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Best O&M Practices of Thermal Units

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BEST O&M PRACTICES
IN
THERMAL UNITS OF M.P.P.G.C.L.

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BEST O&M PRACTICES
IN
THERMAL UNITS OF M.P.P.G.C.L.

OBJECTIVE

- To maximize reliability and availability of power generating units
- To minimize inputs of fuel, auxiliary power, make up water, maintenance cost etc.
- To bring unit's down time to minimum.
- To carryout maintenance jobs qualitatively and effectively as per laid down procedures within stipulated time.
- To carryout operation while maintaining rated parameters (performance & chemistry) keeping in view life of the equipment.
- To carryout optimized startups and shutdowns.
- To keep records and have a learning mechanism from them.
- To plan for overhauls, statutory inspection and their effective execution.
- To have effective overhaul monitoring mechanism.
- To ensure sustainable O&M and preserving environment.
- To ensure industrial health and safety.

Process Optimization through Best O&M Practices is a journey and not the destination. However, it is an effective tool to improve overall performance. Therefore, Focal Points and Objectives of Best Practices for O&M are as below-

S. NO.	FUNCTIONAL AREA
1	PLANT PERFORMANCE
2	PLANT AVAILABILITY & RELIABILITY
3	OPERATIONAL PRACTICES
4	EFFICIENCY MANAGEMENT
5	MAINTENANCE PRACTICES
6	OVERHAULING
7	HEALTHCARE & SAFETY
8	ENVIRONMENT MANAGEMENT & HOUSEKEEPING
9	QUALITY MANAGEMENT
10	KNOWLEDGE SHARING AND UPGRADATION

PROPER OPERATION AND MAINTENANCE MANAGEMENT

In order to achieve the objective of best O&M practices, it is necessary to attain quality during operation, maintenance and re-commissioning through proper-

i. Operation Management.
ii. Maintenance Management.

OPERATION MANAGEMENT:

Daily Site Meeting with all Head of the sections to take stock of plant performance and daily action to be taken on following points:-

- Review of previous day's Performance vis-à-vis Performance parameters
- Shortcomings such as Partial Loss and High Fuel, DMW & other Consumptions
- Separate discussion on Auxiliary Power Consumption.
- Defects and reasons of unit/ equipments outages and the ways out
- Discuss health of the equipments and plan for their maintenance
- To fix target for present day (in line with monthly and yearly targets)
- Review of previous day's meeting minutes
- DG set trial status, TG Lub oil and seal oil system auto cut in trial status.

Weekly Site Meetings for discussion/ actions to be done on following issues:-

- Effective analysis of unforeseen occurrence and practices to be adopted.
- Develop & Display of instructions to tackle various kinds of emergencies.
- Status of instrumentation, auto loops, annunciation, protection and inter locks.
- Good housekeeping. Site specific Scrap Management system to be devised/ reviewed.
- Walk down checks.
- Updation on various issues and training.
- Stack emission/ effluent quality control. Environmental waste management system healthiness.

Monthly operation Review team meeting (ORT) at site:

- Review of O&M issues and plant performance to be discussed in the presence of Station Head along with functional heads' team.

- Detailed operation performance review, analysis of shortcomings (including trippings) & ways of optimization.
- Status of critical and non-critical spares.
- Status of safety compliances along with fire protection system.
- Targets of main operational parameters like Availability, PLF, Heat rate, APC etc. are fixed on monthly basis after discussion considering the constraints and annual targets.
- Site visit of different areas of station and check the same with respect to safety and reliability of plant/ equipment by ORT Coordinator.
- Exception report of ORT of all the stations is reviewed by senior functionaries.
- On issues where difficulty is felt by stations, same is taken up by ORT coordinator with Engineering, PRG, MM and other groups at HQ.

Tripping Analysis-

Trippings to be minimized through following means:-

- Proper analysis of the tripping at site and reporting to HQ
- Review of compliance status.
- Implementation of recommendation of the analysis for avoiding recurrence.
- Feed back to other stations about the incidence and the recommendation to avoid the recurrence.

Efficiency Monitoring & Analysis -

Daily Meeting to discuss the following efficiency issues-

- Daily heat rate deviation report
- Daily parameter deviation report including the following-
  - ✓ Main Steam pressure and temperature.
  - ✓ Reheat steam temperature.
  - ✓ SH & RH spray flow.
  - ✓ Condenser vacuum.
  - ✓ APH flue gas outlet temperature
  - ✓ Oxygen % in flue gas.
  - ✓ Unburnt carbon in fly ash and bottom ash.
  - ✓ Feed water temperature at economizer inlet.
  - ✓ Make up water flow.
  - ✓ Auxiliary Power Consumption
- Monitoring and comparison with historical data of unit/ other similar auxiliaries of controllable parameters, which affect plant energy efficiency.
- Insulation survey to be done as and when possible
- Intelligent soot blowing to be adopted as it avoids excess use of steam, variation in MS & HRH temperature and erosion of tubes.

Monthly (and need based) Efficiency/ other Tasks-

- Efficiency test of each unit.
- Performance test with special purpose instruments viz. clean air and dirty air flow test.
- Condenser performance test.
- APH performance test.
- HP Heaters' performance test.
- Fire fighting mock drill.

Overhaul related following actions to be taken from Operation Management perspective-

- Efficiency test to be carried out before overhaul. The test results to be analyzed and proper recommendations to be made so that works can be carried out during overhaul. Comparisons of post overhaul efficiency analysis data with pre-overhaul data and the outcome to be recorded and circulated.

- Unit Re-commissioning: During overhauling to restore equipments to their normal function after completion of maintenance work, a dedicated team to be formed to bring back the unit in a safe and systematic way through:-

    - ✓ Better coordination.
    - ✓ Interlock/ Protection checking and recording in formats.
    - ✓ Trial Runs
    - ✓ Filling of Checklists (To be prepared at site after discussion at various levels and across various departments)

MAINTENANCE MANAGEMENT:

PLANNING:

A. Preventive Maintenance:

1. Short Term Planning:

- To develop preventive maintenance schedule and follow up.
- To organize the daily planning meeting and plan for maintenance based on Feedback from operation such as-
  - ✓ Operation groups.
  - ✓ Condition monitoring cell reports and
  - ✓ Progress of previous day's work and
  - ✓ Plant Maintenance schedule.
- Review and improve methods of maintenance practices and Revise work specifications accordingly.
- Adoption of Modular Maintenance Technology.
- Co-ordinations amongst operation, maintenance and planning.
- Ensure that the history of equipments is being maintained (to be enabled through ERP system)
- Planning for Opportunistic maintenance.

2. Long Term Planning:

- Annual Overhaul Schedule finalization based on statutory boiler license renewal, running hours, OEM recommendation and Condition of the equipment, 4-6 months before start of next financial year.
- Preparation of 5 Year rolling plan considering business target (Business Plan), reviewed annually.
- Planning of the availability of Critical spares, materials, special tools and tackles e.g. sky climbers, scaffolding materials etc. and work orders with required scope, before start of overhaul.
- Engineering declaration.
- Outage committee with specific responsibility of meeting time schedule and ensuring monitoring.
- Detailed activity scheduling and monitoring & control through bar chart etc.
- Mobilization of contractors before overhaul.
- Co-ordinate with materials, finance, operation and other maintenance department apart from MPC.
- Human Safety.

