

Review of Experience in Strengthening of O&M Practices in Thermal Power Stations in India



Prepared By:



WAPCOS Limited

Under

**Technical Assistance to CEA for Addressing Barriers to Energy
Efficient R&M of Coal Fired Generating Units**

Under

India: Coal Fired Generation Rehabilitation Project

(March 2017)



CENTRAL ELECTRICITY AUTHORITY



Review of Experience in Strengthening of O&M Practices in Thermal Power Stations in India

Prepared By:
WAPCOS Limited

Under

**Technical Assistance to CEA for Addressing Barriers to Energy
Efficient R&M of Coal Fired Generating Units**

Under

India: Coal Fired Generation Rehabilitation Project

(March 2017)



CENTRAL ELECTRICITY AUTHORITY

Table of Contents

Description	Page
Abbreviations	Ab 1 – Ab 2
List of Figures and Tables	T&F 1
Executive Summary	i-iii
Chapter: 1 Introduction 1.1 Background of the Assignment 1.2 Coal Fired Generation Rehabilitation Project 1.3 Technical Assistance Project for Addressing Barriers to Implementation of R&M in India 1.4 Objective of the Assignment 1.5 Scope of Work of the Assignment	1-4
Chapter: 2 Approach and Methodology 2.1 Approach & Methodology	5-6
Chapter: 3 General O&M Practices 3.0 Introduction 3.1 O&M Practices 3.2 Proactive Maintenance Practices	7-10
Chapter: 4 Strengthening of O&M Practices by Utilities 4.1 HPGCL, Haryana 4.2 WBPDCCL, West Bengal 4.3 MSPGCL, Maharashtra	11-28
Chapter: 5 Analysis & Review of Strengthening of O&M Practices 5.1 Strengthening Interventions Undertaken by utilities 5.2 Benefits Accrued 5.3 Drawbacks & shortcomings faced in the O&M Practices	29-35
Chapter: 6 Recommendations 6.1 Operational Practices 6.2 Maintenance Practices	36-37
Appendix-I – Terms of Reference	ApI 1 – ApI 12
Appendix-II - CEA's letter dt. 21.11.2012	ApII 1 – ApII 7
Annexure II (a): Questionnaire of HPGCL	Annex III: 1-3
Annexure II (b): Questionnaire of MSPGCL	Annex III: 4-6
Annexure II (c): Questionnaire of WBPDCCL	Annex III: 7-9

Abbreviations

ABT	Availability Based Tariff
AC	Alternating Current
AHP	Ash Handling Plant
AOH	Annual Overhauling
AOP	Auxiliary Oil Pump
APC	Auxiliary Power Consumption
APH	Air Pre Heater
BDV	Break Down Voltage
BFP	Boiler Feed Pump
BoP	Balance of Plant
BTG	Boiler, Turbine & Generator
CAP	Corrective and Preventive
C&I	Control & Instrumentation
CEA	Central Electricity Authority
CEP	Condensate Extraction Pump
CERC	Central Electricity Regulatory Commission
CHP	Coal Handling Plant
CM	Condition Monitoring
CMMS	Computerized Maintenance Management System
CO	Carbon Monoxide
CPU	Condensate Polishing Unit
CRH	Cold Reheat
CW	Cooling Water
DC	Direct Current
DCS	Distributed Control System
DCS max DNA	A type of Distributed Control System software
DDCMIS	Distributed Digital Control and Management Information System
DEH	Digital Electro Hydraulic
DESH	De Super Heater
DM	De Mineralized
DPR	Detailed Project Report
EE R&M	Energy Efficient Renovation & Modernization
ESP	Electrostatic Precipitator
ERP	Enterprise Resource Planning
FD	Forced Draft
GCV	Gross Calorific Value
GSECL	Gujarat State Electricity Corporation Limited
HPGCL	Haryana Power Generation Corporation Limited
HP Turbine	High Pressure Turbine
HVAC	Heating, Ventilation and Air Conditioning
ID	Induced Draft
IGV	Inlet Guide Vane
IPBD	Isolated Phase Bus Duct
IP Turbine	Intermediate Pressure Turbine

ISO	International Organization for Standardization
KBUNL	Kanti Bijlee Utpadan Nigam Limited
kCal	Kilo Calorie
KPCL	Karnataka Power Corporation Ltd
kW	Kilo Watt
kWh	Kilo Watt hour
LOTO	Lock Out Tag Out
LP Turbine	Low Pressure Turbine
MDBFP	Motor Driven Boiler Feed Pump
MoP	Ministry of Power
MOU	Memorandum Of Understanding
MPPGCL	Madhya Pradesh Power Generation Company Ltd.
MSPGCL	Maharashtra State Power Generation Company Ltd.
MU	Million Units
MW	Mega Watt
NA	Not Available
NO _x	Nitrous Oxides
NTPC	National Thermal Power Corporation Ltd.
OHSAS	Occupational Health & Safety Assessment Series
O&E	Operation & Efficiency
O&M	Operation & Maintenance
OEM	Original Equipment Manufacturer
OPGC	Odisha Power Generation Corporation
OR	Operation Review
OS	Operation Services
PG	Performance Guarantee
PLF	Plant Load Factor
PSPCL	Punjab State Power Corporation Ltd.
PTW	Permit To Work
RCA	Root Cause Analysis
RRVUNL	Rajasthan Rajya Vidyut Utpadan Nigam Limited
SCC	Specific Coal Consumption
SF ₆	Sulphur Hexa Fluoride
SH	Super Heater
SOC	Specific Oil Consumption
SO _x	Sulphur Oxides
SPM	Suspended Particulate Matter
SWAS	Steam and Water Analysis System
TG	Turbo Generator
TOR	Terms of Reference
TPS	Thermal Power Station
UAT	Unit Auxiliary Transformer
UPRVUNL	Uttar Pradesh Rajya Vidyut utpadan Nigam Limited
WBPDCCL	West Bengal Power Development Corporation Ltd.

