Guard live parts
- ◆ Lockout/Tagout
- ◆ Proper use of flexible cords
- ◆ Close electrical panels by Competent Person
- ◆ Employee training
- ◆ Ensure Competent Person on site
- ◆ Use proper approved electrical equipment
- ◆ Qualified person install electrical devices

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

AEGCP=Assured Equipment Grounding Conductor Program
GFCI=Ground -fault circuit interrupters

Electrical Tools



Gloves: Used to protect and comfort hands against cold or heat, damage by friction, abrasion or chemicals and disease.



Wire /cable lugs: Used for connecting cables to electrical appliances, other cables, surfaces, or Mechanisms.



Line tester : Used to test the presence of current and to identify phase/live wire in electrical installations.



Conduit Bender: Used to bend electrical pipes for installation.



Coax Connector : Used for connecting cables to electrical appliances, other cables, surface, or mechanisms.



Voltage tester: Used primarily on AC currents. although some can also be used on DC currents.

Electrical Tools



Wire strippers: Used for removing the protective coating of an electric wire in order to replace or repair the wire.



Solder capillary lead -free wire : used to produce perfect joints quickly and effectively.



Stubby screwdriver : Used to facilitate access to screws located in areas that cannot be reached easily by a regular screwdriver.



Pliers : Used for gripping



Crimpers : Used to make cold weld joints between wires and a connector by deforming one or both of them to hold the others.



Electric drill: Used for drilling circular holes in the materials.

Electrical Tools (Safety)



Flashlights: Used to provide a source of light at a time of night.



Rescue Rod / Hook: Used to remove persons incapacitated by electrical shock from the danger area.



Cable ties: Used for holding items together, most commonly electrical cables or wires.



Electrical Tape: Used to cover and insulate a broad range of cables, wires, and other materials that conduct electricity.



Fishing rods: Used to install wires above ceilings, in attics, through walls etc.



Hacksaw : Used for cutting thin metal such as aluminum, brass, steel or copper.

Electrical Tools



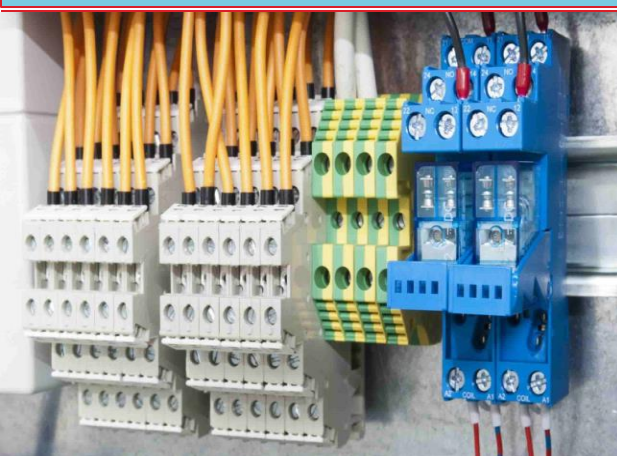
Tape measure : Used to measure distance or size.



Heat Shields/Pads: Used to protect objects from overheating.



Level : Used to determine whether a surface is horizontal (level) or vertical (Plumb)



Terminal block: Used to secure and /or terminate wires.



