Electrical Safety

- Basic Principles of Electricity
- Alternating Current
- Basic Electric Circuits
- Safe Working Practices
- Maintenance

What is electricity ?

- A source of Energy
- Essential to modern life
- Extremely Dangerous
    - Cannot be seen or smelt
- About 10–12 Fatalities at Work per Year

Electric Current

- A flow of electrons !
- Certain materials ‘conduct’ better than others

Electric current

- Conductors
  - Metals such as copper, silver, gold and aluminium.
  - Loose electrons in abundance so charge can be transferred easily
  - Copper very common on cost basis

Electric current

- Summary
  - Movement of electrons
  - Best in soft metals
  - Measured in Amperes or Amps
  - Symbolised by ‘A’
    - i.e. a 13A fuse

Potential Difference

- Charge on an object
- Measured with respect to earth
- Also known as Pressure
- Water Analogy
  - Horizontal pipe – water does not flow
  - Raise one end – water flows out
  - A pressure difference exists

Potential Difference

- Raising pipe created a pressure difference
- Raising electric charge has same effect only electric current will flow

- Amount of current that flows dependant on conductor (…more water could flow in a bigger pipe…)

Potential Difference

- Summary
  - Difference of charge between two objects
  - Causes a current to flow
    - (water analogy)
  - Measured in Volts
  - Symbol ‘V’
    - i.e. 230V

Conductors and Insulators

- Conductors conduct electricity
- Insulators don’t
- Metals conduct
- Wood, plastic, air, oil and rigid glass do not conduct electricity (most of the time)

Resistance

- Back to the water pipe again!
  - A larger diameter pipe allows more water to flow than a smaller one
  - If a small diameter section of pipe is inserted into the large pipe the flow of water is restricted
- Some materials conduct electricity better than others (atomic structure different)

Resistance

- Small diameter wires (conductors) allow less electricity to flow than in similar bigger diameter wires

- The ease by which a material conducts electricity is known as resistance

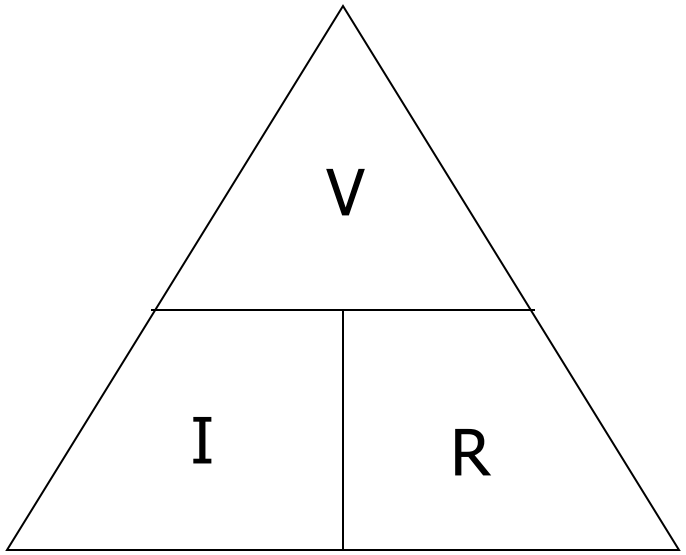
Relationships

- Electric Current - Amperes
- Potential Difference – Voltage
- Electrical Resistance

- All above are related to each other

Ohms Law

French physicist Ohm studied the relationship between Potential difference (V), Amperes, and Resistance.



His findings became known as Ohms Law

Where V = I * R, I = V / R & R = V / I

Sources of power

- Battery DC
- Mains Supply
- Portable Generators
- Solar panels

Electricity Supply System

- Electricity supplied to factories, offices and homes at 230 volts
- Large factories at 11000 volts or above
- Supply has alternating current (a.c.)
- Alternates at (frequency) of 50 cycles per second (50 Hertz or Hz)

Power

- When current flows energy is transmitted and usually consumed by a load
- Examples – heaters, lights, motion
  - Such devices must consume electricity because we have to pay for it!

Power

- Power = Volts X Amps (work done)
- Measured in Watts (W)
- Example – 2300 Watt electric kettle
  - Also referred to as 2.3 kilowatt (kW)

Summary

- Amps, Volts, Ohms
- Power

Effect of electricity on human body

- Burns
  - Surface
  - Deep tissue
- Electric Shock
  - Muscular Contraction
  - Asphyxia
  - Respiratory Arrest
  - Ventricular Fibrillation