List of Tables

Table No.	Table Title	Page Number
1.1	Peak Demand and Peak Met (April-2015 to March-2016)	1
1.2	Power Supply Position (April-2015 to March-2016)	1
1.3	List of utilities along with visit dates	4
4.1	Area wise Technological Interventions introduced by WBPDCCL at Bandel TPS	19
4.2	Technological Interventions at MSPGCL	24
4.3	Performance Parameters of MSPGCL	25
5.1	Technological Interventions at different Utilities	32

List of Figures

Figure No.	Figure Title	Page Number
4.1	Performance Parameters	26
4.2	APC	26
4.3	SOC	27
4.4	Heat Rate	27

List of Flow Charts

3.1	Flow Chart for Management Methodologies of various areas	8
3.2	Maintenance Methodologies	9



Executive Summary

The good O&M practices at thermal power stations have significance not only in terms of achieving high levels of performance parameters but also for ensuring the good health of the equipment at the power stations. Over the years, the power stations show deterioration in their performance due to ageing factor. The conditions of such power plants get further deteriorated if proper O&M practices are not followed in their operation. Improved O&M practices are also needed to sustain performance of rehabilitated power plants. Improving performance through interventions aimed at strengthening of O&M practices coupled with required R&M interventions is the quick and least cost alternative for augmenting the availability of power. This requires multiple interventions across various aspects including people, technology, process and infrastructure etc.

Most of the state sector power utilities display a wide spectrum of operational practices in India having critical gaps in several key operational areas heading to reduced plant performance including efficiency, generation and availability. There is significant scope for improving overall performance of the underperforming State run power plants through strengthening of their O&M practices. The utilities WBPDC, HPGCL and MSPGCL have strengthened the O&M practices at their thermal power stations for improving their performance from availability and efficiency aspects. Such O&M strengthening practices include various aspects like technology, O&M planning, conditional monitoring, preventive maintenance, O&M procedure, enhancement in technical and managerial skills of O&M personnel and infrastructure/facilities improvement.

Under the World Bank financed “Coal Fired Generation Rehabilitation Project” CEA has implemented the “Technical Assistance Project for Addressing the Barriers to EE R&M of Coal Fired Generating Units in India” and appointed WAPCOS for the study on “Review of Experiences from Pilot R&M Interventions in Thermal Power Stations in India” with the objective of sharing of experience mainly in procurement, implementation and improvement in performance parameters in R&M projects taken up in India. The review of experience in strengthening of O&M practices in thermal power stations in India has been one of the core activities of the above project to highlight the benefits and experiences in the interventions by the concerned power utilities for strengthening of their O&M practices.



WAPCOS team visited WBPDC, HPGCL and MSPGCL for collection of necessary data/information and interactions with the plant engineers for capturing their experiences in the interventions for strengthening of the O&M practices by the concerned power utilities. Feedback/suggestions of the members of the Task Force on promotion of R&M were also taken in various meetings as well as in the Workshop organized on 03rd February, 2017.

In case of HPGCL, STEAG Energy Services India (consultant) identified the gaps in O&M practices and gave recommendations mainly regarding operational practices, maintenance practices, Computerized Maintenance Management System (CMMS), Enterprise Resource Planning (ERP), Lock Out Tag Out (LOTO) system, equipment changeover schedule, periodic monitoring of Heat Rate, Simulator Training, Vendor Management System, e-Procurement, e-Auction etc. Some of these recommendations have either been implemented or are at implementation stage in various power stations of HPGCL and HPGCL has already started using computerized PTW system, e-Auction, e-Procurement etc. In addition to recommendations made by the consultant, HPGCL has added some measures to further strengthen their O&M practices like benchmarking based on best performing similar units, Corrective and Preventive (CAP) measures, strengthening of efficiency department etc.

NTPC, as consultant, identified the gaps in O&M practices followed by WBPDC and provided recommendations particularly to strengthen O&M planning for unit overhauling, maintenance, usage of energy efficient technology, carrying out Energy Audit by external agency etc. These recommendations have been implemented at various power stations of WBPDC. Central Generation Coordination Room has been created to monitor generation and critical parameters of all power stations. Also, Operation & Efficiency (O&E) Department, Coal Consumption & Fuel Efficiency Cell and Operation Services Cell were setup. DCS system was installed in place of obsolete analog control system at Kolaghat Thermal Power Plant and various other technological interventions have been done by WBPDC. Safety certifications have been obtained for Bandel Thermal Power Station, Kolaghat Thermal Power Plant, Bakreswar Thermal Power Plant and Sagardighi Thermal Power Plant. On-site emergency and disaster management has been prepared. Enterprise Resource Planning (ERP) is under implementation for inventory control, fuel management, human resource management and finance management. Also, central simulator trainings have been started by WBPDC at Bakreswar Thermal Power Plant. By implementing the recommendations, gains have been accrued in terms of better performance like increased ex-bus availability, improved SOC apart from better trained manpower and better Condition Based Maintenance (CBM) practices like online vibration monitoring.



Further, NTPC, as consultant, has studied the O&M practices followed by MSPGCL and gave recommendations for further strengthening of their O&M practices. The main recommendations include, to setup various committees at plant level as well as at Corporate level to evaluate performance parameters, to implement online monitoring system, analyze condition monitoring data, evaluate causes of unit tripping etc. The utility implemented the recommendations made by the consultant such as establishing various technical committees like Boiler Tube Leakage Committee, Electrical Protection Committee, Expert Support Team etc. All the power stations are now ISO certified. Also, ERP system has been implemented by MSPGCL. Review meetings are held regularly to monitor performance of the utility. Condition Monitoring Cell has been created. Regular coal sampling has been started through third party for analysis purpose and also different technological interventions have been undertaken. Station-wise and Section-wise budgeting has been initiated. To enhance the technical and managerial skills of the manpower, MSPGCL has started management development program for senior executives. Trainings are imparted in training centres at Nasik and Koradi for various work groups. By implementing various recommendations benefits have been accrued in terms of reduced Auxiliary Power Consumption (APC), improved Specific Oil Consumption (SOC) and Heat Rate apart from increased awareness about better O&M practices, availability of common platforms to solve various problems and energy efficient practices.

Under the study, the interventions undertaken by HPGCL, WBPDC and MSPFC for strengthening of their O&M practices have been reviewed by WAPCOS Team. The gaps & drawbacks were identified and measures have been suggested for further improvement in the O&M practices of the three concerned power utilities.

Chapter-1

Introduction

1.1 Introduction

The total installed capacity of India was 302,087.84 MW as on 31st March, 2016, out of which major share of 185,172.88 MW (61.29 %) is contributed by Coal based thermal power stations. This includes old thermal units commissioned way back in 1970s or even earlier which have already outlived their useful life and also those commissioned in early 1980s.

The following Tables give the status of Power Supply Position in various Regions of the country during the period from April-2015 to March-2016. Despite the installed capacity of more than 3 lakhs MW, there have been shortages in the Peak Demand and energy.

