Installation, Operation and Maintenance Manual

for Multipurpose Power Unit (MPPU) at Munar

Prepered for

TIFAC-DST Sponsored Project

Development of Standard Water Mills in Uttaranchal

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PREFACE

This manual has been prepared for various groups of technicians and professionals engaged in development of water mills for multipurpose applications, design operation, maintenance and repairs of Munar water mill site as Multipurpose Power Unit (MPPU) is described in this manual.

Keeping in view the lower educational qualifications of managers and operators, an attempt has been made to keep the contents of the manual simple. However, in such cases there always has to be a trade off between the depth of knowledge which decides its usefulness and simplicity which results in its use by many less qualified practitioners. An attempt has been made here to achieve this trade off.

TABLE OF CONTENT

1. ABOUT THE SITE

1.1 Introduction

Out of many sites, Munar is selected for the installation of multipurpose power unit. Keeping in view, that village Munar is an unelectrified in Distt. Bageshwar. To fulfill the various local needs, agro processing machines like Oil Expeller and Rice Huller are also installed in addition to generator. The Oil expeller and Rice Huller can be coupled through belt pulley to the turbine shaft. Normally Rice Huller and Oil Expeller can be used in daytime while electricity generation can be used in evening and night times. The salient features of the site are shown in Table 1.1 shown below;

Table1.1 : Details of Multipurpose Power Unit (MPPU) at Munar

S.No.	**Items**	**Description**
(a)	**Location**	
i.	State	Uttaranchal
ii.	District	Bageshwar
iii.	Nearest town	Kapkot (Bharari)
iv.	Access	About 16 kms from Kapkot (Bharari) on Kapkot-Pindari motor road.
v.	Owner	Sh. Narendra Singh Takuli
2.	**Details of site**	
i.	Name of stream	Kotigad
ii.	Head (m)	8.5
iii.	Design Discharge (l.p.s)	150
Iv	Installed capacity (kW)	5.0
3.	**Civil works**	
(a)	**Power channel**	
i.	Length (m)	18.40
ii.	Width (m)	0.55
iii.	Depth (m)	0.55
(b)	**Forebay**	
i.	Length (m)	1.52
ii.	Width (m)	1.20

iii.	Depth (m)	2.0
(c)	**Penstock**	
i.	Length (m)	37.50
ii.	Dia (m)	0.25
iii.	Material	PVC
(d)	**Power House**	
i.	Length (m)	4.40
ii.	Width (m)	3.40
iii.	Height (m)	2.50
4.	**E&M Work**	
(a)	**Runner**	
i.	Type	Cross flow, cast in cast steel in single piece
ii.	Orientation	Horizontal, over hung
iii.	Runner dia (mm)	300
iv.	Runner width (mm)	300
v.	No. of blades	18
(b)	**End use machines**	Generator, rice huller and oil expeller

2. SYSTEM DETAILS

2.1 General

In order to develop mechanical power upto 5.0 kW, cross flow turbine runner is suggested to be developed. For this system, head range from 7.0 to 15.0 m has been considered for sizing the runner. Based on the past experiences it may be recommended that 'open cross flow' turbine and over hung layout is economically viable option for this capacity range. The cross flow turbine can operate for the large range of discharge and head so it is quite suitable for the standardization purpose. In addition to this, cross flow turbine is quite simple in design and less costly compared to other turbines. The turbine shaft can be coupled to generator and to Oil Expeller and Rice Huller through belt-pulley drive. The specifications of the system are given in Table 2.1 shown below and design drawings are given in Fig. 2.1-2.4.

Table 2.1 – Specifications of Standard Runners Proposed

S. No.	Types of System	Applications	Head Range (m)	Discharge (lps)	Design Efficiency (%)	Power Output (kW)	Speed (rpm)	Diameter (mm)	Length (mm)
1.	Cross Flow Horizontal Shaft	Electricity and other agro-processing (MPPU)	7.0 to 15.0	150	55	Upto 5.0	350-550	300	300