Goggles : Eye Protection

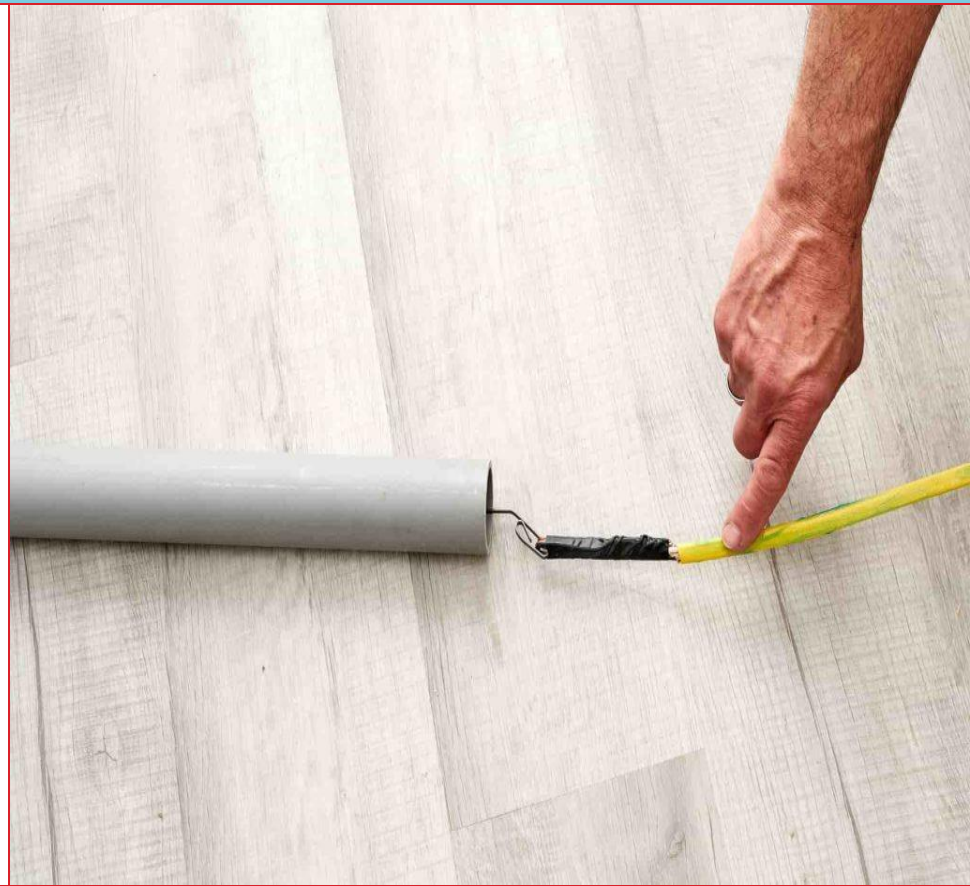


Flux Brush : Used for connections that are joined together by soldering.

Electrical Tools



Super fire Torch: Used for soldering and brazing .



Fish Tape: Used for pulling electrical or other wires through conduits .

GENERAL SAFETY RULES FOR ALL POWER TOOLS

- KEEP WORK AREAS CLEAN.
- Cluttered benches invite accidents.
- AVOID DANGEROUS ENVIRONMENTS.
- GUARD AGAINST ELECTRIC SHOCK. Prevent body contact with grounded surfaces.
- AVOID ACCIDENTAL STARTING. Don't carry plugged in tool with finger on switch.

Hand Tools general safety rules.

Do not use a power hand tool while wearing wet cotton gloves or wet leather gloves. Never operate electrical equipment barefooted. Wear rubber-soled or insulated work boots. Do not operate a power hand tool or portable appliance that has a frayed, worn, cut, improperly spliced, or damaged power cord

PPE

Basic *PPE* consists of:

- Cotton protective clothing with long sleeves
- Helmet or hard hat
- Goggles for eye protection
- Gloves (leather or rubber)
- Hearing protectors
- Safety footwear

Protective equipment for arc flash, as shown in Figure 3 consists of:

- Flame resistant protective clothing
- Arc Flash protection hood
- Helmet
- Safety glasses
- Gloves



