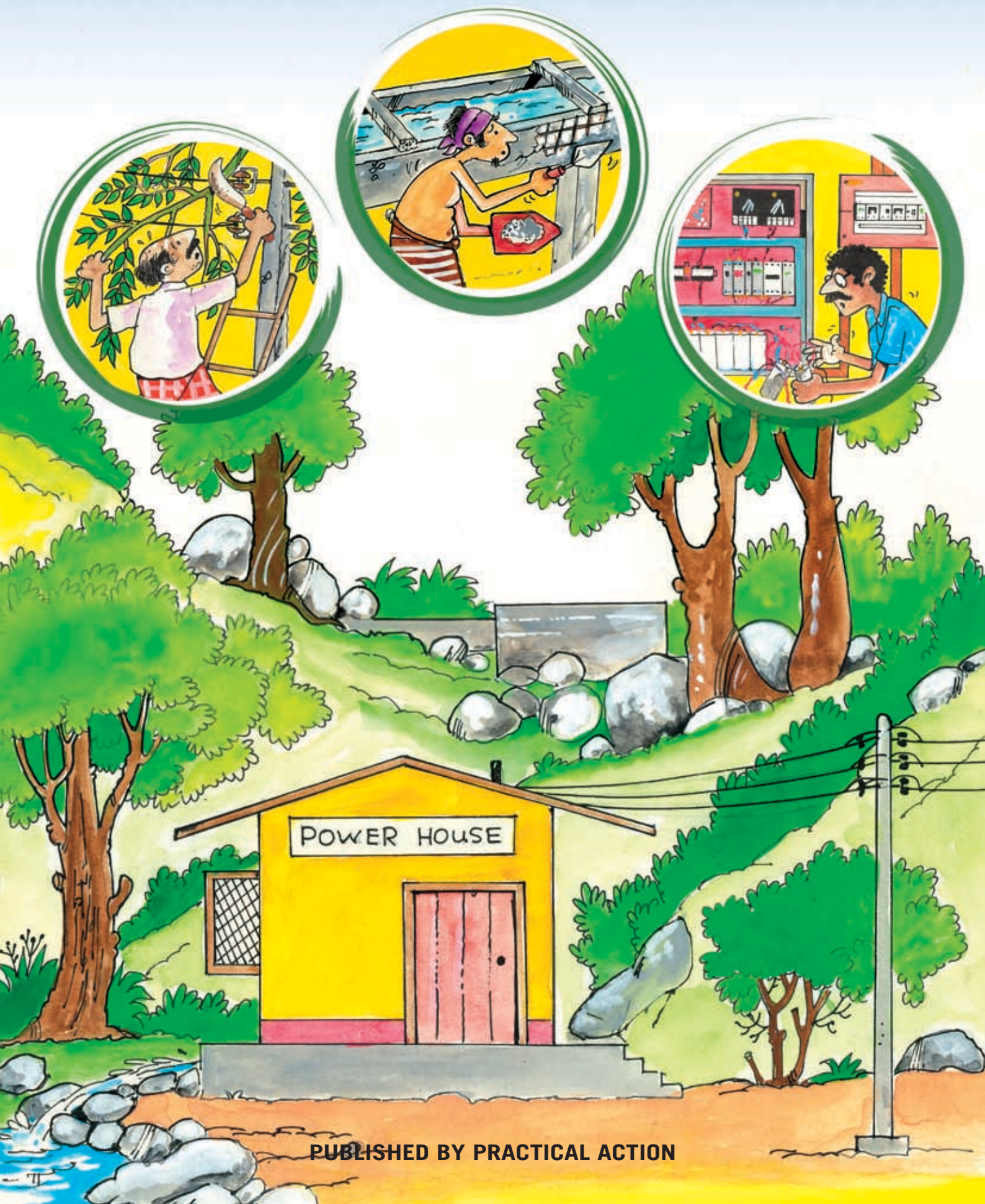


OPERATION & MAINTENANCE of Community Based Micro-Hydro Village Electrification Schemes



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OPERATION & MAINTENANCE OF COMMUNITY BASED MICRO - HYDRO VILLAGE ELECTRIFICATION SCHEMES

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FOREWORD

The continued success of community based micro-hydro electricity schemes depends on the cooperative relations between the members managing and operating the schemes and their relations with developers and other stakeholders. Members of electrified households and their representative consumer society need to operate and maintain the scheme efficiently and adequately. It is only then the community will continue to enjoy the use of electricity, with the assistance of a couple of operators from the village whose capacities have been developed.

Practical Action has worked on micro-hydro village electrification schemes for over 25 years. This community based renewable energy technology has proven to be an appropriate energy solution for remote villages which are not connected to the main electricity grid. At the heart of these schemes lie the village communities. They are not only the consumers and owners of the schemes but are also responsible for managing, operating and maintaining them.

For the smooth running of a micro-hydro village electrification scheme, proper operation and attending to at least preventive maintenance is vital. Small instances of neglect can lead to large problems for the whole scheme. Even a small repair may have to be attended to without delay so as to ensure the whole system is running smoothly. If the villages, often located in remote difficult to access areas, have to rely on external technical inputs, it may take days to repair the system. People will have blackouts in such instances. Therefore, some general understanding and competencies in regular operation and maintenance is a must for the village folk who obtain electricity from the community based micro-hydro village electrification schemes.

This booklet provides basic instructions and advice on how to keep a community based micro-hydro village electrification scheme up and running. It helps the community understand the technology, inculcating the required knowledge in order to provide uninterrupted and quality electricity supply to the village.

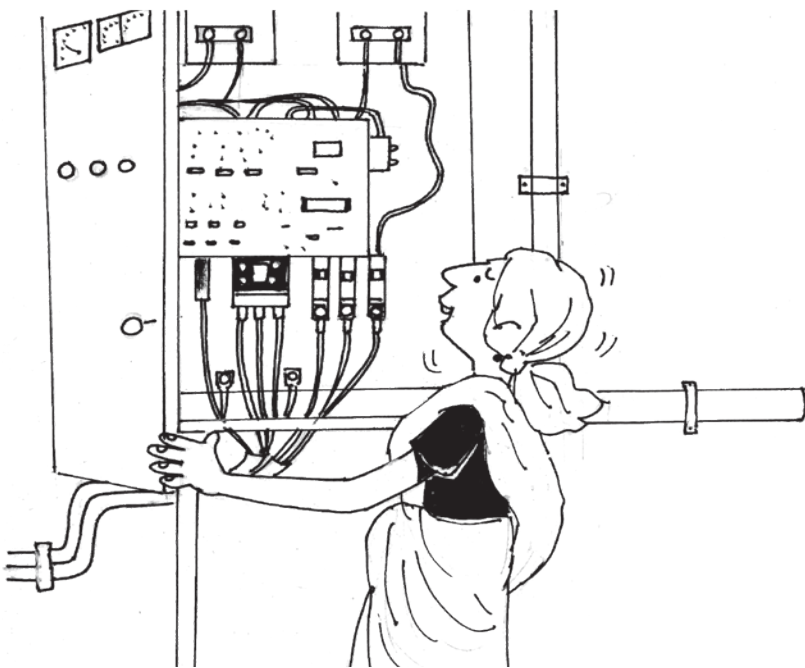
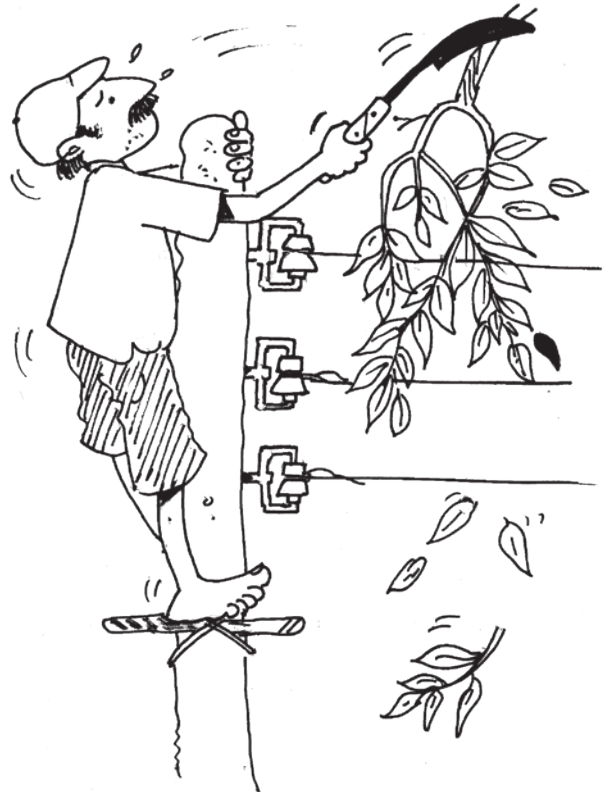
it is recommended that this booklet is used in conjunction with the 'Community Based Micro-Hydro Schemes - Technology & Approach' booklet.

