ELECTRICAL HAZARDS

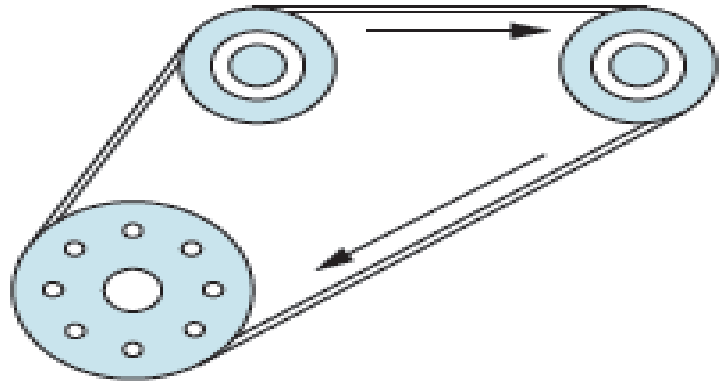
Dindo M. Latonio

TOPIC1: BASIC ELECTRICITY

FORMS OF ELECTRICITY

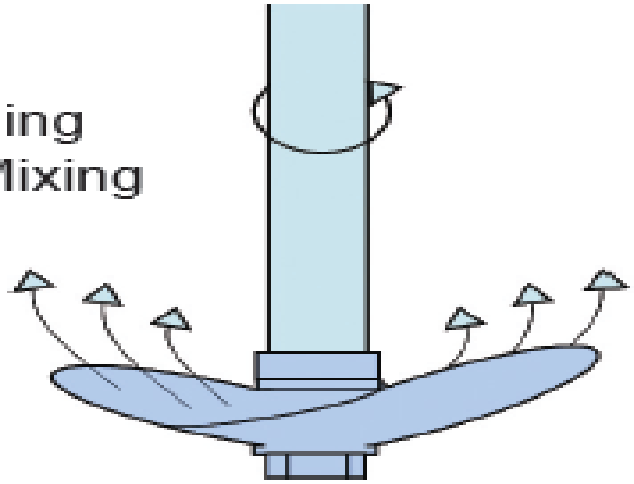
- Static Electricity
  - is an imbalance of electric charges within or on the surface of a material. The charge remains until it is able to move away by means of an electrical discharge.

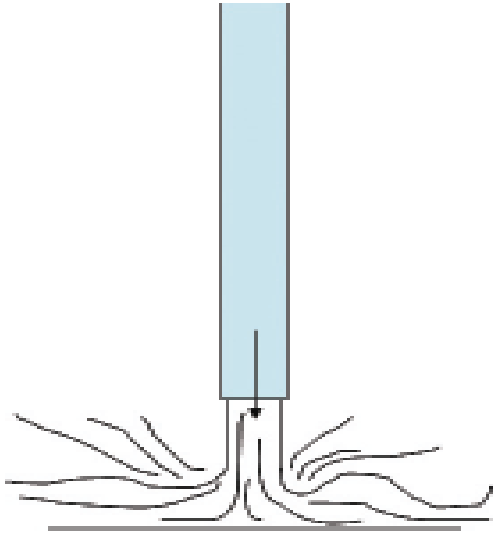
SOURCES OF STATIC ELECTRICITY



Belts

Blending
and Mixing





Splash Filling

FORMS OF ELECTRICITY

- Dynamic or Current Electricity
  - Dynamic electricity is the flow of electric charges through a conductor; in other words, an electric current.

TYPES OF ELECTRIC SYSTEM

- Direct Current (DC)
  - is the unidirectional flow of electric charges
  - characterized by two distinctive polarities, positive (+) and negative (-)

COMMON DC SOURCES

Secodary Cell
(Rechargeable)

Primary Cell
(Not Rechargeable)

Photovoltaic Cells

Rectifier
(Device that converts AC to DC)

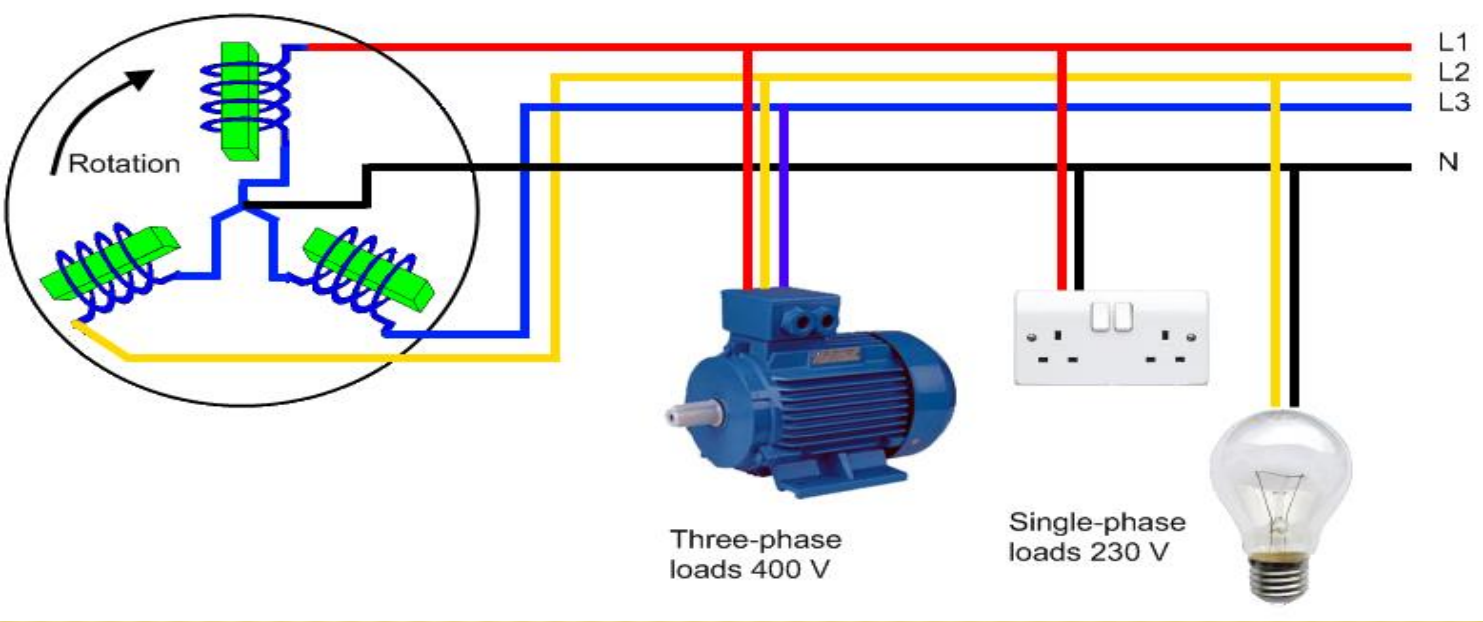
DC Generator (Dynamo)