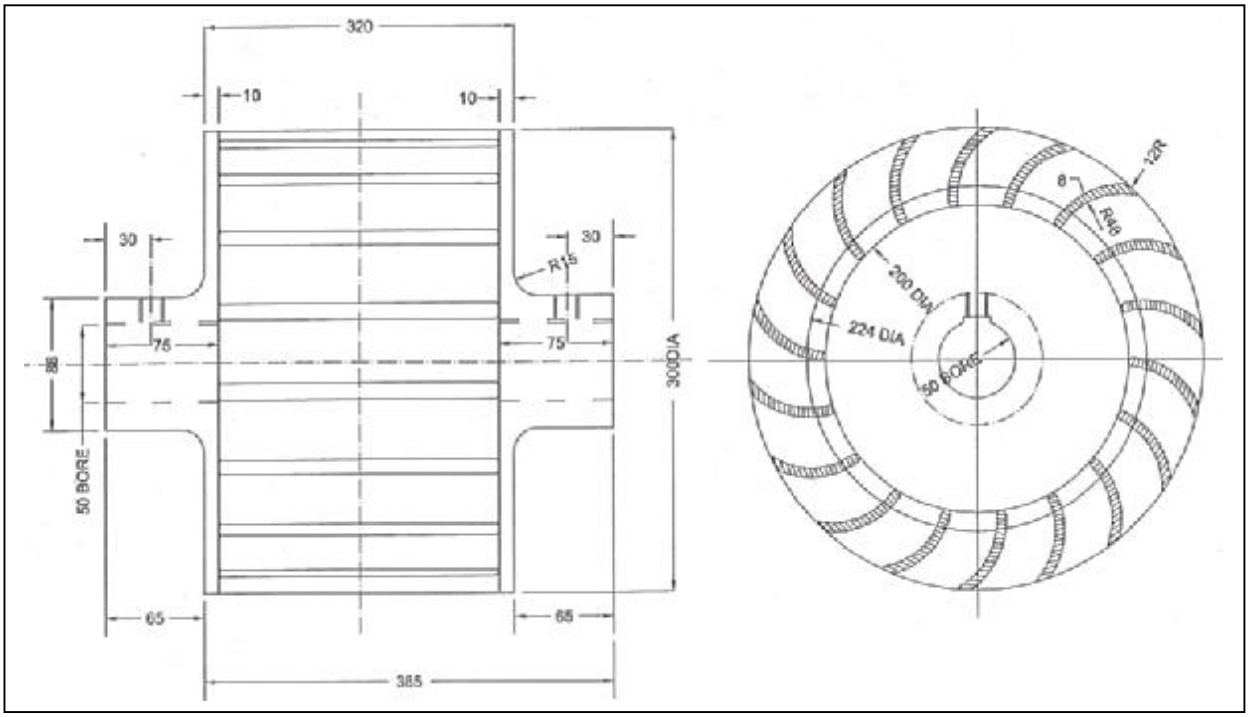


Fig. 2.1 : Runner Drawing

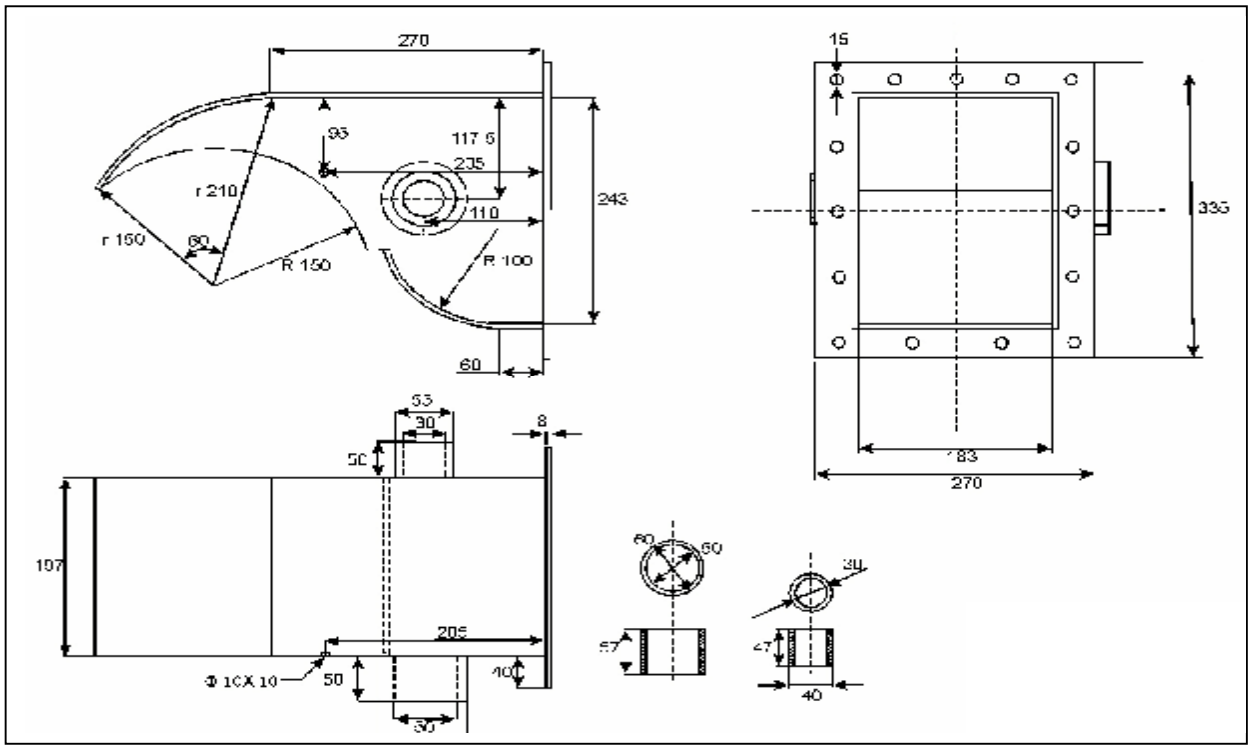