CONTENTS

1. Introduction	07
2. Civil Construction	10
3. Mechanical Equipment	14
4. Electrical equipment	19
Table 2 Checklist	22
Table 3 Remedies for Common Problems in Operations & Maintenance	23
Log Sheet	24

1. INTRODUCTION

Once a community based micro-hydro village electrification scheme has been commissioned and starts providing electricity, nearly 90% of the operations and maintenance can be handled by the community members themselves. Except occasionally, there would not be a need for higher skills to attend to preventive maintenance. In case of major defaults, such repairs can only be addressed by skilled persons who may have to come from far. This is costly, and may take longer time, a time that the community electricity consumers cannot afford. Attending to operations and preventive maintenance on time by assigned persons from within the community (consumers) can reduce such occasions so that electricity can be supplied smoothly and economically.



Operators should always follow the manufacture's guidelines. In case of any variation, they should get advice from suitable persons without delay. Maintenance of a log with daily records is important for the operators. Regular maintenance requires observing for changes and taking remedial action on all the civil constructions, electromechanical equipment and distribution lines at least once a week. This should be done more frequently during rainy and windy periods. Regular preventive maintenance should be attended to on a pre-determined schedule (as recommended by the manufacturers/developers). It is important to maintain a footpath by the side of the components of village electrification scheme. This helps to access the different components, and to identify and attend to faults conveniently.

There are many aspects to the proper operation and maintenance of community based micro-hydro village electrification schemes. All necessary details cannot be given in a small manual like this. This manual is designed to address the most common issues faced in the past. As different schemes are designed by different designers, users of this manual may have to adapt what is mentioned in this manual to their respective settings.

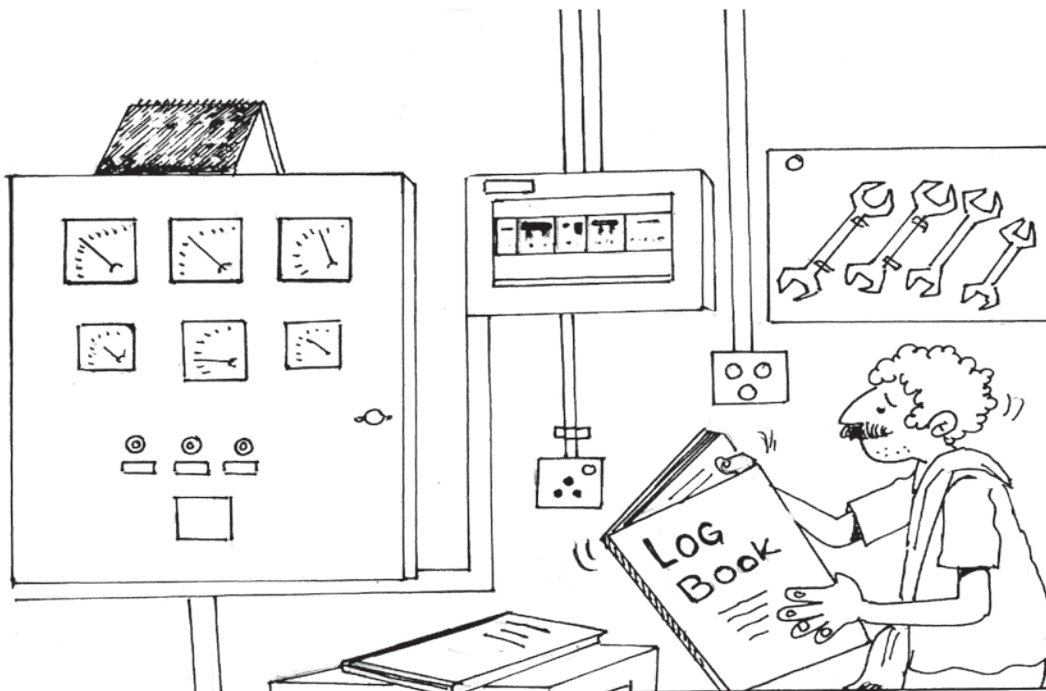
For a smoother generation & supply of electricity, the following points are vital for the consumers to note

- a. Notice whether there are any visible damages to constructions, equipment and distribution / supply lines.
- b. Never extend the wires (service points such as plug bases, bulbs) unless this is done by a skilled electrician.
- c. If the use of electricity is exceeding the stipulated limit (for example 200 W per household), negotiate for the increased consumption with the respective Community Electricity Consumer Society¹.
- d. If unusual noises from the power house or blinking of lights are observed, inform the person in charge of the power house immediately.
- e. Ensure that consumers are aware of appropriate uses and practices, using only the allowed applications and appliances.

When community members attend to repairs or maintenance always

- a. Get only the competent persons to handle the repairs and maintenance – a person assigned by the Electricity Consumer Society.
- b. Do not work alone, always have at-least one companion.

Updating the Log book



¹ The Electricity Consumer Society is made of community members who receive electricity from the hydroelectricity scheme. The society is in charge of managing, operating and maintaining the scheme.

- c. Stop the running of the turbine (from forebay tank or valve).
(Note - Switching off the main switch only has some risks unless the turbine is stopped)
- d. Use the right tools and reliable spare parts.
- e. Wear tight clothes (preferably overalls) when working with moving parts.
- f. If the community members cannot handle the maintenance, keep the turbine stopped and get inputs from competent technicians or the respective manufacturers / developers (who may not be from the same community).
- g. Update the log book with the details of the problems, repairs, components or spare parts replaced, etc.
- h. Have a list of frequently used spares / components (such as adhesives, water proofing material, electronic items) and the places from where they can be purchased.
- i. If certain components / spares (such as belts, bearings, heating elements in the ballast, switches, etc.) fail within an unusually short time, contact the respective suppliers and seek advice without continuously replacing or repairing them

Community Based Micro-Hydro Village Electrification Schemes can be considered as consisting of 3 broad sections, viz.

1. Civil Constructions
2. Mechanical Equipments
3. Electrical Equipments

The main sub-components of them are listed below

Civil constructions

- Weir
- Channel intake
- Channel
- Settling tank
- Forebay tank
- Penstock
- Power house
- Tail race

Mechanical equipment

- Header/manifold
- Valves
- Turbine
- Drive system
- Generator

Electrical equipment

- Generator
- Capacitor bank
- Control panel
- Distribution board
- Ballast
- Distribution lines
- Cluster Panel

2. CIVIL CONSTRUCTION

Civil constructions consist of aspects related to reinforced concrete, cement plaster, random rubble, bricks, steel and uPVC, etc. These types of material are also used for repair work. Constructions may become unstable or vulnerable due to soil erosion, cracks which have formed due to heavy loads or shock loads, deterioration over time, exposure of reinforcement, corrosion (steel), damage to uPVC from exposure to sunlight, etc. Most damages happen to these components during the rainy season. Maintenance work has to ensure that the necessary measures are taken to prevent the same faults from happening again. A delay in a small repair can lead to bigger and more serious problems within days.

Damage to the channel's reinforced concrete



Some general preventive maintenance steps on civil construction

- Construct a rubble wall to divert flood water
- Break any barriers (such as stones) that prevent the flow of flood water
- Divert storm water using gullies
- If the soil is loose, build retention walls with rubble or wood where necessary
- Use sand bags temporarily to prevent water flow when attending to repairs
- Remove any loosened rocks and boulders
- Plant and maintain trees (such as bamboo, lawn) where necessary to prevent soil erosion

WEIR

Check whether the weir base has eroded or is getting eroded. Look for any seepage of water near the weir. It is recommended that observations be made as to whether there is deterioration in the concrete or cement components. Another type of damage which can take place is the washing away of the bank of the stream across which the weir is built. The eroded places have to be filled with suitable material. The driest season is the best time to identify any seepage from the weir and to attend to repairs. After very unusually strong rain, the area in and around the weir has to be closely observed for any additional rocks that block the flow of water or any loosening of constructions. While removing the rocks that block the flow, repairing any damage is also vital. If required, build an additional side/retaining wall.