Table: 1.1 Peak Demand and Peak Met (April-2015 to March-2016)

S. No.	REGION	PEAK DEMAND	PEAK MET	Surplus(+)/Deficit (-)	
		MW	MW	MW	%
i	Northern Region	54474	50622	-3852	-7.1
ii	Western Region	48640	48199	-441	-0.9
iii	Southern Region	40445	39875	-570	-1.4
iv	Eastern Region	18076	17972	-104	-0.6
v	North Eastern Region	2573	2367	-206	-8.0
	ALL INDIA	153,366	148,463	-4,903	-3.2

Source: Central Electricity Authority (CEA). Lakshadweep and Andaman & Nicobar Islands are stand-alone systems, power supply position of these, does not form part of regional requirement and availability.

It is observed that there was Peak Deficit in all the Regions ranging from 0.6% to 7.1%. The deficit in Northern, Southern and North Eastern Regions was remarkably high compared to other Regions.

Table: 1.2 Power Supply Position (April-2015 to March-2016)

S. No.	REGION	REQUIREMENT	AVAILABILITY	Surplus(+)/Deficit (-)	
		MU	MU	MU	%
i	Northern Region	340,488	324,021	-16,467	-4.8
ii	Western Region	346,650	345,848	-802	-0.2
iii	Southern Region	288,004	283,473	-4,531	-1.6
iv	Eastern Region	124,608	123,635	-973	-0.8
v	North Eastern Region	14,487	13,736	-751	-5.2

	ALL INDIA	1,114,235	1,090,713	-23,522	-2.1
--	------------------	------------------	------------------	----------------	-------------

Source: Central Electricity Authority (CEA). Lakshadweep and Andaman & Nicobar Islands are stand-alone systems, power supply position of these, does not form part of regional requirement and availability.

While efforts are being made to develop maximum capacity through Central/State Power Sector Undertakings, large capacity additions through Private sector is also envisaged. Though there is full effort both at State and National level to develop new power projects, the R&M of old thermal units is also a cost effective option to bridge the gap in the power supply in the country.

1.2 Coal Fired Generation Rehabilitation Project

The World Bank has financed the “Coal-Fired Generation Rehabilitation Project-India” for demonstrating Energy Efficiency Rehabilitation & Modernization (EE R&M) at coal fired generating units through rehabilitation of 640MW of capacity across three States- West Bengal, Maharashtra and Haryana. The project would also try to address the critical barriers to large scale Energy Efficiency R&M in India. The project is funded through IBRD Loan of USD 180 Million and GEF grants 45.4 million out of which 7.5 million have been earmarked to technical assessment/studies. The project has two components viz.

- a) Component-1: Energy Efficiency R&M Pilot Projects
- b) Component-2: 7.5 million USD have been earmarked for Technical Assistance to address Critical Barriers to EE R&M. The sub-components for the technical assistance program (Component 2) would cover.
 - i) Support for design of Energy Efficient R&M projects
 - ii) Support for implementation of demonstration of EE R&M investments funded under Component-1 of the project
 - iii) Support for addressing barriers to implement EE R&M projects in India
 - iv) Support for strengthening of institutional capacities of the generation utilities and other relevant sector entities.

1.3 Technical Assistance Project for Addressing Barriers to Implementation of R&M in India

Under the sub-component (iii) of the component-2 (Technical Assistance) around US\$ 1.1 million of GEF Grants are being made available to provide technical support to CEA aimed at addressing barriers to implementation of R&M in India. This component was to be implemented through the Central Electricity Authority through appointments of Consultants including Implementation Support Consultant (ISC) to carry out following studies.

- i) Review of Institutional Capacity and Implementation of Capacity Strengthening Interventions at CEA
- ii) Reduction of barriers to R&M interventions in thermal power plants in India
- iii) Developing markets for implementation of R&M scheme in thermal power stations in India
- iv) Review of experience from Pilot R&M interventions in thermal power stations in India

CEA engaged WAPCOS Ltd on 23.07.2012 for undertaking study on “(iv) Review of experience from Pilot R&M interventions in thermal power stations in India”. The objective of the study is sharing of experience mainly in procurement, implementation and improvement in

performance parameters in Pilot R&M projects and other R&M/LE projects taken up during 11th plan and 12th plan.

The study covered the following activities.

- a) Review of Procurement Experience including preparation of DPR, Bidding documents, etc.
- b) Review of R&M Implementation Experience
- c) Review of Experience in Strengthening of O&M Practices
- d) Review of Post-R&M Experience in O&M
- e) Dissemination of Learnings from Pilot R&M Interventions

1.4 Objective of the Assignment

The main objective of the assignment is to review the experience of the interventions of Operations & Maintenance (O&M) strengthening practices undertaken by the concerned Power Generating Companies i.e. WBPDC, MSPGCL and HPGCL. Such O&M strengthening practices to include various aspects like technology, O&M planning, conditional monitoring, preventive maintenance, O&M procedures, enhancement in technical & managerial skills of O&M personnel and infrastructure/facilities improvement etc. The benefits accrued on account of the various strengthening interventions in O&M practices are to be identified and indicated. It is also intended to list out the drawbacks/shortcomings faced in the O&M practices followed after implementation of the strengthening interventions and suggest possible measures for further improvements.

1.5 Scope of Work of the Assignment

The detailed scope of work to be undertaken is provided below:

- a) To review the interventions of Operations & Maintenance (O&M) strengthening practices undertaken by the concerned Power Generating Companies – WBPDC, MSPGCL and HPGCL.
- b) To review the strengthening interventions undertaken by the utilities for enhancing O&M practices across the various facets including technology, O&M planning, conditional monitoring, preventive maintenance, O&M procedures, enhancement in technical & managerial skills of O&M personnel and infrastructure / facilities improvement etc.
- c) To indicate the benefits accrued on account of the various strengthening interventions in O&M practices undertaken at these thermal power stations.
- d) To list out the drawbacks/shortcomings faced in the O&M practices followed by power generating companies after implementation of the strengthening interventions and suggest possible measures for further improvements.
- e) To undertake visits of above mentioned power generating companies for the purpose of the review of the experience in strengthening O&M practices.
- f) Based on the review and discussion with the generation utilities, to prepare a report on strengthening of Operation & Maintenance (O&M) practices followed by these power generating companies for the purpose of sharing the learning/experience.

