Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

IESC
Infrastructure Equipment Skill Council

Participant Handbook

Sector
Infrastructure Equipment

Sub-Sector
Equipment Service and Spares

Occupation
Equipment Maintenance

Reference ID: **IES/Q1106, Version 2.0**
NSQF Level 3

Junior Mechanic Electrical

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"Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission."

Shri Narendra Modi
Prime Minister of India

Acknowledgements

About this Book

This program is aimed at training candidates for the job of a "Junior Mechanic Engine", in the "Infrastructure Equipment" Sector/Industry and aims at building the very key competencies amongst the learner.

To address the future sector demand, this Participant Handbook is designed to enable training for the specific Qualification Pack (QP). Each National Occupational (NOS) is covered across Unit(s).

Key Learning Objectives for the specific NOS mark the beginning of the Unit(s) for that NOS. The symbols used in this book are described below.

Symbols Used


Key Learning Outcomes


Steps


Tips


Notes


Unit Objectives

Table of Contents

Employability & Entrepreneurship Skills

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1. Introduction

Unit 1.1 – About the Program

Unit 1.2 – About the Electrical Systems

Unit 1.3 – Infrastructure Equipment's Electrical Systems

Key Learning Outcomes

At the end of this module, you will be able to:

1. Understand the training curriculum.
2. List and share training expectations.
3. Understand the basics of Electrical.
4. Learn technical names of Electrical system.
5. Identify the main parts and system.
6. Understand the roles of a Junior Mechanic Electrical.

UNIT 1.1: About the Program

Unit Objectives

At the end of this unit, you will be able to:

1. Understand training curriculum design.
2. Get to know each one in the training program.
3. List out the expectations from the training.

1.1.1 Overview of the Book

The training curriculum will help you to:

1. **Assist in carrying out repairs and maintenance of equipment's electrical assemblies and sub-assemblies.** Basic working of electrical assemblies & systems, identification and use of hand tools and equipment, techniques for removal of defective components and fitment after rectification.

2. **Maintain the workshop area, tools and machinery to support operations.** Maintenance of workshop area, tools and equipment, various cleaning agents and their use, safety precautions and measures.

3. **Comply with workshop health and safety guidelines.** Health, safety and environment policies; personal protective equipment, fire-fighting equipment, basic first aid for common injuries at workshop.

1.1.2 Knowing Each Other

Let's Know Each Other:

- Your Name
- Your Location
- Your Hobby

1.1.3 Expectation Mapping

My expectations from the training program are:

UNIT 1.2: About the Electrical System

Unit Objectives

At the end of this unit, you will be able to:

1. Understand the basics of Electrical/Electronics/Instrumentation.
2. Identify the basic features and use of Electrical/Electronics/Instrumentation Components.
3. Identify the various components of Electrical/Electronics/Instrumentation Systems and their use.
4. Understand the safety features of Electrical Components.

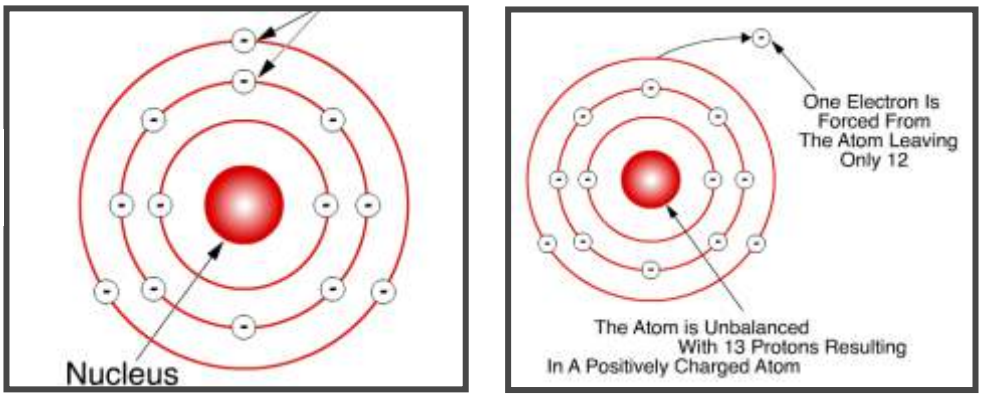
1.2.1 Electrical Basics

1. ATOMIC STRUCUTRE

a. **Atom** is comprised of Protons and neutrons
b. **Protons**: Positively-charged
c. **Neutrons**: No charged and
d. **Electrons**: Negatively-charged
e. **Protons** and **Neutrons**: nucleus" of the Atom, the Electrons travel in "orbits" around the "nucleus"

(Just like earth turns around Sun)

Fig-1



When something upsets this balance, then some of the **Electrons** become out of the orbits. (**Free Electrons**) this unbalanced condition can be caused by rubbing (heat), passing a wire through a Magnetic Field or putting two chemicals together (as in a Dry Cell Battery).

2. VOLTAGE

a. **Voltage** is the electrical force that moves electrons through a conductor.
b. The greater the difference in electrical potential push (difference between positive and negative), the greater the voltage force potential.
c. Unit of measurement = "Volt"
d. Symbol = (V or E)

Fig -1.2.1.1: Electrical Basics

1.2.1 Cont....

3. CURRENT

a. CURRENT is the quality or flow rate of electrons moving past a point within one second.
b. Current flow is also known as amperage, or amps.
c. Unit of measurement = "Ampere"
d. Symbol = (I or i)

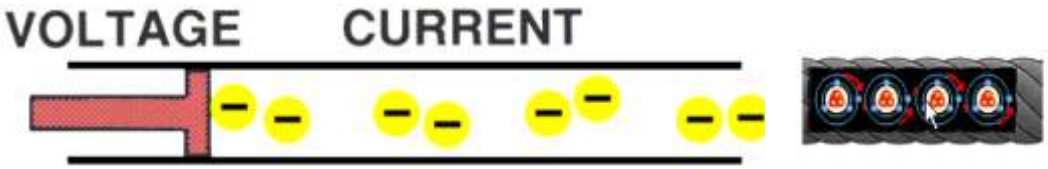


Fig- 1.2.1.2

4. RESISTANCE

a. Resistance is the opposition offered to the flow of an electrical current by the conductor through which it is passing.
b. Unit of measurement = **"Ohm"**
c. Symbol = **(R** or **Ω)**

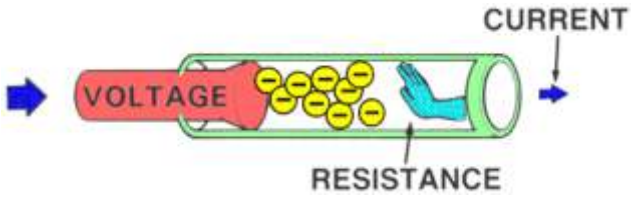


Fig-1.2.1.3

5. OHMS LAW

In a circuit, what would cause an increase in current if voltage remains the same?

a] A Open
b] An increase in resistance
c) A decrease in résistance
d] No change in resistance

Ohm's law states that the current through a conductor between two points is directly proportional to the potential difference or voltage across the two points, and inversely proportional to the resistance between them provided the temperature remains constant.

$$I = \frac{E}{R}$$

$$E = I \times R$$

$$R = \frac{E}{I}$$

1.2.1 Cont....

6. UNIT OF MEASUREMENT

What is the basic unit of measurement for current?

a] Volt **b] Ampere** c] Current d] ohm

What is the basic unit of measurement for Voltage?

a] Volt b] Ampere c] Current d] ohm

What is the basic unit of measurement for Resistance?

a] Volts b] Ampere c] Current **d] ohm**

Process of converting Mechanical energy into electrical energy

a] induction b] Magnetism

c) Electromagnetic induction d] Residue magnetism

7. ELECTROMAGNETISM

a. Electric current creates its own magnetic field around the wire.

b. Magnetic lines have direction and change direction when the current flow changes in the wire from one direction to another.

c. As current increases the field strengthens.

Magnetism Causes Repulsion:

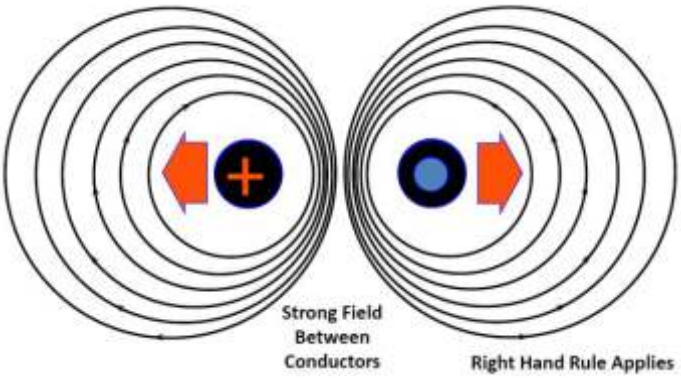
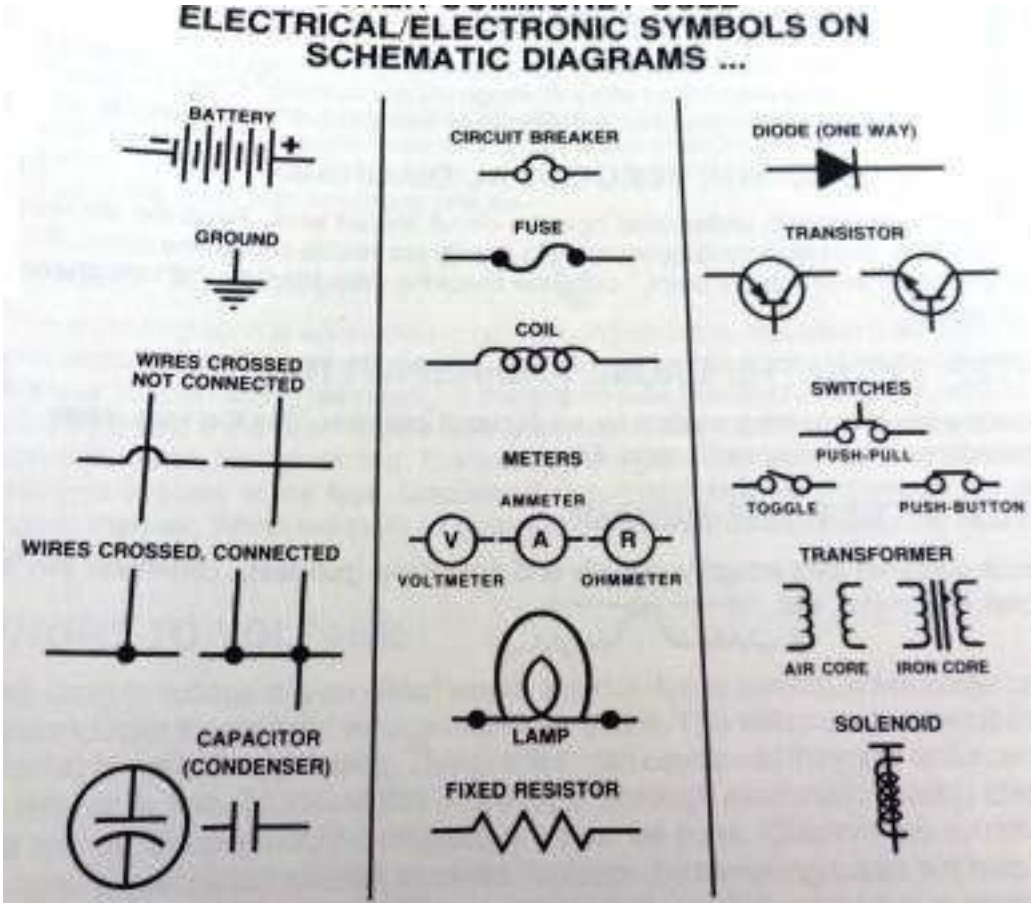
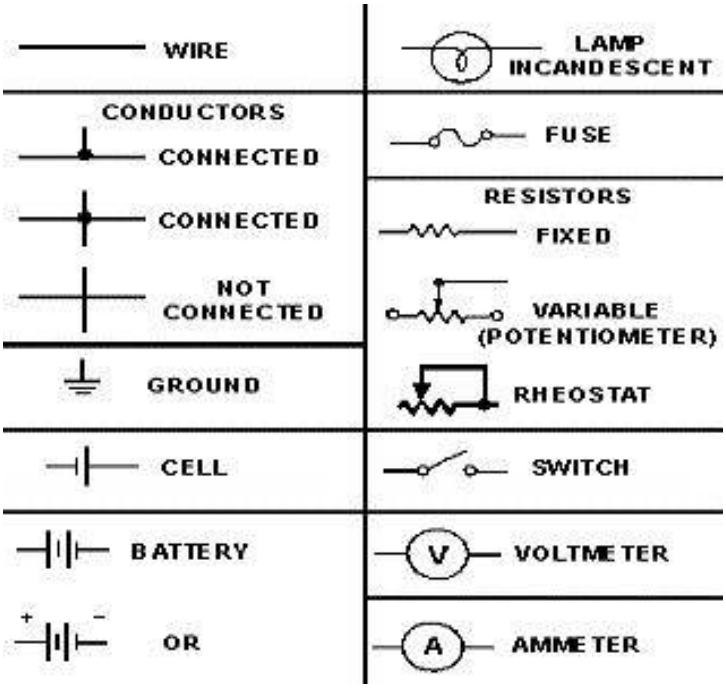


Fig-1.2.1.4

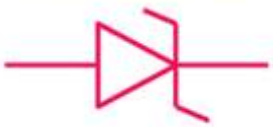
1.2.1 Cont....