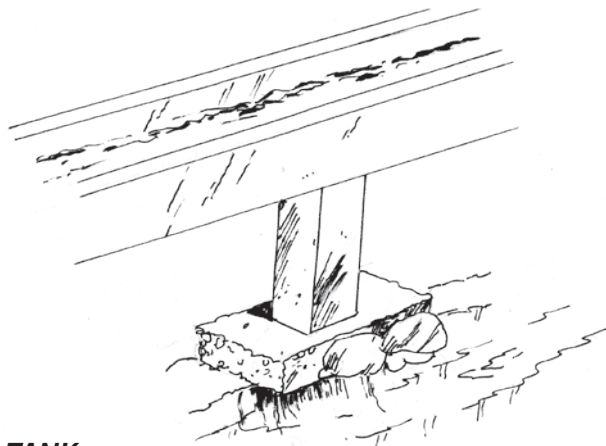
CHANNEL INTAKE & SPILLWAY

If there are any steel parts, protect them with an anti-corrosive paint. In case of sliding parts, such as screw and guide paths, grease them. Paint the wooden gate or replace as required. To stop leaks from the sluice gate, use a rubber beading or polythene at the slot of the sluice gate to proof the leak.

CHANNEL

Check the channel base and the base of the support columns (if any) for erosion. If there is erosion, repair with concrete or rubble work. If rain water damages the base of the channel, divert rain water by making side walls or small storm gullies. If cement works are eroded and reinforcement gets exposed, cover it with concrete. Pay attention to either side of the channel and look for loosen rocks, logs and earth slips, etc. Clean any over and under crossings of the channel.

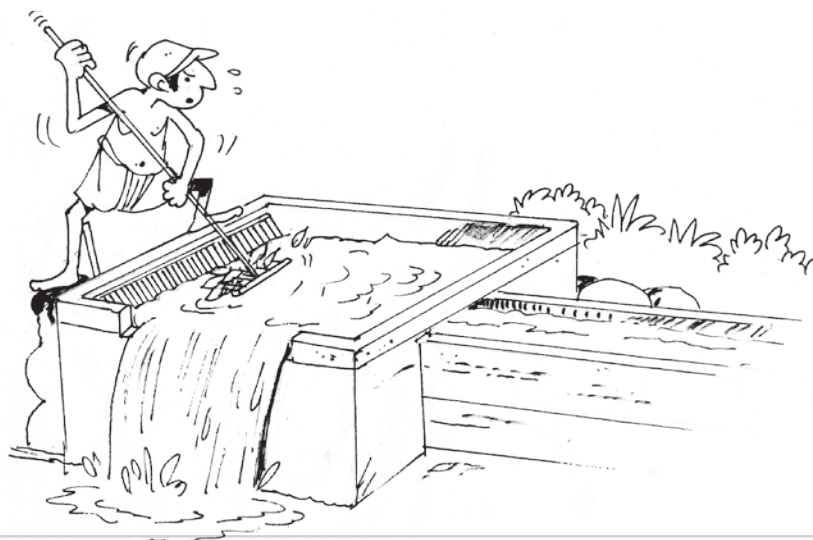
Loosened rock and eroded channel base



SETTLING / FOREBAY TANK

Observe the outside base for soil erosion and the inside for cracks and deteriorated concrete. When doing this, pay more attention to the spillway side. Ensure that the trash rack hasn't got bigger size holes (due to damaged or bent rods). If there is a lot of sand silting, identify from where the sand gets into the water - whether it comes from the stream or gets added to the channel on the way. Sand or any coarse particles can damage reaction turbines and significantly reduce their efficiency. If there is excessive silt present, modification of the civil construction may be required. This can involve constructing one more silting tank, enlarging go the settling tank or keeping the flush out hole open while running during rainy seasons. If too much of vegetation blocks the trash rack (maybe during windy or 'leave falling' season), an additional mesh has to be introduced at the channel intake. In practice, snakes have been found among the leaves around the forebay tank and it is advisable to take extra precautions when cleaning the forebay tank.

Cleaning the forebay tank

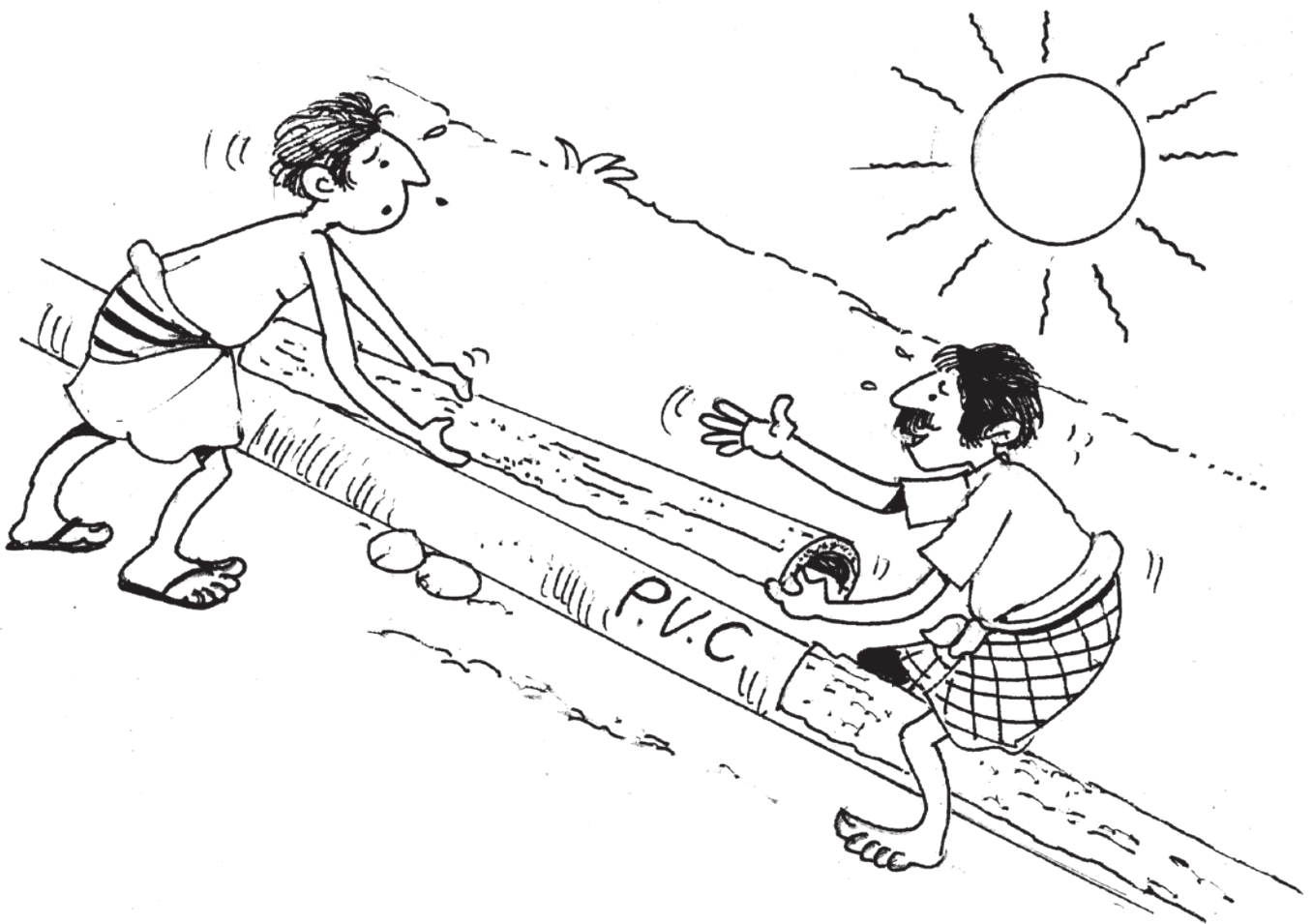


PENSTOCK

The penstock can be long. To maintain it properly, a person may have to walk along it. Thus, a walking path along the penstock is needed. The following are some of the important things the maintenance crew have to look out for when inspecting the penstock, and take collective action