Fig. 2.2 : Nozzle Drawing

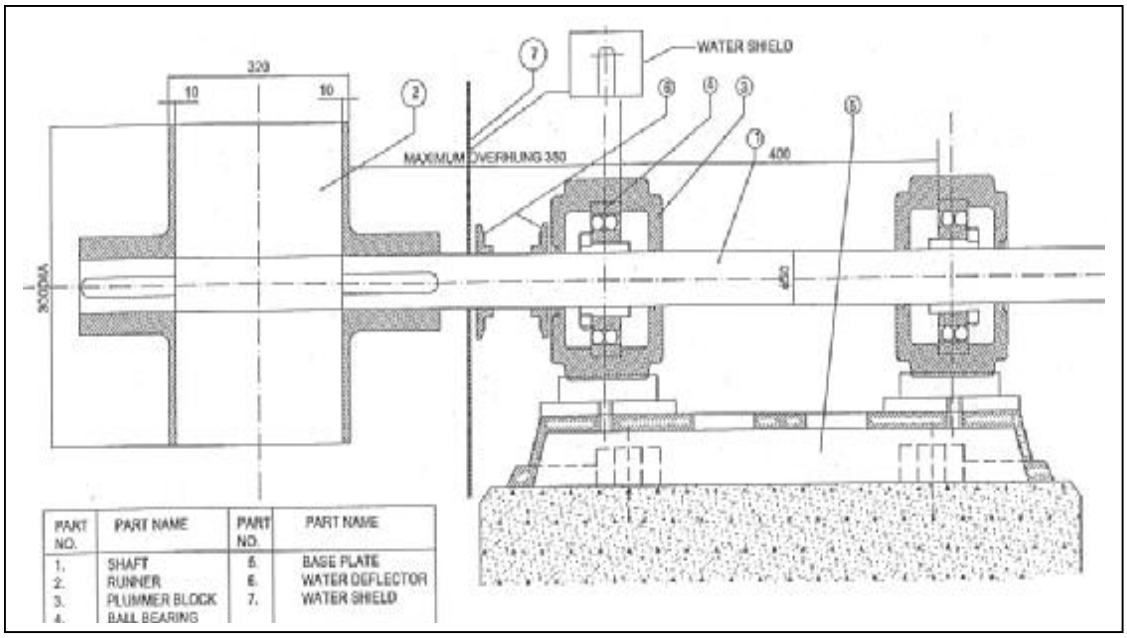