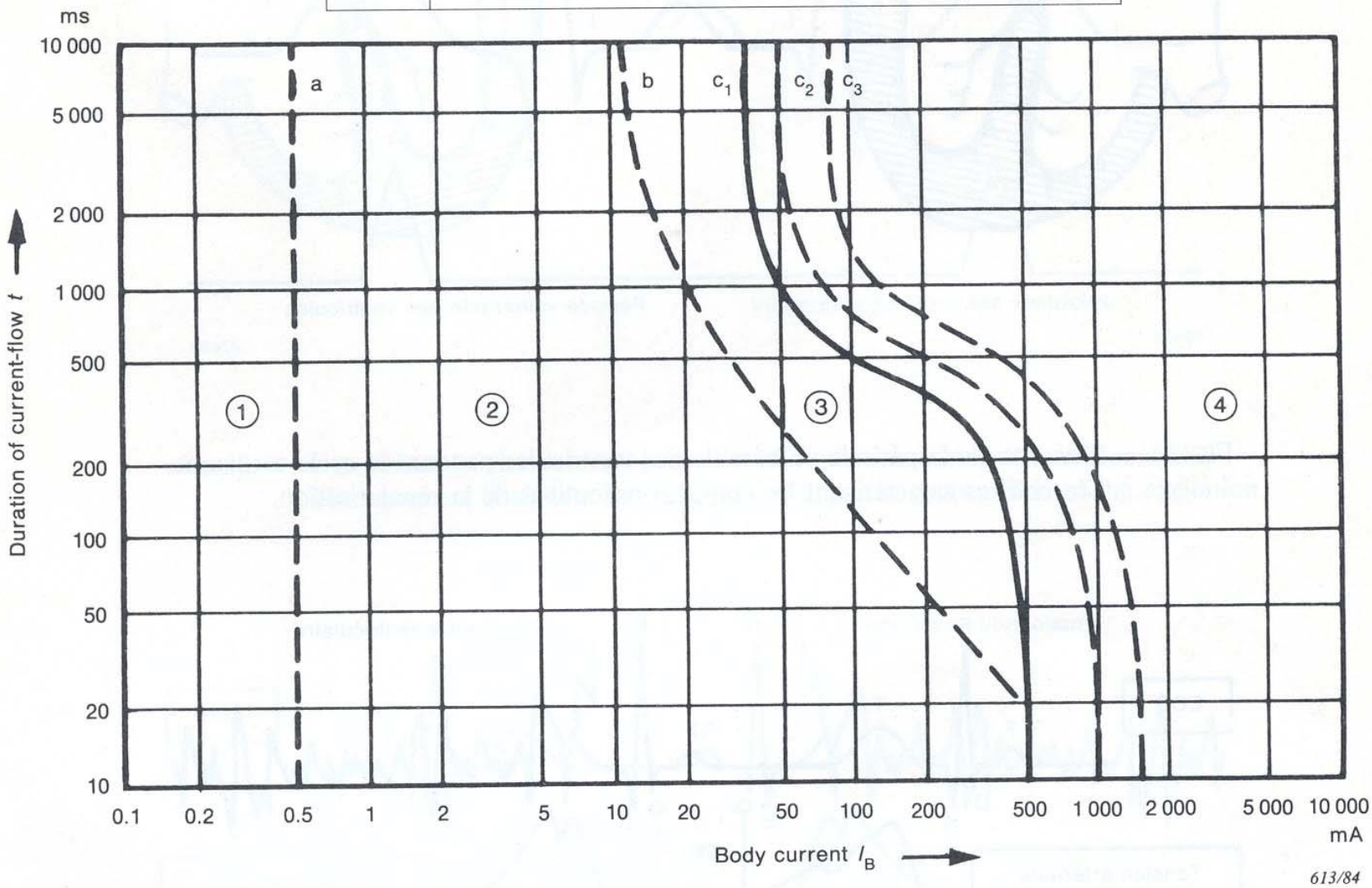
Ventricular Fibrillation

- Factors are Current / Time & Physiological Structure of body
- Can occur at 30mA (0.03 A)
- Causes heart to ‘flutter’
- Muscle cannot open / close properly
- Does not pump
- Lack of oxygen to brain - DEATH

Electric shock

- 0.5mA – 6mA tingling sensation ‘Threshold of perception.’
- 10mA – 16mA muscular contraction sets ‘Threshold of danger’
- 30mA – 60mA & above prolonged exposure can be FATAL
- Death can occur in a fraction of a second

IEC 479 Curves



Notes 1. — As regards ventricular fibrillation, this figure relates to the effects of current which flows in the path "left hand to feet". For other current paths, see Clause 5 and Table III.

2. — The point 500 mA/100 ms corresponds to a fibrillation probability in the order of 0.14%.

For info only

IEC 479 curves

- Zone 1 - No danger
- Zone 2 - Usually No effects
- Zone 3 – Reversible damage, no fibrillation, breathing difficulties
- Zone 4
    - 5% chance of fibrillation C1- C2
    - 50% chance of fibrillation after C3

For info only

Electric Shock - Treatment

- Isolate supply immediately – Dial 000
- If you cannot isolate DO NOT attempt to touch casualty
- Physically remove victim using non-conducting implements
- Check for pulse / breathing, give artificial respiration if necessary

Electrical circuits

- Consist of
  - Power Source
  - Connecting cables
  - Electrical equipment (energy converter)

Electrical circuits - Earthing

- Very important for safety !
- Prevents conducting parts of equipment (ie. metal frames or lids), which do not normally conduct electricity from becoming live during faults.