- Water leakages (especially at joints)
- Supporting column bases for soil erosion
- Stones with sharp edges touching or colliding with the penstock
- Unstable rocks, soil or logs on either side (that can fall onto the penstock damaging it or soil slip away making the soil loose or causing sagging of the penstock)
- Expose to sunlight (uPVC pipe)
- Vent pipe without blocks
- Corrosion (steel parts)

Protecting the uPVC pipes

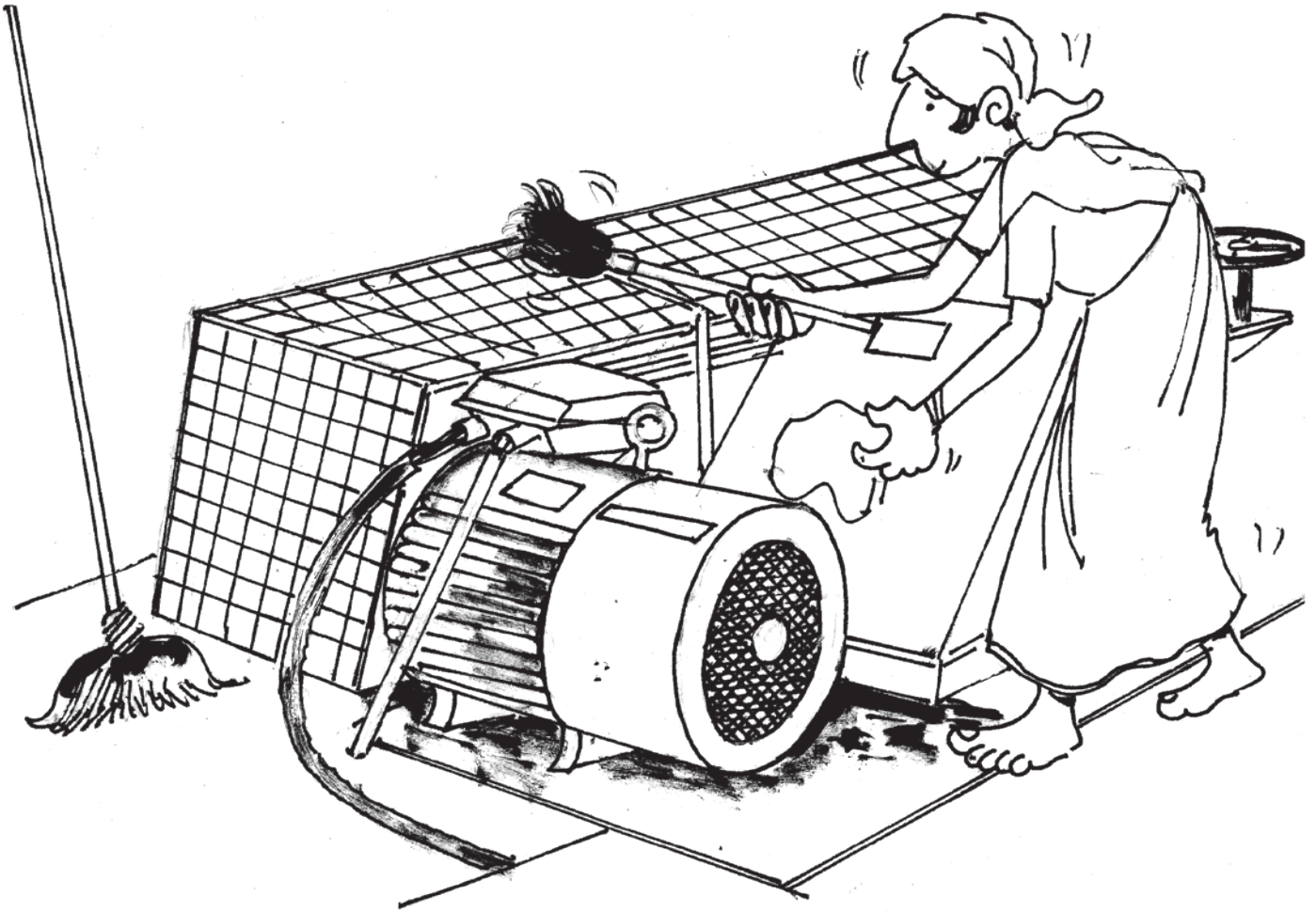


Especially in order to protect uPVC pipes from exposure to sunlight, animals, fire and stone etc. it is best to bury them with earth or cover them with stones and soil. For steel penstocks, regularly apply anti-corrosive paint.

POWER HOUSE

Always keep the power house and machinery clean. Ensure that there are no water leakages (from the turbine and the roof). Animals such as monkeys, birds, squirrels and ants should be prevented from entering/staying inside the power house. There should be good ventilation inside as electromechanical equipment can get heated, or the ballast heat could heat up the power house otherwise. The power house should not be used for any other purposes like running alternative machinery, as a store, or for cooking.

Keeping the machinery clean



TAIL RACE

Water released from the power house should be diverted back to the original stream safely without any leak or damage to environment. Rubble paving or concreting can minimise soil erosion.

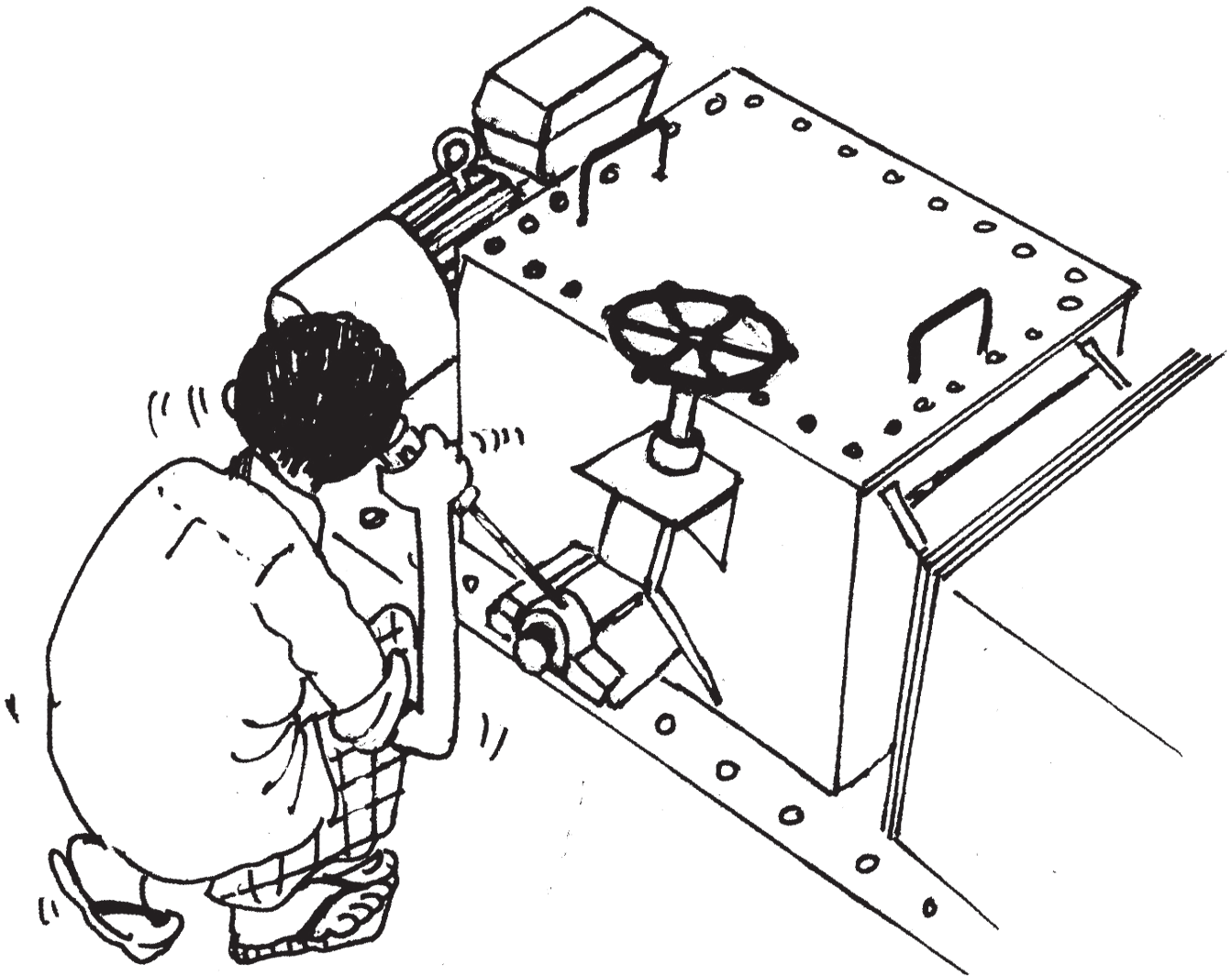
3. MECHANICAL EQUIPMENT

Defects in the mechanical components can generally be identified from the following;

- High vibrations
- Noise
- Overheating
- Inspection

Vibration may take place due to loose nuts and bolts, under - tensioned belts, damages in the turbine and worn out bearings. Tighten up loose nuts and bolts. Check the turbine and see whether it is damaged or loose. If there is a problem with the bearings they may have to be replaced with the help of a competent technician. Worn out bearings can be identified using a long screw driver as shown in drawing below.

