General precautions for preventive maintenance

Maintenance for any equipment needs a working knowledge of that machine is very much essential to the person concerned. For example the volt ampere rating of voltage stabilizer is very important to carryout the preventive maintenance. Low quality, substandard components or materials never be used or recommended for use. Necessary steps to taken for safe temperature controlling and over loading conditions. Proper operating sequence or working steps to follow of all the equipments under maintenance.

Steps to follow break down maintenance

Break down can happen anytime, anywhere. Adequate protection might have provided to all equipments, for its smooth working. However continuous running or usage, lack of maintenance, human error and some unexpected reasons break down is happening.

Once break down maintenance or repair is required a detailed study of that equipment is essential. Always involve more persons pertain to the repair work or maintenance work for achieving a good result. A collective and competitive effort only will produce good results. Give value for everyones suggestion, expertise and workmanship. There must be a clean idea and vision to finalise the maintenance and repair. Ensure the services of experts, availability of spares, details of past records, diagrams and past history of the equipment such as its installation date, service records, number of break downs and its frequency etc; Servicing of voltage stabilizer by trouble shooting method.

Table 1

Trouble shooting chart for stepped automatic stabilizer

Sl. No.	Problem	Section to be suspected	Possible cause for defective	Action
1	No output voltage at output socket.	Input buck/boost relays.	Mains cord, switch, fuse, transformer and relays	Locate and repair or replace
2	The output voltage is more, do not regulate.	Electronic circuit or relays.	Open/shorted rectifier / diodes, or open zener diodes	Locate the defective part and replace.
3	Output voltage is same as input. Do not regulate.	Transformer or Electronic circuit	Transistor or held up relay contacts or Partial open transformer / leads.	Test, repair or replace.
4	Output voltage is low. Do not regulate.	Electronic circuit	Shorted zener diode or transistor or open resistors	Test and replace.
5	Chattering in relays	Electronic circuit/relays	Leakage capacitors	Replace.

Trouble shooting of UPS

The trouble shooting and repair of UPS is difficult as this circuit is so complicated with so many functions. A step by step trouble shooting approach with a reasonable analysing is very important to carryout the troubleshooting in the UPS circuit.

A trouble shooting chart of UPS is given for your reference in table - 2.

Table 2

Troubleshooting chart of UPS

Sl.No.	Fault	Possible Reason	Troubleshooting
1	UPS works on 240V VAC mains but does not operate on battery	1 Battery fuse is blown out 2 Battery is discharged	1 Check the battery fuse. If fuse is blown, replace it, if it is loose, tighten 2 Recharge the battery, also check the polarity of battery
2	When UPS is switched on, charger does not turn on	1 Mains input fuse may be blown	1 Change mains fuse, if fuse blown

Sl.No.	Fault	Possible reason	Troubleshooting
		2 Charger input fuse blown out	2 Check the battery polarity and conditions, correct it if wrong, replace the fuse 3 Check the supply from mains, if OK, then check relay wiring, check relay coil.
3	240 VAC mains supply NOT available	1 Mains supply fails 2 Input AC mains is very low 3 Loose connection in input wiring	1 Check the supply of mains 2 Check the voltage 3 Tight the connection of wiring coming from distribution board
4	DC voltage is OK, but UPS shows DC under voltage and trips	1 Inverter fuse is blown 2 Rust/loose connection in battery	1 Replace fuse 2 Check the connection
5	When the UPS is switched ON with out load but DC under voltage indicator turns ON at load.	1 Load too high 2 Loose connection of battery terminal 3 Short or earth fault in load	1 Check the load, add loads gradually. 2 Tight the connections and check the polarity of battery 3 Check the load circuit wiring
6	Where there is no AC mains supply and the UPS is operating on battery, DC under voltage indicator turns ON	1 Battery is discharged 2 Battery terminal dust or loose	1 Recharge the battery, use proper current capacity cable in the battery circuit. 2 Check the connection
7	DC fuse blows OFF	1 Overload or short circuit	1 Change DC fuse 2 Reduce the overload. If power transistors are short or leaky, replace them.
8	UPS does not switch ON	1 Supply fails due to blown out fuse or some break in cable 2 No DC supply in the control card due to dry soldering or desoldering	1 Replace fuse, check the cables 2 Check and correct dry soldering and de-soldering 3 Check control card wiring
9	UPS trips when full load is connected	1 Overload setting is wrong	1 Adjust the overload setting, check the power consumption of the load. Gradually increase the load.
10	UPS output is high	1 Some connection is broken in the feedback loop 2 Control card is not functioning properly 3 Over voltage sensing is faulty	1 Check feedback transformer wiring and adjust feedback voltage preset. 2 Check /Replace control card 3 Check overload sensing circuit
11	UPS does not switch on in battery mode	1 Mains earthing is not proper 2 Problem in inverter circuit	1 Check the earth connection 2 Check battery, MOSFET, oscillator section, driver section, output section
12	Battery wire getting burned	1 The relay points are joined together	1 Check / Replace relays

Sl.No.	Fault	Possible reason	Troubleshooting
13	Change over time high, computer connected to the UPS reboots during change over.	1 Check oscillator circuit	1 Check /replace IC and other components of oscillator section
14	Low backup time	1 Main filter capacitor problem 2 Battery get short circuit/discharge	1 Check and replace capacitor 2 Check battery, replace if required

Trouble shooting of battery charger and emergency light

As you have seen that the battery charger is a simple circuit compare to UPS. The main function of the charger circuit is to feed the DC voltage to battery at a prescribed level we discuss only the trouble shooting of charger circuit and its repair. Battery maintenance is not discussed in the trouble shooting chart.

Analyse the fault in battery charging circuit (Fig 1) with the help of trouble shooting chart given in Table 3 and 4.