8. ELECTRICAL SYMBOLS





Zener diode symbol



1.2.1 Cont....

9. ELECTRICAL CIRCUIT

Electricity is actually defined as: "The movement (or flow) of free electrons through a material". We cannot see electricity, but we can see it's effects (i.e. light).
There are two types of commonly used electricity:

a) **Direct Current**: This is commonly provided by Batteries.
b) **Alternating Current**: Provided by Electric utilities or other Power Generators in the form of **Electrons** (called "current") flowing through a Wire called a "Conductor".

a) DIRECT CURRENT (DC)

- Electricity with electrons flowing in only one direction is called Direct Current or DC.
- DC electrical systems are used for Starting and charging system, Panel boards, Solenoids and headlights etc.
- **DC 12V and 24V**

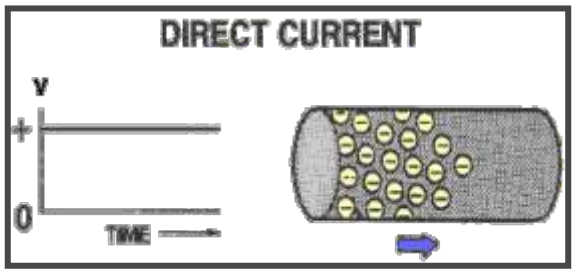


Fig -1.2.1.6

b) ALTERNATING CURRENT (AC)

- Electricity with electrons flowing back and forth, negative - positive - negative, is called Alternating Current, or AC.
- The electrical appliances used for motors, Contactors and limit switches …etc.
- 1 phase 230V and 3 phase 440V

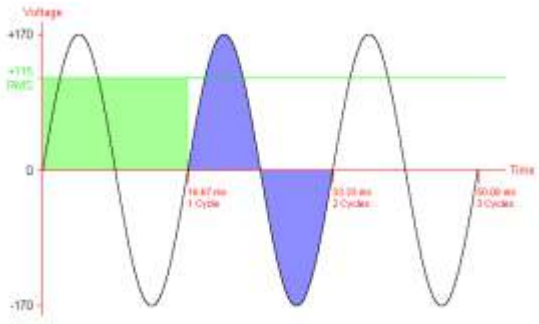


Fig -1.2.1.7

1.2.1 Cont....

10. DC WATTS

What is formula for watt?

a) P = I X E b] P=E/I c] P = I/I d] P = E + R + I

Fig-1.2.1.8

Measure of Electrical Work

24 V x 5 amp = 120 Watts

12 V x 10 amp = 120 Watts

11. DC CIRCUIT

Fig-1.2.1.9

12. SERIES CIRCUIT

What type of circuit has only one path for current?

a) Series b] Parallel c] Series parallel d] Short

In a series circuit, if the voltage increases and the resistance remains the same, what would happen to the current?

a) Increase b] Decrease

c] Remains same d] Fluctuation

ELECTRICAL CIRCUIT

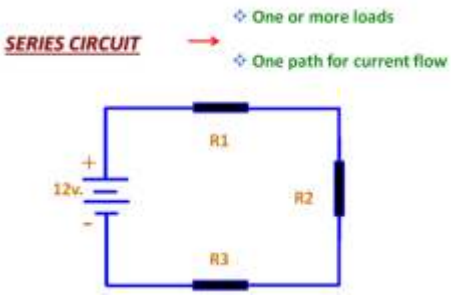


Fig-1.2.1.10

1.2.1 Cont....

CONDITIONS–SERIES CIRCUIT

All current remains the same throughout the circuit.

- **E Total = E 1 + E 2 + E 3 + etc...**
- Voltage is the sum of all voltage drops.
- **I Total = I 1 =I 2 =I 3 etc…**
- Current is the same at any given point in the circuit.
- **R Total = R 1 + R 2 + R 3 + etc...**
- Resistance is the sum of all individual resistances.

SERIES CIRCUIT

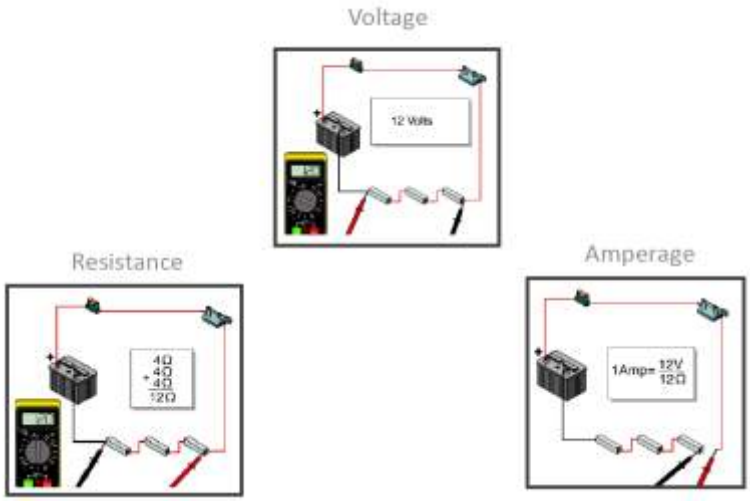


Fig-1.2.1.11

1.2.1 Cont....

13. PARALLEL CIRCUIT

In a parallel circuit, the voltage drop is:
a) The same across each branch b] greater across each branch
c] Less across each branch d] some time increase / decrease

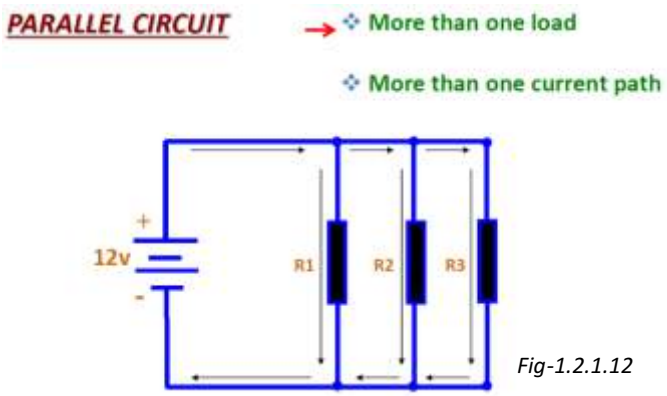


Fig-1.2.1.12

CONDITIONS– SERIES CIRCUIT

All current remains the same throughout the circuit.

- **E Total = E 1 + E 2 + E 3 + etc...**
- Voltage is the sum of all voltage drops.
- **I Total = I 1 =I 2 =I 3 etc…**
- Current is the same at any given point in the circuit.
- **R Total = R 1 + R 2 + R 3 + etc...**
- Resistance is the sum of all individual resistances.

1.2.1 Cont....

PARALLEL- CIRCUIT

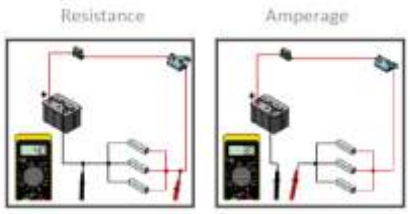


Fig-1.2.1.13

SERIES CIRCUIT

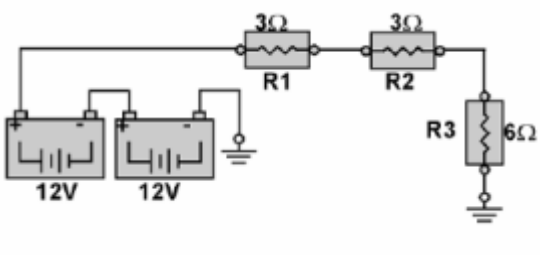


Fig-1.2.1.14

The following equation is used for determining total resistance:

Rt = R1 + R2 + R3, or Rt = 3Ohms + 3Ohms + 6Ohms, or Rt = 12Ohms.

I = E/R, or I = 24V/12Ohms, or I = 2 amperes

The following equations are for voltage drops:

E1 = 2A × 3Ohms = 6V

E2 = 2A × 3Ohms = 6V

E3 = 2A × 6Ohms = 12V

PARALLEL CIRCUIT

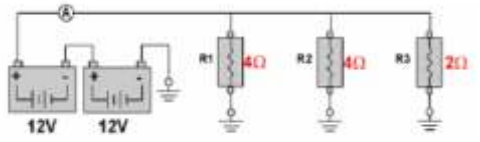


Fig-1.2.1.15

Applying the voltage rule for parallel circuits (voltage is SAME in all branches) you can solve the unknown current value in each branch by using the Ohm's Law circle, whereas I=E/R

I1 = E1/R1 or I1 = 24/4 or I1 = 6 amps

I2 = E2/R2 or I2 = 24/4 or I2 = 6 amps

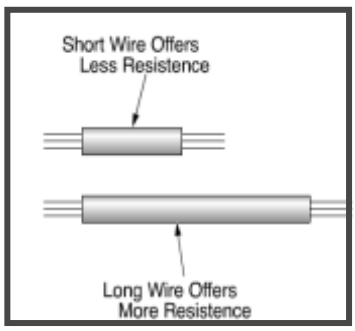
I3 = E3/R3 or I3 = 24/2 or I3 = 12 amps

It = I1 + I2 + I3 or 6+6+12 = 24 amp

The total circuit resistance is calculated as 1 ohm. (Rt = Et/It)

1.2.1 Cont....

14. PROPERTIES



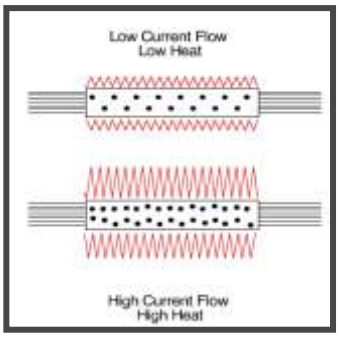
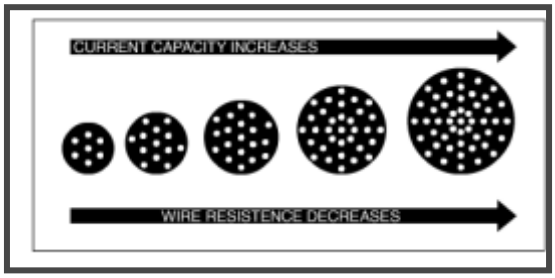


Fig-1.2.1.16

Current flow and heat.
Resistance depends on length of the conductor.



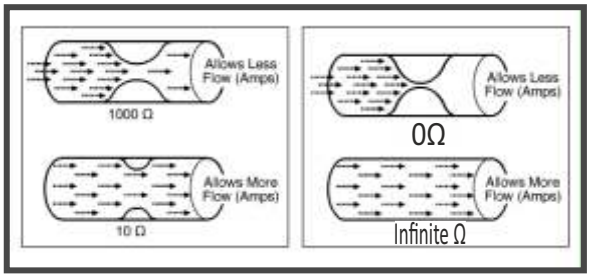


Fig-1.2.1.17

Resistance increases current decreases.
Resistance also depends on cross section of conductors.

15. MULTIMETER

Multimeter measures :

Voltage (AC, DC– Voltage)
Current (AC, DC– Ampere)
Resistance (Ohms, Kilo ohms)
Continuity
Diode
To measure current – Connected in series
To measure voltage – Connected in parallel
To measure resistance - the component must be removed from the Power source.

Fig-1.2.1.18

1.2.1 Cont....

ELECTRICAL CONNECTION

What resistance will a loose or corroded connection have compared to a "good" connection?

a) More b] Less

c] The same d] None of a, b and c

Good connection – No more than 0.2 volt drop maximum.

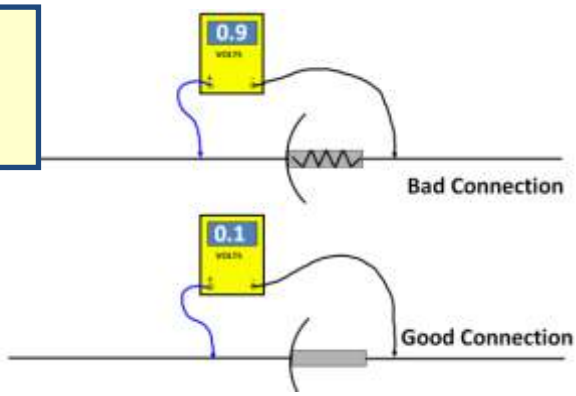


Fig-1.2.1.19

A good connection is no more than 0.2 volt drop maximum. We will show you what a bad connection will look like in the shop. A connection can be a switch, relay contacts, circuit breaker, etc.