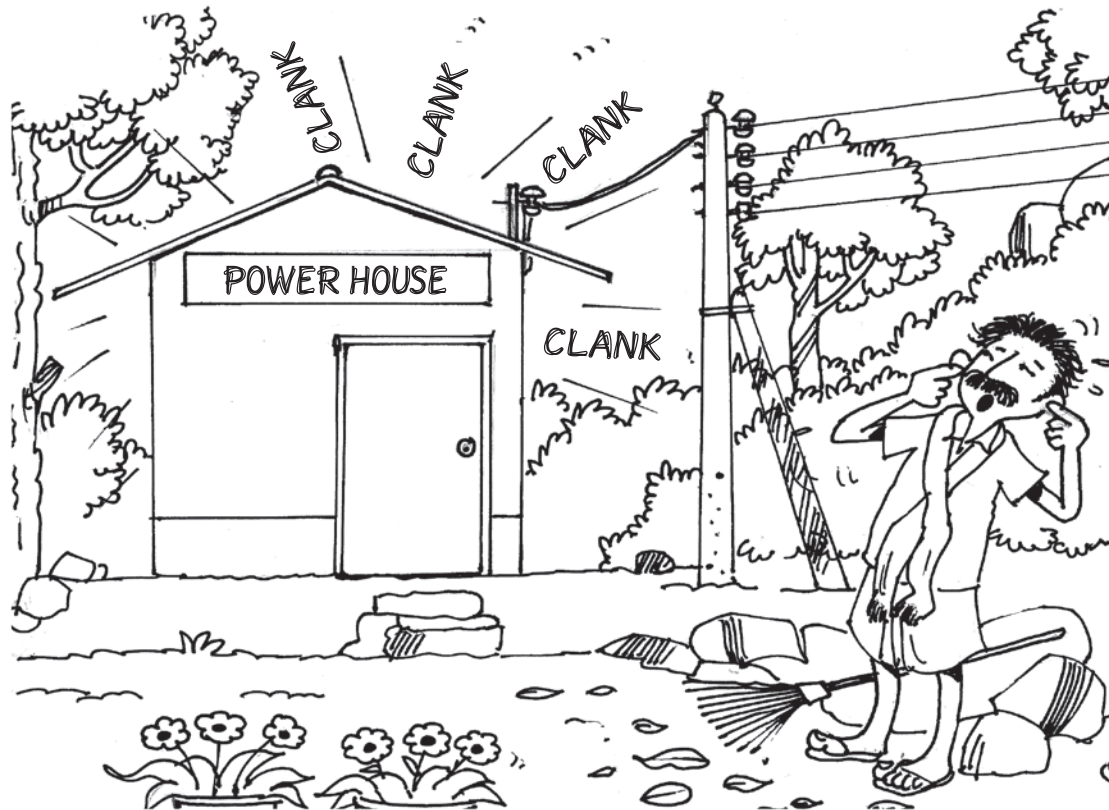
Checking the bearings for Vibration



A smooth sound while running indicates that the bearings function smoothly while a coarse or sharp sound indicates that the bearings have some problem.

Noises can be generated due to the vibrations mentioned, something touching the rotating parts, or the nozzles of the turbine being partially blocked. Identify the source of the noise and undertake adequate repairs.

Unusual noise emitted from the turbine



Some components such as generators, bearings, belts and pulleys get heated due to faulty conditions. By being familiar with the working temperature, you can identify whether it is overheated or not. The following table gives possible reasons for overheating.

Table 1 : Possible reasons for overheating

Item	Possible Reasons	Remedy
Bearing housing	No grease / too much grease	Apply grease as specified by the manufacturer. If this has not been specified by the manufacturer, grease in intervals of 4,000 hrs. If there is excess grease, remove the excess grease.
	Belt too tight / misalignment	Adjust the tightness / alignment
	Bearing is too tight (sleeve adaptor type)	Adjust the bearing sleeve
Generator	Cooling fan is blocked	Remove the fan casing and clean
	Electrical fault in the generator or control system	Please refer to the following paragraph under electrical equipments
Belt & Pulley	Belts too loose	Tighten the belt. Do not use old and new belts together.
	Grease is smeared on belt or pulley	Clean the pulley and belt and get rid of grease

In addition to the above, visual observations on mechanical components is very important. The possible cause for each item is explained below.

HEADER / MANIFOLD

Generally this is made with steel or uPVC. The main problem which can occur in the manifold is water leaking through the joint. If this happens, tighten up the relevant joint. If there are any main repairs required, it is better to do this using new packing material (in other words do not re-use packaging material). In addition, paint this part to protect it from corrosion.