Overhaul Effectiveness through Adequate Overhaul Preparedness and Monitoring-

- The overhauling (AOH/ COH) of units is a comprehensive exercise which has to be done with spares need identification and planning 2 to 3 years in advance. These include techno-statutory scopes such as RLA study of boiler pressure parts, Comprehensive RLA study, NDT of turbine components and spare part planning based on above.
- Overhaul of units with financial management: It includes preparation of annual Repair & Maintenance (R&M) revenue budget as well as capital budget along with 5 years business plan.
- Pre-OH activities are main feature for successful overhaul these include Surveys, Testing, Unit data collection etc.
- Identification of defects, planning of activities and its inclusion in engg. Declaration.
- Overhaul work scope finalization based on – Integrated inputs from Work Requisition Analysis, operational performance degradation & GAP, Energy Audit recommendations, OEM's recommendations etc.
- Monitoring cycle of spares, consumables and contracts 12 to 24 months in advance to ensure availability of material for overhauls 6 months in advance.
- Optimization of Overhaul duration and Intervals based on –
  - ✓ Keeping the modules for replacement readily available.
  - ✓ Learning from previous OH (Proper recording and retrieving to be ensured)
  - ✓ Operational parameters, performance parameters and equipment condition between two overhauls for taking appropriate decision.
- Activity Protocols & Check list for-
  - ✓ Monitoring work during overhauling
  - ✓ Overhauling meetings
  - ✓ Quality checks for completion of all activities during overhaul/ before commissioning etc. **(Some of such checklists are given in Annexure at P-14)**
  - ✓ Monitoring by cross area station
- Study of sustenance of performance improvement after OH based on-
  - ✓ Pre and post OH O&M Data
  - ✓ Cost Benefit Analysis and its validation
  - ✓ Overhauling Reports

B. Predictive Maintenance Planning:

Condition Monitoring Cell is to be a part of planning department and with the help of diagnostic instruments. Selected equipments are to be monitored as per schedule and

recommendation, so as to facilitate finalizing daily predictive maintenance activities during daily planning meeting.

Some of the Condition monitoring techniques are as below:-

- Vibration Analysis
- Oil Analysis
- Temperature Trend Analysis
- Coal Mills Sieve Analysis
- DGA for Generator transformers
- Infrared Thermography
- Motor current analysis
- Noise level monitoring
- Water chemistry monitoring
- RLA Tests

C. BREAKDOWN MAINTENANCE

Equipment failure analysis

- Failure report by area engineer and analysis by experts/ senior functionaries.
- Recommendations/ remedial measures to avoid repeated failure. Planning viz. spare procurement and services required.
- Connect with similar previous failure and lessons from them. Add any other learning from present failure to those records.
- Adoption of Modular Maintenance approach, as it is vital for reduction in down time.

Boiler Tube Leakage Analysis at Power Stations through following steps-

- Initial site report by BMD Engineer.
- Mapping of location of failure on boiler drawing with frequency of failure.
- BTL analysis-Root cause and material testing (if needed).
- Implementation of recommendations.
- Forwarding of BTL report with plan to reduce the same to HQ.

Quality Management:

Adoption of New Technologies in maintenance is the need of the hour. Maintenance Quality Monitoring is to be taken care through FQA group at site and surveillance by team during overhauling.

- Field Quality Assurance at Power Station through dedicated groups doing:

- NDT and destructive testing.
- Maintaining Radiography source with and certified person, to operate it.
- Involvement of FQA during overhaul as well as routine maintenance including breakdown of major equipments.
- Involvement in critical checks Turbine/Boiler/Elect./C&I.
- Preparation of quality plan with the help of site engineers and ensure its implementation.
- Involvement in plant betterment studies, RLA and R&M.
- Involvement in spare parts inspection, storage & preservation in store as well as at site.

- Involvement in Quality Management regarding purchase order/contracts award and Pre-delivery Inspection at site and works.
- QA Group involvement during Overhauling: where the extents of forced outages are more, QA experts' team to visit site for review and guidance during overhauling.

HEALTH & SAFETY

MPPGCL is committed to provide System of Safe working and Healthy working Environment to all employees, while complying with all Occupational Health and Safety regulations and other requirements.

Safety (PTW system): To ensure safety of human beings and equipment while carrying out work, Maintenance (Service function) seeks written permission from Operation (Owner) section on a specific format before start of work. A fully fledged system (being envisaged for further strengthening and implementation through computer software) operates involving isolation, lockout box etc.

HUMAN RESOURCES

Message of Profit & loss are sent by SMS daily to specific officers for use in decision making and to other concerned to improve awareness about organization commercial performance.

Training Calendar:
A 'Training Calendar' to be prepared every year in the month of April covering various available training programs.

Training Need Identification:

Training Need Identification is a vital part of employee development activities. A training format is filled up by the concerned employee and thereafter signed by his reporting officer and Head of Department (HOD) in annual C.R. The training need column of concerned executive may be filled up by his reporting officer after discussion. These can be utilized by departmental training coordinators.

Technical Knowledge Up gradation Program:

MPPGCL is envisaging introducing knowledge up-gradation program for its employees. Regarding HR our mission has to be, "To keep on developing human resources to meet organizational needs." Subjects of such program could be large in number and varied in quality depending upon the field, level and work responsibilities. Some of such programs may be the following-

- Operation engineer to be rendered simulator training. Power plant familiarization in new and advanced technologies.
- O&M personnel to be rendered training, refresher program at various training centers or at the manufacturer's work or by attending different seminars/ workshop at national & international level.
- Inter generators conferences and knowledge sharing visits to be arranged for frequent exchange of knowledge and experiences.
- Interaction with various knowledge bodies such as "Knowledge Exchange Platform- KEP" of BEE and "Energy Enhancement Centre- EEC" and making the literature available to all the O&M engineers.
- Management skill development programs for managerial level.

Best Practice Review

Process Optimization through Best O&M Practices is a journey and not the destination.

1. Various power stations have their own best practices. There are the practices, which need to be shared between various stations so that they can benefit other stations also. Compilation of 'Best Practices' could be one such step. At the station level also there are best practices, which can be shared among various

departments. These can also be shared with colleagues from other stations, various guests and dignitaries who visit the station.

2. Since the 'Best Practices' do keep on becoming 'Common Practices' as the knowledge is shared, there will be a plan for annual updating of the best practices so that the old and common practices are replaced with new ones and the same shall be shared among all power engineers of MPPGCL. Suggestions for further improvement of these practices shall be separately invited.
3. All the power stations are required to make comprehensive checklists for operation, maintenance and overhauling of various equipments after detailed interaction amongst the experts, user and service departments.

ANNEXURE

SOME IMPORTANT PRACTICES TO BE ADOPTED

1. Measures To Minimize Boiler Tube Failure

General Measures:

Following general measures to be adopted in thermal power station to minimize the boiler tube failures:

- Visual inspection of heating surface to be carried out to identify type of failure viz. eroded tube, deformation, swelling, bulging of tube etc.
- Shielding of tubes / bends in identified highly erosion prone areas to be done to reduce erosion due to gas velocity in second pass.
- Tube thickness survey and thickness mapping in all identified areas to be carried out.
- 100% welding inspection to be carried out to ensure quality weld joints. Involvement of experience IBR welders to be ensured for pressure parts welding works.
- Emphasis to be given to prevent flue gas / ash erosion. Erosion prone areas are to be extensively inspected and protected by providing shield / baffles, refractory etc.

Preventive techniques to minimize tube failures:

Following innovative measures may be adopted in thermal power stations to minimize the boiler tube failures:

- Extensive Inspection of Pressure Parts as below-
  - ✓ During annual overhaul, inspection of LTSH/ Economiser banks on left and right sides to be carried out after removing skin casing and cutting fins at places based on experience.
  - ✓ Economiser coils to be lifted on both sides for inspection and to assess healthiness of tubes.

