

CHAPTER 10 OPERATION AND MAINTENANCE

10.1 Introduction

A hydropower plant has an advantage in that it does not need fuels for its operation as compared with oil or thermal power plants. However, there are no differences between both types of plants in that appropriate operation and maintenance (O&M) are essential for their long-term operation. They can be operated for long periods if its facilities are properly operated and maintained. We should effectively utilize hydropower because aside from being an indigenous energy resource, it is also renewable.

We have to operate and maintain micro-hydro power plants with strict compliance to the operation and maintenance manuals. In general, operators of micro-hydro power plants should understand the following:

- (1) Operators must efficiently conduct operation and maintenance of a plant complying with the work plans, rules and regulations.
- (2) Operators must familiarize themselves with all the plant components and their respective performance or corrective and preventive functions. Furthermore, they must also be aware of measures against various accidents for prompt recovery.
- (3) Operators must always check conditions of facilities and equipment. When they find some troubles or accidents, they must inform a person in charge and try to remedy the situation.
- (4) Operators must try to prevent any accidents. For this purpose, they should repair or improve facilities preventively as necessary.

Operation and maintenance manuals should basically be prepared for each plant individually before the beginning of operation. The following are general manuals of operation and maintenance for micro-hydro power plants.

10.2 Operation

The operation of micro-hydro power plants is intended not only to generate electric power by rotating generators but also to control generation equipment and to supply electricity of stable quality to consumers, keeping good condition of all facilities related.

Since facilities and equipment installed depend on site conditions and budget, there are various ways of operation for micro hydro. In case of a plant that has an automatic load stabilizer, the operators do not always have to control equipment except in cases of starting, stopping and emergency. Furthermore, in cases where an automatic stopping system and recording system are installed, operators do not always have to stay in the power plant.

In many cases of micro hydro for rural electrification, however, automatic control system and protection equipment are often omitted because of budget limitations. Therefore, in general, operators always should stay in the power plant to control equipment or be prepared to rush to the plant in order to immediately take measures in case of trouble.

General ways of operation of micro hydro are as follows:

10.2.1 Basic operation

(1) Check points before starting operation

Before starting operation of the power plant, operators must check the following items, and confirm if facilities are in good condition for operation. Especially in cases after long-term suspension of operation, they should check them carefully.

① Transmission and distribution line

- Damage of lines and poles
- Approaching branches
- Other obstacles

② Waterway facilities

- Damage of structures
- Sand sedimentation in front of the intake
- Suspended trash at screens
- Sand sedimentation in the settling basin and the forebay

- ③ Turbine, generator and controller
 - Abnormalities from the outside
 - Wear of brush
 - Insulation resistance of circuits

(2) Starting operation

After checking the above items, the turbine and generator are okay for operation. The procedure of starting operation is as follows:

(Preparation)

- ① Close the flushing gate of the intake weir
- ② Open the intake gate and take water into the waterway system.

(Starting operation)

- ③ Open the inlet valve gradually.
- ④ If there is a guide vane, open the inlet valve fully, and then open the guide vane gradually.
- ⑤ Confirm that voltage and frequency or rotating speed increase up to the regulated value.
- ⑥ Turn the load switch on (parallel in)
- ⑦ Control inlet valve or guide vane so that voltage and frequency are within the regulated range.

(3) Role of operators during operation

Operators must control equipment in order to supply electricity of good quality keeping equipment normal and safe as follows:

- ① Control the inlet valve or guide vane so that voltage and frequency are within the regulated range.
- ② Check vibration and noise of equipment, and then stop operation if necessary.
- ③ Check temperature of equipment
- ④ Check any abnormal condition of equipment, and then stop operation and take a measure if necessary.
- ⑤ Record results of operation and condition of equipment according to fixed format.

(4) Stopping operation

In order to avoid runaway of the turbine and the generator for a long time, the procedure of stopping operation is as follows:

- ① Close the inlet valve or the guide vane.
- ② Cut load switch off (load rejection)
- ③ Close the inlet valve and the guide vane completely.
- ④ Close the intake gate

When load is suddenly cut owing to an accident, operator must close the inlet valve or the guide vane immediately to avoid runaway of the turbine and the generator for a long time.

10.2.2 In case of emergency

(1) In case of flood

In general, micro-hydro power plants can be operated even in case of flood. However, when the river becomes a muddy stream and if there is possibility that sand and soil come into facilities, operation of the plant should be stopped and the intake gate should be closed. After flood, operators must inspect all facilities, and try to recover operation as soon as possible.

(2) In case of earthquake

Since an earthquake affects all facilities of plants, operators must inspect facilities after a big earthquake as follows:

- Check damage of structures
- Misalignment of the shaft of the turbine and the generator
- Damage of other electrical equipment
- Others
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(3) In case of shortage of water

There is an applicable range of water discharge for each turbine. Therefore, a turbine should be operated within the range.