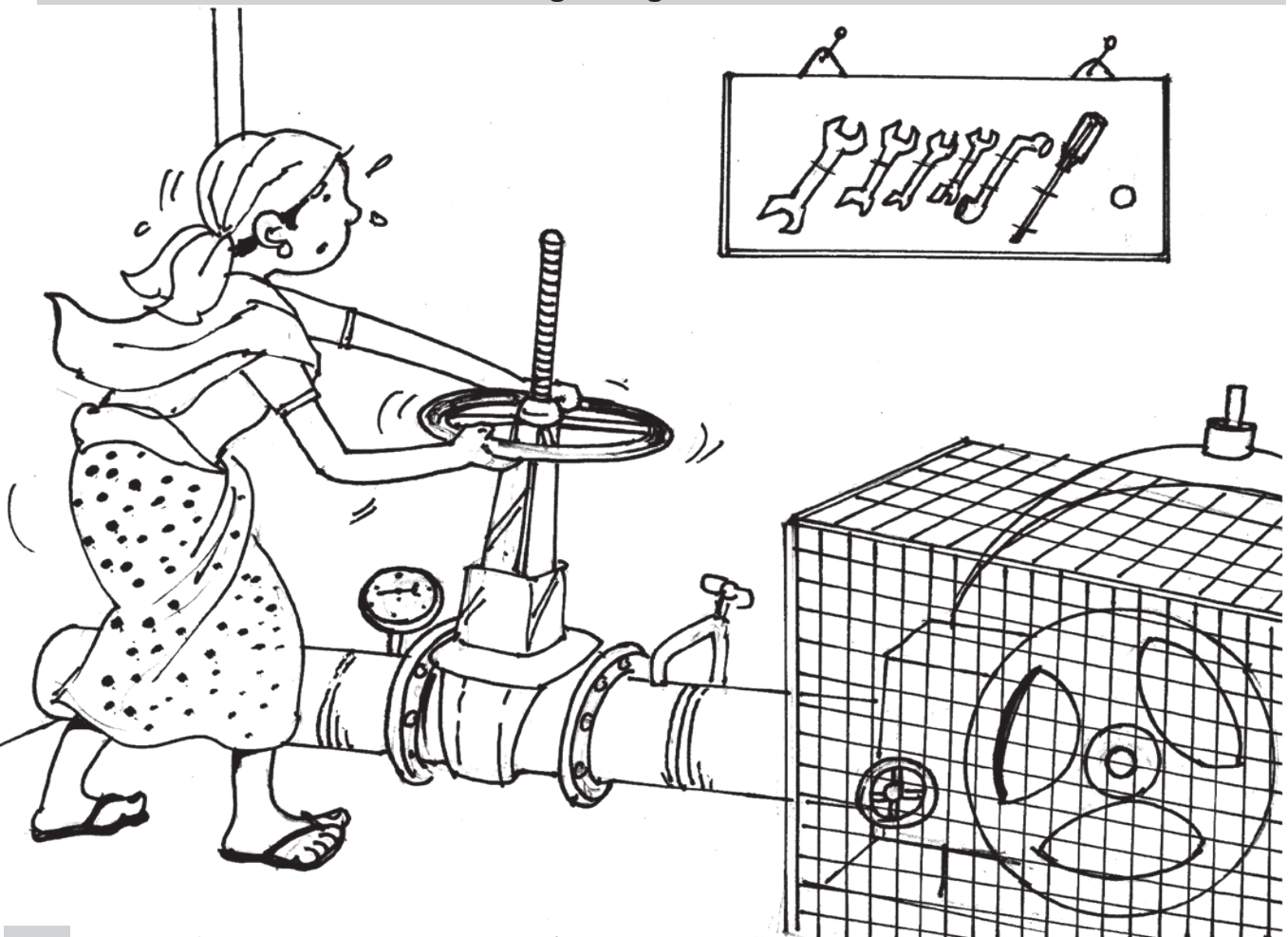
VALVES

According to design of the turbine it may have one or more number of valves. The most common problem that occurs with valves is that water leaks through a worn out valve shaft. If there is a water seal tightening arrangement, the valve can be tightened to stop the water leak. If it leaks again after sometime it has to be further tightened.

In addition, if some particles come with the water (due to improper filtering) this may block the valve. This problem can be identified by the tightness of the valve and difficulty in fully closing the valve. In such a case, the valve has to be taken out and the particles removed.

Whenever the turbine is stopped do not tighten the valve too much. This can lead to the seating surfaces of the valve being worn out quickly.

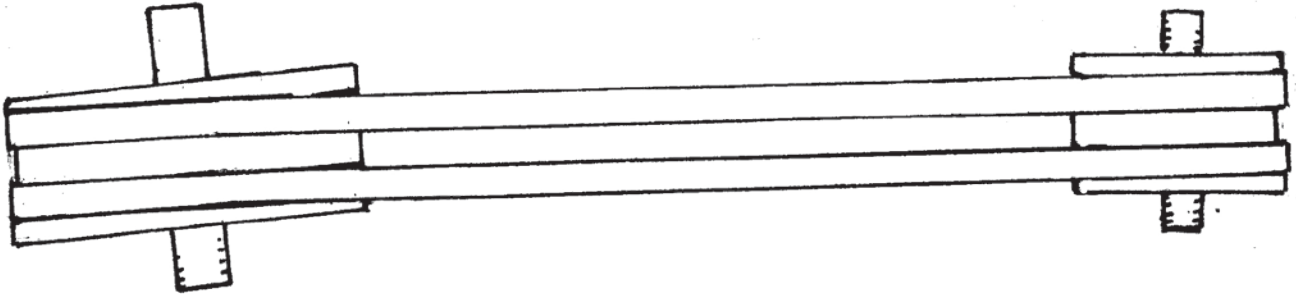
Tightening the valve



DRIVE SYSTEM

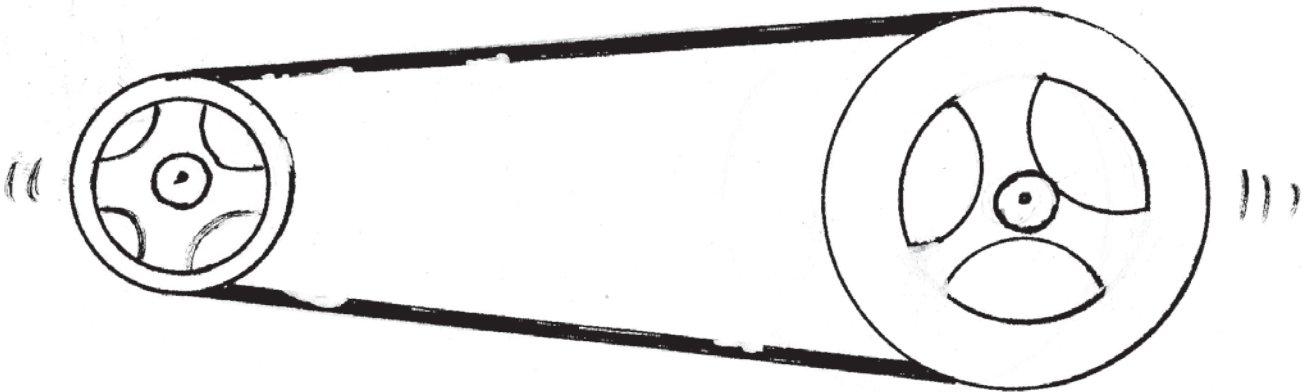
A special drive system is available only if the turbine speed does not match the generator speed. Then flat or V belt and pulley systems are used.

Misaligned Pulleys



Village technicians should have an idea of the tension level of such a belt. If the belt sags too much it should be tightened up to the original level. If the belt tension is too high, be careful to maintain pulley alignment. The possible misalignments are shown in the picture above.

Cracked Belt



As soon as the turbine is stopped after a long period of running, the pulley and belt have high temperatures if they are under or over the required tension level. Thus, familiarising yourself with the belt and pulley temperatures will enable you to identify problems with the tension levels. Further the belt should be inspected for cracks and wear and tear once a month.

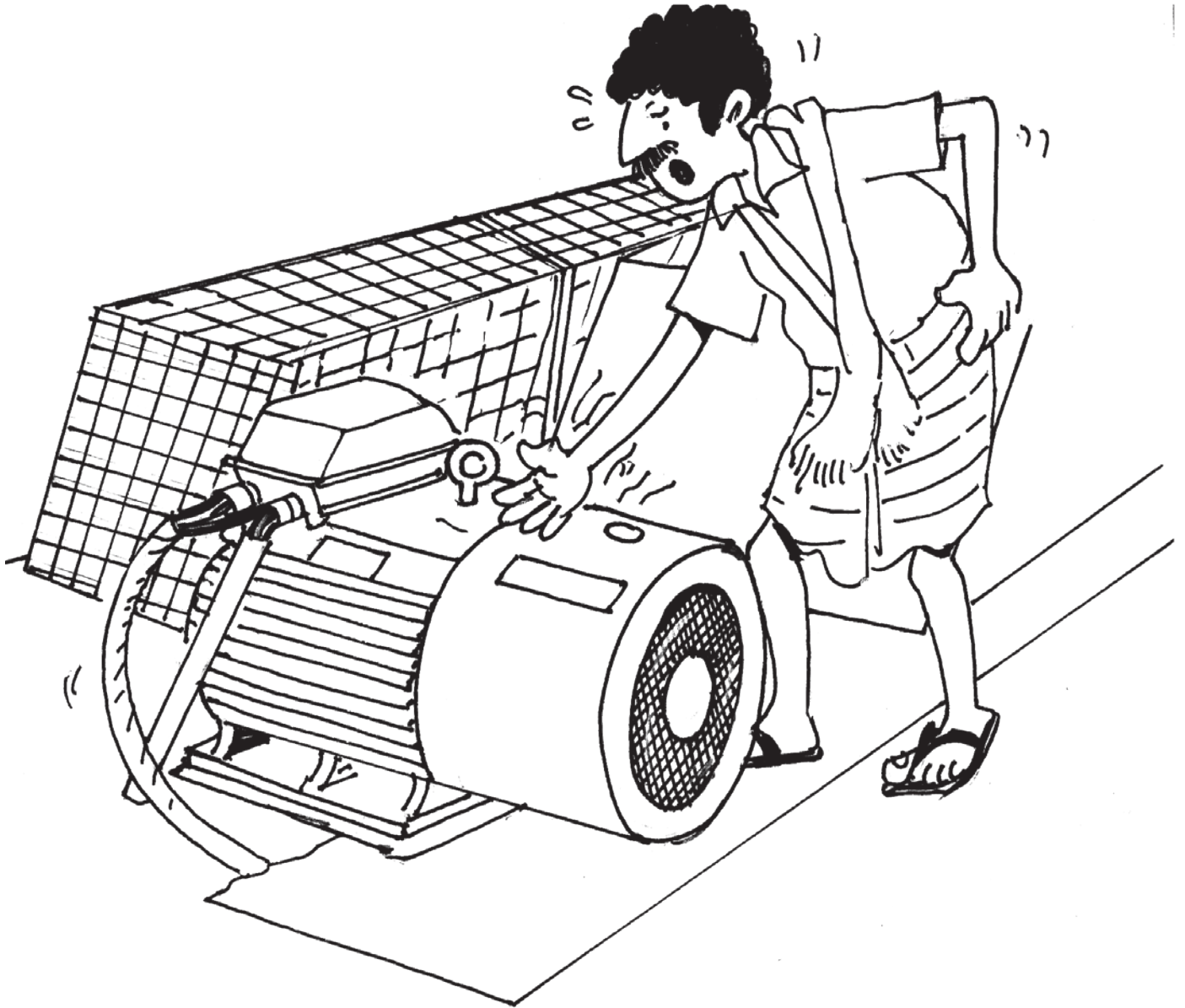
Such a belt system should not be exposed to water and grease, etc. Whenever a new belt is replaced all the belts should be replaced at once. Do not use a mix of old belts and new belts at the same time.