- ✓ Annual inspection of Platen super heaters and Re-heater bank bends to be done by arranging sky climber and platforms.
- ✓ Inspection of Roof tubes: Final super heater tubes and Super heater terminal tubes to be carried out by arranging multi tier platforms.

- Shielding the Tubes at Critical Zones
- To avoid ash erosion failures, shrouding / sacrificial shields to be provided for water wall screen/ extended water wall, Super heater screen tubes, extended steam cooled wall, LRSB's opening bends, LTSH terminal tubes/ ECO hanger tubes, LTSH straight tube, ECO coil straight tubes and rear side straight tubes. LTSH supply tube 90 deg. bends/ offset bends etc.
- Cassette baffles to be provided for bends of LTSH and ECO coil assembly to reduce erosion.

Importance of Boiler Tube Stoppers-

- The alignment of all coil assemblies and tubes in the horizontal pass and second pass to be thoroughly checked.
- Stoppers (locking arrangement) to prevent movement of steam-cooled spacers to be provided for Platen and Re-heater coil assemblies.
- Tubes that come out of connectors / distorted attachment can cause failure and hence to be corrected during boiler overhaul.
- Vibration arrestors/ clamps get deformed and make dent on tubes. They are to be repaired as and when noticed.

Quality Welding:

- Welding electrodes to be procured as per the recommendation of manufacturer and preserved as per standards.
- 100% Radiography of weld joints to be carried out

Maintenance of Flue Gas Path:

- Through inspection of refractory to be made to avoid flue gas diversion and impingement on bends and headers.

- Refractory linings to be provided in areas of high ash erosion where shielding of tubes is difficult.

Expert Analysis of Tube Failure:

- Failure analysis to be carried out through manufacture's experts and metallurgical laboratories to identify root cause of tube failure as and when required.

Post Operational Chemical Cleaning:

- With continued operation over a period of time the magnetite layer grows in thickness due to slow corrosion of boiler steel tubes. Also carryovers from condensers and pre-boiler systems deposited on the inner surface of boiler tubes where the heat transfer is high.
- This growth of oxides and carryovers result in loss of heat transfer and accelerated corrosion of boiler tubes. This makes the boiler less efficient and more prone to localized heating. At times it may lead to tube failure. Therefore, importance to be given for chemical cleaning of boilers.

2. Check Lists for various O&M activities

Check lists are to be prepared to check completion of all pre-decided activities. These are required to be done to ensure that all pre-requisite step in the maintenance or operation/ start up of the Auxiliaries. Some of such activities are given here under. It is required that all field engineers should actively participate in the preparation of all major and micro level activities. Some of such check lists are given here under as example to aid the process of preparation of these check lists at site level.

2.1 WORKS CARRIED OUT: CHECK LIST

2.1.1 EQUIPMENT: XRP-1003 MILLS DETAILS

S.No.	Work Description	Mill A	Mill B	Mill C	Mill D	Mill E	Mill F	Mill G	Mill H
01	Venturi outlet Repl. By New outlet/repair	Done	Done	Done	Done	Done	Done	Done	Ok
02	Venturi collar Repl. by New collar Repl.	Done	Done	Done	Done	Done	Done	Done	Ok

03	Venturi collar height maintained at:	20”	20”	20”	20”	20”	20”	20”	20”
04	MPO base plate Reconditioning:	Done	Done	Done	Done	Done	Done	Ok	Ok
05	Venturi vanes replaced by ceramic lined vanes:	Done 04 No	Done 04No	Done 04No	Done	Done	Done 04No	Done	Ok
06	MPO Replacement by (a) New MPO (b) Recond. MPO	--- 04 No	04No --	-- 04No	-- 04No	-- 04No	-- 04No	-- 04No	Ok
07	Mill discharge Valve door servicing	Done	Done	Done	Done	Done	Done	Done	Ok
08	Mill dis. valve disc plate repl.	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
09	MDV repl. by (a) New (b) Reconditioned	04 No --	04No --	04No --	04No --	-- 04No	04No --	04No --	Ok
10	Coal pipe orifices repl. (new set)	03No	03No	03No	03No	03No	03No	03No	03No
11	Victaulic gaskets repl.	07No	07No	07No	07No	07No	07No	07No	07No
12	Spring assembly, servicing	Done	Done	Done	Done	Done	Done	Done	Done
13	Spring assly brase sleeve repl. (nos.)	01 No	01No	02No	Ok	01No	01No	01No	Ok
14	Spring compression set at:	1600 PSI	1600 PSI	1600 PSI	1600 PSI	1600 PSI	1600 PSI	1600 PSI	1600 PSI
15	Vertical shaft upper radial brg clearance (D)	0.25 mm	020 mm	0.20 mm	--	--	--	--	--
16	Vertical shaft oil seals replacement:	Done	Done	Done	Done	--	--	--	--
17	Seal air housing adjustment & seal air gap:	0.60 mm	0.60 mm	0.50 mm	0.60 mm	--	--	--	--
18	Dust guard adjustment & clearance	2.50 mm	2.50 mm	2.50 mm	2.50 mm	--	--	--	--
19	Insulation cover plate resetting/ adjustment	Done 08	Done 02	Done 01	Done 04	Ok	Ok	Ok	Ok
20	PA Duct Insulation cover plate	Done	Done	Done	Done	Ok	Ok	Ok	Ok
21	Scrapper box body liner repair or replacement	Done	Done	Done	Done	Ok	Ok	Ok	Ok
22	Scrapper box bottom liner replacement	Done	Done	Done	Done	Ok	Ok	Ok	Ok

23	Scrapper box dust guard repair	Done	Done	Done	Done	Ok	Ok	Ok	Ok
24	Lower skirt assembly repla. by new set	Done	Done	Done	Done	Ok	Ok	Ok	Ok
25	PA duct guide vanes replacement	Done	Done	Done	Done	Ok	Ok	Ok	Ok
26	Scrapper assly. rectification	Done	Done	Done	Done	Done	Done	Done	Done
27	Pyrite hopper top spout replacement	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
28	Pyrite hopper top assly. replacement	Done	Done	Done	Done	Done	Done	Done	Done
29	Pyrite hopper bottom spool pipe repair	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
30	Pyrite hopper bottom gate valve servicing and plate repla. by new plate	Done 01No	Done 01No	Done 01No	Done 01No	Done 01No	Done 01No	Done 01No	Done 01No
31	Grinding rolls and bullring segments replacement	---	---	---		Done	---	---	---
32	Mill internal patch repair work	Ok	Ok	Done	Done	Done	Done	Done	Ok
33	Mill Lub oil pump servicing/repl.	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
34	Mill Lub oil pump coup[ling servicing	Done	Done	Done	Done	Done	Done	Done	Done
35	Mil Lub oil filters cleaning	Done	Done	Done	Done	Done	Done	Done	Done
36	Mill coal inlet pipe length replacement	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
37	Mill classifier cone manhole door repla.	Done	Done	Ok	Ok	Ok	Ok	Ok	Ok
38	Mill scrapper box door frame rectification	Done	Done	Done	Done	Ok	Ok	Ok	Ok
39	Mill worm shaft seals topping up	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
40	Mill gear box oil level topping up	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
41	Mill motor to gear box shaft alignment	Done	Done	Done	Done	Done	Done	Done	Done
42	Mill coupling oil changing	Done	Done	Done	Done	Done	Done	Done	Done
43	Roller to bowl gap adjustment	Done	Done	Done	Done	Done	Done	Done	Done
44	Spring seat gap adjustment	Done	Done	Done	Done	Done	Done	Done	Done