METER USAGE

A 10 am fuse keeps 'blowing' open when the cab light switch is turned on. What would be the best way to check during diagnostics?

a] Ammeter b) Voltmeter c] 15 Amp fuse d] ohmmeter

Which test meter requires that the component or circuit be disconnected from the power source?

a) Ohmmeter b] Voltmeter c] Ammeter d] DC Voltmeter

1.2.1 Cont....

ELECTRICAL CIRCUIT MALFUNCTIONS

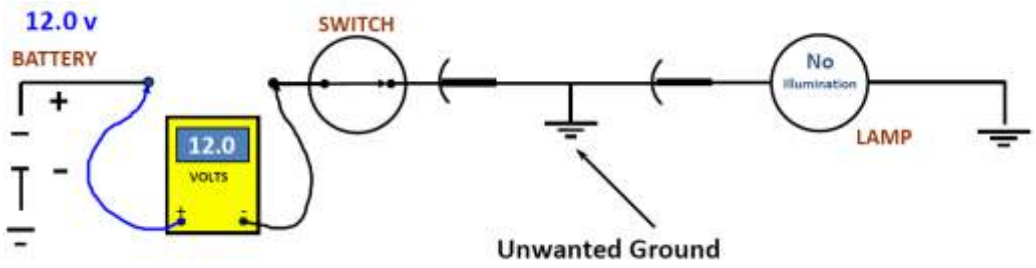


Fig -1.2.1.20

The issue with using a voltmeter in place of the fuse is if you don't disconnect the ground circuit at the end component, the meter reading won't go away when you do remove the unwanted ground.

Test light also could be used in place of fuse. When the unwanted ground is in the circuit, the test light should glow brightly. When the unwanted ground is removed, the test light will dim and the lamp would light at about half brightness.

ELECTRICAL CIRCUIT

MEASURING CIRCUIT RESISTANCE

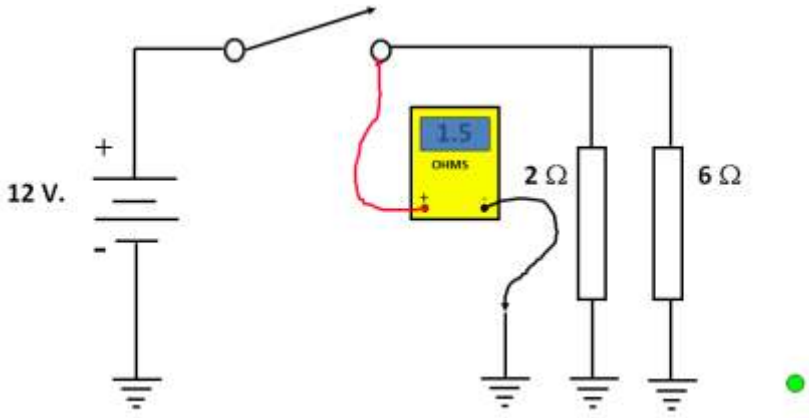


Fig -1.2.1.21

To measure total resistance, the meter would be placed in parallel with the loads. Be sure to isolate the circuit from power.

1.2.1 Cont....

MEASURING COMPONENTS RESISTANCE

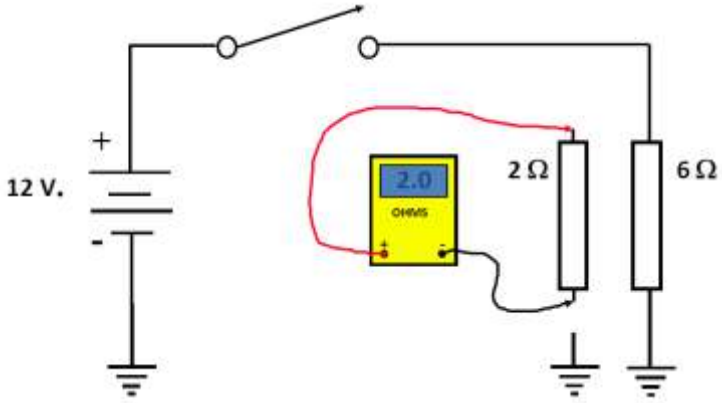


Fig -1.2.1.22

To measure branch resistance, that branch is removed or isolated and the meter placed in parallel with that component.

VOLTAGE POTENTIAL

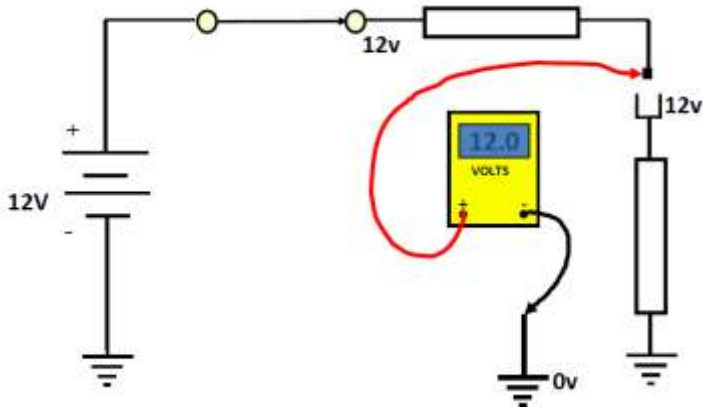


Fig -1.2.1.23

Voltage potential is the voltage that is present at a point in a circuit when the load or ground has been disconnected.

1.2.1 Cont....

AVAILABLE VOLTAGE

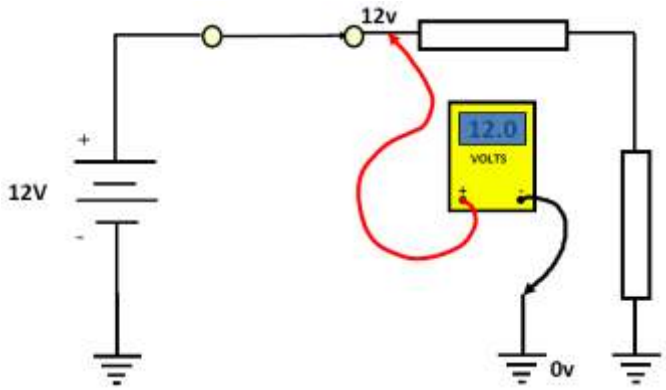


Fig-1.2.1.24

Available voltage is when the switch is closed then current will flow to the component or load. In most cases the available voltage will be lower if there is resistance in that power circuit.

VOLTAGE DROP

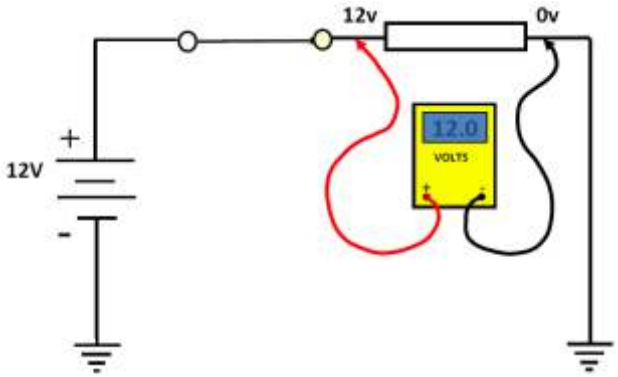


Fig-1.2.1.25

Voltage drop is the difference of voltage values between the meter leads. When the leads are Connected to each side of a light bulb (load), the meter measures voltage into the bulb.The other lead measures the voltage out. The meter reads the voltage difference on the display. In a series circuit with one light bulb, the total source voltage will drop across the bulb.

1.2.1 Cont....

MEASURING TOTAL CURRENT with SHUNT TYPE

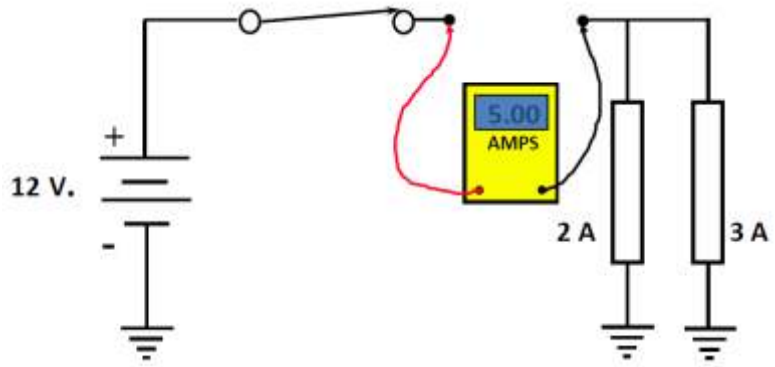


Fig-1.2.1.26

To measure **amperage in a circuit**, the meter must be connected in series in the circuit. Total amperage in the circuit will be measured.

What is the actual value of ohms if display shows 3.56K ohms?

a] 3.56 ohms
b] 356 ohms
c) 3560 ohms
d] 35600 ohms

What is actual value of amperage if the meter shows 30.5Ma?

a] 30.5 amps
b] 3.05 amps
c] .305 amps
d) 0.0305 amps

1.2.1 Cont....

ELECTRICAL UNITS

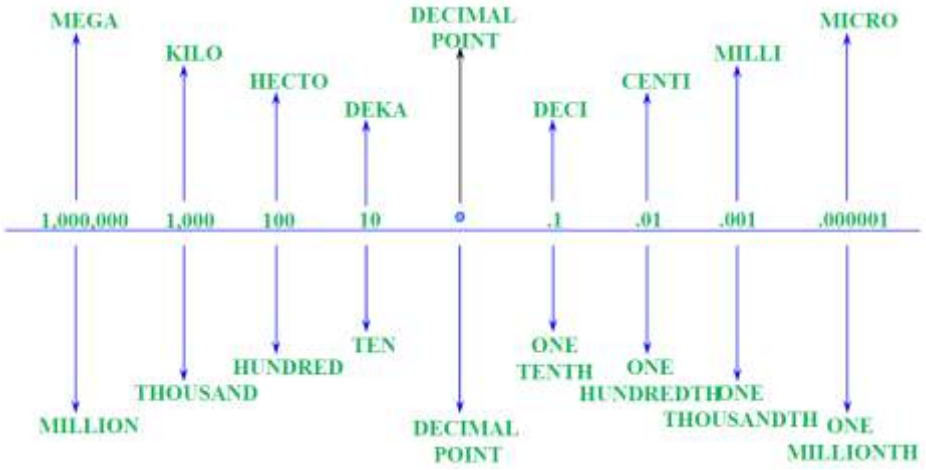


Fig-1.2.1.27

M = Mega or 1,000,000 or value x 1,000,000
K = Kilo or 1,000 or a value x 1,000
m = milli or .001 or a value x .001
Micro or .000001 or value x .000001
M And K indicate a number one or larger
m and u indicate a number less than one

Variable resistors send what type of signal to controller?

a] Digital b] Binary
c) Analog d] pulsed width modulation

Which of the following is a variable resistor?

a] Relay b) Potentiometer c] Switch d] Diode

1.3 Infrastructure Equipment's Electrical Systems

BATTERY:

Battery electrolyte contains sulphuric acid, and batteries generate flammable hydrogen gas, which may explode. Mistaken handling can lead to serious injury or fire. For this reason, always observe the following precautions.

1. Do not use or charge the battery if the battery electrolyte level is below the LOWER LEVEL line. This may cause an explosion. Check the battery electrolyte level periodically and add distilled water to bring the electrolyte level to the UPPER LEVEL line.
2. When working with batteries, always wear safety glasses and rubber gloves.
3. Never smoke or use any flame near the battery.
4. If you spill acid on your clothes or skin, immediately flush the area with large amount of water.
5. If acid gets into your eyes, flush them immediately with large amount of water and seek medical attention.
6. Before working with batteries, turn the starting switch to the OFF position.