With the belt drive system there is an additional bearing set also. Then that bearing should be maintained by greasing on time.

GENERATOR

Village technicians should be familiar with the normal operating conditions of a generator - such as working temperature, cooling air pattern, belt tensioning mechanism, greasing and brush replacing

Know the normal working temperature of a generator



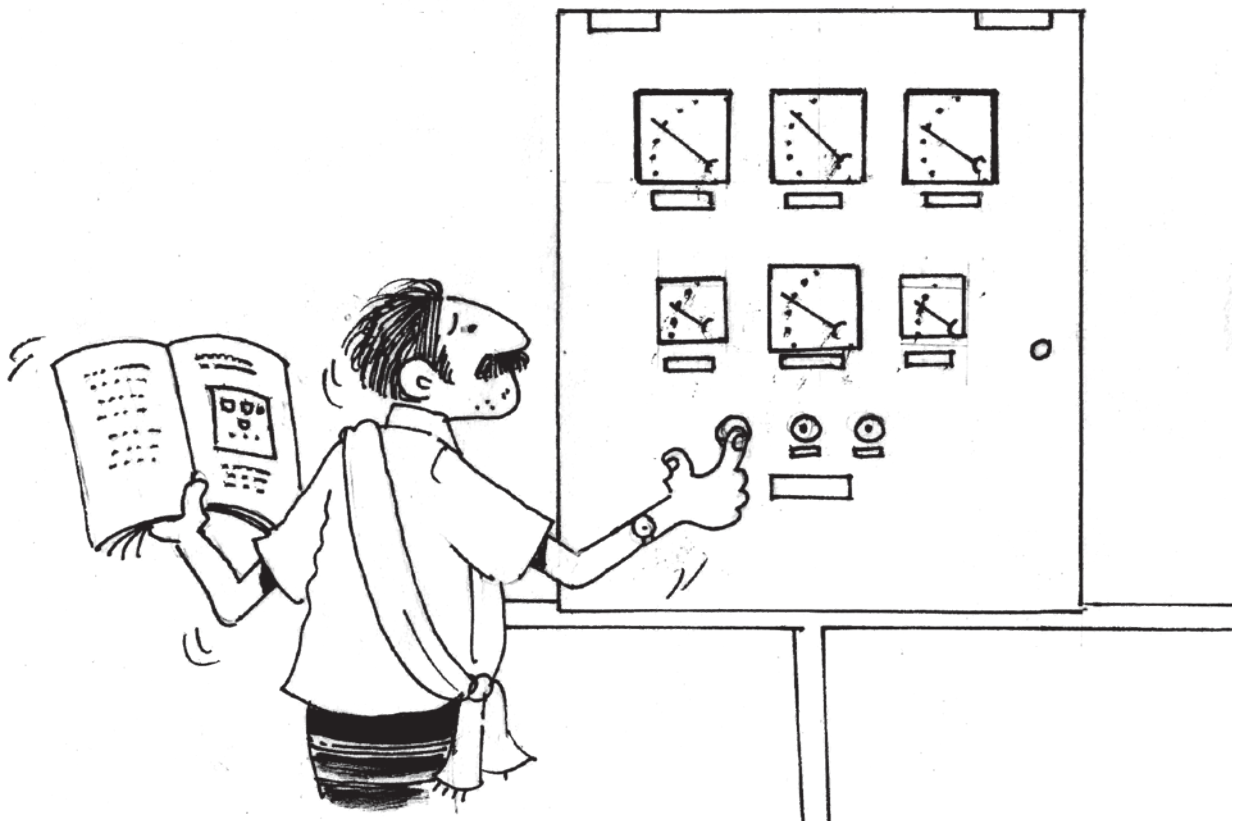
A generator may heat up due to blockage of the air cooling system. In such a case clean the air circulation path. Whenever removing or adjusting the generator in a belt drive system, it is better to put permanent marks on both the generator and the base. This can make it easy to relocate again if necessary with minimum misalignment. In brush type synchronous generators the correct size and type of brush should be replaced.

4. ELECTRICAL EQUIPMENT

Due to small problems in the electrical equipment, the micro-hydro system can end up with fire or electric shocks. The cost of repairing this is high. The following indicators help to identify possible electrical faults:

- A deviation from the normal values indicated in the meters of the control panel.
- No excitation of the generator
- Power off (Trip / MCB / Contactor) automatically
- Bad smell
- Overheating
- Fading / melting components

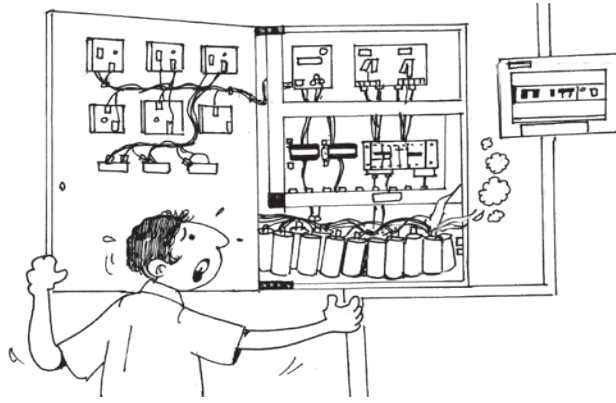
Check meter values on the control panel with normal values



When carrying out maintenance or repair work on electrical equipment always use reliable electric testers and insulated dry tools.

It is advisable to be familiar with the normal colours and temperatures of the equipment. If an electrical item has a loose connection, it gets heated and faded. Then the plastic insulating layer gets melted, emitting a bad smell. In general, as soon as the turbine is stopped after running for a long duration, a person should be able to touch capacitors, wires and wire connectors, Residual Current Circuit Breakers (RCCB - Trip Switch), Miniature Circuit Breaker (MCB – fuse) and other items without difficulty although they may be heated to the normal level (the operator should be familiar with the normal temperature). However, if they are heated to a higher temperature that may be due to the small size of the wires, loose connections, poor or bad components.

Overheating



However there can be so many types of safety devices, sensors and control devices in a controller - Induction Generator Controller (IGC)/Electronic Load Controller (ELC) - that vary based on the manufacturer. Seek information from the suppliers and if there are parts that are repairable by the users themselves, then repair them as per the given guidelines.

During lightning and thunder, the surge arrestors may get damaged. On such days, the surge arrestors should be checked frequently. They should always be maintained, clean, and in dust and wet free conditions. As termites and bugs, etc. can damage electrical items, they must be prevented from entering any electrical or electronic component.

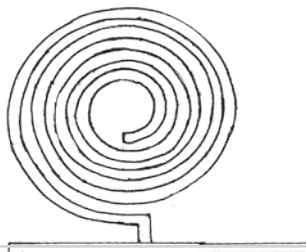
Ballast

The role of the ballast is to drain off excess power and to control and maintain system voltage and frequency at optimum levels. There are two main types of ballasts - air cooled and water cooled. If there is a burnt element it can be identified via the ballast volt and current meters. Both readings should be compared with the initial values under specific load conditions (open valve level). If there is a burnt element there will be a variation in the readings.