Under the assignment, the following thermal power units have been considered for review of implementation experience at the R&M projects. List of Thermal Power Utilities considered for review of the strengthening interventions undertaken by the utilities for enhancing O&M practices along with Period of visit by WAPCOS Team of Experts is as under:

Table 1.3: List of utilities along with visit dates

S. No.	Name of Thermal Power Utility / Thermal Power Station (TPS)	Actual Period of Visit undertaken
i.	HPGCL, Haryana/Panipat Thermal Power Station	27 th to 29 th September 2012 and 14 th to 16 th September 2015
ii.	WBPDC, West Bengal/Bandel Thermal Power Station	28 th to 30 th January 2013 and 5 th to 9 th October 2015
iii.	MSPGCL, Maharashtra/Koradi Thermal Power Station	21 st to 23 rd March 2013 and 26 th to 30 th October 2015
iv.	MSPGCL, Maharashtra/Nasik Thermal Power Station,	02 nd to 04 th May 2013 and 26 th to 30 th October 2015

Chapter-2

Approach and Methodology

2.1 Approach & Methodology

WAPCOS has adopted the following approach & Methodology for review of the Strengthening of O&M Practices in 3 No's Power Utilities viz. HPGCL, MSPGCL and WBPDCCL.

- i. Visited Power Generating Companies i.e., WBPDCCL, MSPGCL and HPGCL for review of the experience in strengthening O&M practices.
- ii. A questionnaire was developed for collecting the relevant information. The available documents collected from the Utilities were scrutinized to prepare the Report. The questionnaire contained following Queries:-
 - a. **Where strengthening of O&M Practices undertaken?**
Name of the Plant & Capacity, Consultant appointed, and important points recommended, Start/Completion of the activities, any special O&M Team and the organizational structure thereof etc.
 - b. **Improvement in O&M Planning/Management**
Details of the consultants hired (including cost), Strengthening & Interventions conducted, whether Integrated Management System [IMS] introduced, Introduction of System Administrative Programme [SAP], Daily Review / planning meetings, Skill development etc.
 - c. **O&M Procedures**
Information on the Condition Monitoring, Reliability-Centric Maintenance, Preventive Maintenance, Proactive/Predictive Maintenance.
 - d. **Departments/cells set up**
Objectives of the new departments/cells, Benefits accrued thereof.
 - e. **Operation Review Meetings**
 - f. **O&M Practices**
Operational Practices, Maintenance Practices.
 - g. **Developments in O&M infrastructure**
 - h. **Benefits accrued on account of the various strengthening interventions in O&M**
Plant Parameters for a period of 2 years before & after undertaking O&M strengthening interventions.
 - i. **Possible measures for further improvements**
- iii. Reviewed multiple interventions of Operations & Maintenance (O&M) enhancing practices across various aspects such as Manpower, Technology, and Process & Facilities / Infrastructure, introduction of energy efficient technology, introduction of technical audits and training program.
- iv. Reviewed the impact after enhancing O&M practices undertaken by other agencies.

- v. The analysis was divided into three steps to identify the benefits accrued on account of O&M practices, drawbacks/shortcomings encountered and recommendations for further improvement.
- vi. Prepared a Report on strengthening of Operation & Maintenance (O&M) practices for the purpose of sharing the learnings/experience.

2.2 Dissemination of learning and experiences

In order to disseminate the learning and experiences WAPCOS in association with CEA conducted a workshop in Delhi on 3rd February 2017 which was attended by authorities from various utilities and firms like World Bank, CERC, WBPDC, HPGCL, MSPGCL, NTPC, PSPCL, UPRVUNL, GSECL, MPPGCL, KPCL, RRVUNL, OPGC, BHEL, KBUNL and ABPS Infra Ltd.

Chapter-3

General O&M Practices

3.0 Introduction

About 70% of power generating capacity in India is from coal based thermal power plants. In India, for the coal based power plants, the overall efficiency ranges from 28% to 35% depending upon the size, operational practices and capacity utilization. Each and every Component/Equipment needs to be operated & maintained strictly as per the O&M Manuals and Guidelines of the respective Original Equipment Manufacturer (OEM). However, with passage of time, the Utilities also gain experience and exposure which is followed by them in future. As such, there are wide variations in O&M practices followed by power generating Utilities. A few of the Utilities have adopted some better systems and procedures, while the others lack in key operational areas, thereby resulting in reduced plant performance.

Proper Operation and Maintenance of Thermal Power Stations has huge potential for increasing the efficiency and longevity of plant.

3.1 O&M Practices

Operational practices among Power Utilities in India display a wide spectrum, with some of the better managed Utilities exhibiting superior systems & procedures while most of the remaining ones have critical gaps in several critical areas, leading to reduced Plant performance in terms of availability, generation and energy efficiency. The general practices followed by WBPDC is given below for reference.

- i) Operation of unit has been done as per O&M guidelines.
- ii) Preventive maintenance as per O&M guidelines, predictive maintenance based on condition monitoring and pre overhauling of unit as guided by Maintenance Planning cell.
- iii) Operation efficiency cell looks after the deviation of operating parameters, controlling factors, efficiency measurement and health assessment of equipments by condition monitoring such as vibration measurement, ferrography/oil analysis, thermovision for electrical hotspots and temperature measurement of high energy drains, DGA of oil of transformer etc.
- iv) Trip committee analyzes the root cause of tripping of unit which helps to avoid recurrence of the same.
- v) Chemical lab plays very important role in respect of Boiler chemistry.
- vi) Procurement cell persists both in plant and corporate.
- vii) Operation service group plays a very important role regarding monitoring of O&M practices.