Fig. 2.3 : Layout of system

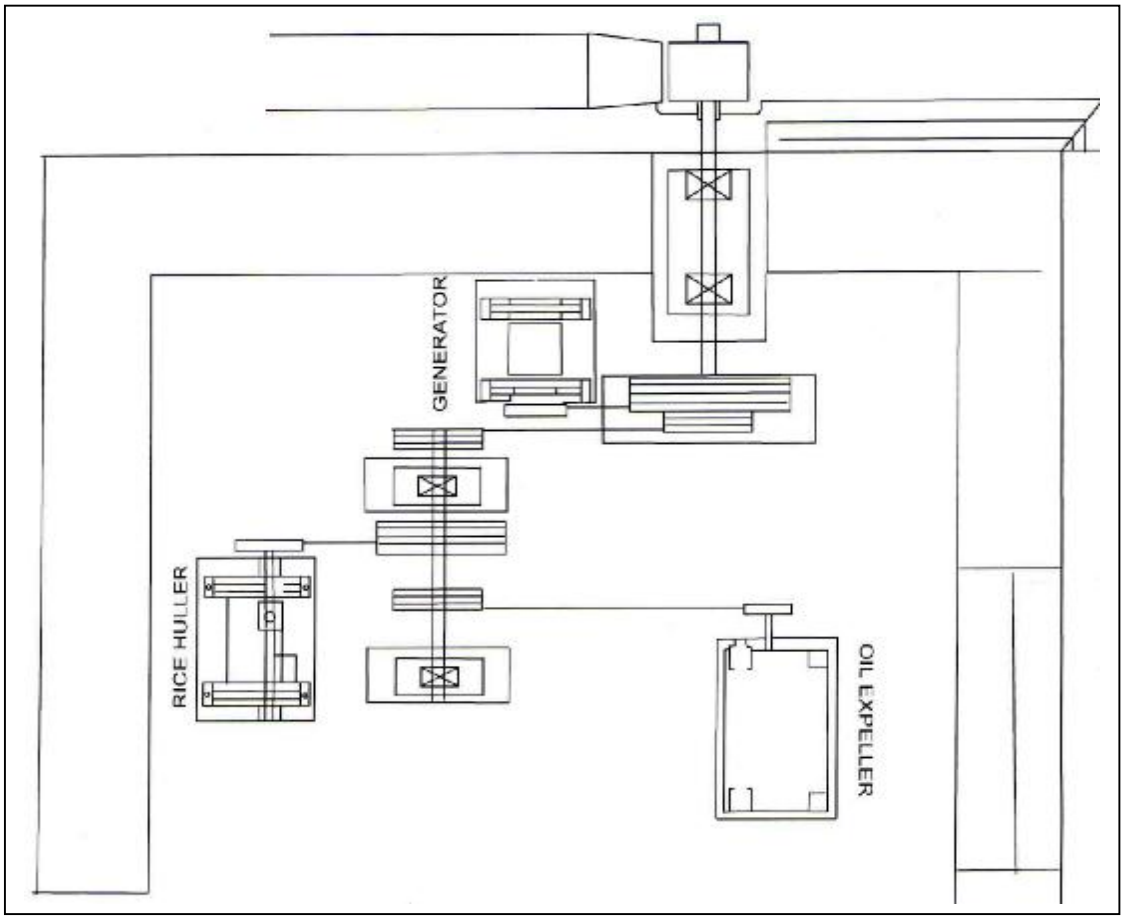
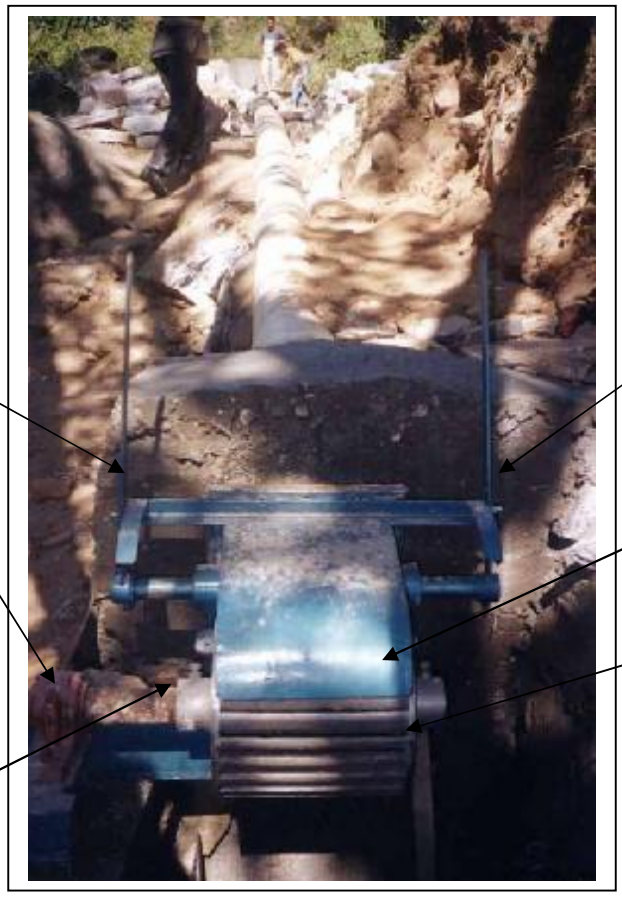