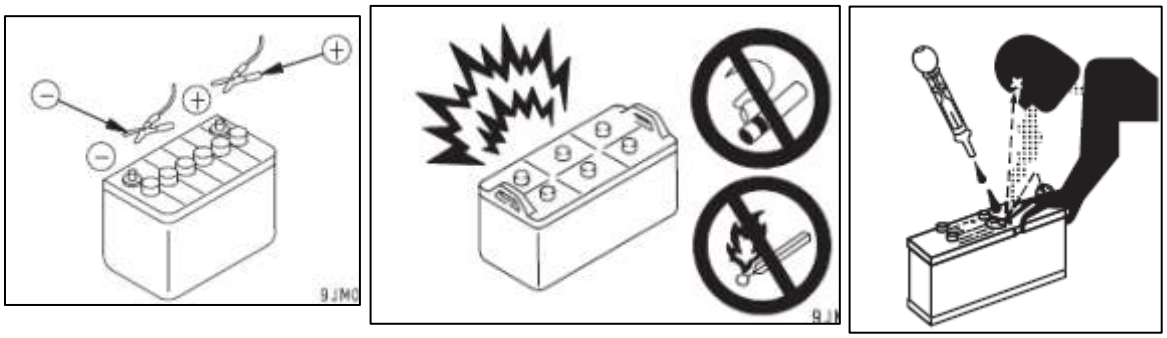


Fig. 1.3 Infrastructure Equipment's Electrical Systems

1.3 Infrastructure Equipment's Electrical Systems

1.3.1 CONTROLS AND GAUGES

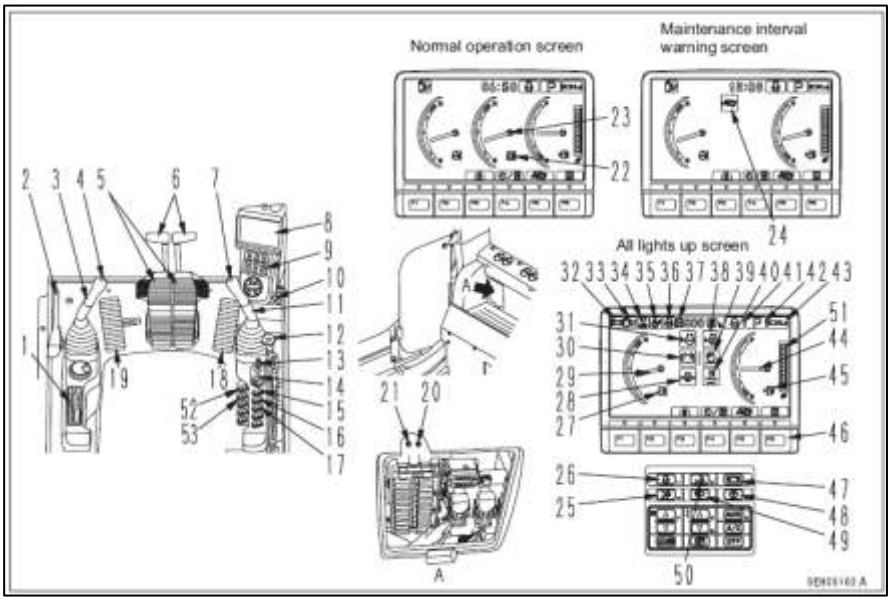


Fig. 1.3.1 Infrastructure Equipment's Electrical Systems

(1) Radio
(2) Lock lever
(3) Left work equipment control lever
(4) Knob switch (2 x spare switches)
(5) Travel pedals
(6) Travel levers
(7) Horn switch (2 x spare switches)
(8) Machine monitor
(9) Air conditioner control switches
(10) Cigarette Lighter
(11) Right work equipment control lever
(12) Blade control lever (if equipped)
(13) Starting switch
(14) Fuel control dial
(15) Lamp switch
(16) Swing lock switch
(17) Revolving warning lamp switch
(18) Attachment control pedal
(19) Attachment control pedal
(20) Swing brake cancel switch
(21) Emergency pump drive switch
(22) Hydraulic oil temperature monitor
(23) Hydraulic oil temperature gauge
(24) Maintenance interval monitor
(25) Buzzer cancel switch
(26) Auto-deceleration switch
(27)
(28) Engine oil pressure monitor
(29) Engine coolant temperature gauge
(30) Charge level monitor
(31) Radiator coolant level monitor
(32) KOMTRAX message monitor
(33) Air conditioner monitor
(34) Wiper monitor
(35) Swing lock monitor
(36) Engine pre-heating monitor
(37) Service meter
(38) Engine oil pressure monitor
(39) Air cleaner clogging monitor
(40) Water separator monitor
(41) Auto-deceleration monitor
(42) Working mode monitor
(43) Travel speed monitor
(44) Fuel gauge
(45) Fuel level monitor
(46) Function switches (F1 to F6)
(47) Travel speed selector switch
(48) Window washer switch

1.3 Infrastructure Equipment's Electrical Systems

1.3.2 MONITORING SYSTEM

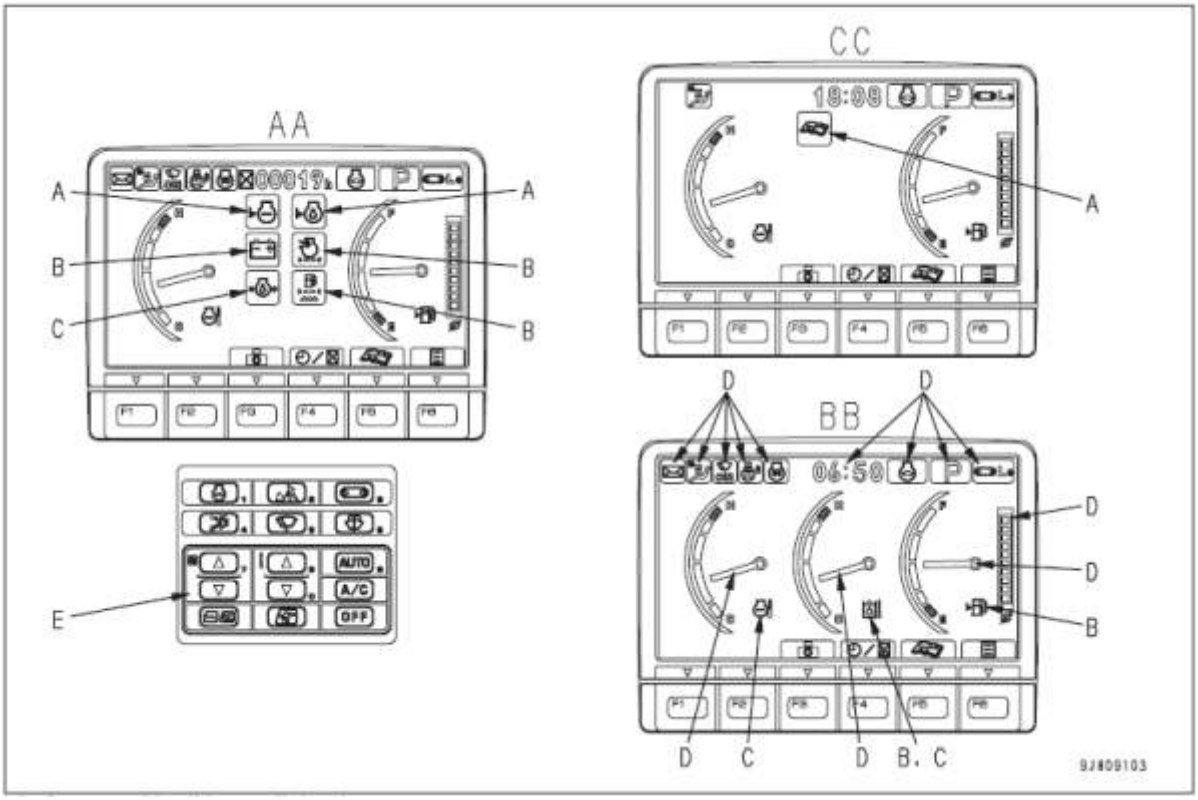


Fig. 1.3.2 Monitoring System

AA: Screen with all lamps lighted up
BB: Screen for normal operation
CC: Maintenance time warning screen

A: Basic check monitors
B: Caution monitors
C: Emergency monitors
D: Meter display portion, pilot display
E: Monitor switches portion

REMARK

One of the features of liquid crystal display panels is that there may be black spots (spots that do not light up) or white spots (spots that stay lighted up) on the screen. If there are fewer than 10 black or white spots, this is not a failure or a defect .

1.3 Infrastructure Equipment's Electrical Systems

1.3.3 SWITCHES

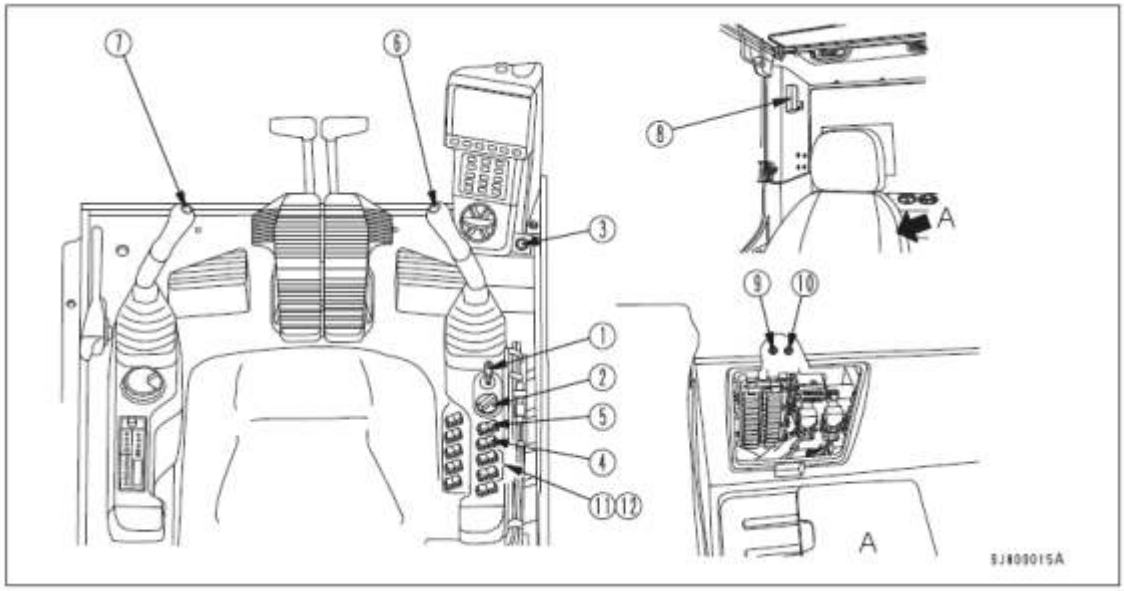


Fig. 1.3.3 Switches

(1) Starting switch
(2) Fuel control dial
(3) Cigarette lighter
(4) Swing lock switch
(5) Lamp switch
(6) Horn switch
(7) Knob Switch
(8) Room Lamp Switch
(9) Emergency Pump Drive Switch
(10) Swing Brake Cancel Switch
(11) Revolving Warning Lamp Switch
(12) Large Capacity Airflow Air Conditioner Blower Switch

1.3 Infrastructure Equipment's Electrical Systems

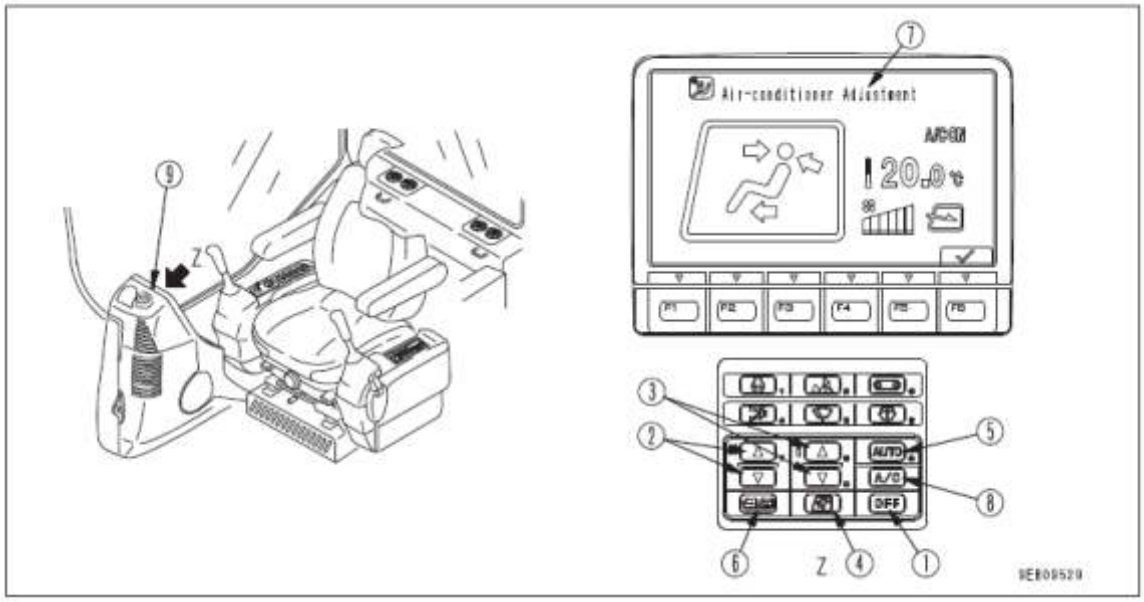


Fig. 1.3.3 Air Conditioner Control Panel

(1) OFF switch
(2) Fan switch
(3) Temperature control switch
(4) Vent selector switch
(5) Auto switch
(6) FRESH/RECIRC selector switch
(7) Display monitor
(8) Air conditioner switch
(9) Sunlight sensor

1.3.4 Air Conditioner Control Panel

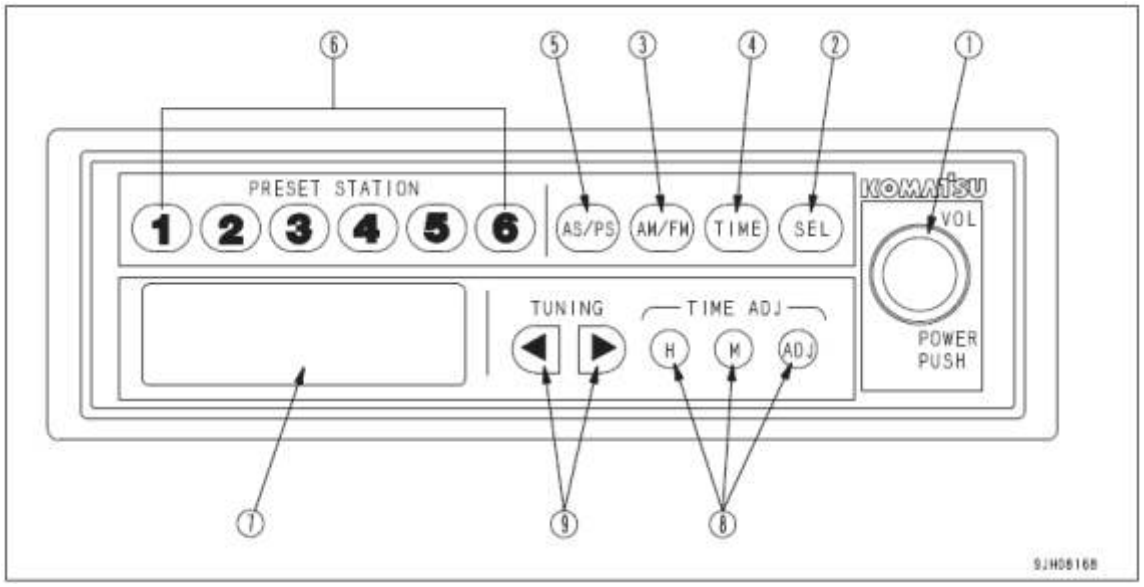


Fig. 1.3.4 Air Conditioner Control Panel

(1) Power switch, Volume control knob,
(2) SEL button
(3) FM/AM selection button
(4) Display selection button
(5) AS/PS button
(6) Preset station buttons (1, 2, 3, 4, 5, 6)
(7) Display
(8) Time reset button
(9) Tuning button