The main aspects affecting the overall performance of the power plant are mentioned below.

i. Standard Operating Procedure

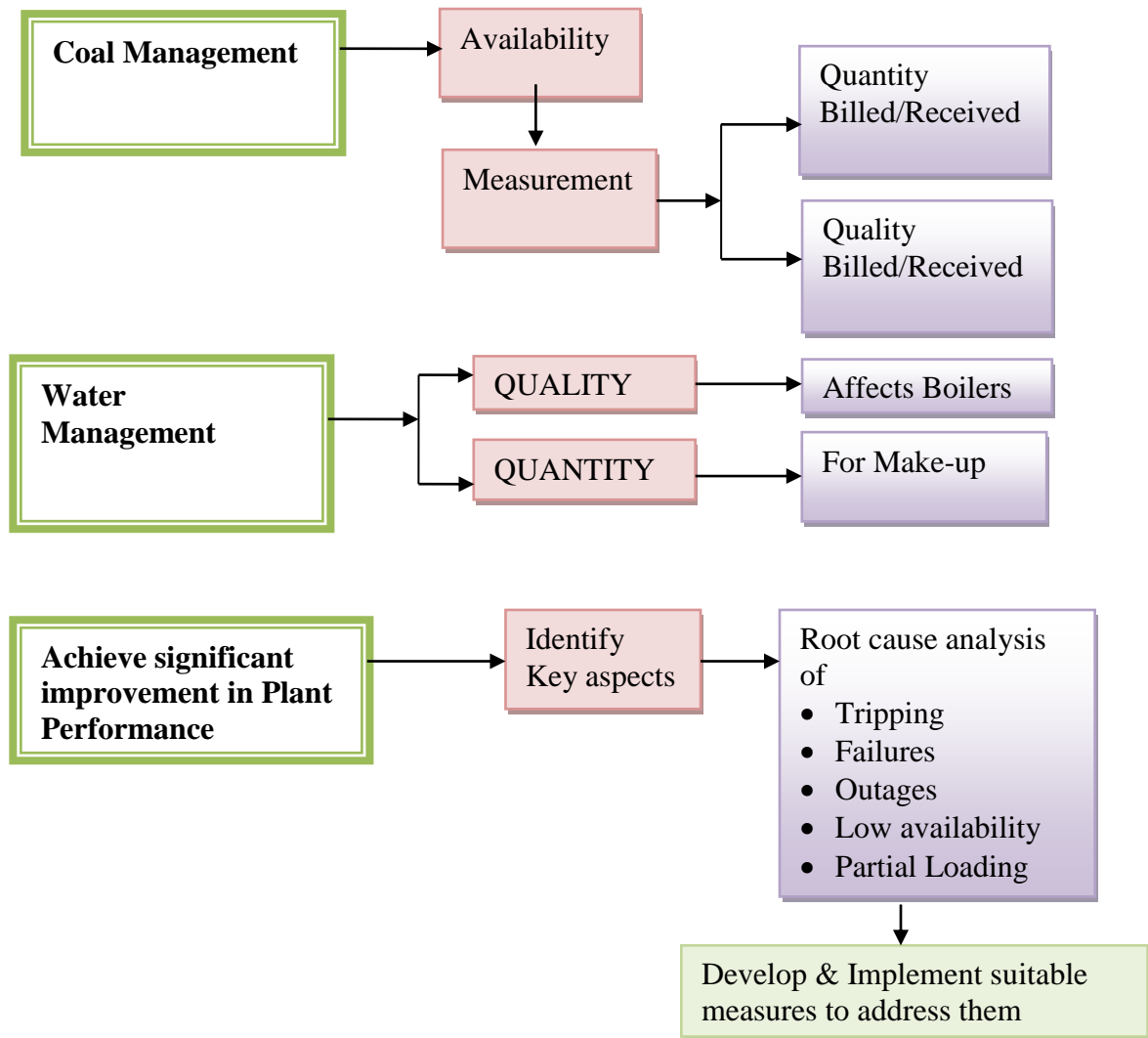
- Paying adequate attention to energy efficiency aspects.
- Effective Monitoring of Heat Rate
- Effective Monitoring of Auxiliary Consumption & Fuel Oil Consumption.
- Well documented Operational Procedures are not available to the relevant operating personnel who often execute their functions based on personal experience or orally transmitted experience.

ii. Analysis of Operation Data

- Operational data is not systematically utilized to generate operational requirements.
- House Keeping

The following Flow Chart depicts Management Methodologies of various areas:

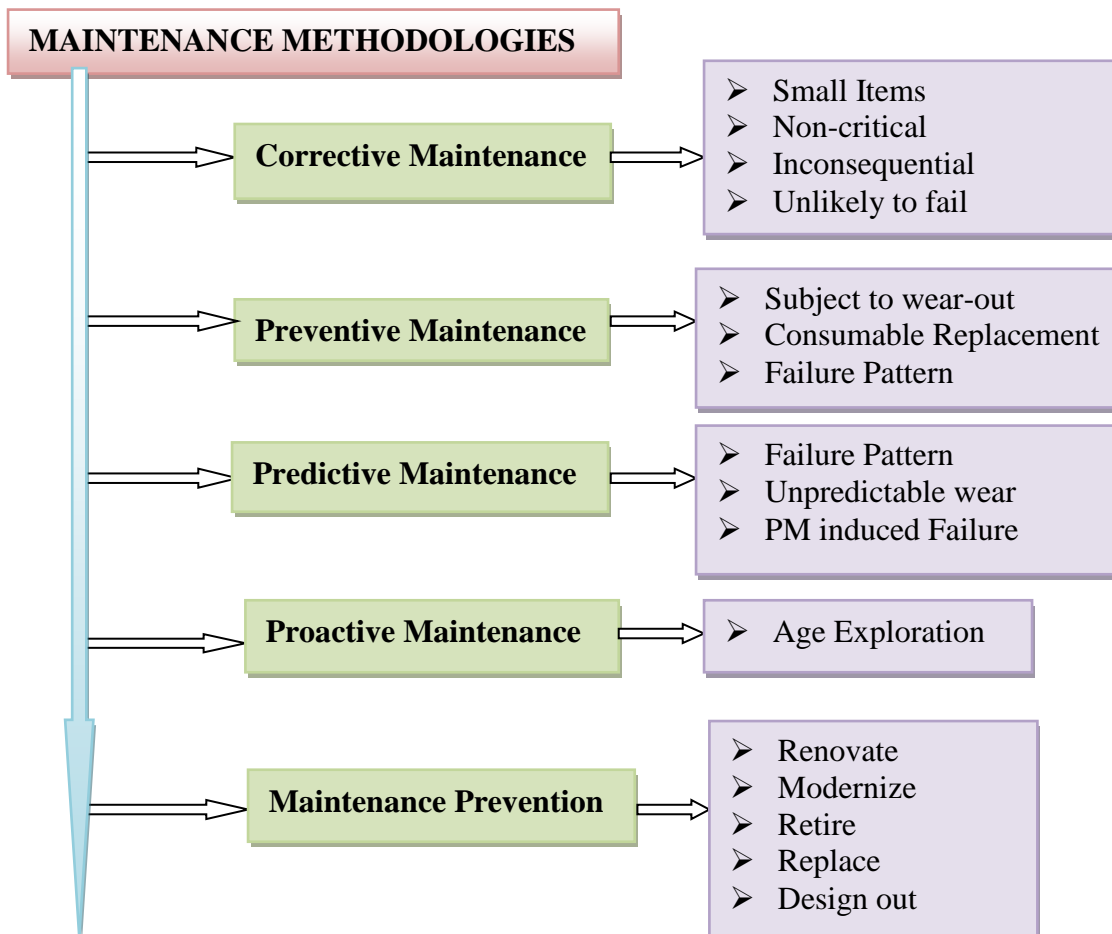
Flow Chart No. 3.1



The following facets in respect of O&M practices were analyzed:

- O&M Planning and Requirements
- O&M strengthening Plan
- Systematic utilization of operational data to generate useful information on O&M requirements
- Procedure to analyze root causes of unforeseen outages
- Efficiency Monitoring System & procedure for performing Tests, Auxiliary Energy Management, and analysis of Tripping & identification of controllable losses
- Analysis of improvement in Performance Parameters such as PLF, Heat Rate, Oil Consumption & Auxiliaries Consumption
- Analysis of O&M Expenses per MW
- Whether optimum inventory for important essential spares is being maintained.
- Maintenance methodologies like Preventive Maintenance, Corrective, Predictive Maintenance to increase life & efficiency of equipment as shown in the Flow Chart given below:

Flow Chart No. 3.2: Maintenance Methodologies



3.2 Proactive Maintenance Practices

While predictive maintenance uses online condition monitoring to help predict when a failure will occur, it doesn't always identify the root cause of the failure. That's where proactive maintenance comes in. Proactive maintenance relies on information provided by predictive methods to identify problems and isolate the source of the failure. Take the case of a pump that has periodic bearing failures. A condition-monitoring program may apply vibration sensors to the bearings, monitor the bearing temperature, and perform periodic analysis of the lube oil. These steps will tell when but not why the bearings are failing. Proactive maintenance might add laser alignment and equipment balancing during installation to reduce bearing stress, lowering failure rates and extending bearing life. But it will also take the next step to find the sources of failures, e.g. looking at cleaning procedures before tear-down to see if contamination during rebuild is a root cause for early bearing failures. By determining these root causes and acting to eliminate them, we can not only prolong the life of the equipment. But also eliminate many seemingly random failures and avoid repairing the same equipment for the same problem again and again.

Chapter-4

Strengthening of O&M Practices by Utilities

For Strengthening O&M Practices, multiple interventions are required across the various aspects which include personnel, processes, facilities/infrastructure, Technology etc. Maintenance practices improvements shall require short term interventions for establishing and Strengthening Maintenance Planning, Condition Monitoring, Computerized Maintenance Management System (CMMS) etc. The main objectives of strengthening of O&M Practices are as follows:

- i. Improve energy efficiency of coal-fired power generation units to enable them perform efficiently including those units which have undergone Renovation & Modernization (R&M) interventions.
- ii. Improve Operation & Maintenance (O&M) practices adopted by the utilities.

The key O&M Strengthening practices being followed by three utilities are given below:

4.1 O&M Strengthening Interventions by HPGCL, Haryana

HPGCL appointed M/s. STEAG Energy Services India, as consultant in May, 2013 for recommending specific measures to strengthen the O&M practices in its power stations i.e. Panipat TPS (PTPS), Deen Bandhu Chhotu Ram TPS at Yamuna Nagar and Rajiv Gandhi TPP at Hisar. After conducting the study of various TPS of HPGCL, M/s. STEAG Energy Services India submitted their observations and recommendations to HPGCL in the year 2015 for their study and approval. After finalisation of the same, the recommendations are being implemented in phased manner in HPGCL since 2016. The strengthening measures undertaken by the utility are still under implementation. Therefore, the final outcome of the measures has not been given. The main gaps, recommendations of consultants and status of implementations in O&M strengthening interventions are given as under:

4.1.1 Gaps identified by the Consultant

The main gaps in O&M strengthening interventions identified by the consultant in the old practices are given as under:

A. Operation Practices:

- i. PTW System presently being followed is manual. This is potentially unsafe work practice.
- ii. The system of raising defects is manual, which suffers from ineffective monitoring, incomplete defect liquidation and non-standard practices.
- iii. Standard operation procedures for various systems presently being followed need to be modified.
- iv. The system of scheduled equipment changeover is not being practiced regularly, which can result in imbalance in equipment running time. This could affect the preventive maintenance schedule & may lead to forced breakdown of the equipment.
- v. Heat Rate improvement programs & equipment performance testing is yet to be

initiated. There is no daily/monthly Heat Rate deviation review to identify the underperformance of equipments / areas.

- vi. Interchangeability of duties of Control Room Engineers is not being practiced. This reduces flexibility with the staff.
- vii. Periodic efficiency testing of the system & equipments is not being carried out.
- viii. There is no system of Pre-overhaul survey for identification of leakages.
- ix. There is no system of indicating Safety Permits for confined spaces, Hot Permit, Permits for working at heights, which show lack of safety in O&M.
- x. Software packages for online performance evaluator was not being used by the utility.
- xi. There is no program for controlling the overflow from the Ash Dyke.

B. Maintenance Practices:

- i. Equipment check list based on Standard Maintenance Practices & OEM guidelines are not available.
- ii. History of Equipment breakdown & repairs is not being maintained.
- iii. Presently the system of creating special overhaul teams for coordination & re-commissioning is not being practiced.
- iv. The maintenance planning function based on CMMS (Computerized Maintenance Management System) is not being practiced.
- v. The Maintenance activities are mainly carried out, based on individual experiences & assessment. This may affect equipment reliability.

C. General Practices:

- i. ERP System is not available at power plants.
- ii. Systematic training of Employers on Simulators is not organized.
- iii. Systematic review of Operation and Maintenance on daily/monthly basis need to be put in place and standard review formats should be developed.
- iv. Vendor Management System need to be developed to avoid inconsistent quality & reduced costs.
- v. The O&M structures provides adequate manpower for each unit but the availability of specific experts & development programs for junior staff is missing.
- vi. At RGTPP almost all purchases & store activities are carried out manually through filing system. This leads to high cycle time and huge manual efforts

4.1.2 Recommendations of the Consultant

In view of the gaps identified in Operation/Maintenance/Miscellaneous activities, as specified above, the recommendations given by the consultant M/s STEAG Energy Services India along with the action required for their implementation are given as under:

A. Enhancement of Operation Practices

- i. Computerized PTW (Permit to work) may be introduced. LOTO (Lock out Tag out) System in O&M for important system may be introduced in phased manner.
- ii. System of raising & closing defects needs to be computerized.
- iii. Standard operating procedures for various systems need to be modified.