Fig. 2.4 : Layout of the devices



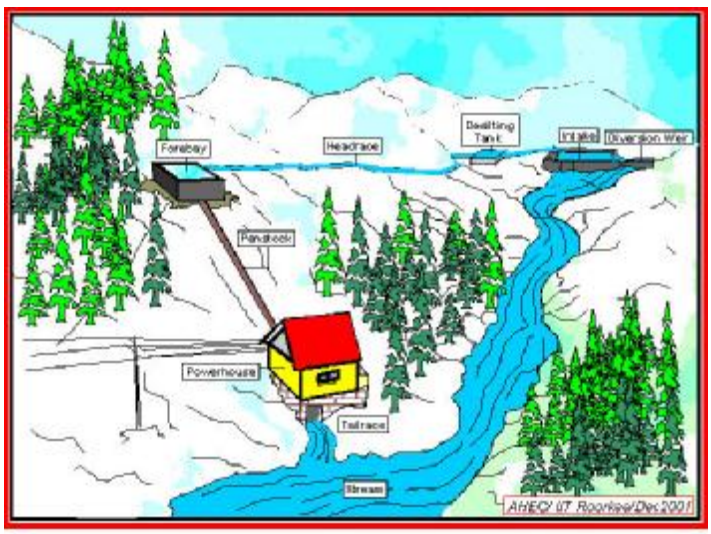
System Details

3. INSTALLATION OF MULTIPURPOSE POWER UNIT (MPPU)

3.1 General

In order to install a MPPU at other sites guide lines for installations are discussed under this part of the manual. Considerable planning and preparations have to be made, information gathered and equipment identified which is to be taken to the site. It may also take between two weeks to six months to complete the installation; depending upon the size of the plant, site remoteness, and whether it is an easy or a difficult scheme.

Various components of such units are shown in Fig.3.1.



Typical Arrangement of Small Hydro Power Station

Briefly, the installation process would include the following.

- Packing and transporting equipment and materials to the site and storing it there.
- Finalization of the sites for weir, intake, power canal and its sub-components (eg., desilting basins, spillways, crossings, etc), forebay, penstock and powerhouse; already demarcated during the surveys.
- Measurement and minor adjustment of locations of some components such as the base of turbine. forebay or intake.
- Construction of all components of civil works including foundations for the turbine, generator, agro-processing equipment, etc; and construction of support piers, anchor blocks, etc.

- Installation of the penstock pipe and accessories.
- Installation of turbine, generator, agro-processing units and coupling/drive systems.
- Installation of transmission and distribution wiring systems.
- Testing & commissioning (starting, testing, measuring output, removing defects).

The whole installation process can be divided into 5 phases as follows;

1.Transportation of Equipments

2. Civil Constructions.

3. Installations of Electrical and Mechanical Equipments.

4 Installation of Transmission lines

5. Installation of Distribution and Service lines.

3.1.1 Transportation of Equipments

Transportation of the equipment to the site includes its proper packing and planning the transportation as well as storage at the site till it is properly installed. In most instances, the equipment may have to be carried manually, for a few meter distance or quite a few kilometers. Therefore, the packages have to be of appropriate size and weight. Packing larger units such as a generator & turbine in wooden cartons is usually expensive and inconvenient to carry.

3.1.2 Civil Construction

The construction of the scheme should be started from the most critical location; i.e., where a slight misalignment or improper orientation may result in significant expenditure for remedial measures. Usually the machine foundation in the powerhouse is the most critical location. This is because once the machine foundation anchor bolts are set in concrete; the turbine and the generator locations cannot be readjusted. Therefore, first the machine foundation should be constructed. Then work should commence on the installation of the penstock pipe from the machine foundation to the forebay. The anchor blocks should also be completed after the entire penstock pipe length has been installed. This is because once anchor blocks are constructed; the penstock pipe cannot be readjusted.