1.3 Infrastructure Equipment's Electrical Systems

1.3.5 FUSE

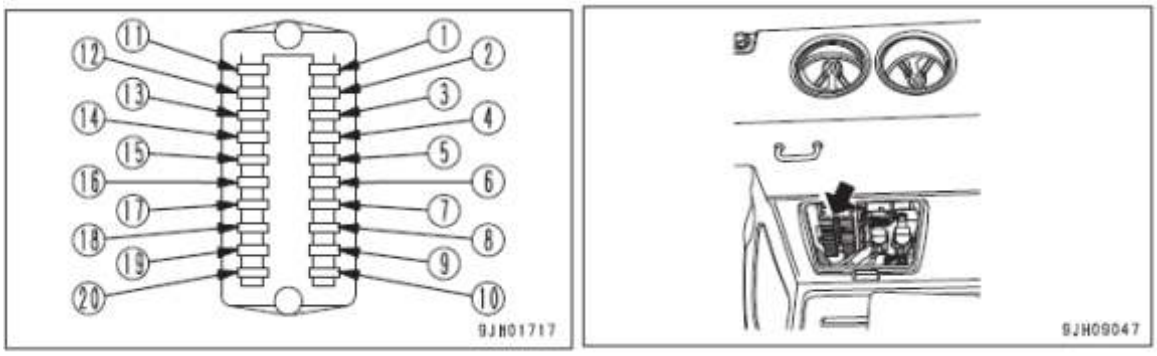


Fig. 1.3.5 Fuse

The fuse holder is at the rear right of the operator's seat.
The fuses protect the electrical equipment and wiring from burning out.
If the fuse becomes corroded, or white powder can be seen, or the fuse is loose in the fuse holder, replace the fuse.
Replace the fuse with another of the same capacity .

Fuse Capacities and Circuit Names

No.	Fuse capacity	Name of circuit
(1)	10A	Relay for lamp
(2)	30A	Solenoid valve
(3)	10A	PPC lock solenoid
(4)	10A	Window washer, cigarette lighter
(5)	10A	Horn
(6)	10A	Lower-Wiper
(7)	10A	Beacon
(8)	25A	Work lamps (front, boom)
(9)	10A	Radio, speaker, left knob switch
(10)	10A	Refuel pump
(11)	20A	A/C unit
(12)	20A	Rear work lamp
(13)	20A	Work lamp relay, cab lamp
(14)	10A	OPT power source (1)
(15)	20A	OPT power source (2), heated seat, 12V power port
(16)	10A	Radio backup, room lamp
(17)	20A	Monitor, controller, starter switch
(18)	10A	Spare
(19)	30A	Engine controller
(20)	5A	Engine controller

Table -1.3

1.3 Infrastructure Equipment's Electrical Systems

1.3.6 Dashboard

The instruments and indicator lights are grouped together on an instruments provided are a tachometer, hour meter, a coolant temperature gauge and a fuel level gauge.
There are warning lights for various fault conditions. When a warning light comes on an alarm will sound. The only way to cancel the alarm is to set the starter to "off". Do not use the machine if it has fault condition, or you might damage the engine and/or the transmission.

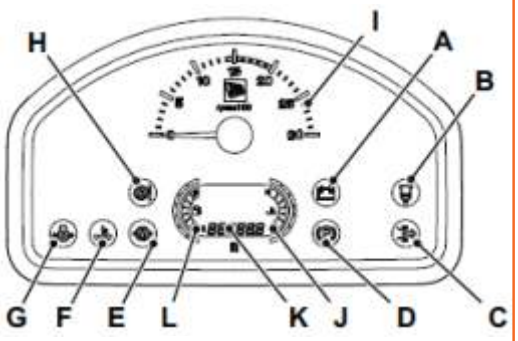


Fig. 1.3.6 Dashboard

A		**No Charge** Audible/Visual. Lights if the battery charging circuit fails while the engine is running. The light should go out a few seconds after the engine is started.
B		**Water In Fuel** Lights if water is detected in fuel. Empty the water separator.
C		**Air Filter Blocked** Lights if engine air filter blocks up.
D		**Park Brake Engaged** Audible/Visual. Lights when the park brake is engaged with the machine in forward (F) or reverse (R). The alarm will sound. The light and the alarm should go out when the parking brake switch is turned off. Always switch on the parking brake before leaving the machine, in case the engine is running.
E		**Transmission Oil Pressure Low** Lights if the transmission oil pressure drops too far. The light should go out a few seconds after the engine is started.
F		**Coolant Temperature** Red Light and Audible Alarm. Lights if the engine temperature is above normal.
G		**Engine Oil Pressure Low** Audible/Visual. Lights if the engine oil pressure is below normal. The light should go out when the engine is started.
H		**Transmission Oil Temperature High** Lights if the transmission oil temperature is high.

1.3 Infrastructure Equipment's Electrical Systems

1.3.7 Starter Motor

When the start switch is closed, the coils in the solenoid are energized, creating a magnetic field. The field pulls the plunger inward, which causes the shift lever to push the drive assembly into mesh with the ring gear on the engine flywheel. Once the pinion is in mesh, the plunger pushes the contacts closed, and closes the circuit between the battery and the motor.

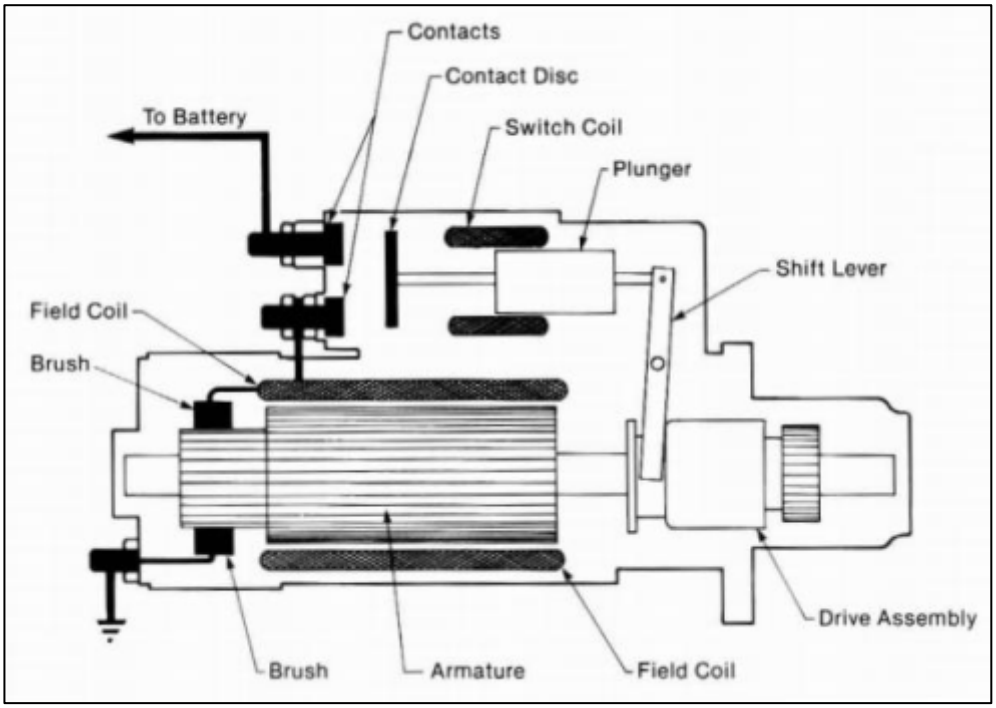


Fig. 1.3.7 Starter Motor

1.3 Infrastructure Equipment's Electrical Systems

1.3.8 Alternator

Fig. 1.3.8 Alternator

An alternator is an electrical generator that converts mechanical energy to electrical energy in the form of alternating current.

Various Sub-assemblies of alternator are as follows;

1 Rotor
2 Bearing (drive end)
3 Fan hub
4 Drive end shield
5 Fan
6 Fan screen
7 Stator winding
8 Stator ribs
9 Stator lamination
10 Polar wheel
11 Balancing disc
12 Exciter field
13 Exciter armature
14 Non drive end shield
15 Bearing (no drive end)
16 Rotating resistances
17 Rotating diodes
18 Diode bridge cover

Tips

Following are recommended tips:

- Visit an electrical, electronics & Instrumentation lab.
- Identify various electrical, electronic & instrumentation equipment's in presence of mechanic or a supervisor.

Notes

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2. Assist in Repair & Maintenance of Electrical Systems of the Infrastructure Equipment

Unit 2.1 – Basic Electrical Components

Unit 2.2 – Basic Electrical Diagnostics

IES/N1106

Key Learning Outcomes

At the end of this module, you will be able to:

1. Identify location and process for storage and disposal of waste.
2. Understand fundamentals of Electrical.
3. Understand common symbols used in electrical circuit diagrams.
4. Learn different methods to identify parts & components like fuses, relays, solenoids, bulbs and wirings.
5. Understand basic working of various electrical system parts like battery, starter motor, alternator, fuses, relays solenoids and other instruments.
   Understand manufacturer's tech specs and brief service procedures for electrical parts/ system in use.
6. Identify and use of various hand & power tools; and their calibration.

UNIT 2.1: Basic Electrical Components

Unit Objectives

At the end of this unit, you will be able to:

1. Understand training curriculum design.
2. Know each one and all.
3. List expectations from the training.

UNIT 2.1: Basic Electrical Components

2.1 Electrical Components

Some of the basic Electrical Components.

1. Potentiometer
2. Rheostat
3. Capacitor
4. Relay
5. Diode
6. Magnetic Pick up unit
7. Circuit Protection

2.1.1 Potentiometer

1. The potentiometer controls a voltage signal with very low current flow.
2. Potentiometer voltage under normal conditions will not reach 0 or 5 volts. 0 and 5 volts are typical of a shorted or open circuit.
3. Potentiometer will usually have three leads into a 5 volt circuit .

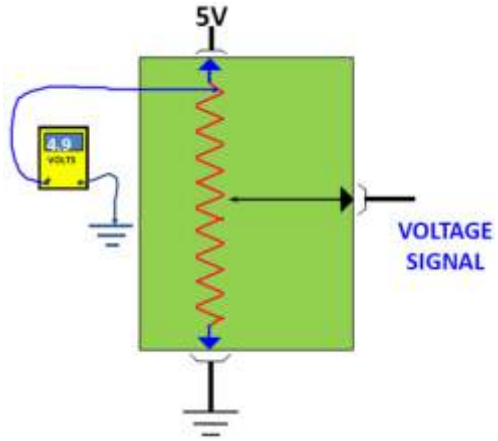


Fig. 2.1.1 Potentiometer

2.1.2 Rheostat

The **rheostat** generally controls current.

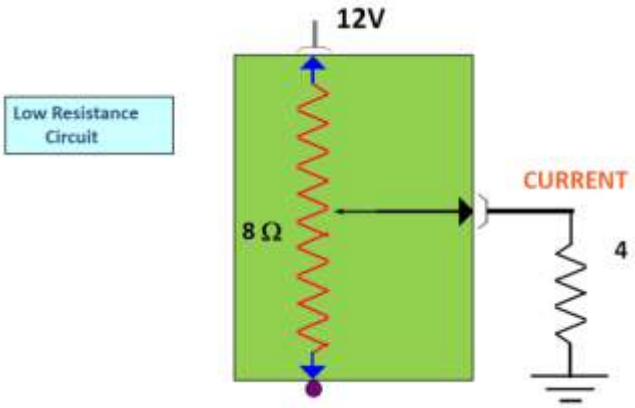
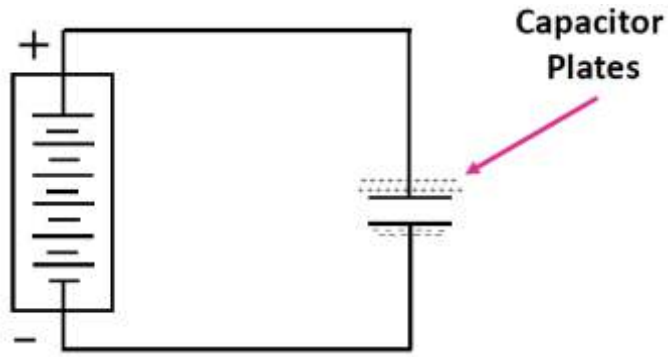


Fig. 2.1.2 Rheostat

2.1.3 Capacitor

Store energy
Filters
Timer Circuits



Charges accumulate on the plates of a capacitor

Fig. 2.1.3 Capacitor

Capacitance = Amount of electrical storage is determined by size of capacitor plates.
Capacitor blocks DC and passes AC.
Measured in **micro farads**.
Symbol = **uF** or **mfd**

2.1.4 Relay

What is purpose of relay?

a] Protect the circuit b] Decrease the current flow

c) Control high amperage circuit with a low amperage signal

d] Increase current flow

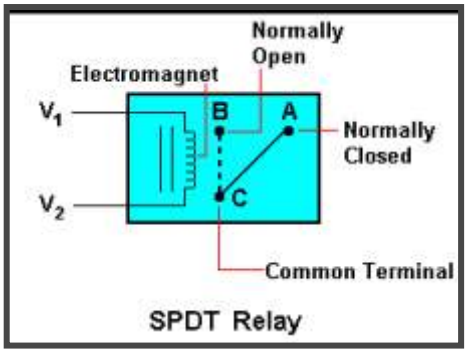


Fig-2.1.4: Relay

Relay is an electrical switch. Relay switching occurred with electromagnet induction.

