

## CHAPTER - 6

### BEST PRACTICES IN OPERATION & MAINTENANCE OF HYDRO POWER STATIONS

*“Operation and Maintenance of hydro power stations must aim at reducing failure rate by ensuring smooth operational levels of the power utility. This can be done by adopting timely preventive maintenance schedule regarding all vital areas of the power project. Engineers are well-advised here to follow the well-known dictum: “Prevention is better than cure”.”*

- 6.1 Best Practices in Operation & Maintenance of Hydro Power stations shall be such that by following such procedures, the downtime of individual generating Unit & Plant should be minimum. The operational reliability of the generating units of the hydro power stations shall be such that whenever the grid demands, it should be available for generation. Some of the aspects, which can be taken into consideration, in Operation & Maintenance of Hydro Power Stations, are given as under :
- i) Each failure/tripping occurrence must be questioned with basic minimum three questions **a) Why this occurred? b) How this occurred? And c) What is to be done to avoid its reoccurrence?** This will definitely reduce failure rate to the greater extent.
  - ii) Since It is important to adopt timely preventive Maintenance Schedules covering all vital areas and plants, the detailed Daily, Weekly, Monthly, Quarterly, Annually and Capital Maintenance Sheets should be maintained properly.
  - iii) During replacement of any part or equipment after its full utilisation or breakdown, it should be ensured that the replaced part or equipment should be of improved version & of latest technology having longer durability to meet all desired requirements so as to

increase plant efficiency and reliability.

- iv) Operating conditions should continuously be monitored and recorded. Records are very important to diagnose the causes of fault / failure/ replacement & to determine residual life. Early action can be taken before any type of failure.
- v) Eventhough Original Equipment Manufacturers recommend max./ min. permissible parameters for their equipment, the records/ experience/past history play important role to set limiting values of parameters of these equipment, as characteristics of identical equipment vary from unit to unit and required to monitor its set values.
- vi) On the basis of past history/records & recommendations of OEMs maintenance schedules can be framed. Breakdowns/forced outages can be minimized by proper follow-up of the maintenance schedules based on recommendations of OEMs.etc. Life of the equipment thus can be enhanced.
- vii) Starting/stopping of the units shall be planned to be minimum to increase the life.
- viii) Procurement of the equipment spares should be planned as per the rate of the consumption, based on minimum requirement to optimise the inventory.
- ix) Optimum utilisation of the men & material to be planned.
- x) It would be beneficial to arrange training to O&M staff to refresh their knowledge and to give advanced technical information to improve work quality & quantity.
- xi) Interaction amongst working staff at various power stations in the country needs to be organised to improve performance of plant and equipment in totality so as to implement good Operation & Maintenance Practices.
- xii) Provision of “On Line Condition Monitoring System” on generator,

turbine and main transformers could be considered for installation on all existing power stations.

xiii) Afforestation in catchment area

Catchment Area Treatment studies for the Stations in operation could be got carried out and as per recommendations of the studies, the Power Station should carry out afforestation work in the catchment area. This would help in reduction of silt content in the inflow water.

## **6.2 MAINTENANCE PRACTICE**

Some of the practices to be adopted at hydro power stations for maintenance of certain main plant are broadly given below.

### **6.2.1 Water Intake, Water Conduit System and Associated Equipment**

Water storage (Reservoir) & water conductor system comprising of intake, head race tunnel, surge shaft, emergency valves & pressure shafts, penstock, main inlet valves are very vital organ of a hydro power plant. .Due to negative and positive water hammer during sudden changes in water flow, it is essential to attend to these plant & equipment very carefully. It is very important to regularly test operation of conduit isolation system/equipment i.e. intake gates, butterfly valves, excess flow device, surge equipment etc.

Periodic physical inspection of water conductor system from inside as well as outside to know its condition, silt deposition, rusting/erosion of conduit system is very much essential to find out various changes due to aging factor, stresses developed due to water hammer etc.. The records of such physical inspection should be maintained by noting all the details i.e. normal as well as abnormal. These records can be compared with the installation data. Any abnormality is to be further investigated by carrying out hydraulic testing, measurement of thickness by Ultrasonic testing & tests for measuring and computing stresses at strategic locations such as intake point, bends, besides observing sudden changes in elevations & sizes of pressure shafts, penstock etc. Leakages, if any, should be scrupulously noted and records maintained. It should be

ensured whether inside / outside (wherever possible) painting is carried out to protect the conduit system. The valve seals, if deteriorated should be replaced by using new seals with latest materials for enhancing the life of this equipment. Purification and frequent testing of hydraulic system oil should be carried out as per recommendations of the manufacturers. For oil purification on-line electrostatic liquid cleaners may give best results. Some of the additional points as mentioned below also need to be considered:

- Cavitation & erosion at top portion due to rushing of air during fill up.
- The inspection schedule for the durability of anticorrosive paints used.
- Replacement schedule for various vulnerable parts such as bends, open conduits etc.
- Due to humidity open conduit deteriorates from outside. As such inspection & cleaning to be carried out from time to time at regular intervals.
- Anticorrosive-painting schedules followed.
- Timely Operation & Maintenance of the cranes & hoists.
- Healthiness of control & protection for isolating gates/valves & for cranes/hoists.
- Maintenance of trash-rack/intake gate filter.
- Maintenance of communication systems, availability of power supply, equipment for emergency operations, approach roads etc.