Table 3

Sl. No.	Problems	Section to be suspected	Possible cause for defects	Action
1	No DC voltage at charging terminal	1 Faulty Ammeter (open circuit)	Aged/over current	Replaced Ammeter
		2 Blown fuse	Over current	Replace fuse
		3 Faulty rectifies diode	Aging/over loading	Replace all diodes
		4 Defective transformer	Aging/over loading	Replace transformer
		5 Faulty Relay contacts	Repeated closed open	Replace contact
		6 Open Relay coil	Over voltage/current	Replace relay
		7 Main fuse blown	Over loading	Replace fuse
		8 No link between meter to battery	Loose connection	Tighten the connection
		9 Defective auto transformer	Over loading	Replace transformer
2	Low terminal voltage	Anyone pain diode open circuited	Ageing	Replace all four diodes
		Partial short in transformer	Over heat	Replace transformer
3	No automatic charging voltage cut off	Defective potentiometer	Long use	Replace new potentiometer
		Driver diode open	Ageing	Replaced 2 diodes(D7)
		Defective electrolytic capacitor	Ageing	Replace capacitor (C_1)
		Defective bleeder resistor	Over current	Replaced same value resistor(R_1)
		Control circuit rectifier diode open	Ageing Over current	Replace both diodes(D_5 & D_6)
		LT winding transformer open	Ageing / over current	Replace new transformer (x_3)
		LT fuse open	Over current	Replace fuses (F_2)
		Defective auxiliary relay terminal	Repeated operation	Replace contact RLI(B)

Table 3 contd...

Sl. No.	Problems	Section to be suspected	Possible cause for defective	Action
4	Irregular over voltage cut off	Defective potentiometer	Loose contact in the disc (track)	replace new potentiometer (VP1)
		Shorted driver diode	ageing/over current	replace new diode (d7)
		Loose in relay contacts leaky electrolytic capacitor	Repeated contacts ageing	replace contacts replace electrolytic capacitor

Table 4

Trouble shooting chart for emergency light

Sl No	Problems	Section to be suspected	Possible cause for defective	Action
1	Lamp dead in both condition lamp	Defective tube	Ageing	Replace tube lamp
		Defective inverter transformer	Over loading/ageing	Replace inverter transformer
		Defective driver	Over loading/ageing transistor	Replace transistor (213055)
2	Lamp out glowing if AC fails	Low/ dead battery	Ageing	Replace New battery

Servicing of equipment are discussed based on a sample circuits. When servicing of other equipments with different circuits may differ from the troubleshooting sequences. However the basic principle based on the block diagram may be taken for guidance to service/repair the equipment.

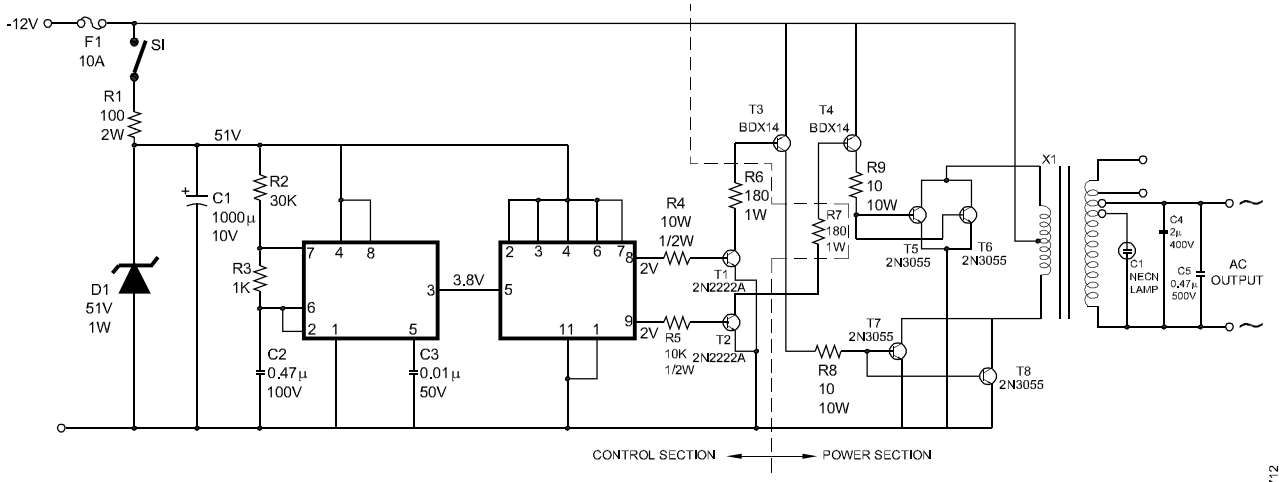
Trouble shooting of inverter

DC to AC inverter is quite complicated circuit, it consists of many functions. The switching circuit, oscillator circuit, control circuit power amplifier circuit, driver, finally the output circuit through the transformer. A feed back is also taken from the output transformer to regulate the output through the control circuits.

A constant DC source; either from a converter or battery is very much essential to keep the power output in a constant stage. DC to AC conversion with a specified frequency and a particular wave is difficult.

Analyse the fault in a inverter is explained (Fig 2) with the help of trouble shooting chart is given in Table 5. However the fault and problem are discussed while considering the 50Hz static inverter circuit is in Fig 2.

Fig 2



COMPELETE CIRCUIT DIAGRAM OF 50Hz STATIC INVERTER

ELN44118712

Table 5

Sl No	Problems	Section to be suspected	Possible cause for defects	Action
1	Output - Dead	- Output transformer	- Transformer open or short	Rectify transformer
		- DC source	- CT & transformer open	Rectify the CT connection
			- No DC from battery	Replace battery
			- Battery dead	
2	Low or high frequency	- Oscillator IC (555)	- Faulty IC	Replace IC
		- Control IC JK Flip-Flop	- Faulty IC	Replace IC
			- No supply to IC (series resistor open)	Replace resistor
			- Capacitor connected to IC 555 shorted	Charge faulty capacitor
3	Low voltage frequency ok	- Driver transistor	Fault in driver transistor	Charge the transistor
		- Power transistor (output transistor)	Fault in power transistor	Replace the power transistor
			Fault in output transformer Partial short in winding / cave	Rectify the transformer fault or Replace the transformer
4	Frequent cut-off the output	- Battery	- Low A/H capacitor of battery	Replace Battery
		- Fault in IC	- Over heat in IC	Provide heat
		- Fault in power transistor	- Over heat in power transistor	Sink to IC Sink to transistor

Installation of inverter in domestic wiring

Objectives: At the end of this lesson you shall be able to
- **enumerate the important points to be kept in your mind to select the inverter to be installed**
- **state how to select the place to install the inverter and battery**
- **explain how to install the inverter with battery and load, and check for its performance**
- **state the rating of inverter and its sample calculation.**

Important points to be considered before installing an inverter

Many time when a new inverter is not giving proper service, the fault is due to improper installation only, not in inverter.

