

Online training of SAARC Professionals on Small, Mini and Micro Hydro Power Generation (Sept 13 - 17, 2021)

Operation and Maintenance of SMMHP Plants

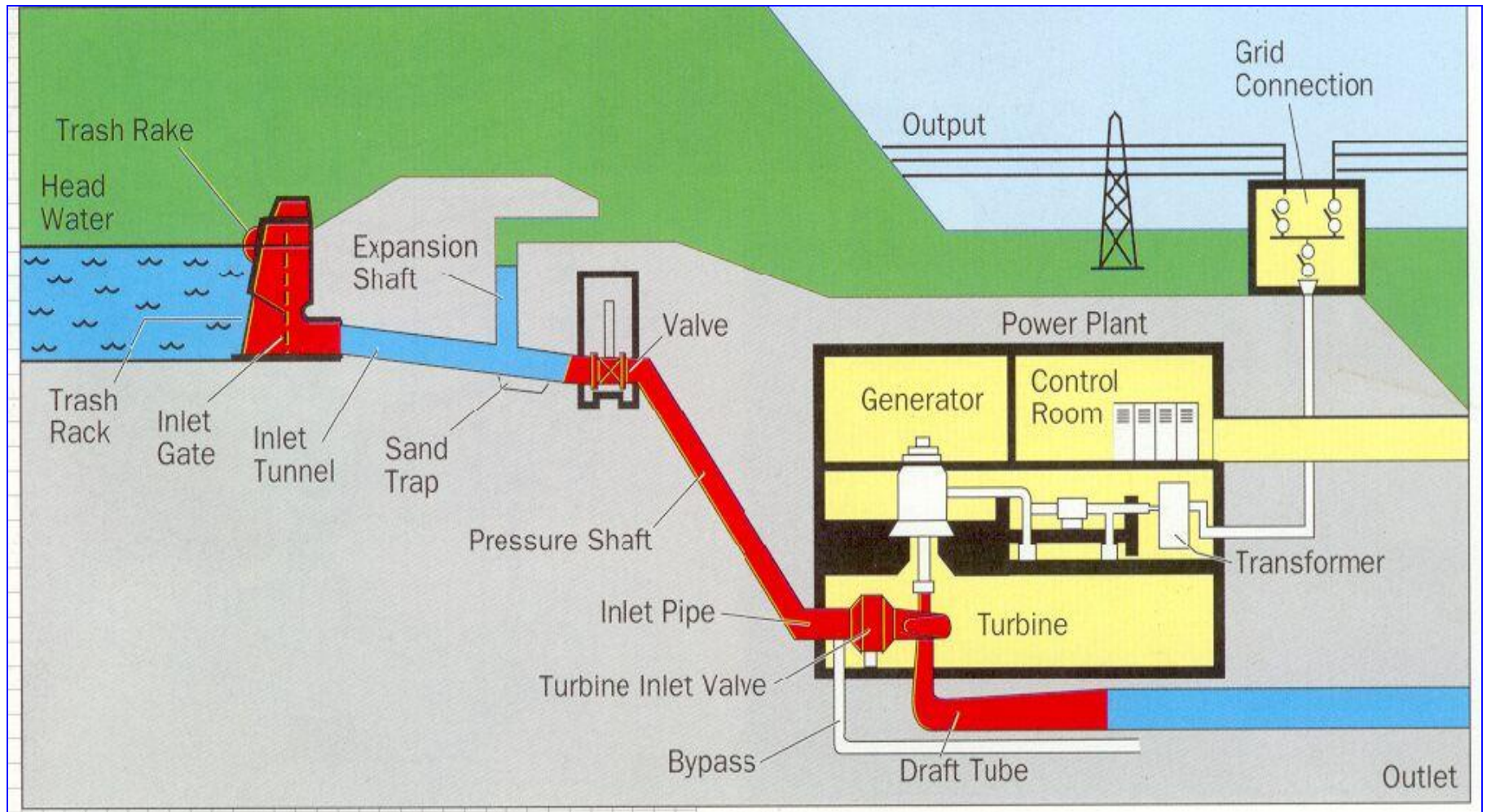
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TYPICAL VIEW OF A POWER PLANT







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Introduction

- The success of any SMMHP plant depends on the successful operation and maintenance of the plant and equipment.
- Many SMMHP's plants could not perform even to their planned life and many had serious equipment failure resulting in closure of the plants.
- Besides design and erection deficiencies, *incorrect plant operation* and poor maintenance is a major cause of non performance of plants.