The heating element of air cooled ballasts must be installed in well ventilated areas and kept away from any flammable items. Generally, the elements are designed for about 20% capacity above the working capacity (example: A 5 kW rated scheme would have its ballast designed to take upto 6 kW). The ballast may consist of many heater elements and would emanate some brightness when the system is running to its full capacity but the load is not connected (when the houses are not supplied with electricity). If one element is burnt out, it would no longer drain any heat, but the brightness of the other elements would change. A person familiar with the system can recognise what the working elements are by observing the colour when system is running but the load is not connected. In general, the lifetime of a brighter element is short and they quickly burn out. The burnt element should be replaced immediately.

In water cooled ballasts, elements are dipped in a water tank. That tank is filled up with water to a specific level. A continuous flow of fresh water is maintained without a block, generally taking water from a separate line from the penstock. The water flows through the tank of the water cooled ballast and comes out from the tail race. The inlet, outlet and the tank should be opened and cleaned periodically removing any dirt or scale.

Air Cool Heating Element



Capacitor bank

This is relevant to only Induction generators. There are two types of defects which can occur in the capacitor banks.

1. Reduction of the capacity of the capacitor. The Capacity of the Capacitor will reduce with usage. This will result in the system frequency increasing. This can be overcome by simply adding extra capacitors according to the same connections.
2. Physical damage of the capacitors may occur due to poor quality or end of lifetime. However this can be pre-identified by just touching the capacitor. If there are defective capacitors their temperature will be higher than that of the others. So it is best that the capacitor bank should be properly observed once a month.

Control Panel & Distribution Board

Both the control panel and distribution board arrangement depend on the manufacturer. So you should get advice from the supplier if there are user repairable items. (Table 3 explains the common troubles, reasons and remedy.

Electrical distribution system

Most of the repairs of the electrical distribution lines can be attended to by the community members themselves. Generally, the community based micro-hydro village electrification schemes may be designed with more safety precautions than those for the national grid. This is due to the fact that these schemes are not attended to by very skilled technicians all the time, which is not the case of the national grid. That is why RCCBs and MCBs are used in the power house in addition to them being used at each of the load centres (houses). With this protection, even if a tree or vine touches the distribution lines or a bird gets electrocuted, the system would get switched off automatically. **It is therefore vital to test the RCCB at least monthly.**

First Aid for Electrocution



- Turn off the power immediately from panel board or valve
- The victim should not be touched until he / she has been separated from the current. Such a person should be removed from the electric contact using a dry board or stick. No one must touch any grounded objects while working on electrical equipment.
- Water should not be used to extinguish fire due to electricity.
- Artificial respiration must be administered if the victim is not breathing
- Working on " live" circuits² must be avoided as much as possible

²"Live" circuit is a circuit which is on and has current flowing through it.

In cases where the loads (houses) are clustered, a major electrical fault at one load centre (house) or cluster would lead to the whole system getting switched off. In such cases, the RCCB or the MCB of both the power house and the relevant cluster would switch off. If the distribution or the service lines are bare conductors, then they should be attended to for the following.

- Cut trees and vine that touch the bare conductors.
- Put support struts or stay wires for tilted poles.
- Re-tension the sagging conductors.
- Replace damaged surge arrestors (specially during lightening season).
- Replace deteriorated wooden poles and cracked concrete poles.
- If there are loose connections or salt formation on copper and aluminium joints (due to bi-metallic effect), the light emitted can be shattering. These joints should be cleaned and tightly connected.

When repairing distribution or service lines, practice the following

- Turn off the turbine and electrical switch from power house. Do not allow them to be turned on until the work is completed.
- Do not do any repair work during thunder/ lightening periods.
- Be careful when climbing old wooden poles (they may have deteriorated).
- Always follow safety measures and wear safety clothes.

Table 2: Checklist

Item	Period	Note
Weir, channel & penstock for damages	Once a month in dry season. During the rainy seasons it is better if it is done a few times per month	
Forebay tank	Once a week. Once a day during the rainy season.	
Greasing the bearings	As recommended by supplier or every 4000 hours.	
Compare panel board values	Daily	Compare meter reading with original values. If there is variation it should correct it
Electromechanical items inspection	Monthly	Check the temperatures and physical conditions as explained in this manual
Distribution line	Once a month in dry season. During the rainy seasons it is better if it is done a few times per month.	

Table 3: Remedies for Common Problems in Operations & Maintenance

Indication	Possible reason	Remedy	Comments
High generator voltage	Ballast heater burnt	Replace the relevant heater element	Relevant ballast voltage increases when ballast heater is burnt or ballast breaker gets switched off. Replacing TRIAC / thyristor – this has to be done by a competent electrician. Frequency increases when a capacitor is at fault.
	Ballast breaker gets switched off	Replace relevant heater element Replace the relevant breaker (MCB)	
	Faults in TRIAC (Tirade Alternating Current Switch) / thyristor	Replace them	
	Capacitor fault	Check the capacitor bank. If there is a damaged capacitor, replace with a capacitor of same value	
Low Generator voltage	Valve block	Check the valves for blocking / clean them	
	Not enough water	Check whether pressure gauge gives exact pressure, whether enough water flows into the forebay tank and whether there are any leaks or blocks. If so remedy them. Close one valve if there is a multi-jet turbine and run with the lesser number of jets.	
High frequency	Ballast fault	Replace ballast element	With the change in frequency, the voltage also changes.
	Capacitor bank fault	Replace capacitors	
Low frequency	Nozzle block	Check the nozzle and clean	Check trash rack and clean, mend the trash rack to ensure only particles that can pass through the nozzles are filtered in.
	Not enough water	Check whether pressure gauge gives exact pressure, whether enough water flows into the forebay tank and whether there are any leaks or blocks. If so remedy them. Close one valve if there is a multi-jet turbine and run with the lesser number of jets.	
Low ballast current	Damaged heating element	Replace ballast element	Ballast voltage may increase under this situation.
High ballast voltage	Damaged heating element	Replace ballast element	Current in ballast may decrease in this situation.
Low ballast voltage	Damage of TRIACs or thyristors	If faulty, replace the respective TRIACs / thyristors	Competent electricians must attend to this.
Fluctuation of the indicator hand of the electrical meters	Fluctuating load (consumers appliances)	Check whether highly load varying electrical appliances are used by community members, and if so, stop it.	This will settle with a small variation in the load (consumption by consumers)
	Intrinsic errors in the TRIACs or thyristors		

No excitation	Capacitor bank is faulty	If there is a damaged capacitor, replace it with a same sized capacitor	If there is no faulty capacitor & TRIAC, stop turbine from valves and exit the generator with 6V or 12V battery. This applies only for brush type synchronous generators.
	TRIAC damaged	Replace TRIAC	
	Short circuited Wiring System	Check control panel & ballast for short circuit or touch the earthed body	
	Surge arrestor damaged	Replace surge arrestors	
	Brushes worn out	Replace new brushes	
RCCB off	Transmission line earthed	Check whether the transmission lines touches leaves and branches etc. If so, trim them.	
	Faulty electrical item had been in use	Check from the users whether their own RCCB is switched off. If so, the fault has been in that house. Get them not to use the appliance that caused this situation.	
	Faulty RCCB	Replace the RCCB	
MCB off	Village load is too high (over the rated capacity)	Check for large use of power by consumers. If so, get them to reduce.	
	Short circuit of a distribution or a service line	Mend any short circuit.	
Control panel off	Village demand is too high	Check for large use of power by consumers. If so, get them to reduce their use.	This is due to village demand being higher than the generated power
	Generating power is too low	Water pressure has dropped due to the lack of water. Apply the remedy described for this situation above	
Bad smell	Heating up electrical items	Observe the place of smelling. If it is due to a loose connection, tighten up the item. If any item is damaged, replace it.	Sniff for unusual smells whenever possible.
Faded items	Electrical loose connections	Tighten up the connection point after turning off the turbine.	
	Passage of time	Replace	
Over heating	Generator over heating	Air flow path to the generator cooling fan maybe blocked or use of too many capacitors.	
	Control panel	This maybe due to the control panel cooling fan not working. Replace the fan.	
	Capacitor bank	Damaged capacitor can be the cause. Replace it with a same sized capacitor.	

Log Sheet

The log book should have a separate column for each meter reading of a power house. These meters depend upon (three / single phase) type and manufacture of equipments. In addition the time, date and signature of the operator are required.

Date	Time	Volt (generator)	Volt (ballast)	Current (village)	Current (ballast)	Frequency	Energy metre	Note	signature

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