### **6.2.2 Turbine & its Auxiliaries**

Regular inspection of runners of turbines should be carried out and record to that effect should be invariably maintained. Many a times it is not possible for Francis Turbine being always immersed in water and needs isolation on either side. For this it is done as recommended by manufacturer without any compromise. Due to cavitation there may be huge damages to turbine wheel causing adverse effect on performance and consequently efficiency. Sometimes, it would be necessary to undertake in-situ repairs of turbine buckets to recoupe/fillup erosions/white pitting by using various cold compounds viz. Belzona compound, Loctite, SS Metalset, Throtex compound etc. This may give satisfactory



*New Turbine Runner of Unit No. 3 of Burla Power House of Hirakud Power System being replaced for RIM & U Works.*

results. Low heat input welding can also be tried at some of the locations to some extent.

An effective system for monitoring of silt content (quantity and size in PPM) may be installed & commissioned by each power station and silt content may be monitored continuously on the basis of which action to mitigate the damaging effect to under water parts may be initiated reducing the down time of units / station.

Best efficiency microprocessor based digital PID speed governors provide fast response. Periodical maintenance of speed governors alongwith all associated mechanical, electrical, electronics component should be carried out. The control circuit should be neatly dressed with identification marks. The electronic components and cards should be carefully maintained at appropriate temperature level to achieve desired performance. Periodical calibration and testing of transducers, meters

etc. needs to be done. Desired purity level of hydraulic oil is to be maintained to give trouble free operations. History of each important part should be maintained. Following maintenance works also need to be taken up:

### **Turbine**

- Periodic NDT viz. Ultrasonic, etc.
- Polishing of the various under water parts of the turbines once in a year to minimize the white pitting.
- Inspection & testing of the runners from experts to decide residual life so as to initiate action for procurement of runners for replacement.
- Inspection of labyrinth seals in case of reaction turbines.
- Painting of runner housing with anticorrosive / tar based paints.
- Applying anti-erosion coating to the runner.
- Checking of brake jet operation in power stations having Pelton turbines once in three months.

### **Governor**

- Purification of hydraulic oils by centrifugal as well as electrostatic liquid cleaner.
- Periodic maintenance of the servo valves and motors after carrying out inspection of the pistons & housings of the servo valves and motors for their worn-out parts. Replacement of the leaking seals.
- Survey of the component failure & procurement of the same and maintain minimum inventory.

### **6.2.3 Generator & its Auxiliaries**

Stator & rotor winding, bearings & excitation system are the main parts of a generator. As regards stator and rotor windings, regular recording of IR Values of these winding should be maintained at regular intervals. Tan Delta and DLA tests of stator winding indicates the status / condition of stator winding insulation. Likewise impedance test (voltage drop test across each pole) indicates condition of the rotor winding. Proper cooling system is to be maintained to limit rise in stator winding temperatures and consequently increase the life of stator winding. Inspection of the





*Machine Hall of Bhabha Power House 3x40 MW*

stator winding is also required to be carried out to verify its firmness in stator core slots and healthiness of overhang portion with firm end winding caps & end spacers, slot wedges checked for healthiness. Windings are revarnished to enhance their life. Looseness of stator core or inter lamination, core insulation are direct factors affecting winding heating due to eddy current loss. Thus recommended maintenance as per schedule should be carried out its records maintained and corrective actions be taken if necessary.

Another precision and very critical components of generator are its guide and thrust bearings. The thrust bearing is main bearing holding complete thrust of rotating mass of turbine and generator unit. The generator and turbine guide bearings act as guides for controlling the vibrations of the unit. If T-G shaft alignment with accurate shaft level is achieved then the pad clearances are adjusted precisely and the rotating machine will operate smoothly without rise in bearing temperature and increase life

of bearings. Following works also need to be taken up:

- Periodic checking of the foundations, tightening the bolts. Filling the foundations with epoxy.
- Checking the vibrations periodically & history of the recorded readings gives guidelines for realignment, looseness if any, unbalanced electrical components, increase in bearing gaps, coupling misalignment, uneven stator -rotor air gap etc.
- Periodic cleaning or replacement of the generator air coolers and bearing oil coolers to improve performance of the generator.
- Primary and secondary testing of the protection system for its healthiness and correct operation.
- Inspection of the CTs, PTs and bus bars for over heating, temperature rise etc.
- Inspection of circuits for protection & control circuits & mock trials of the fire fighting system alongwith evacuation system. Checking weight loss of the CO2 cylinders and replenish as per recommendations of OEM.

#### **6.2.4 Transformer & Switchyard**

- Continuous monitoring of oil & winding temperature.
- Periodic oil filtration.
- Oil testing for various tests and Dissolved Gas Analysis.
- Tandelta & insulation resistance etc. as per schedule.
- Cleaning and replacement of oil cooler
- Testing protection system for healthiness.
- Mock trials of Checking, maintenance and inspection for Fire fighting system, CO2 & mulsifire.
- Tests for operation time of the breaker.
- Operation & testing of isolator opening & closing.
- Checking of control circuit & healthiness of operating system of the breaker.



- Periodic cleaning of transformer bushings & insulator strings.
- Switchyard are to be kept neat & tidy. Minimum area surrounding the yard to be free from growth of scrubs and bushes to avoid any bush fire damaging the equipment.

#### **6.2.5 Emergency D. G. Set**

- Regular maintenance of the emergency set. Checking control & protection system.
- Running of DG set at regular intervals.

#### **6.2.6 Other P. H. Equipment**

- Periodic maintenance of unit auxiliary, station auxiliary & station service transformer.
- Checking healthiness of station batteries & battery chargers. The two charges should be rotated once in a week.
- Regular inspection of cable ducts to ensure proper ventilation / heat dissipation.
- Checking the healthiness of pressure relief valve, if provided.