Once the machine foundation, penstock and the forebay have been constructed, the logical sequence is to continue the construction work upstream until the location of the intake is reached. If the construction work is commenced in this sequence, there will be fewer chances of

misalignment or errors in the elevation of the structures. Construction work at the intake and especially the diversion weir should normally start when all other structures are completed.

(i) Construction of electro-mechanical devices foundation and powerhouse

The machine foundation should be constructed as follows.

Generator & Turbine foundation

Step1 Demarcate the floor area of the power house and the location of the machine foundation as per the design.

Step2 Excavate the machine foundation pit (as per design) until the required depth is reached and compact the floor using a manual ram

Step3 Place formwork at the periphery of the excavation and arrange the reinforcement and anchor bars for the base frame.

Foundation for counter shaft

Step4 Once the formwork and reinforcement of the machine foundation have been placed, prepare the concrete mix at the required ratio (usually 1:1.5:3) and then pour it up to the generator/turbine base frame level.

Step5 Protect the newly poured concrete structure from direct sun and rain for at least 24 hours.24 hours after the construction of the machine foundation, curing should start by keeping it moist for at least a week.

Step6 Remove the form works from the machine foundation only seven days after completion of construction.

(ii) Penstock Installation

The civil works for penstock involves installing the pipe and constructing the support piers and anchor blocks as specified in the design layout. The procedure is as follows ;

Step1 Clear all vegetation along the penstock route and mark the centre line by fixing a tight string.

Step2 Fix the turbine along with the manifold and gate/valve to the machine foundation.

Step3 Start the installation of the penstock from the machine foundation by connecting the first link of penstock (usually a bend) to the turbine manifold and proceed upstream, which is usually more convenient method.

Installation of Penstock

Step5 As the pipe installation work progresses upstream, construct the support piers at the required locations..

Forebay Tank with Penstock

(iii) Construction of Forebay

The construction of the forebay involves the following.

Step1 At the proposed location, mark the excavation lines for this structure according to the design as discussed earlier.

Step2 Excavate the ground to the required depth and shape.

Step3 Compact the earth surface using a manual ram after completion of the excavation work.

Step4 Then construct the structure as per the design. The forebay and other water retaining structures are usually built using stone masonry in 1:4 cement mortar.

Step6 After completion of the gates and masonry work, plaster the water retaining surface (i.e. inside surface) of the forebay. About 12 mm thick 1:2 cement mortar is recommended for the plaster.

(iv) Construction of Power Channel

Once the, canal type (or types for different lengths) has been selected and the sizes worked out, the actual construction procedure involves the following stages.

(a) Setting out of the course of the canal and marking the centre line with pegs.
(b) Preparing the bench for the canal.
(c) Fixing the excavation lines.
(d) Excavating the canal.
(e) Constructing / lining the canal.

Power channel (Kuchha)

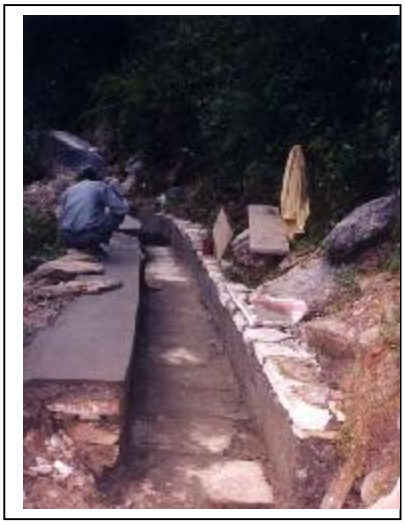
However at existing water mill sites the kuchcha power channels are generally available. The same can be used and their capacity can be enhanced by excavation.

For rectangular channel, start the excavation from the sides down to the required depth. For trapezoidal sections, start the excavation at the central part without exceeding the bottom width lines vertically down to the required depth. Then excavate the slop sides without exceeding the top width and meeting the bottom width at the required depth.

Check the channel bed slope frequently using a leveling instrument.

Once the excavation work has been completed, the construction of the lining of the canal can commence if provided for in the design. For stone masonry in cement mortar canals the minimum thickness for bed and side walls should be 150 mm since thinner walls require more stone work of the lining (dressing & sizing) and may not have the required strength. Since this is a water retaining structure, the ratio of the mortar should not be less than 1:4 cement/sand.