45	Classifier vane position seat (position no)	03	05	06	05	06	05	06	03
46	Mill seal air valves servicing	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
47	Cold air Damper servicing	Done	Done	Done	Done	Done	Done	Done	Done
48	Cold air gate servicing	Done	Done	Done	Done	Done	Done	Done	Done
49	Hot air gate servicing	Done	Done	Done	Done	Done	Done	Done	Done
50	Hot air damper servicing	Done	Done	Done	Done	Done	Done	Done	Done

2.1.2 EQUIPMENT: GRAVIMETRIC FEEDERS:

S.N	Work Description	FEEDER NO							
		4A	4B	4C	4D	4E	4F	4G	4G
01	Internals removal, general servicing and fixing back	Done	Done	Done	Done	Done	Done	Done	Done
02	Feeder belt replacement.	Replaced	Ok	Ok	Ok	Ok	Ok	Ok	Ok
03	Take up pulley replacement	Ok	Replaced	Ok	Ok	Ok	Ok	Ok	Ok
04	Take up pulley brg replaced	02 No	01 No	01 No	Ok	Ok	Ok	Ok	Ok
05	Head pulley replacement	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
06	Head pulley beg replacement	Ok	01 No	01 No	Ok	01 No	Ok	Ok	Ok
07	Head pulley studs replacement	14 No	14 No	14 No	14 No	14 No	14 No	06 No	Ok
08	Head pulley bushes replacement	14 No	14 No	14 No	14 No	14 No	14 No	06 No	Ok
09	Head pulley coupling half replacement	01 No	Ok	01 No	Ok	Ok	Ok	Ok	Ok
10	Inlet span roller repl.	04 No	02 No	04 No	01 No	07 No	03 No	07 No	04 No
11	Inlet span roller brg replacement	08 No	04 No	08 No	02 No	14 No	06 No	14 No	08 No
12	Weight span roller replacement	01 No	01 N0	02 No	03 N0	01 No	02 No	01 No	Ok
13	Brg 6204 replacement	02 No	02 Nos.	04 Nos.	Ok	01 No	01 No	02 No	Ok
14	Side skirt plate replacement	Ok	02 Nos.	02 Nos.	Ok	Ok	Ok	Ok	Ok
15	Shear pin/bolt repl.	01No	01No	01No	01No	01No	01No	01No	01No

16	Feeder gear box servicing	Done	Done	Done	Done	Done	Done	Done	Done
17	Brg Timken 552/360 a replacement	Ok	01 Set	01 Set	Ok	01 Set	Ok	Ok	Ok
18	Gear box output shaft replacement	Ok	Ok	01 No	Ok	01 No	Ok	Ok	Ok
19	Intermediate gear box shaft repla.	Ok	01 No	Ok	Ok	01 No	Ok	Ok	Ok
20	Brg 6206 replacement	Ok	01No	Ok	Ok	01No	Ok	Ok	Ok
21	Intermediate gear box bearing 6307 repl	Ok	01No	Ok	Ok	01No	Ok	Ok	Ok
22	Feeder clean out conveyor	Done	Done	Done	Done	Done	Done	Done	Done
23	Feeder gate & bunker gate servicing	Done	Done	Done	Done	Done	Done	Done	Done
24	Feeder gate rectification and side rack replacement.	Done	Ok	Ok	Ok	Ok	Done	Ok	Ok
25	Feeder gate side rack requirement	Ok	Ok	Ok	Ok	Ok	62No	Ok	Ok
26	Feeder outlet chute preventive shielding with SS plate	Done	Done	Done				Done	
27	Feeder gate stud bearing CF 6526 replacement	08 No	08 Nos.	08 Nos.	08 Nos.	06 Nos.	06 Nos.	04 Nos.	Ok
28	Feeder front and rear doors servicing	Done	Done	Done	Done	Done	Done	Done	Done
29	Feeder gate shaft bearing 6207 repla.	02 No	Ok	Ok	Ok	Ok	Ok	Ok	Ok

2.1.3 EQUIPMENT: FD & PA FANS:

S.No.	DESCRIPTION	FD FAN A	FD FAN B	PA FAN A	PA FAN B
01	Fan cleaning and inspection				
02	Silencer cleaning				
03	SCAPH cleaning				
04	Servicing Lube of unit				
05	Servicing of Main bearing housing				
06	Servicing of Servo motor				
07	Servicing of Rotors				
08	Alignment of motor of fan				

2.1.4 EQUIPMENT: ID FANS

S.No.	DESCRIPTION	ID FAN A	ID FAN B
01	Internal cleaning		
02	NDT or critical weld joints of shaft		
03	Both bearings servicing		
04	Shaft leveling		
05	Alignment of voith to fan		
06	Alignment of motor to voith		
07	Lub oil coolers servicing		
08	Servicing of water lines		
09	Inlet vane operation		
	Spare & Consumables Used		
01	SS 150 oil	80 Lt	80Lt
02	ST 10 oil	100 Lt.	100 Lt.
03	M16X65 bolts with nut	30 Nos.	30 Nos.
04	8 mm packing rope	5 Kg	5 Kg

2.1.5 EQUIPMENT: AIR PRE-HEATERS

S.No.	DESCRIPTION	SAPH A	SAPH B	PAPH A	PAPH B
01	Cleaning and inspection				
02	Support bearing inspection				
03	Guide bearing inspection and rotor leveling				
04	Sector plate leveling				
05	Checking and connection of T-bar				
06	Axial seal plates checking & correction				
07	Bypass seal angle correction				
08	Broded bypass scals replacement				
09	Seals setting including replacement				
10	Kaowool packing replacement				
11	Patch up work				
12	Tabs welding				
13	Lube oil unit servicing				
14	Drive unit servicing				
15	Water washing line vales servicing				
16	General servicing of ALCS				
17	Removal of Jamming in push rod				
18	Baskets replacement				
19	Basket reversal				
20	Duct & Bracing repair				

OPERATION: CHECKLIST FOR UNIT STARTUPS

Checklists earlier developed for STPS units No. 6 and 7 are produced here under as samples. Similarly, checklists for all operations are to be developed and followed in all units, for implementation of best practices.

UNIT START UP CHECK LIST (WARM STATE STARTUP)

SAMPLE – Unit No. 6/7 210 MW, STPS SARNI. **BOILER LIGHT UP**

DATE

S. No.	Activity	Time	Action
1.01	All permits should be cancelled.		
1.02	Check water level in CS tank. It should be normal i.e. above 4.5 M.		
1.2(a)	Ensure bunker level Normal.		
1.03	Check air vents, M.S., CRH, HRH line drains are open and Boiler stop valve is closed.		
1.04	Check S/H drains and start up valves are open.		
1.05	Start filing pump & take water in boiler through low point drains up to 4 ports.		
1.06	Check supply to FSSS panel is ON		
1.07	Check C.W. Pumps are running normal.		
1.08	Check Two BABP pumps are running normal.		
1.09	Check cooling water for ID, FD, PA and mills and check furnace sealing.		
1.10	Check Two BCW pumps & TABP pumps are running.		
1.11	Run instrument and plant air compressor, check air pressure 5.5 to 6.0 Kg./cm^2.		
1.12	Run: LOP's of ID check auto start of LOP's.		
1.13	Run LOP of FD & PA check other pumps comes on auto when the running LOP trips.		
1.14	Run LOP of PA fan and check other pump comes on auto when running pump trips.		
1.15	Run LOP of air heaters, furnace sealing, ESP, A/H hopper sealing.		
1.16	Run ID & FD air fans, igniter air fans and scanner air fan.		
1.17	Light oil guns are ready in AB elevation.		
1.18	Check following boiler protection and see that boiler trips by. a) Tripping of both ID b) Tripping of both FD c) Furnace Pressure high d) Loss of D.C. e) Flame Failure		