Another most important point is when connecting an inverter to the line is, the total load connected to the inverter should not exceed 80% of capacity of inverter.

Before providing points to connect the loads to the inverter, the total connected load must be considered.

If over load occur, then the overload protection will 'cut OFF' the output and reduce the load then the reset key must be pressed, and if the inverter is not provided with overload protection, it may get damaged at the time of over load than the capacity of the inverter.

Selection of place for installation of inverter

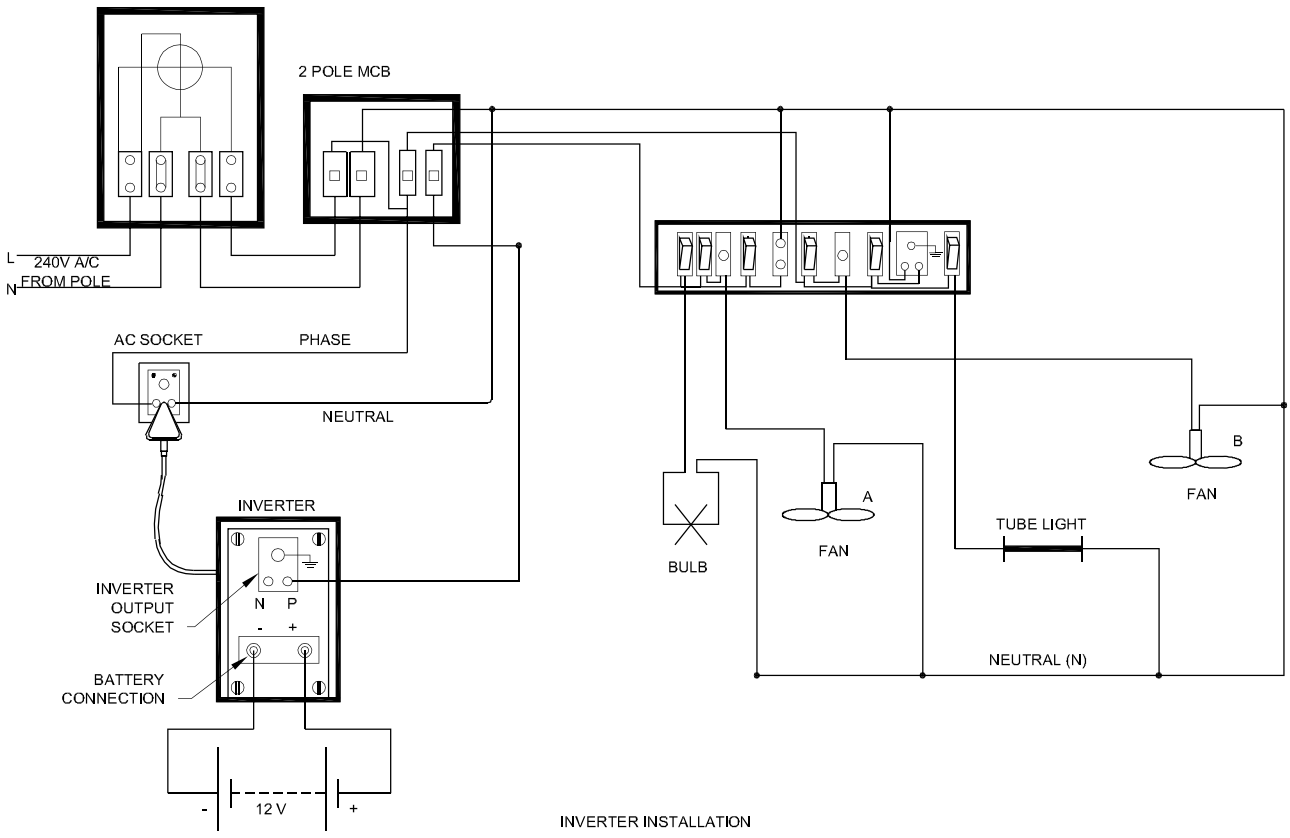
To connect inverter to the supply line, suitable place for the inverter is to be located. That place must be nearer to the service energy meter and ICDP switch and provide a 3 pin output socket from the mains supply line for the inverter and connect the inverter to the socket as in (Fig 1).

Installation of inverter

Collect the suitable inverter with sealed free maintenance battery to be installed, and check for their proper function

Place the inverter's battery to a suitable place near the inverter and connect the battery to the inverter.(Fig 1)

Fig 1



Keep the battery as close as possible to the inverter, so that the wire connecting the battery terminals to the inverter can be small and current loss is reduced. Make sure the battery is fully charged before installation.

The positive terminals of battery (red wire) is connected to the place provided for the positive terminal on the inverter and the negative terminal of the battery (blue or black wire), which is to be connected to the place provided for the negative terminal on the inverter.

When connecting battery terminals to the inverter, use special auto wires do not use common mains wiring with wires such as '3/20' and 7/20 etc.connecting battery using these wires will not provide proper connection between the battery and the inverter.

After connecting the battery, put some grease (or) vase-line on the battery terminals, which reducing the terminal corrosion.

All the connection is completed take the output from the inverters output socket and use it to power the load. Use 1/18 copper wire to the output of the load. Do not use 3/20, 3/22 or 7/20 wires, commonly used in house wiring.

The output is taken from the phase out 'pin of inverter' output socket, and is provided to the ON/OFF switches on the wall pause.(Fig 1)

The neutral line is common for both the inverter output and the mains A/C line. So, only one wire for the phase line can be drawn from the inverter output socket to the switches.

In Fig 1, one bulb, one fan and a 2 pin output socket are connected to the inverter output and the other devices in the room. (ie) the tube light, fan (2) and a 3 pin output socket are directly connected to the mains A/C line.

In the two pin socket, should not be connected with heavy load during power 'OFF' only small load like mosquito repeller can be connected.

As in (Fig 1) the load connected to the inverter will get the mains A.C supply. If the mains supply is 'On' at the same time, other devices will also work on the main supply, because they are connected directly to the mains A.C supply.