TYPES OF ELECTRIC SYSTEM

- Alternating Current (AC)
  - The flow of electric charge periodically reverses direction
  - Affected by frequency of alternation (50 Hz in Oman)
  - Polarity is not fixed to positive or negative
  - Can be single phase
    - Red wire for line
    - Black wire for neutral
    - Yellow/green wire for earth

ALTERNATING CURRENT (AC)

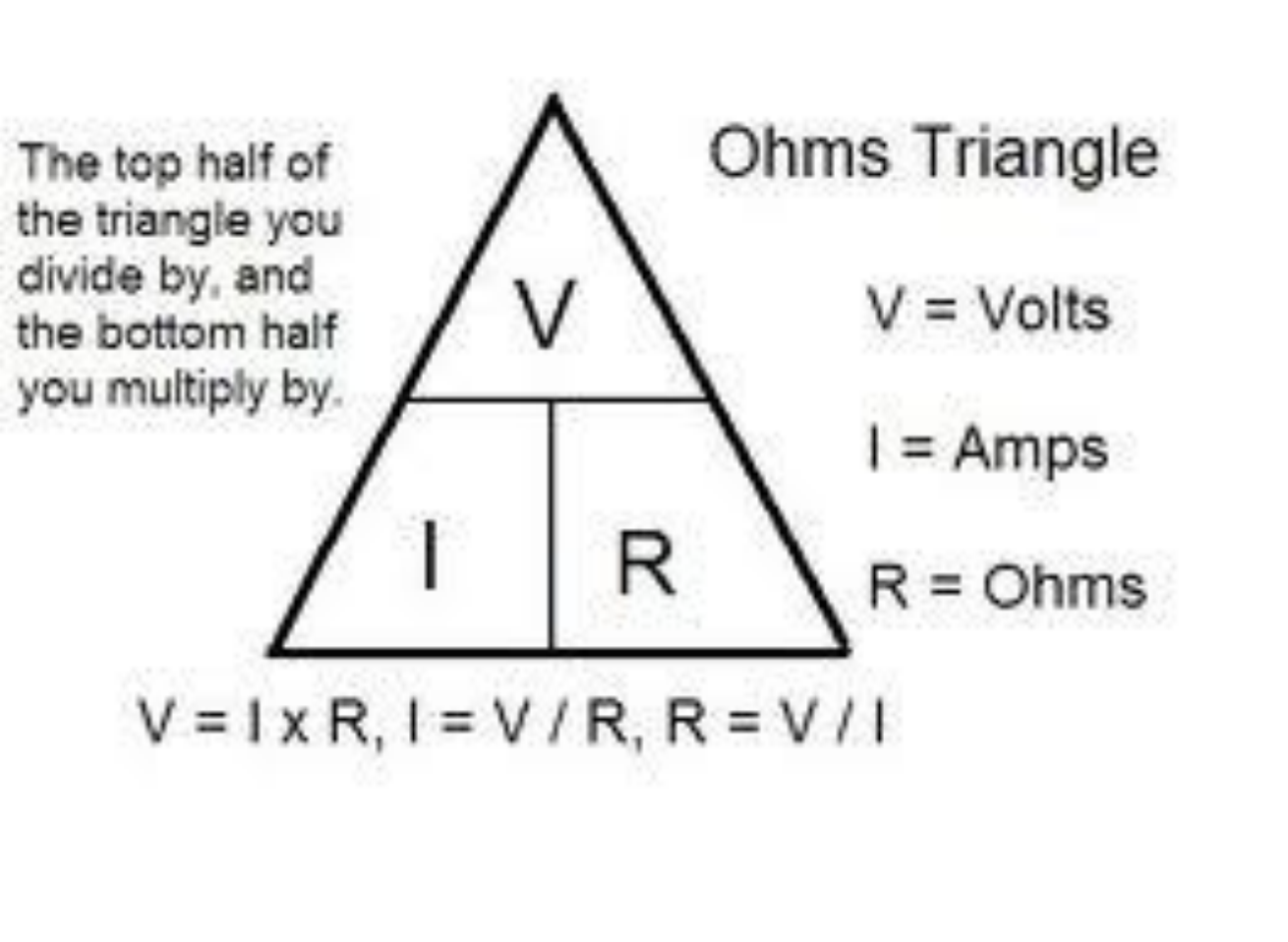
- Can be three phase
  - Red, Yellow, Blue wire for line
  - Black wire for neutral
  - Yellow/green wire for earth



VOLTAGE, CURRENT, RESISTANCE

- Voltage
  - force that causes the electron to move
- Current
  - change of charge with time.
  - quantity of change that moves along a conductive path
- Resistance
  - opposition to current

RELATIONSHIP



TYPES OF MATERIALS

- Conductor
  - material which permits the flow of electric charges in one or more directions
  - Wires, common metals such as copper, iron, steel, aluminum
- Insulator
  - Material that does not allow electricity to flow
  - In some cases it allow electricity
  - Rubber, paper, wood
- Semi-conductor
  - Material whose electrical conductivity falls between conductor and insulator

TOPIC 2: ELECTRICAL HAZARDS

HAZARD

- Event or situation with potential harm in terms of injury, damage to property, damage to workplace environment or combination of these

ELECTRICAL HAZARD

- An electrical hazard can be defined as a serious workplace hazard that exposes workers to electrical injuries

ELECTRICAL INJURIES

- Direct:
  - Electrocution or death due to electrical shock
  - Electrical shock
  - Burns
- Indirect:
  - Falls
  - Fire

COMMON ELECTRICAL HAZARDS

- Improper Grounding
- Exposed Electrical Parts
- Inadequate Wiring
- Damaged Insulation
- Overloaded Circuits
- Damaged Tools & Equipment
- Wet Conditions

ELECTRICAL HAZARD

- In recognizing, avoiding and protecting against electrical hazards keep in mind – safety.

B = BURNS

- A burn is the most common shock-related injury. Burns from electricity are one of three types:
  - Electrical
  - Arc/Flash
  - Thermal Contact

E = ELECTROCUTION

- Electrocution results when a human is exposed to a lethal amount of electrical energy.