Micro-hydro power plant should basically be designed according to water discharge in the dry season. However, in case of shortage of water that is beyond our expectations, operators must stop operation because continuous operation under such conditions will damage the turbine.

(4) In case of accident

In case of accident, operators must stop operation, investigate the cause of it, and then try to recover operation as soon as possible. Operator's roles are as follows:

- ① Inform the accident to the person in charge immediately.
- ② Investigate accident in detail.
- ③ Look into causes of accident.
- ④ Recover operation as soon as possible if operators can prove the causes and if they can repair it themselves.
- ⑤ Contact makers or suppliers of equipment and request them to repair it if operators cannot find out the causes of accident and they cannot repair it themselves.

What operators should prepare in advance are as follows:

- Discuss with maker or supplier of equipment concerning measures in case of trouble of equipment.
- Coordinate within BAPA* about expenditure on the recovery.

*BAPA: Barangay Alternative Power Association

- ⑥ Inform the DOE and LGU related of the accident.

10.2.3 Others

(1) Filling water in waterway system

Procedure of filling water into the waterway system is as follows:

- ① Confirm all flushing gates and valves of the water system are open.
- ② Open the intake gate partially, and intake a small volume of water.
- ③ Close the flushing gate of the settling basin after cleaning the settling basin.
- ④ Close the flushing gate of the forebay after cleaning the headrace and the forebay.
- ⑤ Close the drain valve of the penstock after cleaning the penstock.
- ⑥ Fill the penstock with water gradually.
- ⑦ Open the intake gate fully after filling up the penstock.

(2) Flushing sand in front of intake

If sand sedimentation reaches the intake level, sand will be carried into waterway system and it will affect the penstock and turbine blades. Therefore, in order to prepare against outflow of sand and soil during

flooding, operators must keep the intake approach open. For this purpose, operators should sometimes flush or remove sand that has settled in front of the intake.

If flushing gate is installed at the intake weir, operators can flush sand out by water flow opening the gate during flooding. However, in case of having no flushing gate, operators must remove sand out of the weir manually.

(3) Control of intake water

Volume of intake water changes according to change of water level of river. Normally excess water should be spilled out at spillway, which is located at settling basin or headrace. If excess water, however, reaches the forebay because of lack of capacity of spillway, it always spills out from the spillway of the forebay. The excess water for long time would wash out the spillway. Therefore, operators must control the intake gate so as to avoid too much water spill.

10.3 Maintenance

In order to operate micro-hydro power plants in good condition for a long period, waterway facilities, electric equipment, transmission and distribution lines should be maintained adequately. Operators must try to observe even small troubles and prevent accidents of facilities. For this purpose, daily patrols and periodic inspections are essential and recording and keeping of those data are also important.

Though items and frequency of patrols and inspections should be decided considering conditions of facilities and ways of use, general maintenance of micro-hydro power plants is as follows:

10.3.1 Daily patrol

In order to check if there is anything strange at waterway facilities, electric equipment, transmission and distribution lines, operators conduct daily patrols along the course that has been fixed in advance. Operators must record results of patrols and take measures if necessary.

Items of daily patrol are as follows:

Facilities and equipment	Checking Points	Measures
Intake and waterway	Suspended Trash at screen	To remove it at any time
	Water leakage from weir and gate	To record it To repair it if necessary
	Sand sedimentation	To flush it out as necessary
	Deformation or Crack in structure	To record it To repair it if necessary
Sedimentation basin	Sand sedimentation	To flush it out as necessary
Facilities and equipment	Checking Points	Measures
Headrace	Suspended materials along canal	To remove it at any time
	Sand sedimentation	To flush it out as necessary
	Leakage, deformation and Crack in structure	To record it To repair it if necessary
	Land slide along headrace	To remove sand and rocks after confirming safety
Headtank (Forebay)	Suspended Trash at screen	To remove it at any time
	Overflow from Spillway	To reduce water intaken if overflowing water is too much.
	Water leakage	To record it To repair it if necessary
	Sand sedimentation	To flush it out as necessary
	Deformation or Crack in structure	To record it To repair it if necessary
Penstock	Leakage and deformation	To record it
Turbine	Strange sound and vibration	To record it To check the causes of it
	Leakage from housing	To record it To repair it if necessary
Generator	Strange sound and vibration	To record it To check the causes of it
	Temperature	To record it
	Damage of belt	To replace if necessary
Load stabilizer	Performance of load stabilizer	To check the performance
	Damage of heater	To replace if necessary
Transformer	Leakage of oil	To replace if necessary
Transmission and distribution line	Suspended material	To remove after stopping the operation
	Approaching branch	To cut it as necessary

10.3.2 Periodic Inspection

Operators must conduct inspection periodically to check if there are any troubles in facilities and equipment. At the inspection, operators sometimes overhaul and repair them if necessary.