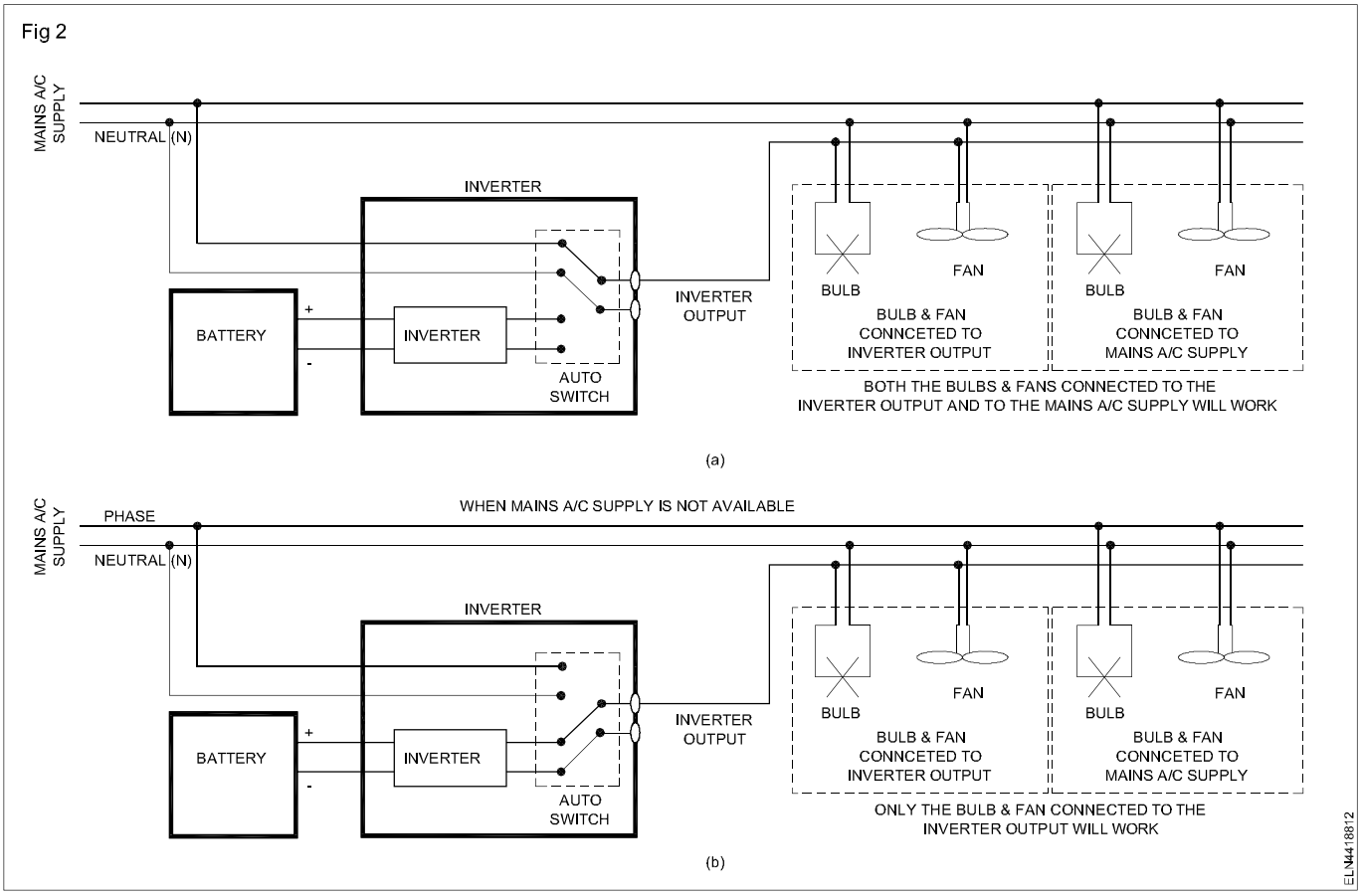
But at the time of power shut down, the devices directly are connected to the mains A.C will stop functioning and the devices, which are connected to the inverter output will keep on working on the inverter output.

Later, if the mains A.C supply returns, the inverter will once again connect the load, which are connected to its output to the main supply. This process is in Fig 2.

Inverter rating calculation

Generally, the inverters are available with ratings such as 200w,300w,400w,500w,600w,1000w,1200w,1500w and so on.

Fig 2



The cost of the inverter is proprotional to their capacity in wattage (or) VA. It must be considered before buying the Inverter.

Calculation of power consumption

True power = Apparent power x power factor
Let us assume,
The loads are - 2 tube lights,(ie) 2x40W = 80W
- 1 fan (ie) 1x60W = 60W
- 1 bulb (ie) 1x40W = 40W
Total load = 180 W

If the total load is 180W, the inverter capacity is to be selected for 300W, giving some safe margin.

Always, the inverter with high rating must be purchased by considering the future the household appliances may be added.

Power consumption Table

Device time	Approx Watts	P.f-0.8 (app) VA	Running for 1 unit of consumption (approx.) Hrs. - Min.
Incandecent bulbs (B.C bulbs)	25W	20	40-00
Incandecent bulbs	40W	32	25-00
Incandecent bulbs	60W	48	16-40
Incandecent bulbs	100W	80	10-00
Fluorescent tube 61 cms	20W	16	50-00
Fluroescent tube 122 cms	40W	32	25-00
4 feet night lamp	15W	12	66-40
Mosquito repellent	5W	4	200-00
Fans	60W	48	16-40
Air - coolers	170W	136	5-50
Air-conditioners (1 to 1.5 ton)	1500W	1200	0-40
Refrigerators (165 liters)	225W	180	4-30
Mixer/blender /juicer	450W	360	2-15
Toaster	800W	640	1-15
Hot plate	1000W	800	1-00
Oven	1000W	800	1-00
Electric kettle	1000W	800	1-00
Iron	450W	360	2-15
Water heater: (a)Instant geysers 1.5 - 2 liter)	3000W	2400	0-20
Water heater: (b)Storage type (10-12 liter)	2000W	1600	0-30
Water heater: (c) Immersion rod	1000W	800	1-00
Vacuum cleaner	700W	560	1-25
Washing machine	325W	260	3-00
Water pump	750W	600	1-20
TV	60W	48	16-00
Radio	15W	12	66-00
Video	40W	32	25-00
Tape recorder	20W	16	50-00
Stereo system	50W	40	20-00
PC Cop.	120W	150	8-20
PC/XT cop.	185W	230	5-25
PC/AT Cop.	255W	320	3-55
386& Higher Cop.	320W	400	3-08
Mono chrome monitor	44W	55	22-45
CGA monitor	64W	88	15-35
EGA monitor	80W	100	12-30
VGA monitor	120W	150	8-20
80-column dot-matrix printer	64W	80	15-40
160-240 cps printer	100W	125	10-00
132- column dot matrix printer	140W	175	7-08