S = SHOCK

- Shock results when the body becomes part of the electrical circuit;
- Electrical shock is defined as a reflex response to the passage of electric current through the body.

A = ARC FLASH/BLAST

- An arc flash is the sudden release of electrical energy through the air when a high-voltage gap exists and there is a breakdown between conductors.

F = FIRE

- Most electrical fires result from problems with faulty electrical outlets, old wiring, problems with cords (such as extension and appliance cords), plugs, receptacles, and switches

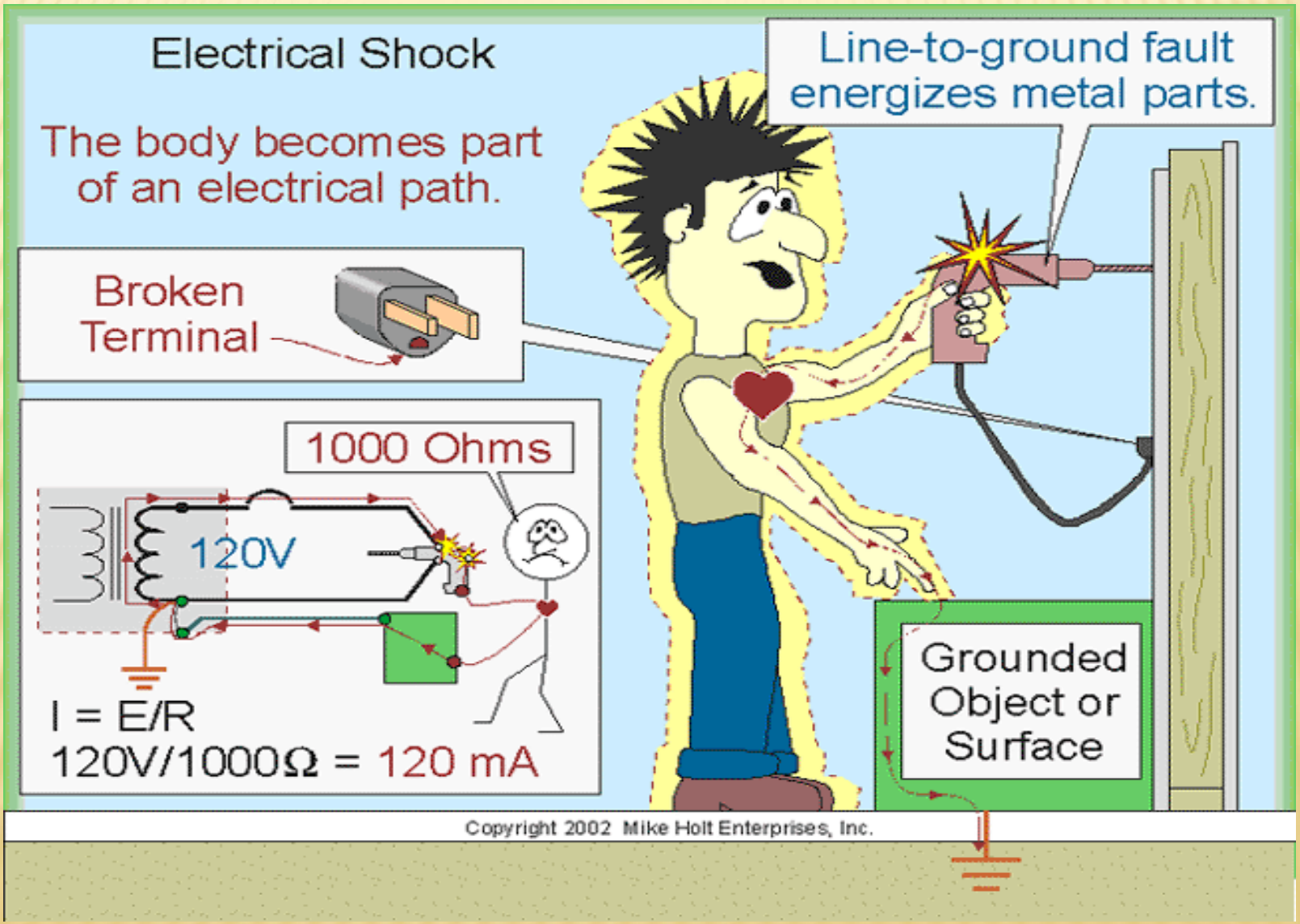
E = EXPLOSION

- An explosion can occur when electricity ignites an explosive mixture of material in the air.