No earthing of equipment

- No bonding
- Person can receive an electric shock if equipment becomes faulty

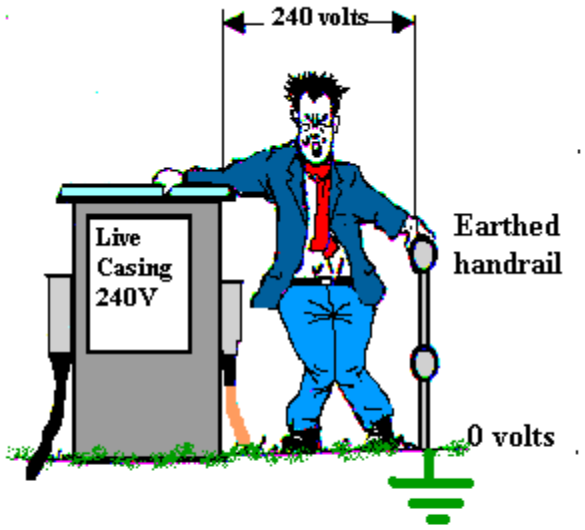


Fig. 2 No Bonding - UNSAFE

Equipment bonded together

- All equipment bonded together
- No potential (voltage) difference between live casing and handrail
- If case becomes live fuse should blow
- Equipotential Bonding

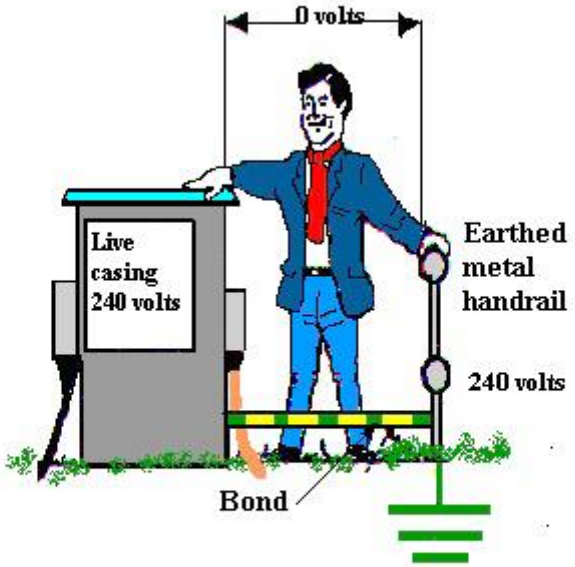


Fig.3 Earthed equi-potential Bonding - SAFE

Fuses and RCD's

- Fuses
  - essential for safety, will cut off supply at a certain current level i.e. 13A, 5A, 3A mains supply fuse
  - Fuse has a 'fuseable' wire element which heats up when current flows
  - Excessive current = excessive heat & wire melts preventing current flow
- RCD's
  - Residual current device
  - Compares current in Live & Neutral if different and above a certain value supply switched off

Double Insulation

- Lots of portable equipment is Double Insulated
- Extra layer of insulating material over live conductors to prevent exposure of conductors
- Can mean that an earth conductor is not required – risk reduced by additional insulation.

Electrical Fires / Arcs / Explosions

- Fires
  - Overheating, arcing & sparking
- Arcs
  - Generated during faults / flashover (Lightning)
  - Very high temperatures / causing burns
- Explosions
  - Flammable substances give off vapours
  - Electrical sparks can ignite (ie. domestic light switch)

Maintenance of Portable Electrical Equipment

- Many accidents result from 230 volt portable equipment
- Pressure Washers / Vacuum Cleaners
- Resulting from
  - Incorrect selection
  - Inadequate maintenance / poor repairs
- Most important checks are easy to do !

Maintenance of Portable Electrical Equipment

- Visual Inspection
  - Check flexible mains cable for damage to insulation
  - If insulation is damaged – REPLACE
  - DO NOT wrap conductors together and tape up
  - So called ‘Electrical Insulation Tape’ will not provide a sufficient barrier between you and a potentially fatal electric shock – as has been proven on many occasions

Maintenance of Portable Electrical Equipment

- Plug
  - Check that only the outer insulation has been clamped / gripped. Clamping inner conductor insulation will potentially lead to exposure of live terminals.
  - Is fuse correct rating (Instructions should advise correct current value – DO NOT use a nail)
  - Check that all 3 pins are present and in good condition

Maintenance of Portable Electrical Equipment

- Testing
  - Only by a competent person
  - Earth bond test
  - Insulation test
  - On-load test