Device time	Approx Watts	P.f-0.8 (app) VA	Running for 1 unit of consumption (approx.) Hrs. - Min.
Image writer II	80W	80	12-30
Laser write plus	880W	1100	1-08
HP Laser jet Printer	840W	1050	1-11
External Hard Disks	80W	100	12-30
Tape Back up	140W	175	7-08

Preventive and breakdown maintenance

Preventive maintenance : It improves the performance safety of a business instead of a large repairs being needed and major problems arising. Consistent maintenance is carried out to reduce these risks. This improves the performance of all equipment. It also helps to avoid unplanned repairs and unexpected maintenance needs.

Preventive maintenance further divided into two parts they are;

a Planned preventive maintenance and

b Unplanned preventive maintenance

a Planned preventive maintenance

A planned preventive maintenance cut-down maintenance cost and ensure the long life of equipment and a steady quality output. The following is the benefits of planned preventive maintenance.

a overtime costs reduced

b reduced risk of problems

c reduced no. of repairs

d small repairs can be carried out regularly

e ensures all equipment safe in good conditions

f If meets safety and environment standards

g Improves the safety and health of workers.

b Unplanned preventive maintenance

The unplanned preventive maintenance is nothing but a routine maintenance work. For example lubricating, cleaning, tightening of nuts and bolts etc, are same of the maintenance. This not involves any predetermined work associated. The following is the draw backs of unplanned preventive maintenance.

a Increases overall material cost

b Improper usage of manpower

c Not guaranteed of quality or quality or quantity in production

d No guarantee of machine condition

e Increased risk of problems

f Unexpected problems in production and quality.

Breakdown maintenance is a form of material or equipment remediation that is performed after the equipment or material has lost its functioning capabilities or properties.

Breakdown maintenance is maintenance performed an equipment that has broken down and is unusable. It is based on a breakdown maintenance trigger.

Demerits of breakdown maintenance

a Loss of production and business unexpected

b Huge expenses for restoration

c Non availability of spares and experts

d Accidents, environmental problems

e Leads to major accidents loss of life

f Wastage of raw material if time based supply

A well planned preventive maintenance can avoid breakdown of machines and keep maintain steady quality production and maintain company standards.

Sources of energy - Thermal power generation

Objectives: At the end of this lesson you shall be able to
- **explain conventional and non-conventional energy source**
- **state the various source of energy**
- **state the type of fuels used for power generation**
- **explain the working principle of thermal power station - cool and nuclear based**
- **explain schematic arrangement and constituents of thermal, diesel and gas turbine power plants.**

Introduction of power generation

Energy is the basic necessity for the economic development of a country and it exists in different forms in nature. But the most important form is the electrical energy . The modern society is fully depend on the electrical energy and it has close relationship with standard of living. The per capita consumption of energy is the measure of standard of living of people.

Sources of electrical energy

Since electrical energy is produced from energy available in various forms in nature, it is desirable to look into the various sources of energy. The natural sources of energy which are used to generate the electricity are :

i Sun

ii Wind

iii Water

iv Fuels

v Nuclear energy

vi Tidal

Out of these sources, the energy due to Sun and wind has not been utilized on large scale due to a number of limitations. At present, the other three sources viz, water, fuels and nuclear energy are primarily used for the generation of electrical energy.

i Sun : The Sun is the primary source of energy. .Solar cells are the one of the methods which uses the heat energy of the sun to generate the electrical energy in present days. this method came into large application of solar cells to produce electricity.however, than the limitations as:

a) It requires a large area for the generation of even a small amount of electric power.

b) It cannot be used in cloudy days or at night

c) It is an uneconomical method compared to conventional method

ii Wind: This method can be used where wind flows for a considerable length of time. The wind energy is used to run the wind mill which drives a small generator. In order to obtain the electrical energy from a wind mill continuously, the generator is arranged to charge the batteries which supply the energy even the wind stops. This method has the advantages that maintenance and generation costs are negligible. However, drawbacks of the method are that it is unreliable because of uncertainly about wind pressure and power generated is quite small.

iii Water: When water is stored at a suitable place, it possesses potential energy because of the head created. This water energy can be converted into mechanical energy with the help of water turbines. The water turbine drives the alternator which converts mechanical energy into electrical energy. This method of generation of electrical energy has become very popular because it has low production and maintenance costs.

iv Fuels: The main sources of energy are fuels viz. solid fuel as coal, liquid fuel as oil and gas fuel as natural gas. The heat energy of the fuels is converted into mechanical energy by suitable prime movers such as steam engines, steam turbines, internal combustion engines etc. The prime mover drives the alternator which coverts mechanical energy into electrical energy. Although fuels continue to enjoy the place of chief source for the generation of electrical energy, yet their reserves are diminishing day by day. Therefore, the present trend is to harness water power which is more or less a permanent source of power.

v Nuclear energy: Towards the end of Second world War, it was discovered that large amount of heat energy is liberated by the fusion of uranium and other fissionable materials. It is estimated that heat produced by 1 Kg of nuclear fuel is equal to that produced by 27,50,000 kg of coal. The heat produced due to nuclear fission can be utilized to raise steam with suitable arrangements. The steam can run the steam turbine which in turn can drive the alternator to produce the electrical energy.

Comparison of energy sources

The main sources of energy used for the generation of electrical energy are water, fuels and nuclear energy. Below is given their comparison in a tabular form in Table 1.