1.19	Run L.D.O. pumps.		
1.20	Select L.D.O.		
1.21	Check water level in drum is + 50 mm, Check LPD valves.		
1.22	Start purging.		
1.23	Open igniter trip valve after purging.		
1.24	Take igniters of AB, CD and EF elevation in service.		
1.25	Check for healthiness of flame and oil leakage.		
1.26	Start A/H soot blowing.		
1.27	Open LDO trip valve.		
1.28	Light up the boiler with one pair of LDO guns in AB elevation. Check for leakage and healthiness of flame, note time.		
1.29	Change the LDO gun pair of AB elevation after 30 minutes.		
1.30	Take 4 LDO guns in AB elevation 1 hour after changing pair. Check for oil leakage and flame.		
1.31	Monitor flame condition and steam coming out from air vents.		
1.32	Close air vents at 5.0 kg drum pressure.		
1.33	Check temp. of flue gas at air heater inlet.		
1.34	Charge heavy oil heating station.		
1.35	Change to HFO when flue gas temp. at air heater inlet exceeds 170^0 C		
1.36	Gradually start opening main stream stop valve (Boiler) at 10 kg/cm^2 drums pressure.		
1.37	Increase firing rate by taking additional guns in CD elevation and maintain pressure of 40-50 kg/cm^2 till start of rolling.		
1.38	Increase firing rate by taking additional guns in CD elevation and maintain pressure of 40-50 kg/cm^2 till start of rolling.		
1.39	At 1200 rpm start PA fans, coal mills and coal feeders, scale air fans inter connection of seal air.		
1.40	Before synchronizing the machine keep coal mill ready for loading.		

TURBINE START UP (COLD START)

Sample Check List

UNIT NO. 6/7, STPS

S. No.	ACTIVITY	TIME	ACTION
01	Check that drains of MS, CRH, HRH aux PRDS station, gland sealing steam header are open.		
02	Check M.O.T. level is normal.		
03	Check that seal oil system lub oil system is charged.		
04	Check machines on barring (for min 8 hours before rolling.)		
05	Check H_2 pressure is 3.0 kg/ cm^2/ for # 6 & 3.5 kg/ cm^2 for # 7.		
06	Check turbine lub oil protection through OPDR and note the values for :- AC lub oil pump cuts in at ----------kg/ cm^2 D.C.L.O.P. cuts in at ---------- kg/ cm^2 Barring gear trips at ---------- kg/ cm^2		
07	Check opening of ESV, IV control valve, V2-6, V2-7, V2-8 from local and speeder gear. ESV start opening at 5.5 mm of speeder gear and fully open at 6.8 mm of speeder gear. IV opens at 4.5 mm of speeder gear and fully open at 5.8 mm of speeder gear. CVSM starts opening at 8.5 mm of speeder gear and fully opens at 10.5 mm of speeder gear. Note: - Protections air to be checked before light up of the boiler.		
08	Open atmosphere drains of Gland sealing header		
09	Check emergency turbine trip from local		
10	Check emergency turbine trip from PCR		
11	Check that ESV, IV are closed.		
12	Check Aux. PRDS, V/V flange heating V/v stud heating V/v are closed		
13	Check that isolating V/v, PRDS2 are closed.		
14	Check at least one CEP is running		
15	Check deaerator level is normal 2300 mm		

16	Check hot well level is normal 700 mm		
17	Make one feed pump ready for service.		
18	Check steam admission, valve to gland cooler is closed.		
19	Check all the six V/v of Gland seals to HP, IP, L.P. closed.		
20	Check that spray valve for Aux. PRDS is in closed condition.		
21	Check that drains are open.		
22	Charges Aux. PRDS station open V2-15 gradually at MS pressure 25 Kg/ Cm^2.		
23	Gradually open regulating valve of bypass line.		
24	Charge steam line up to ejector		
25	Start vacuum pulling through starting ejector		
26	Check siphons are full.		
27	After vacuum reaches 150/ 200 mm, charges sealing steam to glands and maintain pressure 0.15 to 0.25 kg / cm^2. Ensure GST temp.>150^0 C & Open all six V/V of Gland seals.		
28	Charge main ejectors and maintain steam pr. about 10 Kg/ Cm^2.		
29	Check vacuum is 600 mmHg (Min).		
30	After achieving MS pressure to 40 Kg/ Cm^2 and temp. 300^o C.		
31	Open of DSS-1 and DSS-2.		
32	Open isolating V/V V2-27 for PRDS-2		
33	Check cooling water ESV and IV is charged.		
34	Look IV in closed position.		
35	Open V2-7 and crack open V2-8		
36	Open ESV 20 to 30 mm		
37	Check steam pressure before IV is 1.0 kg		
38	Open IV by 10 to 15 mm		
39	Heat steam admission pipes check ESV IV body temp.		
40	Check IPT casing, V/V are heated to about 100 % c		
41	Close V2-27		
42	Close PRDS 2 control valves.		
43	Check pressure in CRH & HRH line drops.		
44	Close main and isolating. Valve of DSS 1 and DSS 2.		

45	Check turbine parameters (A.S., HP. Diff. eccentricity O/A expansion) See that eccentricity should be less than 70 microns.		
46	Close ESV. IV. V2-7 and V2-8		
47	Unlock ESV & IV		
48	Open MS by pass isolating valve V2-7		
49	Open ESV, IV through speeder gear and continue till control valve open and machine rolls check machine for sound, vibration, check oil flow through flow glasses.		
50	Check barring gear trips when machine speed more than 3-4 rpm.		
51	Open HP cylinder IP cylinder drain for 5 mints & close.		
52	Raise speed gradually to 500 rpm. Check for sound, bearing temp. Keep close watch on turbine supervisory instruments and note the readings. During rolling lub. Oil temp, to be maintained around 40^0C		
53	Soak the machine at 500 rpm for 15/20 minutes note parameters.		
54	If parameters are normal, raise speed to 1200 rpm gradually. Note parameters.		
55	Start stator water pumps, check availability of stand by pump on auto. Check water flow.		
56	Charge Hydrogen coolers, lub oil coolers, stator water coolers.		
57	Soak machine at 1200 rpm for about 1/2 hrs. Note parameter. Check for constant temperature and normal parameters.		
58	Close 220 KV isolators.		
59	Gradually increase speed to 3000 rpm crossing critical range quickly.		
60	Build up the voltage on auto mode of AVR		
61	Synchronise the machine, take load of 5/10 MW		
62	Charge flange and stud heating system if required.		
63	Close the drain valve MS line, before MSSV MS line between MSSV & ESV transfer pipe drains.		
64	Close condenser spray after exhaust temp. reaches 50^0 C		
65	After synchronising the machine, take coal mill in service and raise the load according to parameters.		