Use 1:2 cement sand mortar for plaster work in the headrace canal. The thickness of the plaster should be about 12 mm.



Construction of Power Channel

(v) Intake works

At the intake, construction of the flood protection walls and the mouth should commence first according to the detailed drawings. Such work may require diverting the flow towards the opposite riverbank. The weir should be constructed only when all other work at the intake is completed. Depending on the design flow and the nature of the weir (temporary orpermanent) this too may require temporarily diverting the river flow towards the opposite bank. The construction work is easier when the water level in the river is low and the water temperature is also not too low.

Intake works

3.1.3 Installation of Electrical & Mechanical Equipments

(i) Machine Foundations

Depending on the design, separate machine foundations may be constructed for each machine or one foundation platform may be sufficient for all the machines. For smaller electricity generation units a single foundation block is usually built for both the turbine and

generator, which are fitted on to a single base frame. The base frame is then fitted to the anchor bolts cast in the foundation block. For system with milling machinery, it is cheaper to have separate foundations for each machine since the machines are more spread out and having a single foundation block for all of them would not be practical.

(ii) Machine Installation: Once the concrete has fully cured the machines should be fitted to the base frame on the foundation block. The installed machines should be level and be checked by using a spirit level on the machine shaft. If the machine is not level then place shims under the footplates to raise the appropriate part of the base frame or the machine until it is level.

Installation of Generator

(iii) Alignment : The power from the turbine is transmitted to the generator or other machinery by direct coupling or belt drives .Before the machines are run, the pulleys (for belt drive) and the shafts (for direct coupling), must be aligned properly.

4. OPERATION OF MPPU

4.1 General

Correct operation of the system is beneficial in many ways. Managers and operators must be fully familiar with the equipment, its functions a operational procedures. Technical specifications must also be known and properly recorded in the Operations & Maintenance Manual provided by the installer and also in the Log Book.

4.2 General Operation Procedure

The following checks should be made during starting, stopping and running of unit. At any stage if a problem is noticed; say, unusual sound, the unit should be stop problem rectified before starting or running the unit.

4.2.1 The start up procedure

(i) For Water and Turbine

(a) Follow the specified procedure for cleaning up the civil works as applicable.
(b) Visually inspect all equipment (e.g. turbine, generator, control panel etc.)
(c) Ensure that penstock and turbine valves are closed.
(d) Turn on water at intake.

(ii) For Electricity

(a) Check that all switches on the load side are in the "OFF" position.
(b) Inform users that unit will be starting.
(c) If belts are removed, put them on the pulleys, check belt tension also.
(d) Gradually let water into the turbine by opening the turbine valve.
(f) If there are any push button switches for exciting the generator, press the voltage rises up to 200 V.
(g) Increase water flow by opening turbine valves further until the speed, and power comes up to desirable/rated level.

Electronic Load Controller

(h) For plants having ELC, gradually divert power to the load by switching the oad switches.
(i) If there is no load controller increase the water flow until the voltage rises 220 V while the load is connected.
(j) The allowable voltage fluctuation, for such units is within ± 10-15%.

(iii)For agro-processing

(a) Check all nuts, bolts, etc. of agro-processing machinery; move everything away from the drive system.
(b) Engage the belt from the turbine to the line shaft and then to the machine.

Rice Huller

(c) If there is no line shaft, place the belt directly from the turbine to the machine; for example, rice huller.

(d) Admit grains to the huller, oil seed to the expeller, etc.

(e) Let water into the turbine, gradually opening the turbine valve until the required speed is reached.

(f) Listen for any abnormal noise or vibration when the unit is running. Stop the turbine if this happens and look for the fault.

Oil Expeller

(g) Check drive systems (belt, coupling, etc.)

(h) Connect only those units simultaneously for which power is sufficient.

(i) If the turbine is powering a generator and agro-processing equipment simultaneously priority goes to electricity and connect the agro- processing unit only if sufficient additional power (i.e flow) is available.

4.2.2 Continuous Checks during Running

The following checks are to be made during the running of the plant. If at any stage an abnormal condition arises, the plant should be shut down and the problem diagnosed and rectified.