Table 1

Sl.No	Terms	Water Power	Fuels	Nuclear Energy
1	Initial cost	High	Low	Highest
2	Running cost	Less	High	Least
3	Reserves	Permanent	Exhaustible	Inexhaustible
4	Cleanliness	Cleanest	Dirtiest	Clean
5	Simplicity	Simplest	Complex	Most complex
6	Reliability	Most reliable	Less reliable	More reliable

Types of fuels used for power generations

Fuels are categorized into Three; They are

1 Solid fuels

2 Liquid fuels

3 Gaseous fuels

Solid Fuels

This can further be classified an

a Natural solid fuel

b Artificial soild fuel

The natural solid fuels are wood and different variation of coal, while the artificial solid fuels are charcoal, coke and pulverized fuel.

Liquid Fuels

This can replace coal for the production of steam. The major petroleum products, considered an liquid fuels are the following.

1 Gasoline (Petrol)

2 Kerosene

3 Gas oil

4 Diesel

Gaseous Fuels

This fuel can be divided in the following categories.

1 Natural Gas - It is obtained from soil by mean of dup wells and it is pumped out.

2 Producer Gas - This is a mixture of CO and H_2 with a little CO_2.

3 By product gases - This gas is obtained from blast furnace and coke ovens.

Advantages and disadvantages of liquid fuel

Advantages

i The design and layout of the plant where liquid fuel is used are quite simple and it occupies less space as the number and size of the auxiliaries are small.

ii Liquid fuel plant can be started quickly and can pick up the load in a short time.

iii There are no stand by losses.

iv The overall cost is much less than that of coal.

v The thermal efficiency is higher than that of a coal.

vi If requires less operating staff.

Disadvantages

i The plant where liquid fuel is used has high running cost as the fuel (i.e. diesel) used is costly.

ii The plant can generate only low power.

Advantage and disadvantage of solid fuel :-

Advantages

i The fuel (i.e coal) used in quite cheap.

ii The coal can be transported to the site of plant by rail or road.

Iii Solid fuel plant requires less space as compared to the hydro-electric power station.

v The cost is lesser than that of diesel.

Disadvantages

i It pollutes the atmosphere due to the production of large amount of smoke and fumes.

ii It's handling cost is high.

Types of electrical power generation

Basically power generation are of two types

a Conventional power generation

Power generations by using non- renewable sources of energy through various methods such as hydro, thermal and nuclear etc is called conventional power generation. It contributes to the major power requirement.

b Non conventional power generation

Power generation by using renewable energy sources such as wind, Tide and sun etc, is called non-conventional power generation. They are small scale power generation used for specific purpose.

Generating stations

Bulk electric power is produced by special plants known as generating station or power plants. A generating station employs a prime mover coupled with an alternator or generator for the production of electric power. The generated power is further transmitted and distributed to the customers.

Depending upon the form of energy converted into electrical energy the generating station are classified into,

1 Steam power stations /Thermal power stations

2 Hydro - electric power stations

3 Diesel power stations

4 Nuclear power stations

5 Gas - turbine power stations

1 Thermal /steam power station

A generating station which converts the heat energy of coal combustion into electrical energy is known as a steam power station.

The scheme of generation can be divided into two phases (i) Formation of steam in the boiler house (ii) Generation of electrical power in the generator room.

In the boiler the fuel is burnt and the water is converted into high pressure steam which is further super heated in a super - heater. The super - heated steam is passed in to the turbine to rotate the turbine blades, thus it converts the heat energy into electrical energy.

The turbine is the generation room acts as a prime mover of the alternator which generates electric energy. The alternator is connected through the circuit breaker to the bus bars.

This type of power station is suitable where coal and water are available in abundance and a large amount of electric power is to be generated.

2 Hydro - electric power station

A generating station which converts the energy posses by the water into the electrical energy is known as hydro-electric power station.

Water is a great source of energy. There are two types of energies which the water can posses. The flowing water in stream may have only kinetic energy. The flowing steam of water may have both kinetic as well as potential energy or simply potential energy at some elevation with respect to a lower datum level. The practical examples of which are water - falls or water stored at the back of a dam. The water stored in the reservoir is allowed to fall on the blades of a water turbine placed at the foot of the dam.

The initial cost of harnessing water and converting the potential energy into electrical energy is quite high but recurring expenses etc. are quite less. So, the overall system will be very economical.

3 Nuclear Power Station

A generating station which converts the nuclear energy into the electric energy is called as nuclear power station.

The nuclear power obtained by nuclear fission is fast entering into arena of energy sources. The heat produced by nuclear fission of atomic material is utilized in special heat exchangers to produce steam to run steam turbines. The atomic materials utilized for nuclear fission are thorium and uranium. Another reason of fast development of nuclear power is that the natural resources of coal and petroleum will exhaust early if the pace of industrial development remained so fast.

4 Non conventional energy

It is evident that all energy resources based on fossil fuels has limitations in availability and will soon exhaust. Hence the long term option for energy supply lies only with non-conventional energy sources. These resources are in-exhaustible/do not deplete for the next hundreds of thousands of years.

For example electrical energy from solar energy, Bio-energy, Wind energy, Geothermal energy, Wave, Tidal and Micro-hydro.

Choice of site for steam power stations

In order to achieve overall economy, the following points should be considered while selecting a site for a steam power station.

i **Supply of fuel :** The steam power station should be located near the coal mines so that transportation costs of fuel is minimum. However, if such a plant is to be installed at a place where coal is not available, then care should be taken that adequate facilities exists for the transportation of coal.

ii **Availability of water :** As huge amount of water is required for the condenser, therefore, such a plant should be located at the bank of a river or near a canal to ensure the continuous supply of water.

iii **Transportation facilities :** A modern steam power station often requires the transportation of materials and machinery. Therefore, adequate transportation facilities must exist. i.e., the plant should be well connected to other parts of the country by rail, road etc.

iv **Cost and type of land :** The steam power station should be located at a place where land is cheap and further extension, if necessary is possible. Moreover, the bearing capacity of the ground should be adequate so that heavy equipment could be installed.

v **Nearness to load centers:** In order to reduce the transmission cost, the plant should be located near the center of the load. This is particularly important if DC supply system is adopted. However, if AC supply system, is adopted, this factor becomes relatively less important. It is because AC power can be transmitted at high voltages with consequent reduced transmission cost. Therefore, it is possible to install the plant away from the load centers, provided other conditions are favourable.