3. Practices To Reduce Furnace Pressure Tripping

- Furnace pressure protection switches (For high as well as low) to be checked and repaired/ replaced as per condition.
- Furnace pressure (High/ Low) Trip set point to be kept OK as per manufacturer's recommendations.
- Coal pipe purging to be done for all Mills on regular periodic basis i.e. once in a shift.
- Orifices of coal pipes are to be checked during opportunity S/D or unit overhaul. To be replaced one by one during every S/D.
- Clean Air & Dirty air flow test to be carried out for all Mills to assess the velocity distribution amongst coal pipes of any Mill.
- SAD's full open to full close operation to be checked for all Sec. air dampers its physical conditions are also to be checked during opportunity S/D for any damage/ erosion etc. and the same should be rectified.
- Oil supports to be taken in low load condition, Gun cleaning frequency should be as per requirement and 04 nos. of cleaning guns are to be always kept ready at firing floor.
- Leakages in primary air side cold & hot air duct to be attended on available opportunity.

4. Operational Support Features for Mill Maintenance

- External Filtration Unit: A trolley mounted external filtration unit is to be put into service. This can be shifted as per requirement and can enable in-situ filtration of gearbox oil, even in a running mill. This will help in maintaining required purity of oil and avoid pre mature failure of costly bearings.
- Mill Maintenance Bay: In all power stations mill components assemblies are being carried out in a separate place by constructing a mill maintenance bay. The bay has to be equipped with all the facilities required for maintenance activities. Construction of mill maintenance bay has become very useful, as it provides safe and clean environment for working.

- Display of Mill Running Hours: Running hours of mill components should be displayed in all UCBs, Mill Maintenance Room & Sectional Heads Room. While, this helps the operation engineer in loading the mills efficiently, it also helps maintenance engineer to plan spares and draw maintenance schedule.

5. Practices To Prevent Barring Gear Stalling:

- Monitor the Lub oil temp. and it is to be maintained around 50^0C.
- Check proper working of steam traps provided in Aux. PRDS.
- Check source aux. steam temperature to be as per OEM's recommendation.
- Check CRH NRV's for proper seat contact and full closure (If it is passing during initial HPBP opening, low temperature steam with spray is likely to decelerate the turbine when on Barring).
- Check that no extra pocket is formed near jacking oil recess and proper jacking oil recess is there inside the bearing.
- Lift Pedestal Covers and see if any abnormality or leakage is there in hose joints, pressure gauge etc.
- Check J.O. Hose of proper length, routing and flexible clamping with adjacent oil piping and clamping of metal pipe in each pedestal.
- Check and set required bearing lift by adjusting jacking oil pressure with one jacking oil pump and Maintain protocol for Jacking oil header pressure, bearing lift and jacking oil pressure at each bearing.
- Checking J.O. pipe supports from MOT room to bearing Pedestal for tightness/adequacy by actual shaking of piping (To prevent pipe failure due to vibration during start up and shut down).
- J.O. Flushing of the system to be done whenever bearings are opened.
- Visually check the condition of Barring Gear Oil supply isolation valve for actual opening.
- Ensure that Pipe for Manual Barring is always available at fixed location near the Barring Gear.
- Check condition of Barring gear nozzle and wheel blades and clearances during Overhauling.

6. Practices On Hydrogen Leakage Problem

- Gaskets are to be procured from OEM only as presently MPPGCL Stations are not having separate quality assurance system.
- All Gaskets neutral as well as phase bushings are to be replaced during Capital Overhaul or every 04 years interval.
- Preservation of these gaskets is to be done under controlled atmospheric conditions i.e. Air conditioned storage space at each station.

7. Best Practices For Electrical Failure Reduction

- Use of appropriate Fuses as per requirement :
  I.G – General purpose
  II.M – Motor Protection
  III.T – Transformer Protection
- Audit of all fuses for appropriate rating is to be carried out.
- If Seal air fan takes very high starting current, ensure full closing of discharge damper. Seal air fan should be started with discharge damper closed only.
- Reverse rotation of standby fan when not running must be stopped.
- Feeder setting to be seen with respect to fault level.
- Canopy should be provided in Buchholz relay protection to safeguard the same from moisture ingress.
- Bucholz relay cover should be sealed with silicon sealant after dry out.
- Bucholz relay mercury switch should be meggred with 250 megger (never use>250v Megger, do not do if megger is not available) for ensuring healthiness of relay.
- After every unit OH excitation system from auto to manual & manual to auto should be checked.
- After overhauls AVR should be checked for a "tuck-tuck" like sound if any. This may be to improper insertion of cards in their slots.
- The practice of measurement of resistance of the thyristers of excitation system during routine maintenance should be discarded, as it tends to harm the thyristers themselves.
- There should not be any joint in protection cable from switchyard to Unity control Room.
  During overhauling trip cable from breaker is to be meggered for phase to phase and phase to ground.
- Replacement of Lightning Arrestor (LA) when megger value of individual stack is less than 10000 Mega Ohm OR 3rd harmonics testing to check the healthiness of LA.
- To ensure the healthiness of CVT, tan-delta testing or secondary voltage monitoring to be done.

If tan delta of stacks is more than 0.8% or capacitance more than 10% of specified value replace CVT. Ensure proper earthing of CVT. For old CVT damping resisters if installed need to be removed if failure is reported.

- Thyrister rooms/ Excitation Room should be furnished with Air conditioner. All rooms are to be sealed against water/ dust ingress from outside.
- On startup after short shut down measurement of IR Values of Generators & Generating Transformer separate and combined and HT motors must be done and analyzed before putting into service.
- Condensed water from Breakers in Switch Yard and compressors and its line in PH are drain out as per routine practice and daily in rainy days.
- The practice of long duration shut down of 220 KV, bus must be stopped. PTW on bus should be returned before evening and bus should be charged with all protections in service.
- Audit of all LT, HT panels should be carried out and sealing ensured through gasket and appropriately locking the panel doors. Wherever panel-locking arrangement is not available, same should be restored.
- Pieces of GI wires loosely lying in switchyard area should be removed. They have been found to be used by birds like kites for making nests, which give them potential free space but are liable to cause short circuits.

8. Best Practices of Overhaul of units:

Arrangements for Overhaul of Units

A. Pre OH External Arrangements :

- Scrap, Coal mill rejects, Ash & clinker removal from boiler zero meter area.
- Removal of filled & empty oil drum from boiler zero meter & ID fan area.
- Area lighting in boiler area to be improved by providing extra flood lights.
- Drinking water arrangement should be done at around 40 m level in boiler.
- Availability of Boiler Lift is to be ensured during AOH.
- Work is to be continued 24X7.
- Arrangement of one 10 T hydra/ fork lifters and one trailer to facilitate quick removal of scrap coils & scrap APH sector plates & baskets, burner tips etc. during overhauling period. Passage of hydra & trailer are to be kept clear.
- 10 T winch in good working condition i.e. motor in healthy condition and black colour cadmium oil pasted on the rope are to be arranged on both side of Boiler for lifting heavy material like coils/ baskets, sector plates, burner tips, elbows, coal pips, bellows etc.
- Load testing of all chain pulley blocks, hook-chooks, winches to be used in AOH by the contracting agencies is to be ensured and duly certified by Competent Person.
- All bunkers are to be emptied before S/D to facilitate Bunker inspection (For Rat hole/ Choking/ Intactness).
- PID test of string insulations to be carried out.

B. Pre OH discussion with Contracting Agency :

- Pre AOH meeting with the contracting agencies along with their supervisors is to be conducted to decide the procedure to be followed for coil removing etc. and it should be strictly adhered.