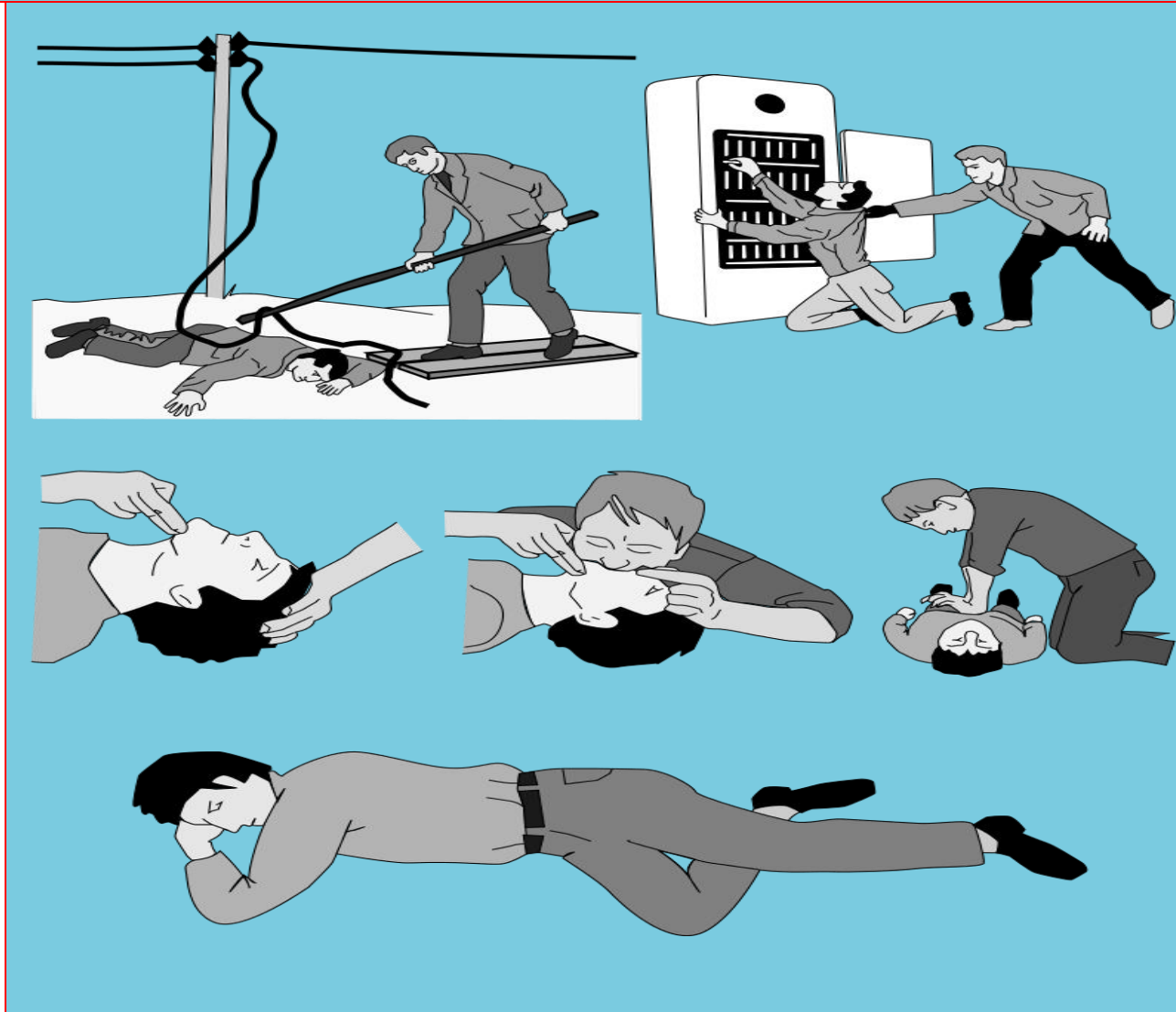
First Aid for Electric Shock Victims

- Don't touch them!
- Unplug the appliance or turn off the power at the control panel.
- If you can't turn off the power, use a piece of wood, like a broom handle, dry rope or dry clothing, to separate the victim from the power source
- Do not try to move a victim touching a high voltage wire. Call for emergency help.
- Keep the victim lying down. Unconscious victims should be placed on their side to allow drainage of fluids. Do not move the victim if there is a suspicion of neck or spine injuries unless absolutely necessary.
- If the victim is not breathing, apply mouth-to-mouth resuscitation. If the victim has no pulse, begin cardiopulmonary resuscitation (CPR). Then cover the victim with a blanket to maintain body heat, keep the victim's head low and get medical attention.