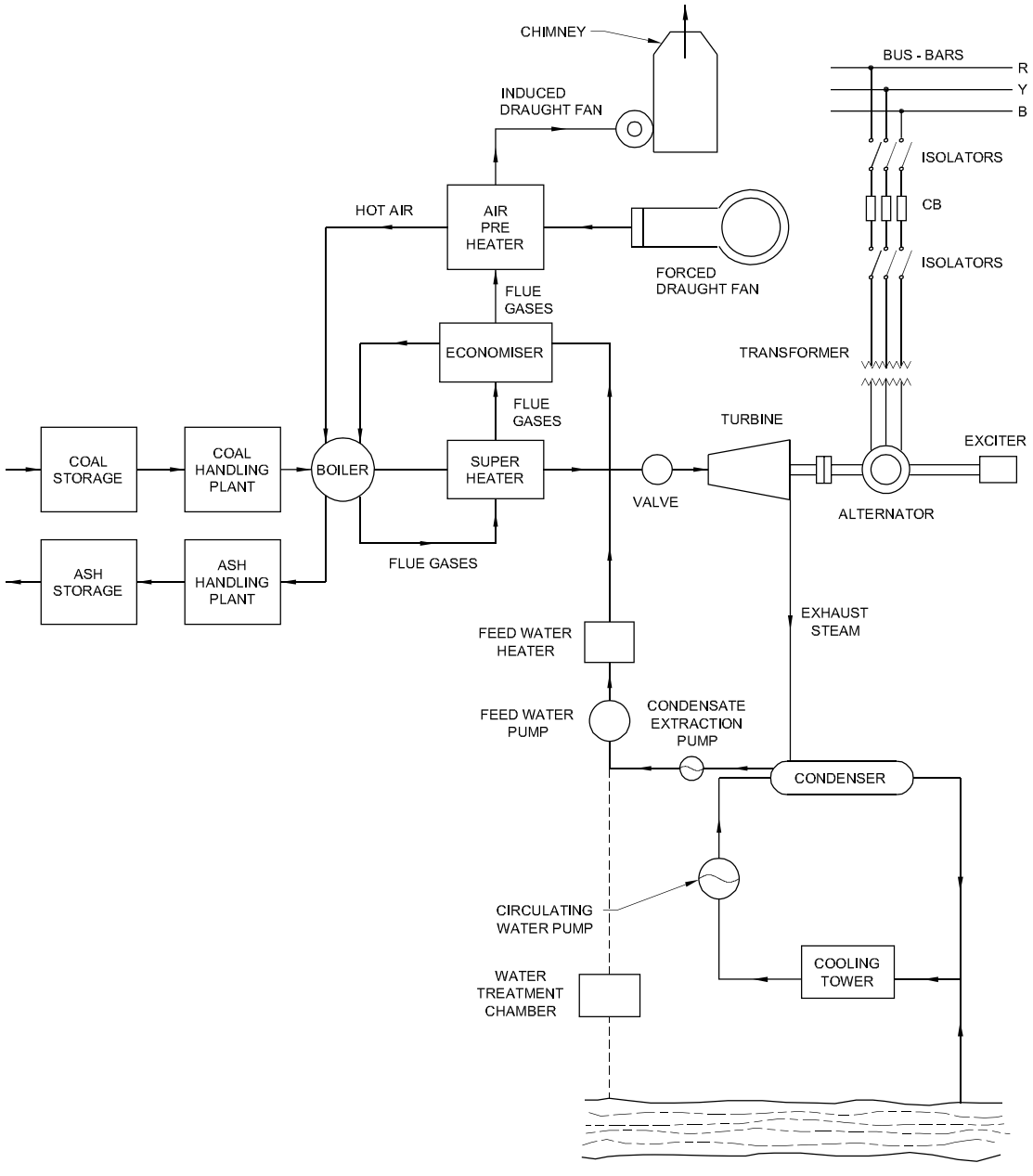
vi **Distance from populated area :** As huge amount of coal is burnt in a steam power station, therefore, smoke and fumes pollute the surrounding areas. This necessitates that the plant should be located at a considerable distance from the populated areas.

Conclusion : It is clear that all the above factors cannot be favorable at one place. However, keeping in view the fact that now- a -days the supply system in AC and more importance is being given to generation than transmission, a site away from the towns may be selected. In particular, a site by river side where sufficient water is available and fuel can be transported economically, may perhaps be an ideal choice.

Schematic arrangement of steam power station

Although steam power station simply involves the conversion of heat of coal combustion into electrical energy, yet it embraces many arrangements for proper working and efficiency. The schematic arrangement of a modern steam power station is in Fig.1. The whole arrangement can be divided into the following stages for the sake of simplicity.

Fig 1



SCHEMATIC ARRANGEMENT OF STEAM POWER STATION

1 Coal and ash handling arrangement

2 Steam generating plant

3 Steam turbine

4 Alternator

5 Feed water

6 Cooling arrangement

Constituents in steam power station

A modern steam power station is highly complex and has numerous equipment and auxiliaries. However, the most important constituents of a steam power station are :

1 Steam generating equipment

2 Condenser

3 Prime mover

4 Water treatment plant

5 Electrical equipment

1 Steam generating equipment

This is an important part of steam power station. It is concerned with the generation of superheated steam and includes such items as boiler, boiler furnace, super heater, economizer, air pre-heater and other heat reclaiming devices.

i Boiler : A boiler is closed vessel in which water is converted into steam by utilizing the heat of coal combustion. Steam boilers are broadly classified into the following two types.

a Water tube boilers

b Fire tube boilers

In a water tube boiler, water flows through the tubes and the hot gases of combustion flow over these tubes. On the other hand, in a fire tube boiler, the hot products of combustion pass through the tubes surrounded by water. Water tube boilers have a number of advantages over fire tube boilers viz. require less space, smaller size of tubes and drum, high working pressure due to small drum, less liable to explosion etc. Therefore, the use of water tube boilers has become universal in large capacity steam power stations.

ii Boiler furnace : A boiler furnace is a chamber in which fuel is burnt to liberate the heat energy. In addition, it provides support and enclosure for the combustion equipment i.e burners. The boiler furnace walls are made of refractory materials such as fire clay, silica, kaolin etc. These materials have the property to resist change of shape, weight or physical properties at high temperatures.