O&M Objectives

- Streamlined and efficient operation and maintenance of the plant.
- Minimizing plant down time and optimizing the generation.
- Maintain quality of power supply.
- Adherence to all relevant rules and regulations and safety measures
- Adherence to approved maintenance schedules to maximize plant life

- Maintain and repair civil structures , machines, instruments, and tools .
- Maintaining the records of generation, aux. consumption, export and import.
- Optimizing the plant operation as per water AVAILABILITY

To achieve above objective strategy for O&M will differ as per the capacity of power plant as manpower requirement as well T&P, handling, lifting tackle requirement will change as per max weight to be handled.

Up to 100kW:

The personal engaged for O&M may be required to carry out operation as well as routine mechanical, electrical maintenance of plant equipment installed.

100kW to 1000kW:

Same as above but requirement of staff and T&P would be more.

1000kW to 5000 kW:

Operation personal working in shift to run machines and maintenance staff to carry out day today maintenance will be required to be engaged for keeping the machines running to its full capacity.

Above 5000kW:

Full fledge shift of electrical and mechanical technicians will be required to run the machines smoothly. Separate groups of technicians for mechanical, electrical and testing work will be required to carry out routine maintenance and keeping the machines fit for generation.

Scope of Operation Work

- Operation of plant in such a way that Optimum generation is achieved ensuring safety of equipment and personals.
- Daily shift duties of operation personal.
- Daily, monthly data logging and preparation of reports
- Annual plant operation record
- Shift wise recording all tripping
- Outages and faults occurred as also short cuts taken to keep the plant running
- Communicating emergencies to authorities

Scope of Maintenance

- Maintenance of plant , equipment , tools and instruments.
- Logging of all maintenance activities.
- Keeping records of observations, measurements taken, remedial actions taken, final measurements taken.
- Others :
 - Safety of personal and equipment.
 - Procedure for taking / handing over plant and equip.
 - Recording additions and alterations during maintenance .

- Securing all plant drawings, maintenance manuals and history of plant
- Fire prevention , protection, fighting and safety drills.
- Man power requirement and training.

Operation Management

- Management of shifts
- Arrangement of log books, registers and other stationery items
- Daily, monthly and annual reports
- Arrangement of necessary T&P, consumable items viz. indicating lamps, fuses , cotton waste, cotton cloth, cleaning agents etc.
- Training of engineers and operators
- Quarterly safety drills
- Reporting of electrical and other accidents
- Reporting blockades of water ways due to land slides

Maintenance Management

- Human resources
- Planning and arrangement of spares, consumables, ordinary T&P and Special T&P
- Preparation of maintenance schedules and adherence of same
- Preventive Maintenance
- Routine Maintenance
Daily, Quarterly, Annual
- Capital Maintenance
- Break down maintenance

Technical Guidance on O&M of SMMHP Plant

- Giving technical help for site problems.
- Conducting O&M training programs for operation and maintenance staff at site / institute.
- Preparation of model specifications for O& M.

Problems Associated with SMMHP Operation

- Remote location
- Shortage of skilled man power
- Communication difficulties
- Low plant load factor
- Frequent start ups
- Long transmission lines & low power
- Minimum facilities at site
- Natural calamities like land slides, floods, earth quakes etc
- Silting
- Water discharge restriction
- Less contact with engineers / manufacturers

Plant Performance Indicators

- Designed generation
- Actual generation
- Auxiliary consumption
- Plant load factor
- Plant availability
- Forced outages
- Safety record
- System emergency response.