- The contracting agency should be intimated accordingly so that there is no extension of stipulated OH duration. Manpower should be mobilized keeping this aspect in consideration.
- All workers should wear personal protective items. The workers should be having valid insurance coverage in the event of any untoward incidents.
- There should be a safety officer each from MPPGCL and contractor side to coordinate and supervise the safety aspects during AOH.
- Cutting of railing or floors if done to facilitate material handling, are to be restricted to the minimum extent. Safety tapes & ropes are to be used for cut railings for barricading the affected area. Any cut floor is to be barricaded by railings made out of old/ scrap boiler tubes.
- All HP welders, LP welders and gas cutters are to be tested before commencement of job.
- All do's and don'ts are to be discussed with supervisors in the pre AOH meeting and displayed wherever possible. System of reward may be contemplated in order to improve the safety awareness of the workers during AOH.
- Proper welding Electrodes as per contract are to be checked and kept deposited at a designated place.

C. Actions during Overhauling :

- Portable ovens and one big size oven in good working condition are to be arranged keeping in mind regarding the usage of low hydrogen electrodes.
- 100% radiography in true sense of the term is to be carried out and there should be a supervisor from the contracting agency who should report about the progress of the radiography of joints in every evening AOH meeting.
- Radiography of old joints is to be planned in the initial days of OH and contracting agency should be informed from beforehand regarding the radiography of old joints.
- Thorough water jet cleaning of furnace, coils and the APH baskets to be done.
- Coil replacement should take place following practices of coil replacement.

- The cup lock scaffolding should be erected properly and must have staircase arrangements. There should be complete sealing at 40 m level and above S-panel level to allow parallel work without any risk and trouble. Safety nets are to be used at 2-3 levels.
- Oxide scale measurement in SH & RH coils is to be done once in two years and remaining life of tube is to be assessed.
- If RH coils and S panel tubes are to be replaced simultaneously then complete sealing above S-panel is to be erected. Sideways and corners are to be sealed with rubber/ conveyor belt pieces.
- The expansion joints which are due to be replaced are to be identified from beforehand and pre-fabrication of expansion joints is to be started. If need be separate group may be engaged as early as possible.
- Furnace Air tightness test to be carried out and air leakages are to be attended before boiler light-up.
- Condenser Water box tube cleaning, Hotwell & Deaerator cleaning & condenser flood test, CEP/ BFP strainers cleaning should be done.
- CW Inlet & Outlet duct inspection & cleaning to be carried out.
- CW Pump butterfly v/v inspection & operational checks to be carried out.
- High energy drains valves' defects, as identified in Pre OH survey to be attended.
- Heat Exchangers cleaning to be done.
- HT & LT switch gear sections (Bus/Modules/breakers/relays/ contractors / transducers/timers) overhaul to be done.
- Testing of protections of incomers/bus couplers/auto changeover to be done as per schemes.
- Servicing of HT/ LT motors (Bearing inspection, Greasing Lugs inspection, fan inspection, insulation varnish, rubber cord replacement, hydraulic test of water cooler, meggering tan-delta test) to be carried out.
- Hydrogen & Exciter coolers servicing to be carried out
- Transformers servicing (cleaning. OLTC checking, Conservators cleaning, Protection elements checking, Silica gel replacement, Oil sampling, Oil flushing & Testing) to be carried out.

- Among all the main activities during a unit overhauling in a power plant, the turbine overhauling generally remains on critical path. Therefore, any reduction in the duration of turbine overhauling would ultimately bring down the overall unit outage time. Turbine overhaul is therefore to be monitored closely and empowered with resources.

D. Post Overhaul Review :

- Surprise issues and Learning from them to be recorded separately so that preparations can be done accordingly for future OH and time/ effort can be saved.
- Deviation from the planning, if any should be recorded and reasons thereof to be analyzed for future corrections.
- Performance of contracting agencies to be assessed.
- Post Overhaul Efficiency test (Boiler & Turbine) to be carried out.
- Comparison of Pre & post performance test results to be done to estimate the improvement.
- Overhaul reports should be prepared with list of spares consumed and cost of overhaul.

9. Practices In Chemical Treatment

The Specifications of feed water have to under following limits-

S. No.	Parameter	Units	Normal Operation		During Start up
			Alkaline Water Treatment	Combined Water Treatment	
1	pH		Min 9.0	8.0-8.5	Max 9.0
2	After Cation Column Conductivity	µs/cm	Max 0.2	<0.15	Max 0.5
3	Dissolved Oxygen	ppb	<5	30-150	Max 100
4	Iron	ppb	<2	<2	<20
5	Sodium	ppb	<2	<2	<10
6	Silica	ppb	<10	<10	<30
7	Turbidity	NTU	<2	<2	<5

Operational Actions To Be Ensured-

- Scale formation due to hardness, silica and corrosion product deposits can decrease heat exchange capacity and efficiency of boiler. With higher operating pressure of boiler, the purity requirements are also high. Therefore boiler water quality standards must be strictly adhered to.
- Condensate polishing units to be kept in service, wherever available.
- Preservation of boiler during short and long shut down must be done as below-
    - Wet: For one month to six months; with 200 ppm N2H4, pH>9.0 at pressure 5.0 Kgf/ Cm2
    - Dry: For short period
- Closed Cycle Condenser Cooling Water.
- As there are evaporation cycles in cooling tower, there is a concentration effect of the water. There are various CoC limits recommended by the OEMs. In order to maintain the parameter blow down of cooling water to be performed and key parameters to be monitored closely.
- Alkalinity and hardness are to be monitored to evaluate the calcium carbonate precipitation risk. pH measurement must be less than the critical pH (8.3) where calcium carbonate begins to precipitate; H2SO4 is injected for

decreasing total alkaline carbonates (TAC). Nevertheless, if pH level escalates above 8.3, H2SO4 is to be injected to avoid calcium carbonate precipitation.

- Biocides must be added to the clarified/ raw water to minimize microbiological induced corrosion and therefore to avoid bacteria ingress into cooling system which could rapidly damage condenser tubes.

10. Operation and Maintenance of Locomotives

1. Before commencing the inspection of Locomotive, ensure the following-
   a) The hand brake is applied
   b) The Driver's Valve is 'OFF' position (at '0')
   c) Handles of air brakes must be in normal position
2. Following daily checks of Locomotives are to be carried out before dispatch from the yard:
   a) Check the exterior of the Locomotive and running gear for slackness of bolts, nuts or missing bolts, cotter pin etc.
   b) Check centre buffer couplers for operation
   c) Check brake blocks for wear and clearances and get them adjusted, if necessary. The normal clearance between and wheel tread should not exceed 5 mm. Clean brake valves and brake cylinders.
   d) Check fuel oil and top up, if necessary
   e) Check fuel supply lines; lube oil piping, water pipes. Transmission air pipes for leakages and get them rectified, if necessary
   f) Check and replenish, if necessary, the following
      i) Diesel engine cooling water in radiator
      ii) Lube oil in diesel engine sump
      iii) Transmission oil in sump
      iv) Oil level in final drive gear box
      v) Oil level in compressor
   g) For diesel Engine, transmission, compressor and grease points of Loco, use recommended grade of oil/grease; do not mix different grades.
   h) Check whether sand boxes are filled with dry sand
   i) See that all cocks and stop valves are in correct position
   j) Drain condensate from air reservoir
   k) Check 'V' belt driving radiator fan, compressor, alternator, water pump
      i) If broken, missing or torn replace with new

ii) If loose, adjust as required

Note: while renewing belts, it must be ensured that all belts on the same drive are matched correctly

l) Check that battery connections are tight.

m) Check carbon brushes of traction motors.