The size of furnace has to be limited due to space, cost and other considerations. This means that furnace of a large plant should develop more kilo calories per square metre of furnace which implies high furnace temperature.

iii Super heater : A super heater is a device which super heats the steam (i.e) it further raises the temperature of steam. This increases the overall efficiency of the plant. A super heater consists of a group of tubes made of special alloy steels such as chromium-molybdenum. The steam produced in the boiler is led through the super heater where it is superheated by the heat of flue gases. Super heaters are mainly classified into two types according to the system of heat transfer from flue gases of steam viz.

a Radiant super heater

b Convection super heater

iv Economiser : It is a device which heats the feed water on its way to boiler by deriving heat from the flue gases. This results in raising boiler efficiency, saving in fuel and reduces stresses in the boiler due to high temperature of feed water. An economizer consists of a large number of closely spaced parallel steel tubes connected by headers of drums. The feed water flows through these tubes and the flue gases flow outside. A part of heat of flue gases is transferred to feed water, thus raising the temperature of the latter.

v Air Pre-heater : Super heaters and economizers generally cannot fully extract the heat from flue gases. Therefore, pre - heaters are employed which recover some of the heat in the escaping gases. The function of an air pre-heater is to extract heat from the flue gases and give it to the air being supplied to furnace for coal combustion. This raises the furnace temperature and increases the thermal efficiency of the plant. Depending upon the method of transfer of heat from flue gases to air, air pre-heaters are divided into the following classes.

a Recuperative type

b Regenerative type

2 Condensers

A condenser is a device which condenses the steam and the exhaust of turbine. It serves two important functions. Firstly, it creates a very low pressure at the exhaust of turbine, thus permitting expansion of the steam in the prime mover to a very low pressure. This helps in Converting heat energy of steam into mechanical energy in the prime mover. Secondly, the condensed steam can be used as feed water to the boiler. There are two types of condensers, namely

a Jet condenser

b Surface condenser

3 Prime movers

The prime mover converts steam energy into mechanical energy. There are two types of steam prime mover viz., steam engines and steam turbines. A steam turbine has several advantages over a steam engine as a prime mover

viz., high efficiency, simple construction, higher speed, less floor area requirement and low maintenance cost. Therefore, all modern steam power stations employ steam turbines as prime movers.

Steam turbines are generally classified into two types according to the action of steam on moving blades viz.

a Impulse turbines

b Reaction turbines

In an impulse turbine, the steam expands completely in the stationery nozzles (or fixed blades), the pressure over the moving blades remaining constant. In doing so, the steam attains a high velocity and the impulsive force on the moving blades which sets the rotor rotating.

In a reaction turbine, the steam is partially expanded in the stationery nozzles, the remaining expansion take place during its flow over the moving blades. The results is that the momentum of the steam causes a reaction force on the moving blades which sets the rotor in motion.

4 Water treatment plant

Boilers require clean and soft water for longer life and better efficiency. However, the source of boiler feed water is generally a river or lake which may contain suspended and dissolved impurities, dissolved gases etc. Therefore, it is very important that water is first purified and softened by chemical treatment and then delivered to the boiler

The water from the source of supply is stored in storage tanks. The suspended impurities are removed through sedimentation, coagulation and filtration. Dissolved gases etc, are removed by aeration and degasification. The water is then 'softened' by removing temporary and permanent hardness though different chemical processes. The pure and soft water thus available is fed to the boiler for steam generation.

Nuclear based thermal power stations

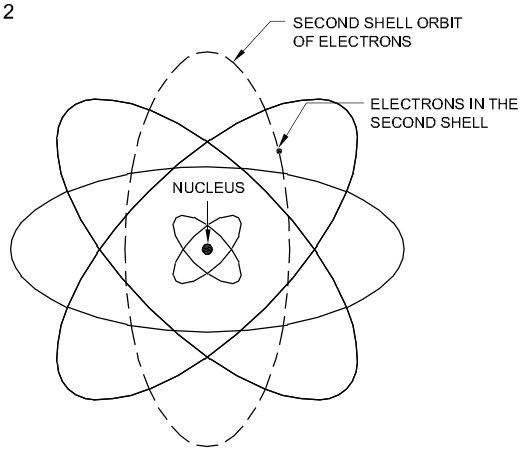
Composition of an atomic nucleus

A matter is said to be composed of small particles called atoms and the atom itself is composed protons, neutrons and electrons, arranged in a particular fashion. The centre of the atom consists of a very dense nucleus formed by protons and neutrons. Around the nucleus the electrons revolve in orbit. The system so formed is similar to that of planetary system as shown in Fig 2. The radius of the nucleus is about 10^{-12} cm. While that of electron orbit is about 10^{-5} cm.

The important properties of the atomic structure are:

The mass of proton and neutrons is almost same while the mass of each electron is 1/1840 times that of a proton or neutron which shows that the mass of an atom is only due to the nucleus. From avogadro's hypothesis, the number of atoms in a gram atom is 6.03×10^{23} (actually its mass is 1.008 gm)

Fig 2



REPRESENTATION OF SPINNING OF ELECTRONS

$$= \frac{1.008}{6.03 \times 10^{23}}$$

$= 1.67 \times 10^{-24}$ gm $= 1.67 \times 10^{-27}$ kg..... (1)

The mass of 1 electron

$$= \frac{1.67 \times 10^{-27}}{1840} = 9.10 \times 10^{-31} \text{ kg} \ldots\ldots\ldots\ldots\ldots (2)$$

It has been practically observed that, to deposit 1 molecule gram of hydrogen 96,493.7 coulombs of electricity are required.

So, charge on each electron

$$= \frac{96.493.7}{6.03 \times 10^{23}}$$

$= 1.602 \times 10^{-19}$ coulombs ..... (3)

The charge of proton is the same as that of electron

$= 1.602 \times 10^{-19}$ coulombs ..... (4)

The charge and mass of an electron, proton and neutron can be summarized as.

Name of atomic ingredient	Electric charge in coulomb	Mass in kilogram	Mass in atomic mass unit (a.m.u)*
1. Electron	-1.602×10^{-19}	9.10×10^{-21}	0.000, 548
2. Proton	$+1.602 \times 10^{-19}$	1.67×10^{-27}	1.00,758
3. Neutron	0	1.67×10^{-27}	1.00,898

*1 a.m.u = 1.6597×10^{-19} kg.