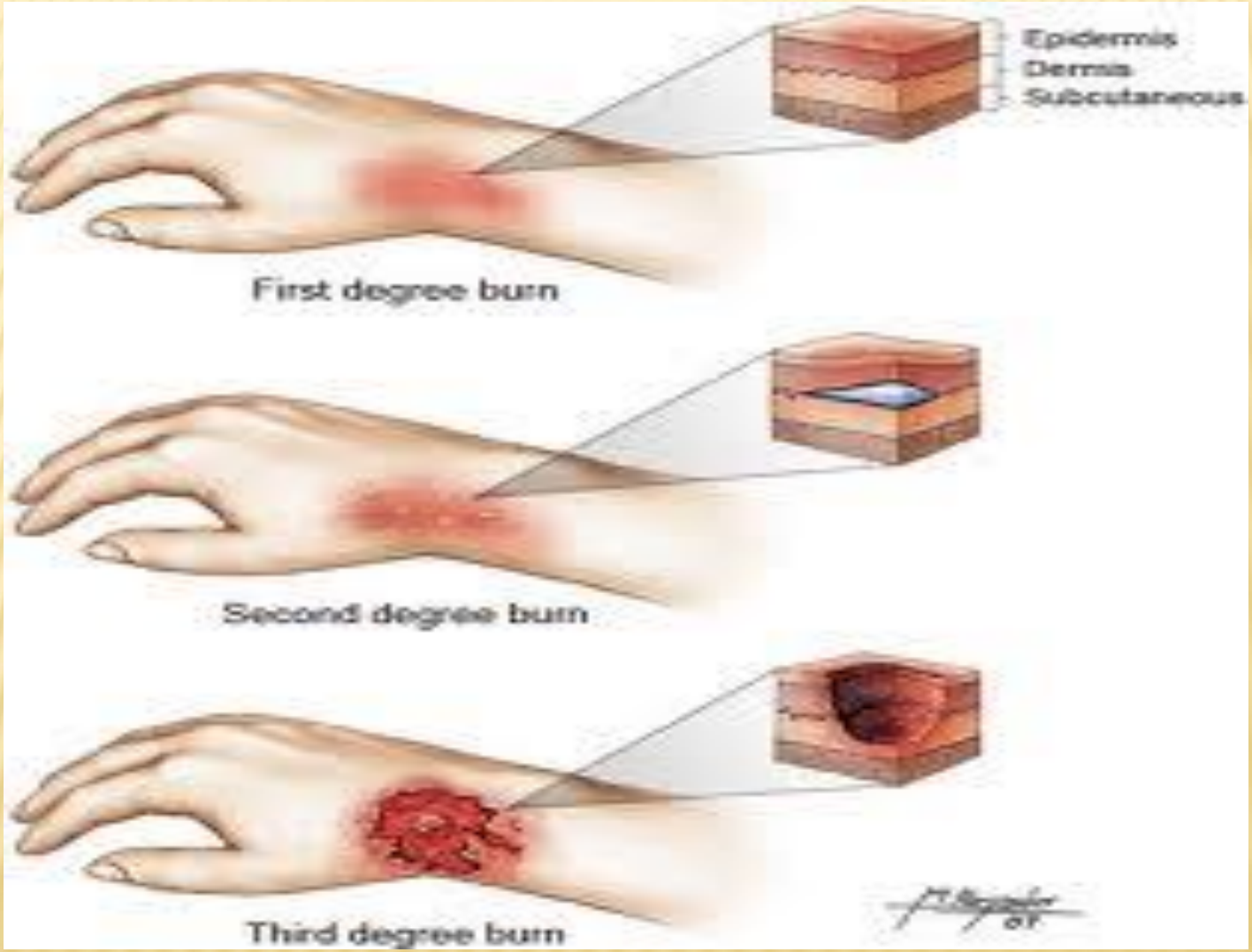
CONTACT WITH ENERGIZED SOURCES

- The major hazards regarding contact with energized sources are electrical shock and burns.

ELECTRICAL SHOCK



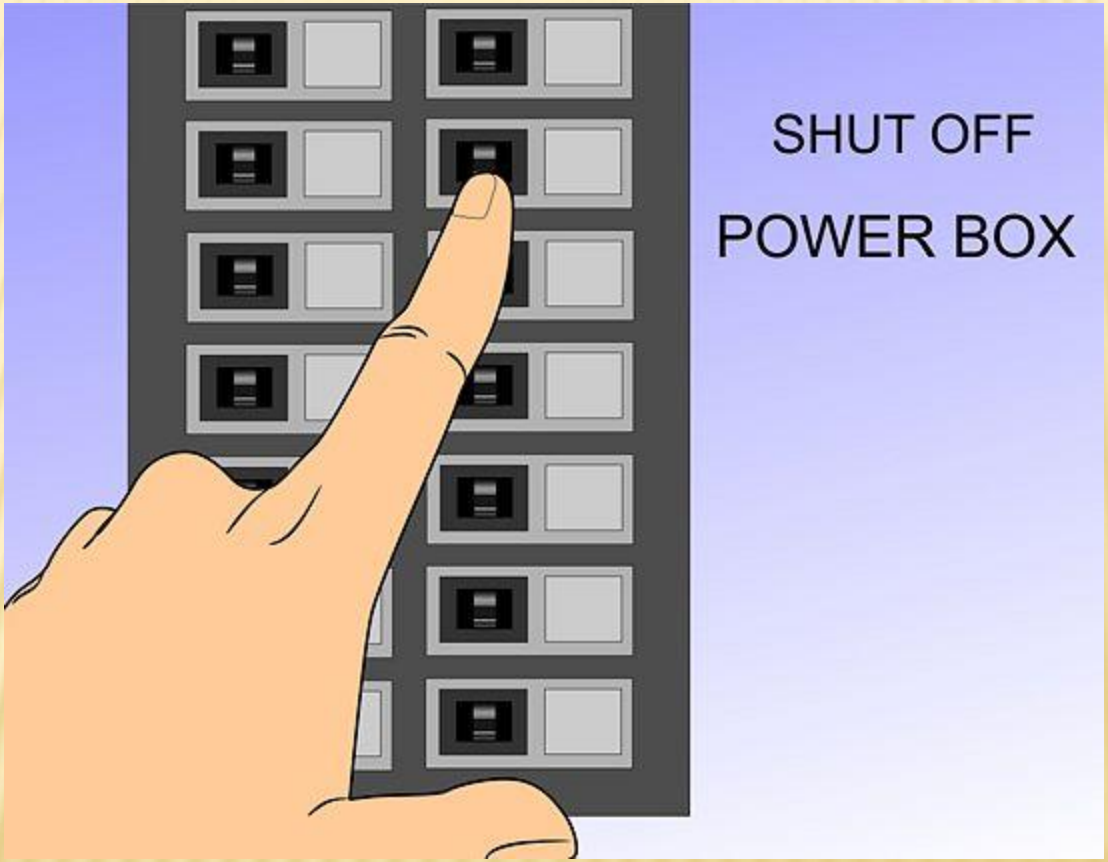
BURN


Epidermis
Dermis
Subcutaneous
First degree burn
Second degree burn
Third degree burn

WHAT TO DO?

- Do not go near to the casualty until the electricity is proven off

- Break the current



- Call for emergency assistance

- If the victim is unconscious, check to see if they are breathing and have a pulse

- Check

  A – Airway (Is it open?)

