Chapter 7
Commissioning and Testing

Commissioning and testing of an MHP provide a system for checking that all the components of the MHP are functioning properly as per the design and/or as specified by the supplier. The commissioning and testing procedure also provides a record of the operational status of the plant at start-up, which is a useful reference for the future. More practically, some problems may be encountered when the plant is operated for the first time. These problems, whether in the civil works or in the electromechanical equipment, must be removed completely, before the plant is put into normal operation.

7.1 Commissioning Procedure

The commissioning procedure should begin only after all the installation work has been completed and checked. The commissioning report must have a list of all the items to be checked or tested. A note should be made next to each item, specifying the condition, and whether this condition is satisfactory or whether it needs to be rectified. Similarly, the test results should show the data obtained, calculations of the results (e.g., efficiency), and whether or not these meet the specifications.

7.1.1 Cleaning the Penstock

Inevitably, some debris will have dropped into the penstock while it was being assembled. This debris must be removed before running the turbine, otherwise the turbine will be damaged.

The penstock valve should be closed and the penstock partly filled with water in order to flush the debris to the bottom from where it can easily be removed. The debris will collect behind the valve. The water should then be drained by opening the valve or turbine vane just enough to allow the water to drain very slowly. After the water has drained out, the debris can be removed in one of the following ways.

- If a gate valve is installed, by removing the top half which houses the spindle and gate
- By removing the valve (in the case of a butterfly valve) and/or turbine adapter
- By removing the turbine cover

7.1.2 Checks before Starting

Before starting the plant, the whole system from the weir and intake to the end of the transmission line must be inspected to ensure that there is no damage or possibility of

break-up, especially in the canal. The following must be checked and/or carried out to ensure this.

Intake

- Intake and trashrack are clean.
- The intake gate operates properly.

Canal

- The canal is clear of all loose stones and dirt.
- There are no cracks or damage to the canal. Repair cracks or damage if any.

Desilting

- The flushing valve opens and closes properly.
- The desilting basin is clear of all debris.

Gates/Stoplogs

- They operate properly.

Penstock Supports/Anchors

- All nuts on the penstock straps are tightened properly.
- There is no damage to supports/anchor blocks, and the bases of the anchor blocks/supports have not been eroded. Repair if necessary.
- The drainage arrangements around the anchor blocks/supports are not blocked or damaged. Repair if necessary.

Penstock

- All bolts are tightened properly.
- The penstock has not sagged at any point. Reconstruct support piers if necessary.
- The paintwork is intact. Repair if necessary.

Turbine

- The turbine is well mounted and in good condition.
- Corrosion protection and paint are ok.
- The ball bearings are well lubricated.
- The shaft is turning smoothly, there is no noise or vibration.

- The turbine-alternator alignment is ok.
- All the nuts and bolts are properly tightened.

Power Transmission

- The coupling is aligned properly, there are no loose bolts.
- The belt is aligned and tightened to the correct tension.

Alternator

- The alternator is well mounted and in good condition.
- Corrosion protection and paint are ok.
- The ball bearings are well lubricated.
- The shaft is turning smoothly, there is no noise or vibration.
- The turbine-alternator alignment is ok.
- There are no loose or untightened bolts.
- The ventilation system is not blocked.
- The stator windings to terminal are properly connected.
- All cabling is ok and fixed well.
- The nameplate has the correct information.
- The insulation resistance is ok.
- The continuity of each grounding circuit throughout the system is ok.

Control Panels

- Panels are properly fixed, doors and locks function properly.
- Paint is ok.
- Earthing is done properly, screws and terminals are tight.
- All cabling, connections, terminals, and wiring are ok and there are no loose connections.
- The general cabling layout is ok and there is no damage.
- Labels are well fixed, have the correct information, and are readable.
- Wiring diagrams are available.

Transmission/Distribution

- The resistance of all earthing systems is within the given limits (usually less than 5W).
- There is no excessive sag in any section.
- The ground clearance of all transmission lines is satisfactory.
- The lightning protection system is in place.
- The connections to the transformer are properly tightened.
- The transmission line is clear of trees and branches. Cut off any branches or trees that are too close (within 2 metres of the transmission line).

- All service wires are properly connected.
- All poles are undamaged, vertical, and fixed properly.
- All insulators are undamaged.
- All connections to the insulators are properly made.
- All joints and splices in the transmission are properly made.

After all the checks have been completed and are considered to be satisfactory, the waterways should be filled slowly with water to test all overflow systems and to test for slippage or leakage. All gates, stoplogs, and flushing valves must be operated in this situation to ensure that they function in their normal operating conditions. Check to see whether the penstock leaks.