Water Management for Max. Generation

- Knowledge of river inflow pattern
- Diversion of max. water for electricity generation
- Plugging loss of water in water conductor system

Plant Maintenance

- Break down maintenance
- Routine maintenance
 - daily plant maintenance
 - quarterly maintenance
 - annual maintenance
- Preventive maintenance
- Capital maintenance

Breakdown Maintenance

This advocates to run the machine till it fails which should not be accepted by any management but in small hydro power stations it generally happens

Routine maintenance

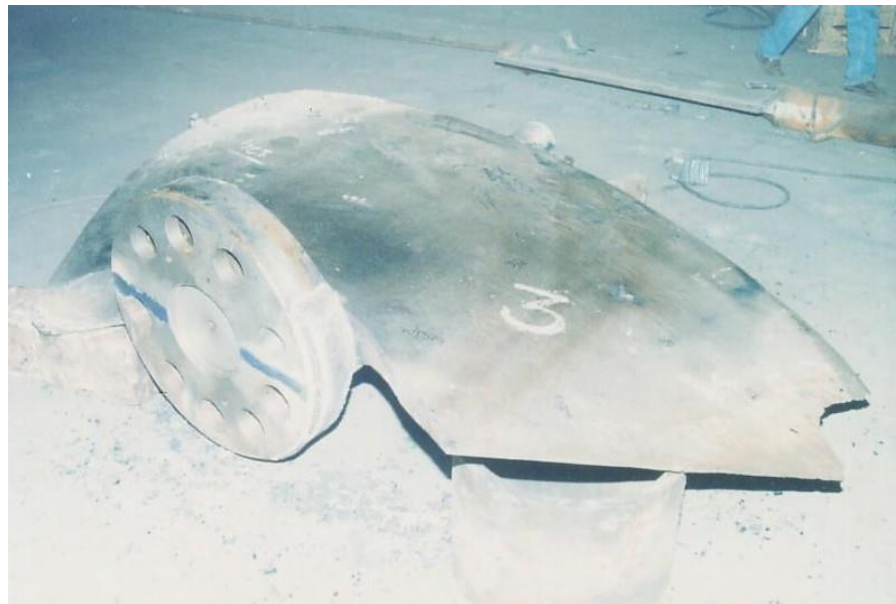
In this category , the machines are maintained at suitable intervals by inspection, cleaning, tightening of nuts and bolts and repairing different components without completely dismantling the machines. It may involve daily, weekly, monthly , quarterly ,biannually or annual routines. For example during routine maintenance Cleaning of commutator, replacement of brushes , oiling and greasing of guide vanes and bearings etc.

Preventative Maintenance

- In this type of maintenance different diagnostic test on different parts of the machine are carried out to ascertain the condition and health of the equipment.
- On the basis of these tests , the residual life of different parts can be assessed. Parts needing immediate or near future replacement can also be identified.
- Thus the preventive maintenance enables us to predict the potential faults which occur in future and enable us to take remedial steps to prevent these potential faults. Eg. IR ,tan delta, ultrasonic tests

Capital Maintenance

- During routine maintenance , the machine is not dismantled and so the major portion of most of the components like stator windings, rotor windings, guide vanes etc. remains inaccessible.
- It is not even possible to inspect these part properly. The extent of deterioration is not known. It is therefore necessary that the machine be completely dismantled so that all the parts are properly inspected and wherever required necessary repair is carried out.
- The periodicity of capital maintenance depends upon plant to plant.







Routine Maintenance Planning

- Finalise list of equipment needing repair/ maintenance
- Follow equipment manufacturers instructions
- Prepare maintenance sheets
- Prepare procedure
- List tools required
- Assign responsibility of maintenance staff
- Assign responsibility of verification
- Review procedure and modify.
- Consult person carrying out work

Annual / Quarterly Maintenance Planning

- Prepare annual maintenance schedule
- Check defect reports during year
- Check previous repair and performance
- Arrange man power ,tools and specialist
- Arrange for spares for replacement
- Follow manufacturers instruction
- Allot work to maintenance teams
- Arrange outage
- Inspect equipment safety before starting maintenance work
- Place notices on isolated points

Annual Overhaul

- Checks before dismantling in dewatered condition
- Precautions during dismantling : segregating different items in different trays of nuts, bolts, studs, fasteners etc, match marking of parts
- Precautions in storing dismantled parts: Bin cards for each item describing identity and quantity
- Maintenance of worn out under water parts: low heat welding, grinding and polishing

- Overhauling of generator and its auxiliaries
- Overhauling of turbine auxiliaries
- Dry out turbine oil
- Assembly of unit, checking alignment, centering, horizontality, verticality, magnetic axis, balancing and bearing settings

Maintenance of other electrical systems

- Maintenance of Transformers
- Maintenance of switch yard equipment
- Maintenance of station auxiliaries
- Checking working of D.C. system
- Checking working of controls, metering and protection systems

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 I 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.