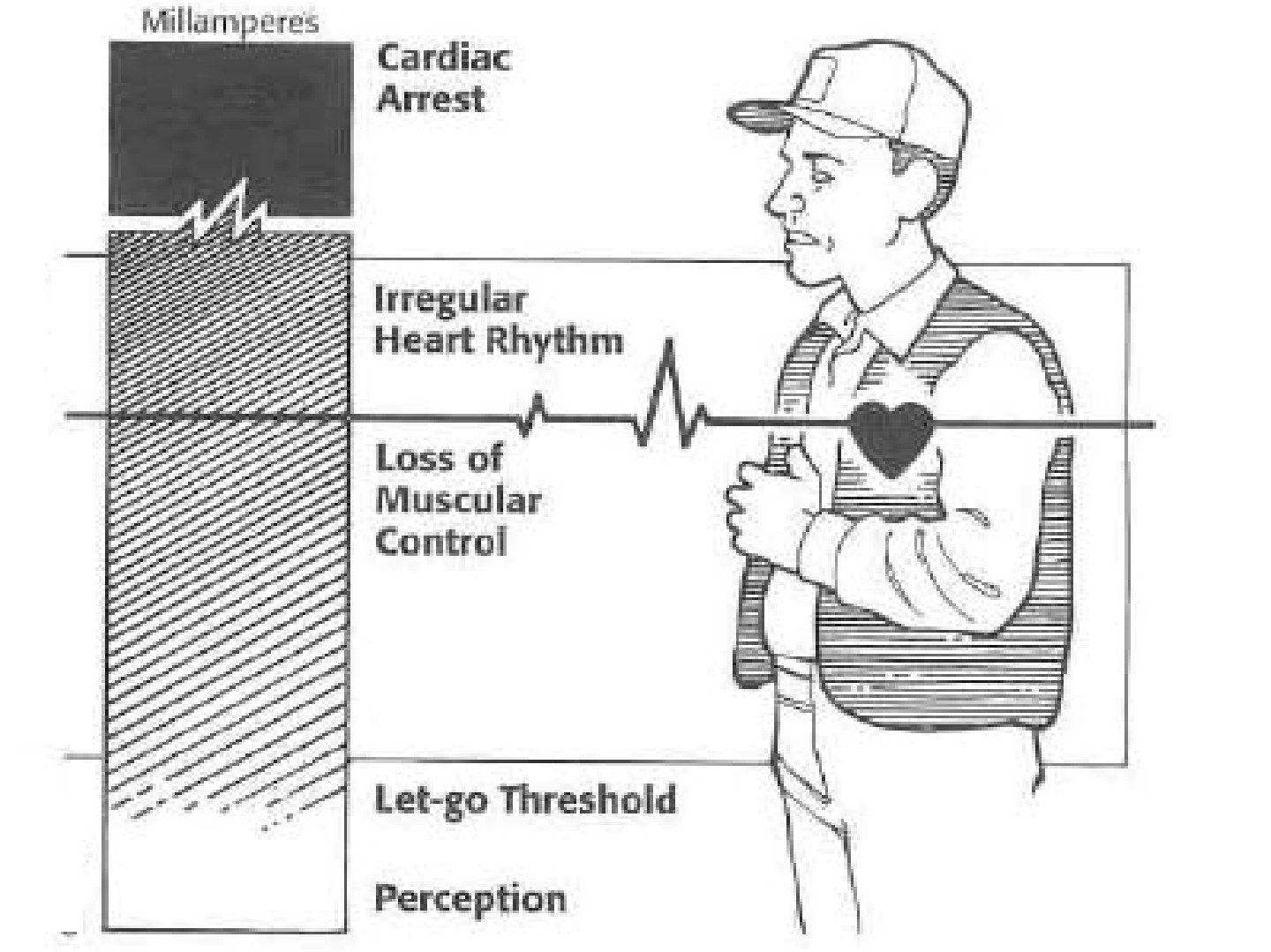
  B – Breathing (Is the casualty breathing normally?)

  C – Circulation (Does the casualty have normal pulse?)

- Do not attempt to move the victim unless they are in further danger.

- Stay with them until help arrives

PHYSIOLOGICAL EFFECTS OF ELECTRICITY



PHYSIOLOGICAL EFFECTS OF ELECTRICITY

(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.

PHYSIOLOGICAL EFFECTS OF ELECTRICITY

Current	Reaction
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 mlliamperes	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.

PHYSIOLOGICAL EFFECTS OF ELECTRICITY

Current	Reaction
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

FACTORS INFLUENCING SEVERITY

- The severity of electric shock or the amount of current which flows on the body depends on
  - Frequency of supply
  - Level of voltage
  - State of the point of contact with the body
  - Duration of exposure
  - Resistance of the body

FREQUENCY OF SUPPLY

- The frequency of supply here in Oman is 50Hz. This frequency is close to that of heart when functioning properly. It can have an effect of disrupting the operation of the heart causing it to beat in a disagreeing manner, to fibrillate

LEVEL OF VOLTAGE

- It is the driving force behind the flow of electricity.
- According to ohm's law: I = V/R

Current is proportional to the voltage

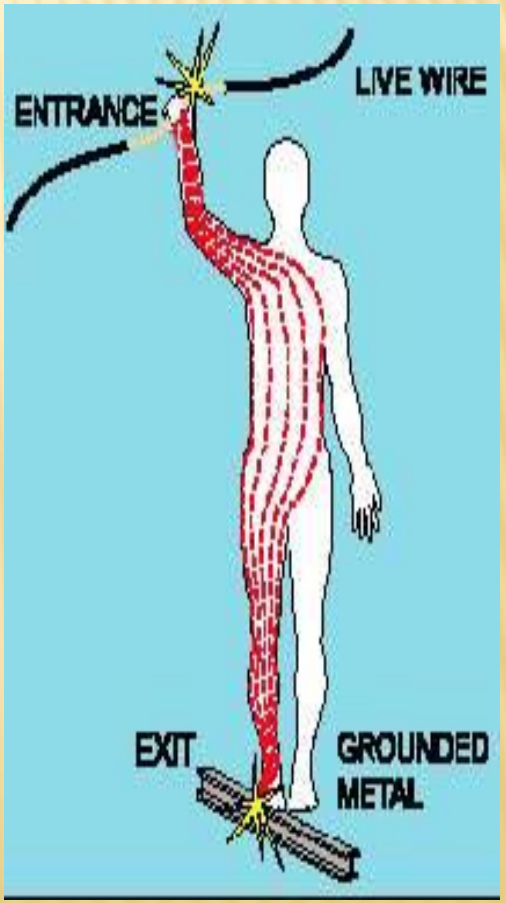
LOW VOLTAGE DOES NOT MEAN LOW HAZARD

DANGERS IN LOW VOLTAGE SYSTEM

- Secondary shock hazards
- Arc in a low-voltage system has the same potential for igniting explosive materials
- Short circuit

CURRENT PATH

- From one finger to another finger the effect will be concentrated between two points
- From one hand to another hand, current will pass through the heart
- From left hand to right foot, current will pass through vital organs



DURATION OF EXPOSURE

- For an electric shock to have an effect a person needs to be in contact with the circuit for sufficient time. The longer the person is in contact with the current the more harm it may cause

RESISTANCE

- A rough value for the resistance of the human body is 300-1,000 Ohms. Naturally, the resistance also depends on the path that electricity takes through the body - if the electricity goes in the left hand and out the right foot, then the resistance will be much higher than if it goes in and out of adjacent fingers.
- Other factors affecting resistance are
  - Body's chemical make – up
  - Dryness
  - Thickness of skin
  - Clothing being worn such as shoes and gloves

HAZARD OF STATIC ELECTRICITY

- The main hazard of static electricity is the creation of sparks in an explosive or flammable atmosphere. These sparks can set off an explosion or fire. The danger is greatest when flammable liquids are being poured or transferred.