Items and frequency of periodic inspection are as follows:

Facilities and equipment	Checking Points	Frequency	Measures
Intake ~ Penstock And Tailrace	Leakage, deformation and Crack in structure	6 months	To record it To repair it if necessary
	Deformation or Crack in structure	6 months	To record it To repair it if necessary
Turbine	Supply grease to bearing	6 months	
	To replace bearing	3 years	
	Bolt connection	1 year	To fix them
Generator	Supply grease to bearing	6 months	
	To replace bearing	3 years	
	Winding insulation resistance	6 months	To replace generator
	Bolt connection	1 year	To fix them
	Damage of belt	6 months	To replace if necessary
Load stabilizer	Performance of load stabilizer	6 months	To repair it
	Damage of heaters	6 months	To replace if necessary
Inlet valve	Leakage	1 year	To
Transformer	Leakage of oil	1 month	To replace if necessary
Transmission and distribution line	Approaching branch	1 month	To cut it as necessary

10.3.3 Special Inspection

In case of earthquake, flood, heavy rain and accident, operators must stop operation and inspect facilities.

10.4 Recording

Operators must record results of operation and maintenance of plant. Recording is not only of much help to operators in reminding themselves of operation and maintenance that should be done, but also good data to find out causes of trouble in case of accident.

A sample of operation record and daily patrol check sheet is shown in the next page.

Check Sheet

Civil Construction

Month : _____

Year : _____

No	Description	Daily Checking																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
I	Dam																															
1	Construction																															
2	Stop Log																															
II	Settling basin																															
1	Construction																															
2	Screen																															
III	Headrace																															
1	Construction																															
2	Stop Log																															
IV	Forebay tank																															
1	Construction																															
2	Screen																															
V	Penstock																															
1	Penstock																															
2	Foundation																															
VI	Power House																															
1	Construction																															
2	Sanitation																															
VII	Tailrace																															
1	Construction																															
Damage Note																																
Cause of Damage																																
Repairing Note																																
Repaired by																																

Remarks : ! Fill the column as the actual condition such as : (N) Normal, (B)Bad, (R)Broken

Approval by

Checker

Chief

Operator

Check Sheet

Mechanical and electrical

Month : _____

Year : _____

No	Description	Daily Checking																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
I	Turbine																															
1	Runner																															
2	Bearing turbine																															
3	Plummer Block Bearing																															
4	Pull Turbine																															
5	Cover pulley																															
6	Coupling																															
II	Panel control																															
1	Meter																															
2	Lightning rod																															
3	Ballast Load																															
4	Main Board																															
Damage note																																
Cause of Damage																																
Repairing Note																																
Repaired by																																

Remarks: : ! Fill the column as the actual condition such as : (N) Normal, (B)Bad, (R)Broken

!! If there is a fatal damage, repair immediately, or coordinated with IBEKA team Telp. 022-4202045

Approval by

Checker

Chief

Operator

Check Sheet

Distribution Line

No	Uraian	Daily Checking																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
I	Transmission																															
1	Pole																															
2	Cable																															
3	Connector																															
4	Group MCB																															
II	In house installation																															
1	MCB																															
2	Installation Cable																															
Damage Note																																
Cause of Damage																																
Repairing note																																
Repaired by																																

Month : _____

Year : _____

Remarks : ! Fill the column as the actual condition such as : (N) Normal, (B)Bad, (R)Broken

!! If there as problem with the distribution facility, repair immediately and fill the damage column

Approval by

Checker

Chief

Operator

Lubricant & Spareparts

Year : _____

No	Description	Lubrication based on total operation hour											
		January	February	March	April	May	June	July	August	September	October	November	December
		720	1440	2160	2880	3600	4320	5040	5760	6480	7200	7920	8640
A	LUBRICATION												
1	Bearing Turbine												
2	Plummer Block Turbine Bearing												
3	Plummer Block Turbine Generator												
B	SPAREPARTS												
1	Bearing												
2	Seal												
3	Coupling												
4	Flat Belt												
5	Others												
	Re-setting												

Notet. : Fill the column with the lubrication date

LOG BOOK

Year : _____

Date	Time		Operation		Opening of Guide vane %	Frequency meter (Hz)	Volt			Ampere			Watt			Output Total Watt	Remarks
	Start	Stop	Hour/day				R-N(V1)	S-N(V2)	T-N(V3)	A1	A2	A3	V1xA1	V2xA2	V3xA3		
1																	
2																	
3																	
4																	
5																	
6																	
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Note: Fill the column after installation to the house
 Calculation of power output = (A1+A2+A3)x220 on condition ballast 0 (zero) volt

Recorder

Operator