- iv. Equipment change-over schedules may be developed & followed regularly. Software packages for online performance, evaluation should be used.
- v. Interchangeability of duties among Control Room Engineers needs to be implemented.
- vi. Audit for Auxiliary Power, Condenser vacuum & consumption of DM water should be done periodically.
- vii. Periodic monitoring of Heat Rate along with deviation thereof, needs to be reviewed/discussed at all the HPGCL power Stations.
- viii. System of pre-overhauling survey needs to be established.

B. Enhancement of Maintenance Practices

- i. Check list from OEM Manuals and Standard Maintenance Practices needs to be developed.
- ii. History of equipment breakdown & repairs should be assessable online through Computerized Maintenance Management System (CMMS).
- iii. Special overhaul team for overhaul coordination and re-commissioning may be created and followed.
- iv. Computerized Material Management System (CMMS) should be introduced.
- v. Computerized Integrated Plant Management System available at PTPS, should be put into full usage

C. Enhancement of Miscellaneous Practices

- i. Comprehensive ERP system with various essential modules may be introduced. Systematic Training on Simulators needs to be organized.
- ii. Systematic review of operation & maintenance on Daily/Monthly basis needs to be put in place & standard review formats need to be developed.
- iii. Vendor Management System needs to be put in place
- iv. Development Program for junior staff needs to be organized.
- v. HPGCL should adopt latest ERP software & implement e-Procurement, e- Auction.

4.1.3 Segment-wise Interventions Undertaken

- I. In order to implement the recommendations of the consultant for strengthening the O&M practices following segment-wise interventions were undertaken:

a) Enhancement of Operation Practices

- i. Computerized PTW system will be implemented as a part of ERP system. However, LOTO (Lock Out Tag Out) system has been implemented in phased manner in HT system.
- ii. Computerized system for raising & closing defects would be implemented as a part of ERP system.
- iii. M/s PWC has been appointed as a consultant for developing Standard Operation Procedures for HPGCL Power Stations & training of concerned staff. The same is under progress
- iv. Equipment changeover schedules is being followed & discussed in monthly Operation Review Team (ORT) Meetings.

- v. Heat Rate Improvement is being discussed in monthly ORT meetings.
- vi. Instructions have been issued to power stations regarding interchangeability of Control Room Engineers & are being followed.
- vii. M/s PWC has been appointed as consultant for conducting audit of Power, Condenser Vacuum and consumption of DM water for HPGCL Power Stations
- viii. Monthly ORT meetings to review Plant Heat Rate & other Performance Parameters is in place. Further efficiency calculations are being carried out fortnightly.
- ix. Pre & Post overhaul Performance monitoring system has been introduced.
- x. The Computerized system will be in place at all power stations.
- xi. Services of NTPC was hired for water balance/optimization study at Panipat TPS, and Rajiv Gandhi TPP and for strengthening of firefighting system of CHP-II of Panipat TPS.

b) Enhancement of Maintenance Practices

- i. M/s. PWC has been appointed as a consultant for developing Standard Maintenance Practices for HPGCL Power Station and training of the concerned staff. The work is in progress.
- ii. History of equipment breakdown & repairs will be accessible online through computerized system after implementation of ERP System.
- iii. Special overhaul team for coordination during overhauling has been constituted.
- iv. Computerized Maintenance Management System (CMMS) will be implemented during ERP.
- v. Check lists is being developed along with preparation of Standard Operation Practices and Standard Maintenance Practices.

c) Enhancement of Miscellaneous Practices

- i. M/s L&T Infotec is implementing ERP System in HPGCL.
- ii. Training on simulator are being organized periodically.
- iii. Daily Plant Meetings (DPM) chaired by respective Chief Engineer is in place.
- iv. Vendor Management has been initiated and is being implemented in HPGCL.
- v. Training programs for junior staff is in place
- vi. E-Tendering & E-Auction has been started. Further improvement will take Place after implementation of ERP System.

II. Additional Measures:

In addition to the recommendations made by HPGCL consultant, following measures were also added by HPGCL to further strengthen the O&M Practices:-

a) O&M Planning

- i. It was suggested to strengthen the maintenance planning.
- ii. Systematic action plan for implementation of Corrective and Preventive (CAP) measures need to be developed and implemented.
- iii. To begin with, benchmarking may be initiated based on best performing similar units

in the Power Station of HPGCL.

- iv. Systematic review of Operation & Maintenance on daily/monthly basis needs to be made and standard review formats need to be developed with clear responsibilities and targets.
- v. Preparation of checklists, maintenance instruction sheet, emergency operating instructions and other systems may be developed by the departmental engineers and compliance ensured.

b) O&M Procedures

- i. It is suggested that Maintenance Contract Management function wherever applicable should be entrusted to centrally coordinating agency specifically in case of overhauling.
- ii. Maintenance Planning should involve spares assessment and coordination.

c) Environment, Health and Safety

- i. Programs for controlling the overflow from the ash dykes needs to be developed. (HPGCL informed that steps for raising ash dykes has been initiated. Further no case of overflow of Ash Dyke has been reported since long).
- ii. Housekeeping may be improved.

d) O&M Practices

- i. Software packages for online performance evaluation were not used by the utility. (It was confirmed by HPGCL that they had started using software system).
- ii. Development programs for junior staff need to be organized. (HPGCL informed that training programs were now in place for junior staff).
- iii. WTPs (Water Treatment Plants) should be brought under unified command- Chief Chemist (overall for all WTPs). One mechanical maintenance cell may be formed for maintenance of all WTPs (Water Treatment Plants) under the Chief Chemist to facilitate immediate attention of the maintenance work. WTP is a very important plant and therefore, all records should be computerized and reviewed by the Chief Chemist to ensure that all the parameters related to water, steam, fuel etc. are being maintained within limits. The shift in-charge of the main plant should be in the knowledge of all the water chemistry parameters.

e) Efficiency

- i. The existing MIS system for monitoring Plant Performance need strengthening.
- ii. Efficiency departments need strengthening in terms of manpower, knowledge, tools, software and training. (HPGCL informed that steps to impart training to Engineers have been initiated).
- iii. Efficiency department should closely be associated with operation department during start-ups and unit shutdown.