HAZARD OF STATIC ELECTRICITY

- For static electricity to be a hazard, four conditions must be met:
  - There must be a means for a static charge to develop.
  - Enough energy must build up to cause ignition.
  - There must be a discharge of this energy (a spark).
  - The spark must occur in an ignitable vapour or dust mixture.

HOW TO IDENTIFY WORKPLACE HAZARDS

- Create a hazard scenario
  - Where it is happening (environment),
  - Who is affected or what it is happening (exposure),
  - What causes the hazard (trigger),
  - The outcome that would occur should it happen (consequence), and
  - Any other contributing factors.

HOW TO IDENTIFY WORKPLACE HAZARDS

- Staff in the workplace should provide answer to the following questions
  - What can go wrong?
  - What are the consequences?
  - How could it arise?
  - What are other contributing factors?
  - How likely is it that the hazard will occur?

HOW TO IDENTIFY WORKPLACE HAZARDS

- Document the answer to these questions

Job Location:	Analyst:	Date:
Task Description:		
Hazard Description:		
Hazard Controls:		

SCENARIO

- In the Physics laboratory, while performing an experiment on the resistance of wire, two alligator clips came in contact with each other. It shorted out the terminals and burned out the power supply

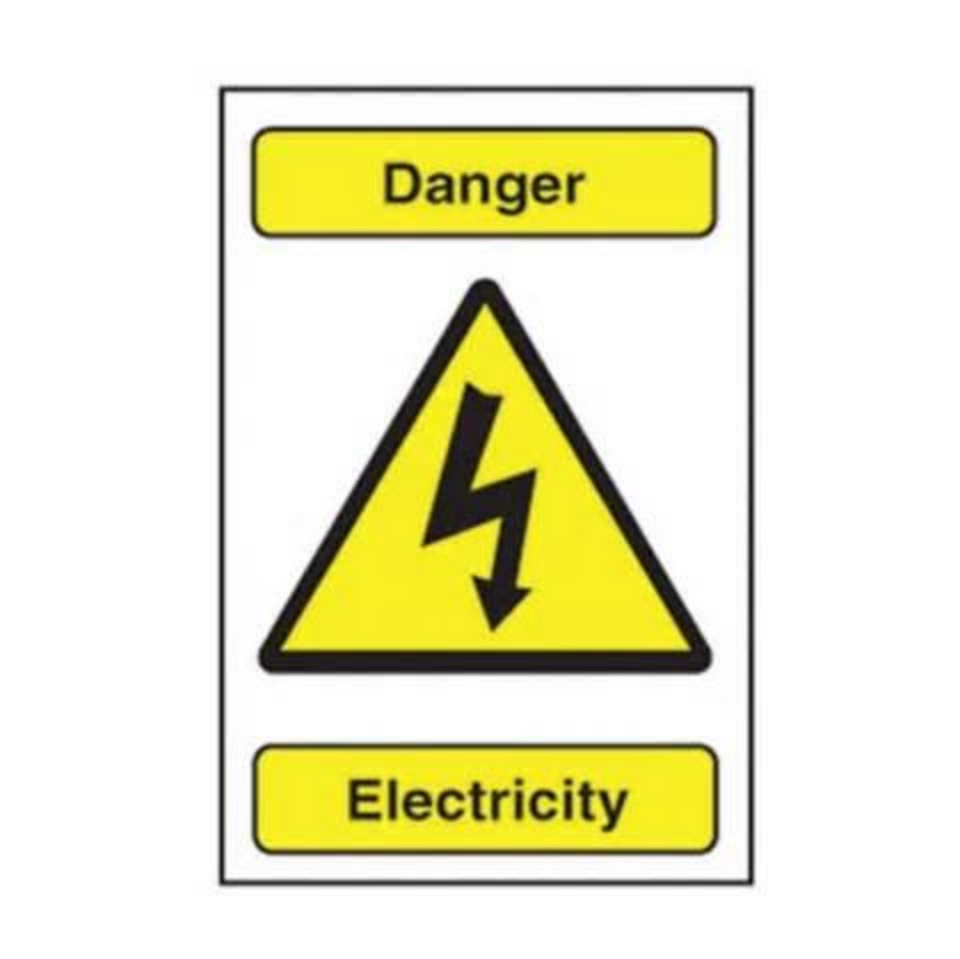
ANALYSIS

- What can go wrong?
  - The clips were not properly inserted and causes it to be thrown to the other terminal
- What are the consequences?
  - Short circuit that damage the power supply and cause the circuit breaker to trip
- How could it arise?
  - The student or staff did not practice caution while connecting the clips.