V1 and V2 Power source

C Common terminal

B Normally Open

A Normally Closed.

Note: Low power control circuit which controls high power load.

Relays allow a small amount of current to control a large amperage load.

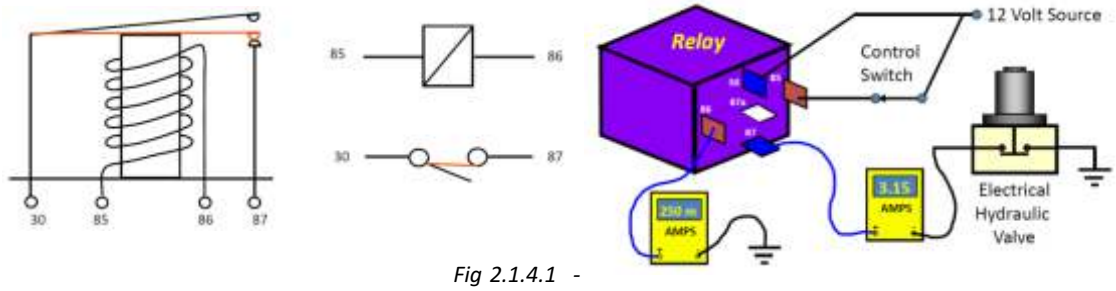


Fig 2.1.4.1 -

Do we have to pass voltage? No. We could pass ground.

Best way to check relay – apply power, ground to control circuit and check with a voltmeter across terminals 30 and 87 – looking for a maximum of **0.2 voltage drop.**

2.1.5 Diode

What a diode is in reverse biased state, what happens?

a] permit current flow
b) Does not permit current flow
c] Amplifies the current voltages
d] Decrease current flow

A suppression diode protects the circuit from:

a) **Voltages " Spikes"**
b] Voltage drops
c] Low voltage
d] Reversed Voltage

When testing a diode that is forward biased, what will the meter read?

a] 12 ohms
b] 3.5 ohms
c] 0.1 ohms
d) 0.3 to 0.7 ohms

Diode is like a hydraulic check valve.

Diodes can be made of Silicon or Germanium. **Diode** functions include:

a) Rectification – changing AC current to DC current
b) Circuit Control where there is a direct current in a specific direction between circuits, and
c) Clamping Protection, which helps to keep spikes from damaging the sensitive solid state material and helps to maintain circuit voltage within a specific range.

This is an example of **forward bias** as a one way check valve. Current will flow if positive voltage is applied on the arrow side (anode) of the diode.

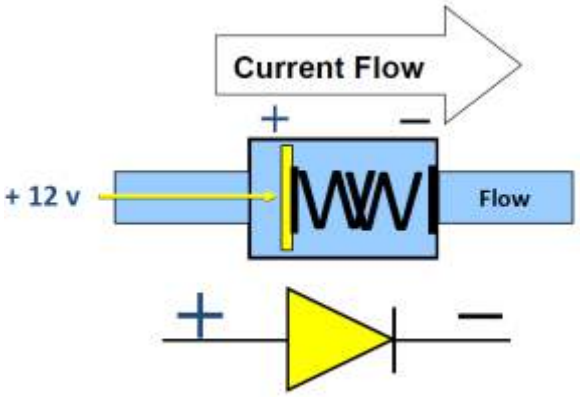


Fig. 2.1.5 Diode

2.1.6 Magnetic Pick up Unit

A **magnetic pickup** generates an analog signal. This is accomplished with a winding around a permanent magnet.
When the ferrous gear tooth passes the sensor it induces voltage. The processor counts the time between the highs of the analog signal and calculates the speed. These are generally used for rpm sensing.

Is this analog or digital – it's an analog signal.
Do I need a voltage source – **No.?**

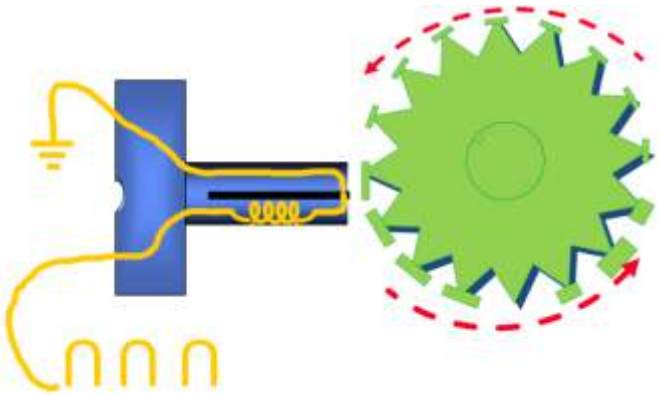


Fig. 2.1.6 Magnetic pick up Unit

What is the purpose of fuse?

a] Amplifies the current
b] Protect circuit from too much current
c] Voltage reducer
d] another switch in the circuit

2.1.7 Circuit Protection

Fuse:

A “one - time” protection device and must be replaced each time it melts

Fig -2.1.7: Circuit Protection

Circuit Breaker:

A device designed to open the circuit when the current flow exceeds the rated capacity.

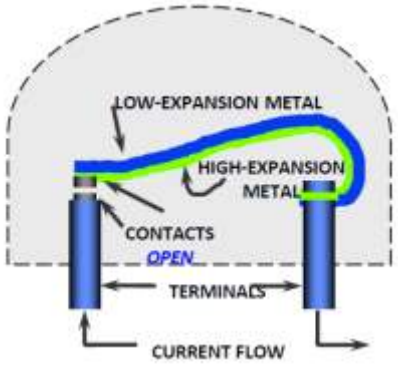


Fig. 2.1.7 Circuit Protection

UNIT2.2: Basic Electrical Diagnostics

2.2 Electrical Diagnostics Basics

1. In the illustration below, what must be done to correct the problem?

   a) Clean the battery connector
   b] No problem to repair
   c] Replace the battery
   d] Test the charging system

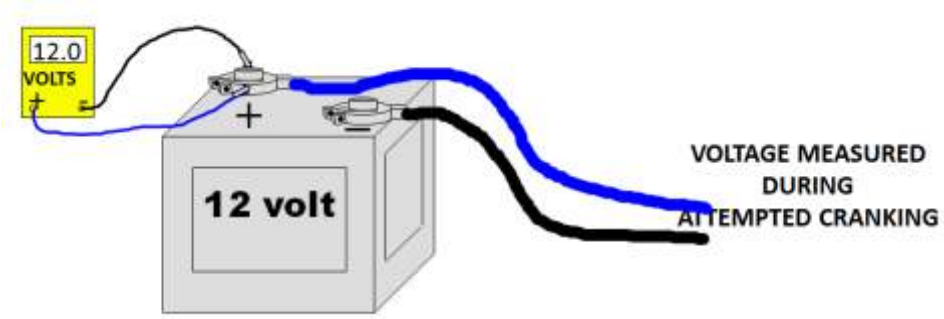


Fig -2.2.1

The voltmeter is testing the connection between the battery and the cable. Since there is a 12 volt drop, no voltage is available to the machine. There should only be a **0.2** Voltage drop.

2. The positive battery on a backhoe has been replaced. When you attempted to start the backhoe the positive cable melted. What is wrong?

   a] Ground cable gauge size too large
   b] The starter motor had too much resistance
   c] Ground cable not making a good connection to ground
   d) The replacement positive cable gauge size too small

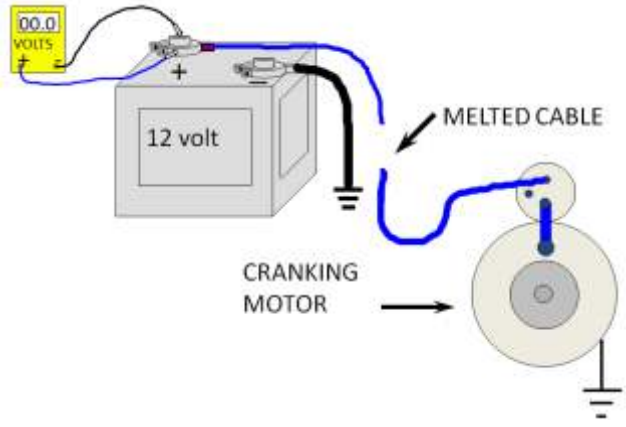


Fig -2.2.2

The cable could not handle the amperage because it was too small so it melted.

2.2 Cont.

During a voltage drop test, a voltage drop of 0.1 volt was found across the ground Cable of a cranking circuit. What does this tell the technician?

a] The cable size too small

b] Cable needs to be replaced

c] Clean connection to the frame

d) the cable is okay

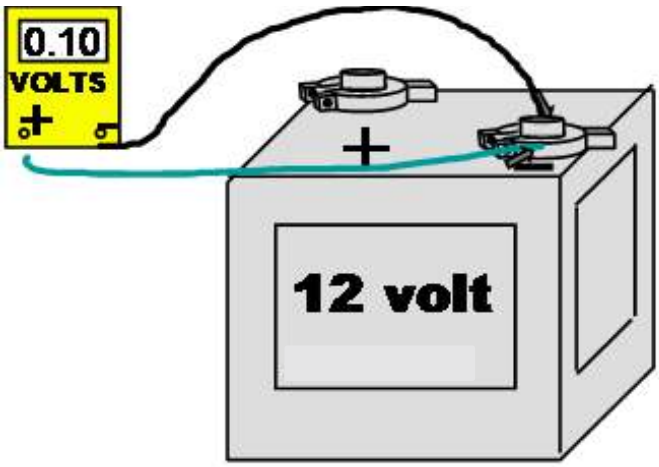


Fig -2.2.3

It's **OK** because the drop was less than **0.2 V**

2.3 Diagnostic Repair Tools

Inspect the electrical circuits regularly for:

– Damaged connectors
– Loose connections
– Chafing on wiring harnesses
– Corrosion
– Missing insulation
– Incorrect routing of harness

Do not use the machine if one or more of these faults are found. You must make sure that the electrical circuit is repaired immediately.

Multi-meter measures:

Voltage (AC, DC – Voltage)
Current (AC, DC – Ampere)
Resistance (Ohms, Kilo ohms)
Continuity
Diode
To measure current – Connected in series
To measure voltage – Connected in parallel
To measure resistance - the component must be removed from the Power source.

Fig -2.3.1

2.4 Battery Warning Indicator.

	Green colour indicates that battery is OK
	Blue colour indicates that battery is OK
	White colour indicates that battery needs charging
	In the event of the indicator showing red, open service plugs with the help of a coin and top up with pure distilled water or call any authorised battery dealer. Do not use screw driver for opening the plugs.

Fig -2.4.1

Checking the Electrolyte Level

1 Get access to the battery. See Access Panels.
2 Disconnect and remove battery. See Battery Disconnection/Connection.
3 Remove service plugs A. Look at the level in each cell. The electrolyte should be 6 mm (1/4 in) above the plates. Top up if necessary with distilled water or de-ionized water.
4 Refit battery.
5 Close and lock the access panels.

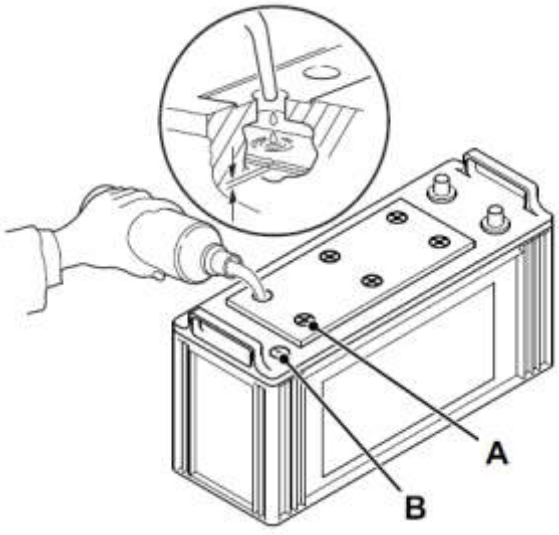


Fig -2.4.2

Notes

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3. Assist in Maintenance of Workshop, Tools and Machinery

Unit 3.1 – Basic Electrical Repair Supplies

Unit 3.2 – Soldering

Unit 3.3 - Cable Ties

Key Learning Outcomes

At the end of this module, you will be able to:

1. Identify location of tools and equipment; procedure for issue and return.
2. Understand different types of cleaning equipment & their usage.
3. Understand effects of contamination on products i.e oil, dirt.
4. Understand and follow different ways of minimizing waste.