This test should be carried out for a period of at least 24 hours while the canal remains full and some flow is spilling from the forebay. During this time the system must be monitored to check for any leakage of water from the canal and the forebay. Also check that no damage has been caused by the overflowing water.

7.2 Commissioning and Performance Tests

After all the above tests have been carried out the system is ready for commissioning.

Open the main valve or turbine valve SLOWLY to start rotating the turbine. The turbine should be allowed to run at a low speed, with the generator connected, while ensuring that there are no unusual sounds, vibrations, or behaviour.

If any unusual sound or odd behaviour is noticed then shut down immediately. The problem(s) should be investigated, identified, and rectified before the tests are resumed (e.g., misalignment, loose nuts/bolts, leakage).

Increase the turbine speed gradually until normal operating speed is attained. Allow the turbine to operate at this speed, with the generator excitation ON and with no load or a very small load, for about two hours. During this time, constantly monitor the equipment, particularly for excessive temperature rises in the bearings and alternator windings.

Increase the load on the machines in steps of 20 per cent until maximum output is reached. At every load step the system must be allowed to reach a steady state (i.e., there are no fluctuations, and flow and output are constant) and normal running condition before readings are taken.

While the machines are running, continue monitoring for unusual sounds, vibrations, and odd behaviour.

7.2.1 Performance Test

While operating the machines at different loads as described above, a performance test should be carried out by taking the readings of the machines and the outputs at different loads. The following should be measured and recorded.

The flow (if possible), pressure at the penstock outlet, turbine speed, bearing temperature, alternator temperature at different points, alternator voltage and current on all phases, exciter voltage, and current and voltage drop across transmission line lengths on each phase.

The different readings should be taken at steps of 20 per cent up to the rated power output of the plant. In cases in which an ELC is installed, the power output may be increased by increasing the water flow. The ELC automatically switches on the ballast to maintain the correct speed. The tests can be continued using the ballast load, but it is advisable to use an external load as this will provide visible evidence to the customer that the required output has been produced. For example, in a 10kW plant, ten 1kW heaters could be used; and for plants of 1-2kW, 10-20 100W bulbs could be used.

A sample format for the test results is given in Annex 2.

7.3 Rectifying Faults

During the commissioning tests, problems may be encountered in the functioning of the plant, or faults detected. The severity of any problems must be assessed and action taken as follows.

7.3.1 Serious Problems

Stop further commissioning work until the problem is fully rectified. Such problems are broadly of two types.

Safety related Any conditions which, if not rectified and the equipment is operated, could lead to injury, loss of life, or serious damage to the infrastructure and equipment of the plant.

Examples

- Inadequate spillway, which could result in erosion of anchor blocks or supports, or erosion of land.
- Transmission wires that can be touched by a person while standing on the ground.
- Any situation that causes electrical cables to overheat.

Operational. These are problems that prevent the full output of the plant from being produced and can have an adverse effect on the life of the plant in the long term if it continues to be operated.

Examples

- Blocked or restricted canal preventing the required flow being attained
- Rapid and high rise in temperature of bearings or generator windings
- Excessive vibration
- Resonance speed that is close to the operating speed

7.3.2 Ordinary Problems

These are the problems that can be rectified straight away or later and will not hinder the commissioning work which can continue.

Examples

- Minor leakage of water from the canal or pipe joints
- Minor misalignment that can be adjusted
- Damage to paint work where repainting is needed

After any rectification work on a component, the component must be tested before proceeding with the commissioning.

7.4 Endurance Test

After the performance tests have been completed, the equipment should be run continuously for a period of at least 24 hours at full load to find out if the machines are able to give continuous and trouble-free service. During this test the machinery should be continuously monitored for the following.

- Excessive vibration and noise
- Overheating of mechanical and electrical components
- Loss of output
- Deviations in frequency, voltage, and current

If any of the above problems occur, then the cause of the problem must be found and rectified before further tests are done or before the commissioning and handover are completed.

After completing the endurance test successfully, the plant is almost ready to be handed over to the owner-manager(s). However, it would be advisable for the owner-manager and operators to continue operation of the plant for an additional two to three days under the supervision of the installers. The plant should be started, stopped, load(s) applied/removed, and the flow varied, while continuously monitoring the output, instruments, and overall behaviour (noise, temperature, vibration, leakage). This will lead to more confidence about the performance of the equipment, and the plant operators will also have received some on-the-job training.