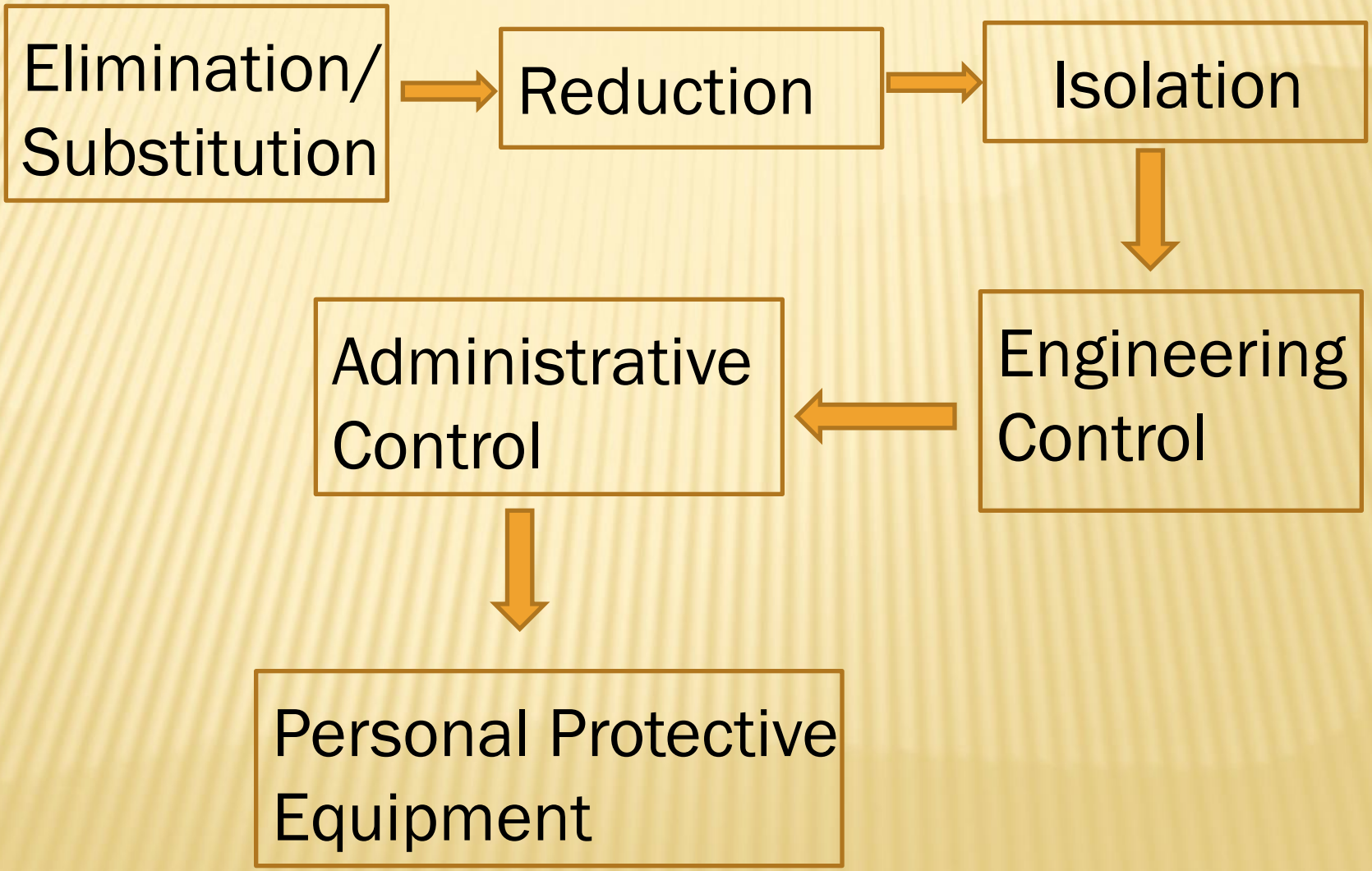
ANALYSIS

- What are other contributing factors?
  - The accident happened very quickly and the staff have no enough time to recover or prevent when the alligator clip slips away. The experience has shown that the staff needs an effective training to effectively control hazard
- How likely will the hazard occur?
  - If there have been near misses or actual cases, then the likelihood of recurrence would be high

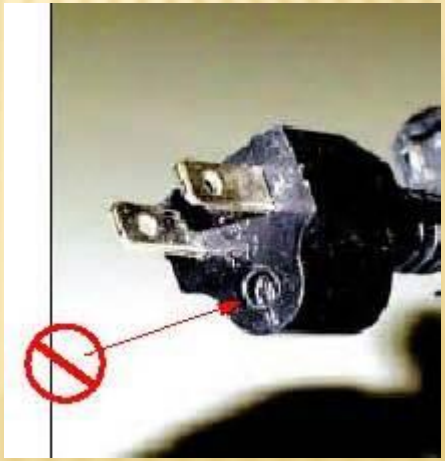
TOPIC 3: CONTROL MEASURES



HIERARCHY OF CONTROL



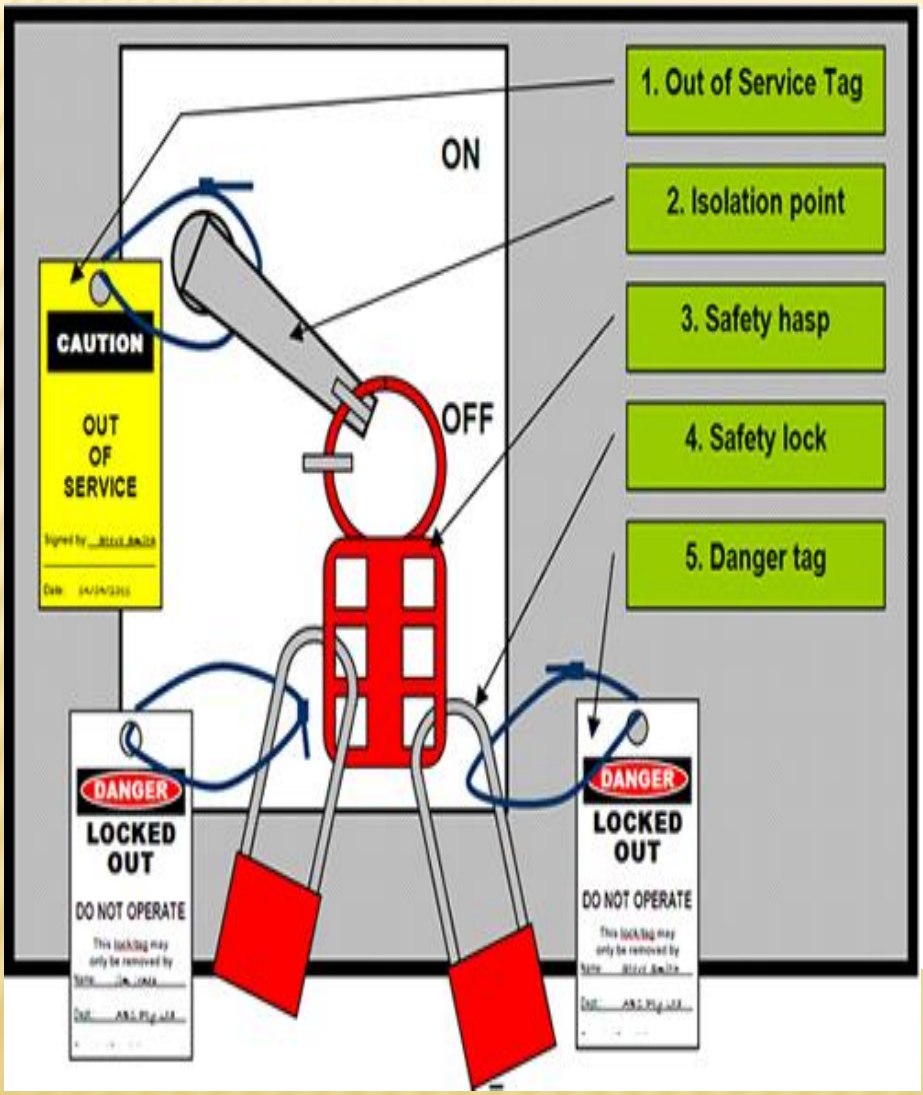
ELIMINATION/SUBSTITUTION



REDUCTION

- Inspection and testing
  - Use correct tools and equipment
- Reduced voltage
- Installation of emergency controls
- Residual current device (RCD)