UNIT3.1: Basic Electrical Repair Supplies

3.1 Electrical Repair Supplies.

Electronic Tuner/Connector Cleaner: This is approved for cleaning connectors.

Fig -3.1.1

Not Approved:

Brake Cleaner: Any petroleum based cleaner **NOT approved** for cleaning electrical components.

Ether Start Aid: **EXPLOSIVE AND NOT APPROVED**. Documented cases of use with an intermittent electrical problem and has caused an explosion.

Fig -3.1.2

Not Approved Silicone

Not approved for electrical and acidic smell

Silicone sealer – not approved for electrical. It has an acidic smell because it contains an acid-type substance. Will cause corrosion and problems long term.

Fig -3.1.3

3.1 Cont...

Approved RTV Clear Silicone Sealant [Room Temperature Vulcanizing].
100% Silicone.
Approved JD sealer.

a) A general-purpose, **RTV silicone** suitable to use as a form-in-place gasket, as well as for caulking and bonding.
b) Formulated to withstand extreme temperature changes, ultra -violet light, and ozone.
c) Adheres to metal, glass, paint, ceramic, most plastic, rubber, and wood.
d) Insulates thermally and electrically.
e) Provides a water and weatherproof seal.
f) Permanently flexible in –60- to 450-degree F (-51- to 232-degree C)
g) Available in a squeeze tube or tube for use with caulking gun.

Electrical Tape.

Cheap vs. good electrical tape – Don't over stretch the tape when finishing your wrap. Use a knife & cut it.

Fig - 3.1.4

UNIT3.2: Soldering

3.2 Soldering

Not usually a good idea because wire & connection loses flexibility.

Acid core solder.
Rosin core solder – Is it a good idea to solder connections?
Generally **No** because you lose some flexibility, in my opinion, **OK** if you use good solder.
Practices… Be careful of running the solder into the wire making a piece of stranded wire into a solid wire.

GOOD SOLDERING PRACTICES:

- Parts must be clean, free from dirt and grease.
- "Tin" the iron tip with a small amount of solder.
- Clean the tip of the hot soldering iron on a damp sponge.
- Heat all parts of the joint with the iron for under a second.
- Continue heating, then apply sufficient solder to form an adequate joint.
- Remove and return the iron safely to its stand.
- Do not move parts until the solder has cooled.

Fig -3.2.1

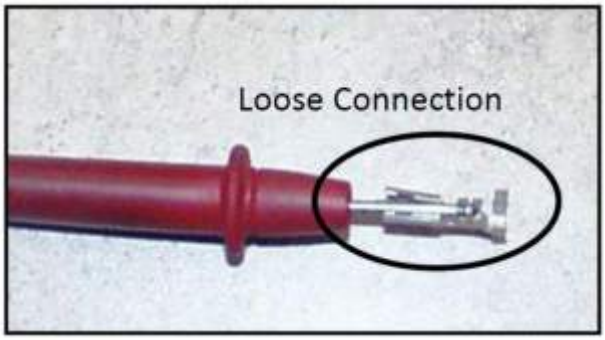

Fig -3.2.2

Some kind of connector with meter test leads. Figure 3.2.2 shows what can happen when leads are forced into the female pins, expanding them.

UNIT 3.3: Cable Ties

3.3.1 Cable Ties

Band wire ties– important to tie up harness like the factory did after making a repair. Many documented cases of electrical problems when not done.

Fig -3.3.1.1

Depending on application usage may change:

Fig -3.3.1.2

3.3.1 Cont...

Components of a good connection:

a) Clean
b) Seals and connectors correctly matched
c) Don't strip too much insulation
d) Don't cut wires
e) Same size wire or larger
f) Weather tight

- **Remove all rings from fingers**
- **Remove ground clamp first and replace last**
- **Be careful around batteries**

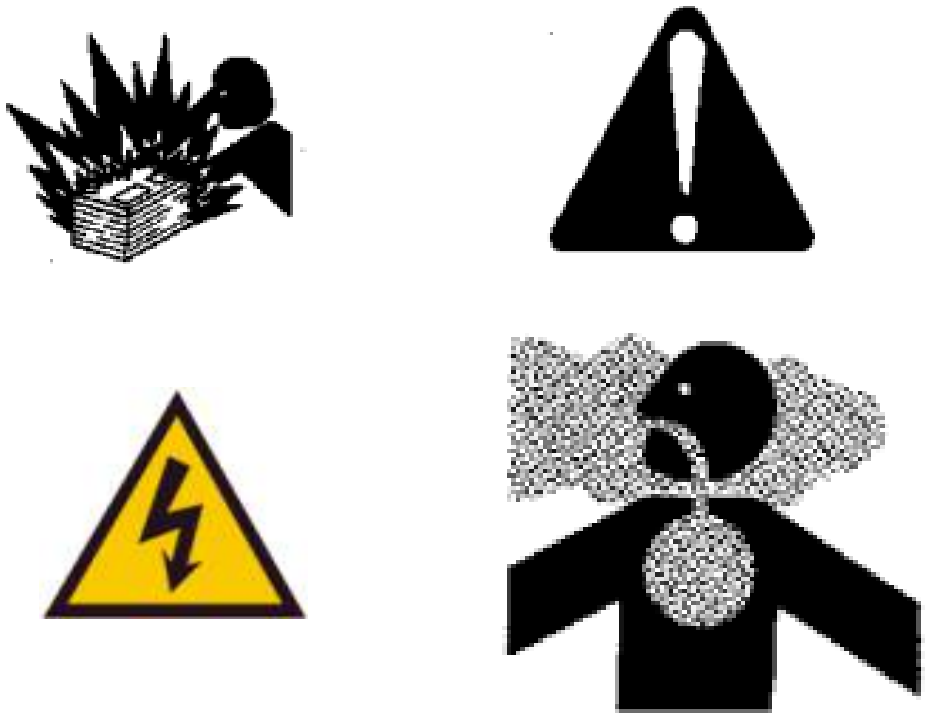

Fig -3.3.1.3

Notes

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4. Work Shop Health & Safety

Unit 4.1 – Environmental Safety, Health Policies

Unit 4.2 – Types and Uses of Personal Protective Equipment

Unit 4.3 – Common Hazards and Preventive Measures

Unit 4.4 – Segregation and Disposal of Waste

Unit 4.5 – Basic Fire Fighting Equipment and Use

Unit 4.6 – Common Injuries and Appropriate First Aid

Key Learning Outcomes

At the end of this module, you will be able to:

1. Health, safety, environmental (HSE) policies and guidelines of the company & their importance.
2. Reporting channel and documentation procedure for all HSE related matters.
3. Contact details of personnel responsible for HSE related matters & in case of emergencies.
4. Location of workshop store, first aid station and assembly points.
5. OEMs guidelines for health, safety and security requirements.
6. Types, use and importance of Personal Protective Equipment (PPE).
7. Types of common hazards and risks at workshop and preventive measures.
8. Safe practices when working with tools and machines.
9. In case of emergencies procedure to stop/ shut down machinery.
10. Common injuries and appropriate basic first aid treatment.
11. Fire-fighting equipment: Basic knowledge of handling and using them.
12. Guidelines for transport, storage and disposal of hazardous materials and waste.
13. Safety signs/symbols and warnings used in workshops and their meaning.
14. In addition to the core and generic skills listed above.
15. Use correct PPE and other safety gear while in the work shop.

UNIT4.1: ESH Policies And Guidelines

Unit Objectives

At the end of this unit, you will be able to:

1. Know about the safety precautions that a junior mechanic needs to follow while at work.
2. The various Do's and Don'ts while working with the machine.

4.1.1 Safety Precautions to be taken

It is in the interest of every employer and employee involved in the use of mobile plant and equipment to promote safety within their workplace.

The junior mechanic too has a duty to:

1. Be responsible and as safe and careful as possible in his work, so as not to put hisown health and safety or others at risk, including members of the public.

2. Co-operate with and assist the mechanic or any other person, as far as necessary, to enable them carry out their legal duties in health and safety.

3. Not interfere with or misuse any safety device or equipment .

4. Not intentionally or recklessly interfere with anything provided in the interest of health, safety and welfare

5. Follow mechanic's procedures and the manufacturer's instructions which apply to the care and safe operation of the machine they are responsible for.

6. Inform the mechanic, without unreasonable delay, of any work situation that they are aware of which presents a risk to the health and safety to them or others

7. Immediately report any defects in workshop and equipment which might endanger safety.

4.1.2: Do's and Don'ts During Operation

Do's

- Comply fully with instructions given by the junior mechanic.
- Follow the manufacturer's instructions (operator manuals) for the specific equipment you are assisting on.
- Take safety precautions when assisting on the machine prior to, during and after work.

Don'ts

- Assist on machine unless you have received appropriate training and are authorized to do so.
- Ignore hazards.
- Misuse, tamper or interfere with your machine and any associated safety equipment provided.
- Endanger your own health and safety, or that of anyone else, by being negligent.

UNIT 4.2: Types and Uses of PPE

Unit Objectives

At the end of this unit, you will be able to:

1. Understand common personal protective equipment's.
2. List and know the various uses of PPE.

4.2.1: Personal Protective Equipment

PPE is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as gloves, foot and eye protection, protective hearing devices (earplugs, muffs) helmet, respirators and full body suits.

Safety Helmets (Don'ts)

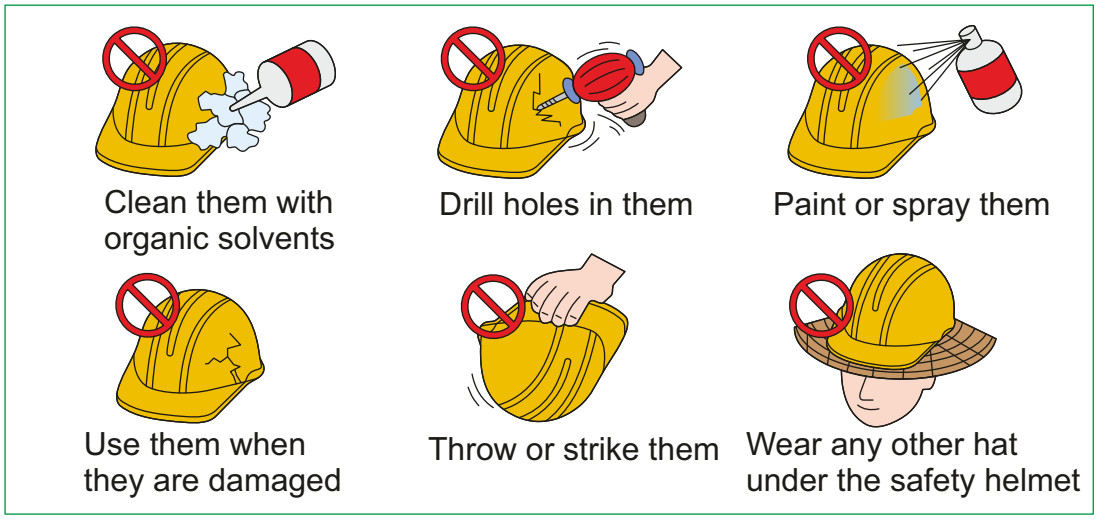

Fig 4.2.1a: Personal Protective Equipment

Eye Protectors

Fig 4.2.1b: Personal Protective Equipment

4.2.1 Personal Protective Equipment Contd..

Ear Protectors

Protective Gloves

Safety Footwear

Protective Clothing

Fig. 4.2.1.2. Personal Protective Equipment

Fig. 4.2.1.3. Personal Protective Equipment

UNIT 4.3: Common Hazards & Preventive Measures

Unit Objectives

At the end of this unit, you will be able to:

1. Understand the common hazards and preventive measures.
2. Follow the necessary Do's and Don'ts that may help avoid accidents at work.

4.3.1 Accident Prevention and Control Do's and Don'ts

Common accidents with hydraulic are overturns, falls, run overs and contact with other people and other objects. By following some basic Do's and Don'ts many of such accidents can be prevented:

Do's

- Wear all protective clothing and personal safety equipment issued to you or required by your working conditions.
- Understand and follow safety procedures when working on site and using plant and work equipment.
- Ensure you are fully aware of the job requirements and how they need to be carried out Know from where to get help. Know the first aid and emergency procedures.
- Study the manufacturer's operator's manual for using your plant and equipment. If the manual is not provided, ask your supervisor or the suppliers of the plant / equipment to supply one.
- Report faulty / unsafe plant or equipment and any dangerous incidents Use the plant equipment safely so as not to affect its stability.
- Ensure you watch out for others who are affected by your actions.
- Ensure all personal injuries, no matter how slight, are reported and entered in the accident book (or equivalent).
- Take advantage of any training program offered by your employer or contractor. You are never too old to learn new practices or techniques.

Don'ts

- Use plant or work equipment that you have not been trained to use throw or drop objects from plant or work equipment.
- Attempt to carry out work on moving parts of plant or work equipment with the safety guards removed.
- Indulge in horseplay on plant or work equipment.
- Attempt to operate any type of plant or work equipment under the influence of drugs, alcohol or any other substance, which affects your health or judgment Ignore warning instructions or safety signs.