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 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 re-varnished 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 along with evacuation system. Checking weight loss of the CO2 cylinders and replenish as per recommendations of OEM.

Transformer & Switchyard

- Continuous monitoring of oil & winding temperature.
- Periodic oil filtration.
- Oil testing for various tests and Dissolved Gas Analysis.
- Tan-delta & insulation resistance etc. as per schedule.
- Cleaning and replacement of oil cooler
- Testing protection system for healthiness.
- 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.

Annual Maintenance of Hydro Mechanical Components of Project

- Barrage gates
- Head regulator gates
- Intake gates
- Spillway gates
- Trash racks
- MIV, Expansion Joints

Annual Maintenance of Civil Structures

- Barrage
- Head regulator
- Desilting basin
- Power channel/ tunnel
- Fore bay
- Surge tank
- Tail race channel
- Power house building
- Switch yard foundations and trenches

Taking Over of Plant for Operation After Planned Maintenance

- Before charging of water conductor system
 - check cleanliness of all elements of water conductor system
 - check cleanliness of all elements of turbine, generator, auxiliaries, transformer, cable galleries, switchyard and all nooks and corners of Power Station
- After charging
 - check for leakages of water, oil in various systems
 - check all pressure gauges and flow meter
 - check working of all auxiliaries
 - check all records of settings and adjustments during erection of machine

- check all records of shop assembly tests
- check all records of field testing
- check all records of pre-commissioning and commissioning tests
- check records of performance and efficiency tests
- check behavior of machine during 72 hours continuous running of machine

Planned plant outage procedure for attending plant problems

- Water conductor system outage
- Problem in hydro mechanical equipment
- Problem in under water parts of hydro turbine
- Problem in other parts of hydro turbine and accessories
- Problem in hydro generator and its accessories

Plant outage for planned maintenance

- Fill Outage request form
- Read Planned outage instructions properly
- Authorized Operation personal must follow procedure for allowing planned plant outage

On Completion of Each Job

- Remove men and material
- Clear all the permits for work
- Carry out test and trial under separate permits
- Clearance for operation
- Observe the units start up and synchronizing
- Check for any problems and attend it, if safe
- Check unit performance for a week
- Keep all records of work and spares used.

Maintenance of Auxiliaries and Other Systems Installed

- EOT crane
- Cooling water system
- Drainage and dewatering system
- Station illumination and emergency lighting
- Station D.C. system , batteries and battery chargers
- AVR and excitation system
- Fire extinguishing system
- MIV ,intake gates ,draft tube gates, bye pass gates

Essentials of Efficient Hydro Power Plant Operation & Maintenance

- Trained man power
- Best operating procedure
- Best in plant and system communication
- Best equipment maintenance
- Ensuring availability of essential spares, consumables and T&P
- Best record keeping
- Open discussions and fault analysis

- Good house keeping
- Regular technology update
- Best staff amenities
- Best safety procedure.
- Well defined operating philosophy

Advantages of Staff Training

- Reduced down time of unit
- Increased availability plant
- Higher generation / revenue
- Increased life of the plant
- Increased plant efficiency
- Less equipment maintenance cost
- Increased profit
- Better returns on investment
- Safety of personal and equipment

Area of Training

- Plant operation
- Plant safety
- Fire fighting
- Plant maintenance
- Testing of electrical equipment
- Knowledge of civil structures, hydro mechanical, mechanical and electrical equipment installed
- First Aid

Operation Manual

- General plant information.
- Single line diagram and important plant and equipment drawings
- Equipment operating instructions
- Equipment outage procedure
- Emergency operating instruction
- Manufacturers instructions
- Trouble shooting.
- Equipment operating parameters/ limits
- Safety tagging and interlocks
- Designation wise duties of staff

Safety Related Issues

- Safety against fire hazards
- Safety against electrical hazards
- Safety against mechanical hazards
- Safety against natural hazards
- Regular safety drills
- Training in first aid and availability of first aid box
- Display of safety and first aid charts
- Ensuring availability of safety t&p
- Plan for safety tagging and preparation of standing orders for safety of personals and plant



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Thank you