(a) Every hour check voltage, frequency and power output and record in the logbook once a day. Abnormal readings must be recorded whenever noticed along with the corrective action taken.

(b) If voltage or frequency decreases due to over-load, remove some loads.

(c) Check for abnormal noises and water leaks.

(d) Check bearing and generator temperatures by touching the housings.

(e) If the power consumption is more than design capacity, disconnect some load from the distribution box.

(f) If over-load occurs, it could be that some consumer is using a higher load (i.e. heater, etc.) than permitted so checks should regularly be made at the premises of such type of users,

4.2.3 Shutting down procedure

Following procedure should be followed prior to and during shutting down of the unit.

(a) Inform users that the unit will be shut down, if time permits (unless they already know, in the case of regular shut downs).

(b) Switch 'OFF' all connected load.

(C) Close turbine control valve gradually to prevent rapid penstock pressure rise.

(d) Close penstock valve.

(e) Stop water from forebay tank and intake if necessary.

(f) Ensure that powerhouse and equipment are clean and tidy.

5. MAINTENANCE

5.1 General

One of the keys to reliable operation is routine preventive maintenance, ie, regular inspection, lubrication, cleaning, replacing worn items and responding to concerns identified during inspections immediately rather than waiting for machinery to break down before taking action. Every day the following items should be inspected and corrective action taken if necessary.

5.1.1 Before Start Up

(a) Clean the trash racks at the intake, desilting basin and forebay.

(b) Check whether' sufficient water is flowing -through the headrace.

(c) If not; the plant load should be reduced accordingly or it should not be started at all.

(d) Flush the forebay and desilting basin during the monsoons (every other day if the debris amounts are less).

5.1.2 During Operation

(a) Check the temperatures and vibration level of housings/casings of bearings of turbine and generator.

(b) Check the leakage from valves, turbine housing, or base frame.

(c) If the leakage is excessive from any location, repairs should be organized straight away r in due course as the situation demands.

Good and timely preventive maintenance would almost always help to reduce the number of breakdowns and increase the life and productivity of the equipment. A check list and schedule for routine maintenance is given in Table 5.1. This should be filled regularly for proper maintenance.

Table 5.1 : MAINTENANCE CHECK LIST AND SCHEDULE DURING MONITORING

Item	**Daily**	**Weekly**	**Monthly**	**Observation/ Action Taken**
Intake Weir				
For debris	√			
Wall for cracks			√	
Silting up		√		
Power Channel				
Foreign objects in channel	√			
Correct flow level in channel	√			
Leakage from channel		√		
Water diverted for irrigation/for other use	√			
Channel surfaces			√	
Erosion under/around channel			√	
Forebay				
Forebay trash rack clear of debris	√			
Leakage			√	
Level of silt not above maximum		√		
Penstock				
Leakage	√			
Joints leaking/condition		√		
Anchor block cracking			√	
Erosion around anchor blocks			√	

Item	Daily	Weekly	Monthly	Observation/ Action Taken
Power House				
Any leaking valves	√			
Powerhouse clean	√			
Prime mover/Turbine				
Turbine speed satisfactory	√			
No unusual noise from turbine	√			
Control valve assembly				
Function of valve		√		
Lubrication		√		
Leakage at sealing		√		
Runner				
Foreign objects in runner vanes	√			
Condition of runner vanes			√	
Clearance of runner with nozzle		√		
Vibration	√			
Shaft and Bearings				
Temperature of bearings	√			
Condition of Rollers / Balls			√	
Condition of housing			√	
Alignment of housing	√			
Drive system				
Drive pulley		√		
Driven pulley		√		
Drive belt tension		√		
Drive belt condition			√	
Generator / Load Control				
Check generator bearings for vibration	√			
Generator bearings not overheating	√			
Generator not overheating	√			
Generator environment clean and tidy	√			
Load controller functioning correctly	√			

Item	Daily	Weekly	Monthly	Observation/ Action Taken
Load on system within limits	√			
Tailrace				
Leaks from tailrace		√		
Foreign objects in channel	√			
All tailrace surfaces sound and crack free			√	
Check for erosion under/around tailrace			√	
Transmission Lines				
Insulators not damaged			√	
No. trees/bushes encroaching on conductors		√		
No loose connections or hot joints			√	
General				
Spare parts available	√			
Tools in correct place and in good condition	√			
Meeting with consumers	√			