UNIT4.4: Segregation and Disposal of Waste

Unit Objectives

At the end of this unit, you will be able to:

1. Understand to segregate different type of wastes.
2. Identify various ways to safely dispose of waste.

4.4.1 Waste Management

- Waste if not dealt properly is a big environmental issue. A junior mechanic needs to remember some basic waste management rules:
- Use ONLY authorized waste disposal sites
- Never store lubricants in open or unlabeled containers.
- Never pour used engine oil into sewers, drains or on the ground.
- Look out for the proper bin (black in case of general rubbish) in case of non-industrial waste at your work site. Most bins clearly mention the waste that can go in it.

Fig 4.4.1: Waster Management

UNIT4.5: Basic Fire-Fighting Equipment and Use

Unit Objectives

At the end of this unit, you will be able to:

1. Identify various type of fire-fighting equipment's for different types of fire.
2. Understand and acquire suitable fire-fighting equipment operating.
3. Understand the usage of right fire-fighting equipment on type of fire.

4.5.1 Fire Extinguisher

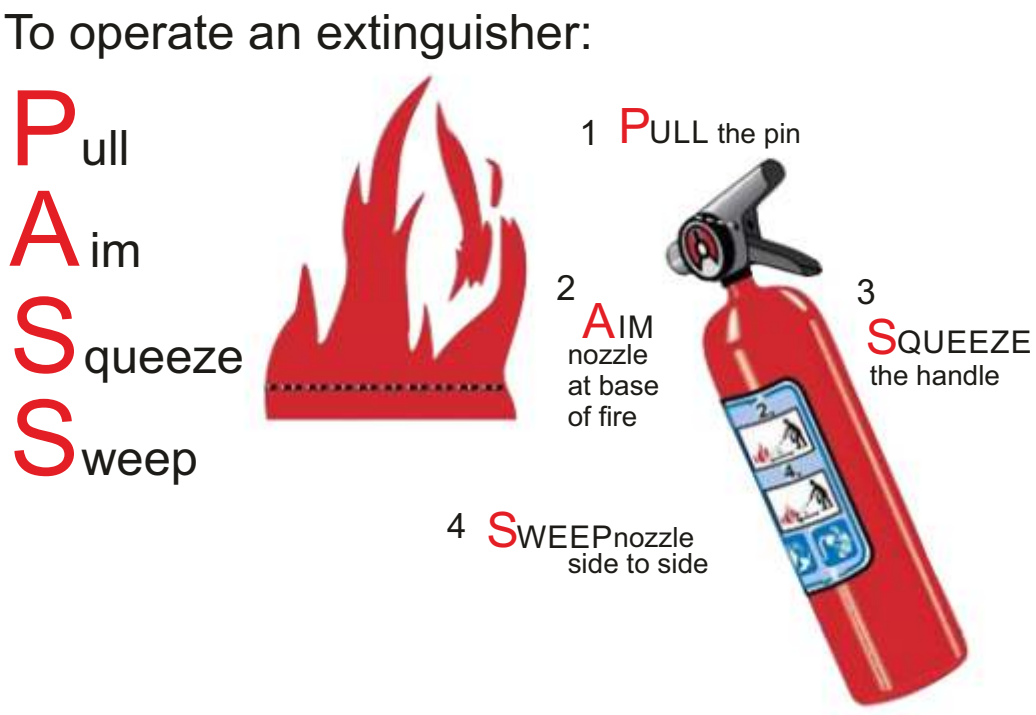

Fig. 4.5.1. Fire Extinguisher

4.5.2 Sand Bucket

Fig. 4.5.2. Sand Bucket

UNIT4.6: Common Injuries and Appropriate First Aid

Unit Objectives

At the end of this unit, you will be able to:

1. Understand about the first aid kit.
2. Administer first aid for common injuries.

4.6.1 Basic First Aid Kit

A junior mechanic must have basic knowledge of emergency medicines that can be used as primary medical service for cuts, wounds, fever, etc.

Scissors

Glove

Tweezers

Anticeptic wipes

Roller Bandage

Thermometer

Alcohol

Antibiotic ointments packets(approx 1g)

Fig. 4.6.1. Basic First Aid Kit

4.6.2 Administer Aid

Mouth-to-Mouth Resuscitation:

Mouth-to-mouth resuscitation, a form of artificial ventilation, is the act of assisting or stimulating respiration, where a rescuer presses his or her mouth against that of the victim and blows air into the person's lungs.

Steps

 *Fig 2.3.4 (a) Step 1*	**Step-1**: Make sure the person is lying on a hard, flat surface. Look into the mouth and throat to ensure that the airway is clear. If an object is present, try to sweep it out with the fingers (wear disposable surgical gloves if they are available). If vomiting occurs, turn the person on his or her side and sweep out the mouth with two fingers. Do not place the finger in the mouth if the person is rigid or is having a seizure.
 *Fig 2.3.4 (b) Step 2*	**Step-2**: Tilt the head back slightly to open the airway. Put upward pressure on the jaw to pull it forward.
 *Fig 2.3.4 (c) Step 3*	**Step-3**: Pinch the nostrils closed with thumb and index finger. Place the mouth tightly over the person's mouth. Use a mouthpiece if one is available. Blow two quick breaths and watch for the person's chest to rise.
 *Fig 2.3.4 (d) Step 4*	**Step-4**: Release the nostrils. Look for the person's chest to fall as he or she exhales. Listen for the sounds of breathing. Feel for the person's breath . If the person does not start breathing on his or her own, repeat the procedure.

4.6.2 Administer Aid

Choking:

Choking occurs when a foreign object becomes lodged in the throat or windpipe, blocking the flow of air. Choking cuts off oxygen to the brain, administer first aid as quickly as possible.

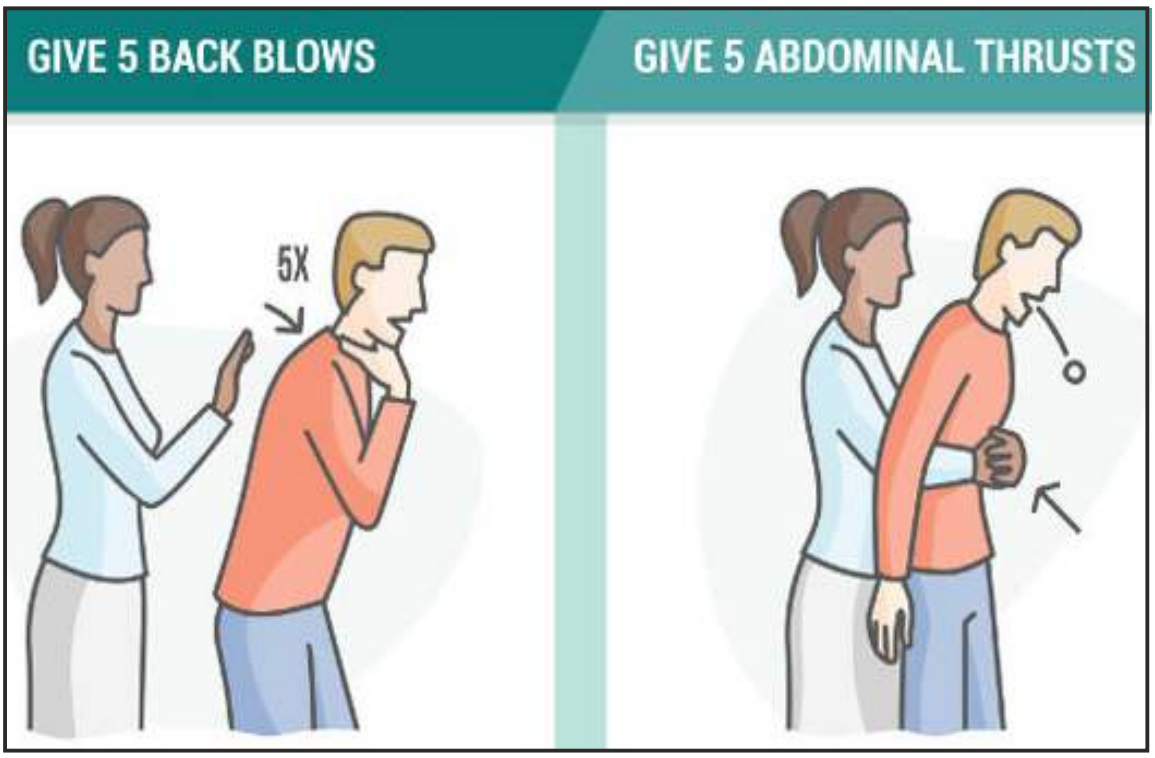

Fig 2.3.4 (e) First Aid for Chocking

- 5 back blows: First, deliver five back blows between the person's shoulder blades with the heel of your hand.
- 5 abdominal thrusts: Perform five abdominal thrusts.
- Give alternate 5 blows and 5 thrusts until the blockage is dislodged.

4.6.2 Administer Aid

Chemical Burns in an Eye:

To assist the person who has experienced chemical burns in eyes, follow these steps:

- Immediately rinse the eye or eyes under a water tap or in a gentle shower or with a clean container of water. Position the person's face so that the injured eye is down and to the side. Avoid spraying a high-pressure water stream into the eye or eyes.
- Flush with lukewarm water for 15 to 30 minutes. The person should keep the eye open as wide as possible. Wash the person's hands thoroughly to make sure no chemical is still on them.
- Do not rub the eye or place a bandage over the eye.
- While waiting for medical care, have the person wear sunglasses to decrease light sensitivity.

Foreign Particle in an Eye:

To assist the person who has experienced a foreign particle in an eye, follow these steps:

- Tell the person not to rub his/her eye – this could cause scratches on the eye surface.
- Ask the person to sit down and gently, separate his/her eyelids with thumbs or thumb and finger.
- Ask the person to look right, left, up and down and examine the eye for foreign objects.
- If something is present in the white of the eye, wash it out by pouring clean water or a sterile eye wash from the inner corner of the eye towards the outer corner.
- If this is unsuccessful, try lifting the object off with a moist swab or the damp corner of a clean handkerchief. If still the particle is not removed, seek medical help.

Fig 2.3.4 (f) Washing Eyes in Running Water

4.6.2 Administer Aid

Severe Bleeding:

For severe bleeding, take these actions immediately:

- If there is an object embedded in the wound, control bleeding by pressing firmly on either side of the object, do not remove or press the object, otherwise apply direct pressure on the wound.

Fig 2.3.4 (g) Controlling the Bleeding

- Apply a dressing firmly to control bleeding. Ensure that it is not so tight that it restricts circulation.
- Prevent/treat shock by lying the casualty down with his/her feet raised (if possible).
- If the casualty has a head in[illegible]d slightly raise his/her head and shoulders.

Fig 2.3.4 (h) Controlling the Bleeding

- If blood comes through the dressing apply another bandage on top.
- If blood seeps through this too, remove both dressings and re-apply a new sterile dressing using direct pressure to the wound.
- Support the injured area in a raised position.
- Seek medical attention if the bleeding does not stop or if the casualty goes into shock.
- Keep the casualty warm by laying him/her on a blanket or some other item.

4.6.2 Administer Aid

Fracture:

In case of a fracture, provide first aid before taking the injured to professional care

Aptly follow the few first-aid treatment till the professional medical treatment is given:

- If the injured person is bleeding, elevate and apply pressure to the wound using a sterile bandage, a clean cloth or a clean piece of clothing.
- If the injured person is bleeding, have fracture in his/her neck or back, help him/her stay as still as possible. If the injured person have fracture in one of his/her limbs, immobilise the area using a strap or suspend.
- Wrap an ice pack or bag of ice cubes in a piece of cloth and apply it to the injured area for up to 10 minutes at a time.
- Treat the injured for shock. Help the injured to get into a comfortable position, encourage him/her to rest and reassure. Cover him/her with a blanket or clothing to keep himself/herself warm.

R-Rest

After the injury, stop the injured person from taking part in any painful activity. Moving the injured part can increase bleeding and swelling and slow down the healing process.

I-Ice

Use an ice pack to reduce the pain and swelling in the affected area. Apply ice for 15minutes every two hours for 24 hours, then for 15 minutes every four hours for 24 hours.

C-Compression

Bandage the area firmly (but not too tightly), starting just below the injured area and moving up. Overlap each layer by half. Finish bandaging about one hand's width above the injured area.

Fig 2.3.4 (i) Rest Ice Compression Method

4.6.3 Do's and Dont's

Sl.No	Do's	Don'ts
1	Report suspicious activity.	Do not leave your system unlocked if not in use.
2	Communicate and co-ordinate with respective officials in case of any potential threat.	Never misuse the office resources (Pax manifest, duty mobile, system credential etc) it may lead to potential threat.
3	Stay alert.	Do not share your login credentials.
4	Closely monitor passenger (pax) activity during check-in and boarding to report any suspicious activity.	Do not only depend on human calculations, use calculator to reduce human error.
5	Ensure your safety at all point of time.	Effectively use the time to avoid flight delays.

Exercise

Briefly answer the following questions.

How can the junior mechanic help create a safer work place?

List some common PPE?

What precautions a junior mechanic has to follow when dealing with waste?

What makes up a basic first aid kit?

Tips

Following are recommended tips:

- Wash skin contaminated with oil thoroughly in warm soapy water.
- Do not use petrol, diesel fuel or paraffin to clean your skin.

Notes

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