3. Operational Practices:
   a) Allow the engine to warm up for some time to allow the lubrication to be established. Ensure that the engine has warmed up sufficiently and that the engine water temperature reaches about 70^0C.
   b) Brake System- Before moving the Locomotive, check that the brake system of the Locomotive is operative.
   c) The main reservoir pressure should be about 6.5 to 8 kg/cm^2
   d) The brake cylinder should build up to 3-3.5 kg/cm2. Check physically that the brake blocks are hard against tyres.
   e) Measure brake cylinder piston travel. If it exceeds 75 mm, brake linkage requires adjustment.
   f) Release independent air brakes.
   g) Locomotives should not overshoot the cut point without permission of the station master of the area.
   h) Sufficient point men should be engaged with locomotive for changing the point or for crossing. Point operation must be done strictly as per railway norms and after confirmation of closing of point and clamping, the locomotive may be moved by the driver.
   i) During supply/ pushing of load wagons. Point man has to start the hooter for safety warning.

<u>OPERATIONAL CARES</u>

1. Operation on down gradient:
   While operating on down grade take care not to EXCEED THE MAXIMUM PRESCRIBED LOCOMOTIVE SPEED. Locomotive transmission is endangered due to over speed
2. Precaution before leaving the Cab:
   a) Move the driver's valve hand wheel/lever to '0' position
   b) Bring the handle of transmission cut off valve to 'OFF' position /run switch to idle position
   c) Stop diesel engine, if the duration of absence is long, otherwise, the engine can be left idling at 690-750 rpm.

d) Apply hand brake.

3. Shutting down the Locomotive:
   a) Move the driver's valve hand wheel/lever to '0' position
   b) Bring the handle of transmission cut off valve to 'OFF' position /run switch to idle position
   c) If cooling water/transmission temperatures are high, allow the engine to idle for some time
   d) Switch off all lights, cab fan, wiper etc.
   e) Apply hand brake
   f) Close all windows and doors of the Locomotive
   g) Check Locomotive externally and internally for leaks
   h) Bring any defects observed to the notice of maintenance personnel
   i) Shut down the diesel engine
   j) Set the battery switch to 'OFF' position
   k) Drain the condensate from the air reservoir
4. Forced shut down of diesel engine:
   a) The diesel engine will be shut down completely if the water temperature is too high ($> 93^0$C) or the lub oil pressure is too low (< 0.7 kg/cm^2). If the shutdown occurs due to water temperature high, check:
      i) Fan belt for breakage, looseness etc
      ii) Low water level (this check must be done after water has cooled to a reasonable level. Never open radiator cap when temperatures are very high)
   b) Shutdown could also occur due to any one or more of the following:
      i) Dirty oil
      ii) Choked or dirty filters
      iii) Incorrect regulating valve, relief valve adjustments
      iv) Dirty or clogged lube oil cooler
      v) Leakages in piping
5. Proper signaling system, fouling mark, point & crossing and rail tracks should be maintained as per Indian Railways norms.
6. Retired Indian Railway's Locomotive drivers should be engaged for operation of MPPGCL's Locomotives.
7. Locomotives should, at all times, navigate only within the siding limit point/cut point, and, under no circumstance, enter into rail section reserved for

movement of Indian Railway Locomotives, without prior permission of Railway Authority.

8. All operation procedure should be carried out as pre-decided, any operational change is permissible after obtaining consent from Railways.
9. Sufficient point men are to be engaged with locomotive for changing of points and crossings (as per Indian Railways norms). Locomotive movement may be commenced only after confirmation of point closing and clamping.
10. During supply/pushing/backing of load wagons, point man must turn on hooter for safety of men and machine
11. Locomotive driver should blow the horn/flash lights before level crossing as per Indian railways norms
12. Do not over speed, keep within prescribed shunting speeds as recommended for the siding
13. Do not board or disembark when locomotive is in motion
14. Periodically test/service hand and emergency brakes
15. Periodically check/test all protections
16. Periodically carry out detailed inspections of Locomotive structure, bogies, wheels-axles, pivots, transmission, diesel engine etc. for any abnormality.
17. Idle or shut down Locomotive, light or with trailing load should be parked correctly with respect to fouling mark.

10. Weather Specific Precautions

During Summer:

- Loose roof sheet and loose material lying upon roof should be taken care of against flying off during high wind.
- All the materials which are susceptible to fire including coal dust, oil papers, cloth, leaves etc. be cleared from the nearby areas of trench.
- All the fire tenders and fire protection devices to be kept ready for use in emergency.
- All the cable trenches are to be cleaned and materials susceptible to fire are to be removed there from.
- EOT/ Tower Cranes/ Derricks are locked to avoid over run.
- Proper lighting CHP area housekeeping, specially dewatering of tunnel.

- In order to achieve the proper cooling, preventive opportunity based maintenance such Back Washing and tube cleaning are carried out in oil coolers of Mill, Fans, BFP etc.

Pre-Monsoon Works:

- All surfaces/ sub-surfaces, roof drain & the trenches in and around the power station are to be cleaned.
- All leakage/ seepages from roof/ opening etc. to be checked and repaired to avoid ingress of water and wetting of panels/ equipments.
- Dewatering pump and submersible pump are to be made ready & trail to be taken to meet emergency.
- Maintenance of stacker/ re-claimers to be completed and made available to feed crushed coal in case of problems in unloading system.
- Cleaning, testing and replacement of silica gel in breathers etc. of Transformers are to be done.
- All the junction boxes in outdoor area are to be properly sealed to avoid water ingress.
- Testing of oil filled electrical equipments & corrective action thereof is to be taken up.

11. Energy Efficiency Measures

During Normal Operation & Maintenance (Other than O.H.)

- Maintain Main Steam Pressure, Main Steam Temperature & HRH Steam Temperature close to the design values in narrow band as far as possible through process optimization.
- Closely monitor air ingress into boiler furnace and flue gas duct/ Expansion Joints/ ESP by daily round through visual inspection and attend them at every opportunity.
- Maintain DP across Feed control valves as low as possible.
- Keep soot blowers available and implement its operation frequency based on monitoring of furnace temperature in various zones (as per availability of measurement)/ spray water flow.

- Regular monitoring of coal mill sieve analysis and maintain the same within recommended limit.
- Monitor and analyze combustibles in Bottom ash and Fly ash, furnace condition etc rather frequently and make correction in excess air/ Wind Box Pressure/ PA header Pressure to achieve combustion optimization.
- Keep the APRDS charged as per OEM's recommendations.
- Keep the drain valves closed unless it is essential to open them.
- Monitor Steam from vents/ water from drains of IBD tank and check for leakages if any.
- Steam traps in all steam drain lines must be kept in service.
- Ensure proper sealing of manholes and peep holes of boiler furnace.
- Insulation survey may be made a regular practice and the same may be implemented in Boiler, Turbine, piping, tanks etc. It will not only reduce the heating of ambient air, but it will also improve heat utilization.
- Ensure regular preventive maintenance and lubrication schedule. It will not only enhance the life of the equipments, but will also reduce auxiliary power consumption by some amount.
- Ensure keeping all regenerative heaters in service and maintain proper level of drip.
- Keep condenser clean by making the COLTCS system available (Wherever provided) with due effectiveness or by tube cleaning at every opportunity. Keep Travelling water screens and stationary screens clean.
- Maintain proper CoC through dozing in close cycle condenser cooling water.
- Stop a C.W. Pump in winter season, if condenser vacuum permits it with adequate margin. Similarly, stopping of other running auxiliaries as permitted by unit parameters may be considered.
- Maintain only optimum service air pressure. (Running the system with high air pressure increases power consumption).
- Use VAM chiller in air conditioning system as far as possible to attain desired temperature in the area.
- All sorts of undesired leakages must be plugged at the earliest opportunity.