Then, check for breathing as follows:

1. **LOOK** for the rise and fall of the chest.
2. **LISTEN** for the sounds of breathing.
3. **FEEL** for air on your cheek
4. Carry this out for up to 10 seconds

First Aid for Electric Shock Victims



First Aid for Electric Shock Victims

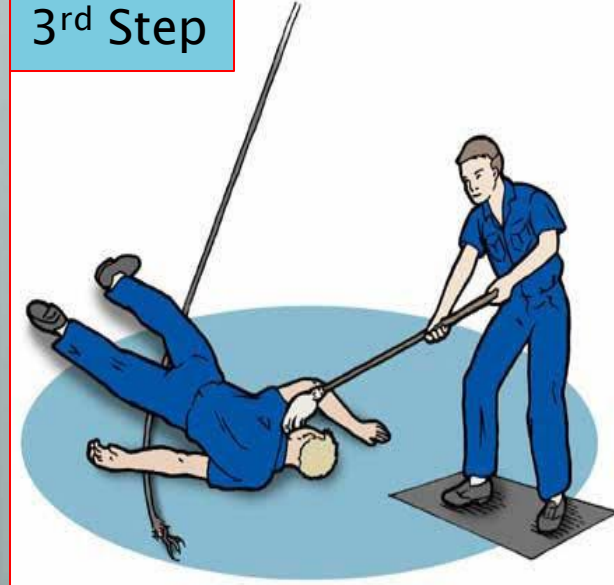
1st step



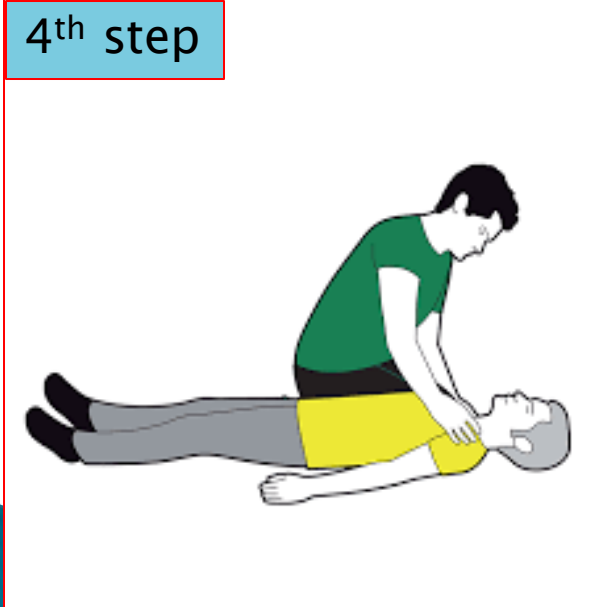
2nd step



3rd Step



4th step



5th Step



6th Step



First Aid for Electric Shock Victims

7th Step



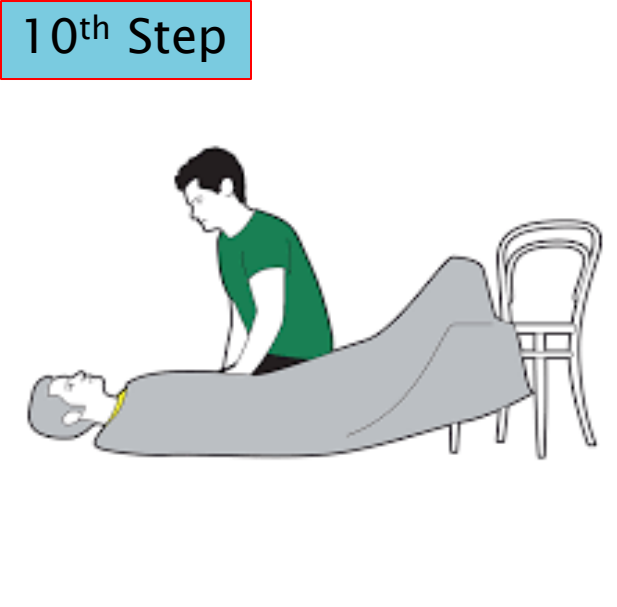
8th Step



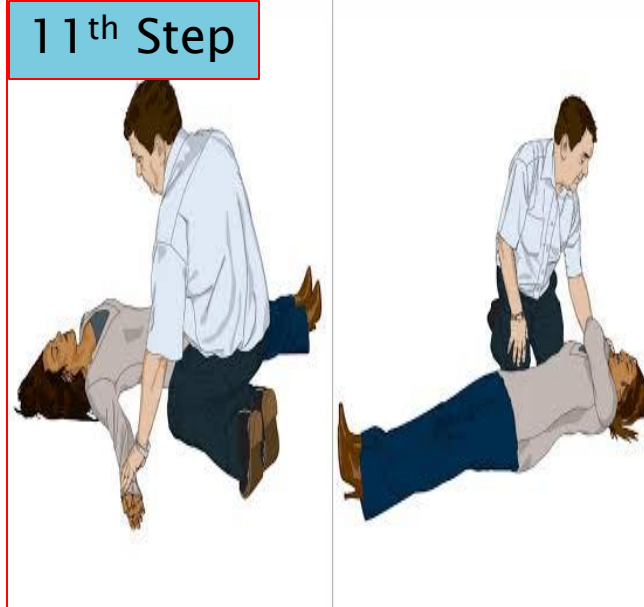
9th Step



10th Step



11th Step



First Aid for Electric Shock Victims

12th Step



13th Step



14th Step



15th Step



Uses of Fire Extinguisher

Symbols found on
fire extinguishers
& what they mean

						
		Water	Foam spray	ABC powder	Carbon dioxide	Wet chemical
Wood, paper & textiles		✓	✓	✓	✗	✓
Flammable liquids		✗	✓	✓	✓	✗
Flammable gases		✗	✗	✓	✗	✗
Electrical contact		✗	✗	✓	✓	✗
Cooking oils & fats		✗	✗	✗	✗	✓

Extinguishing Method

Fire Extinguishers

Extinguishing Method

**P
A
S
S**

Pull the Safety Pin

**Aim the Nozzle to the
Fire**

**Squeeze the Handle
Discharge**

**Sweep side to side of
Fire**

Remember