ISOLATION


1. Out of Service Tag
2. Isolation point
3. Safety hasp
4. Safety lock
5. Danger tag
ON
OFF
CAUTION
OUT OF SERVICE
DANGER
LOCKED OUT
DO NOT OPERATE
DANGER
LOCKED OUT
DO NOT OPERATE


WHEN INSTALLING COVER, ENSURE BOTH OPERATING LEVER AND INTERNAL SWITCH TOGGLE ARE ALIGNED IN 'OFF' POSITION TO GIVE CORRECT 'ON' - 'OFF' INDICATION
NO.UKF3-420
series
20A
440V
IP56
M180

ENGINEERING CONTROL

- Redesign a process to place a barrier between the person and the hazard
- Remove the hazard from the person, such as machinery guarding, proximity guarding, extraction systems
- Removing the operator to a remote location away from the hazard.

ADMINISTRATIVE CONTROL

- Adopting standard operating procedures
- Safe work practices
- Providing appropriate training, instruction or information to reduce the potential for harm and/or adverse health effects to person(s).
- Isolation and permit to work procedures are examples of administrative controls.

PERSONAL PROTECTIVE EQUIPMENT

- Use only when
  - Engineering control is not feasible or totally do not eliminate the hazard
  - On the process of developing engineering controls
  - Safe practices do not provide additional protection
  - During emergency situation

SAMPLE CONTROLS

Hazards	Control Measures
Live working	Avoid (i.e. No Live Working), use competent people when essential
Hand tools	Regular inspection, testing of electrical integrity and replacement (where appropriate)
Heaters (elements)	Isolate from combustible material, guarding, special construction required in hazardous areas
Machines	Periodical inspection, electrical testing and maintenance, good electrical safety design (e.g. RCD protection)
Stored energy	Good construction, insulation and earthing protection

EXERCISE

- List down the hazard controls that you want to implement. Use the hazard identification form in Topic 2.

TOPIC 4: INSPECTION AND MAINTENANCE

USER CHECKS

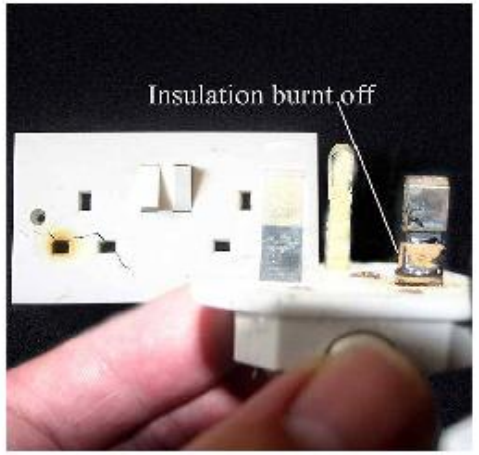
Damaged cable insulation

Damaged plug

Taped or other inadequate

Outer cable insulation not secured into the plugs

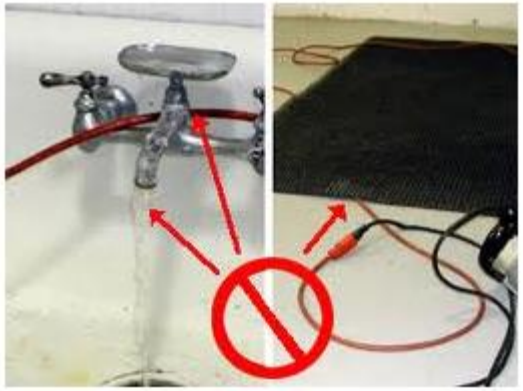
Electrical switches



Burn marks or discoloration

EXTENSION CHORDS

loose or damaged socket outlet



Wet or contaminated equipment

FORMAL INSPECTION

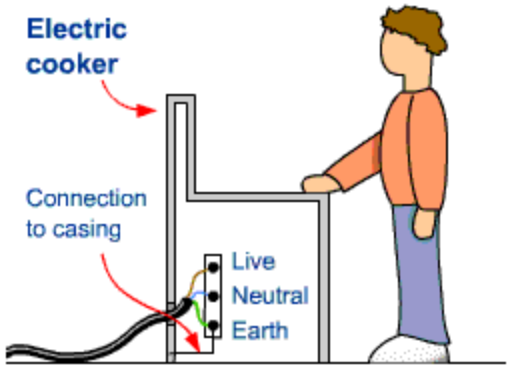
- Visual Inspection
  - Frequency depends on the type of equipment and where it is used
  - Done by trained staff
  - Not limited to defects found in the user check. Includes
    - Use of correct fuse
    - Effective cord grip
    - Secure and correct cable termination

INSPECTION FOR FIXED INSTALLATION

Damaged or loose conduit, trunking and cabling

Missing, broken or inadequately secured covers

Loose wires and faulty joints



Loose earth connection

Open or inadequately secured panel doors

INSPECTION FOR FIXED INSTALLATION

- Ease of access to isolators
- Presence of temporary wiring
- Moisture, corrosion and contamination
- Burns and discoloration marks

TESTING

- Done by qualified personnel (Portable Appliance Testing Certified
  - PAT pass/fail test
    - Earth continuity
    - Insulation resistance
    - Polarity

How frequent is the inspection and testing activities?

MAINTENANCE RECORD

Log ID	Date	Type of Maintenance	Person Performing Maintenance	Instrument Owner	Comment
	_____ From _____ To	E.g., routine/non routine	_____ Printed Name _____ Signature	_____ Printed Name _____ Signature	E.g., recalibrated
	_____ From _____ To		_____ Printed Name _____ Signature	_____ Printed Name _____ Signature	