- **Safe Distance between you & the fire Flames is 6-8 feet**

Workplace Fire Safety Tips & Fire Orders

Workplace Fire Safety Tips



Identify the fire hazards

Identify the people at risk

Evaluate and reduce hazards

Set up an emergency plan
and conduct training

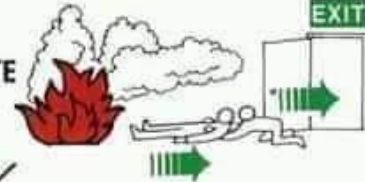
Review risk assessments



FRONTLINE
DATA SOLUTIONS

STANDARD FIRE ORDERS

1 RESCUE ANY PERSON IN IMMEDIATE DANGER ONLY IF SAFE TO DO SO



2 CLOSE THE DOOR



3 CALL THE FIRE AND RESCUE SERVICE



4 ATTACK FIRE IF SAFE TO DO SO



5 EVACUATE TO ASSEMBLY POINT



6 REMAIN AT ASSEMBLY POINT AND ENSURE EVERYBODY IS ACCOUNTED FOR



Knowledge Check

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

Arc flash/arc blast can reach maximum temperatures up to 350 °F?

- a. True
- b. False

Answer: b. False - temperatures can reach up to 3,500 °F

Knowledge Check

What does GFCI stand for?

- a. Ground Flexible Conduit Insulator
- b. Ground Flow Current Interceptor
- c. Ground Fault Circuit Interrupter
- d. Ground Floor Connection Interjector

Answer: c. Ground Fault Circuit Interrupter



Knowledge Check

Which of the following is a safe practice?

- a. Carrying 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