4.1.4 Benefits Accrued

Since the recommendation for strengthening of O&M Practices are still under implementations, no feedback from HPGCL has been received so far regarding benefits

accrued. As such the benefit accrued from strengthening interventions cannot be ascertained at this stage.

4.1.5 Drawbacks & shortcomings faced

The shortcomings faced by HPGCL were as follows:

- a) The thermal power plants were not recording vibrations and temperatures of major load bearing equipments, online.
- b) Practically all the old units are installed with old systems which were sluggish.
- c) There was no regular periodic review of plant performance and other critical issues.

4.2 O&M Strengthening Interventions undertaken by WBPDCCL

For improvement of O&M and to learn best practices WBPDCCL had hired services of NTPC on 01st April, 2010 for providing consultancy, for two years from 2010 to 2012 for Bandel TPP (BTTP), Kolaghat TPP (KTTP), Bakreswar TPP (BkTPP), Sagardighi TPP (STTP) and Santaldih TPP (STTP). NTPC helped for Gap Analysis and for Strengthening O&M Practices, which was implemented during the period mentioned above.

4.2.1 O&M Practices being followed before Interventions

Before interventions, following practices were generally being followed in WBPDCCL thermal power plants. Operation of unit was done as per O&M guidelines. Preventive maintenance as per O&M guidelines, predictive maintenance based on condition monitoring and AOH of unit as guided by Maintenance Planning cell. Operation Efficiency Cell looks after the deviations in operating parameters, controlling factors, efficiency measurement and health assessment of equipments by condition monitoring such as vibration measurement, Ferrography/Oil analysis, Thermovision for electrical hotspots and temperature measurement of high energy drains, Dissolved Gases Analysis (DGA) of transformer oil etc. Trip Committee analyses the root cause of tripping of unit which helps to avoid recurrence of the same. Chemical lab plays very important role in maintaining Boiler chemistry. Procurement Cell operates both in Plant and Corporate offices. Operation Service Group plays an important role in monitoring of O&M practices. After implementing the O&M strengthening interventions more emphasis has been given for better functioning of the above activities.

4.2.2 Recommendations of the Consultant

- I. The important points recommended by consultant (NTPC) for assessment and strengthening of O&M practices are given as under:-
 - a. **O&M Planning**
 - i. Planning for Unit overhauling.
 - ii. Daily planning for equipment maintenance.
 - iii. Opportunity & condition based maintenance.
 - iv. Based on availability and quality of received Coal, unit was running at optimum load to achieve its share on total generation of WBPDCCL to meet up system demand.

- b. **O&M Procedure**

- Condition monitoring of equipment
 - i. Vibration analysis for ≥ 45 kW equipment
 - ii. Debris analysis of BFP, Mill, PA fan etc.
 - iii. Thermography of outdoor electrical equipments, Boiler insulation and ducting
 - iv. Electrostatic Liquid Cleaner (ELC) for HP/LP Bypass in BkTPP
- Reliability-centric maintenance, study of Mean Time Between Failure, In-house Failure analysis, failure analysis to be carried out by outside agency
- Preventive maintenance to be followed religiously.
- Proactive/Predictive maintenance, opportunity based replacement to be carried out.
- Introduction of Technical Audits area wise for understanding the problems
- Formulation of possible solutions
- Implementation and review

c. Preventive Maintenance

Preventive maintenance schedule for equipment based on loading factor & experience. The Preventive Maintenance has been done proactively based on performance degradation.

Condition monitoring

- i. Vibration monitoring (On line & off line): Online vibration monitoring system was installed in major load bearing equipments
- ii. Wear debris analysis in lube oil
- iii. Motor current signature analysis
- iv. Thermographic survey {Switchyard and motor terminal}
- v. DGA & Furan analysis for transformers
- vi. 3rd Harmonic current monitoring of LA
- vii. Boiler tube metal temperature
- viii. Turbine Supervisory
- ix. RLA of old equipment

d. Technological Interventions

- i. New Energy Efficient Technology
- ii. Energy efficient lighting VFD in Coal Feeders.
- iii. Energy efficient pump coating in CW & ACW pumps.
- iv. Hollow FRP blades of CT fans.
- v. Low NO_x burner, modified air register, dynamic classifier

II. Additional Measures:

In addition to above, following additional recommendations were also made by the consultant:

- i. Starting of O&E department at plant level and operational services department at corporate level.
- ii. Preparation of Engineering declaration for each unit overhauling and carrying out the job accordingly.
- iii. Improvement in O&M planning and Management Through in house discussion and follow up between plant and corporate.

- iv. There was need to adopt procedure to analyse root causes of unforeseen outages
- v. The Efficiency Monitoring System to be undertaken and steps to be taken for plant efficiency improvement.
- vi. Energy Audit to be undertaken on regular basis by external agencies and by O&E Department.
- vii. Maintenance methodologies like preventive maintenance, Corrective maintenance, and predictive maintenance may be adopted to increase life & efficiency of equipment.
- viii. Tripping Analysis Committee reports and suggestions to be implemented to avoid repetition of failure.
- ix. Skill development for O&M personnel through training programs to be imparted at plant level.
- x. Implementation of ERP to be done
- xi. Online vibration measuring/monitoring to be carried out

4.2.3 Segment-wise Interventions Undertaken

Following segment-wise interventions were undertaken by the utility at its various thermal power stations.

a) O&M Planning

- i. New departments were set up such as Operation Service Cell at Corporate and Operation & Efficiency (O&E) at stations.
- ii. New departments were set up which included Operation & Efficiency Cell (O&E), Coal Consumption & Fuel Efficiency Cell (CC&FE) and M&C Cell. The function of O&E Cell is to identify process Heat loss, minimizing APC etc. similarly CC&FE Cell does the function of monitoring coal quality, M&C Cell does the function of procurement of goods more than worth Rs. 1/- Crore. For strengthening of O&M Practices, meetings were started across all stations of WBPDC. NTPC experts were hired initially but now the development process is carried out by WBPDC engineers.
- iii. Monthly Operation Review (OR) meeting held at Plants about the O&M issues of Plants. OS Cell representatives attend the meeting, all plants performance and critical issues are discussed.
- iv. Periodical meetings held at corporate office involving top management and Plants Head to review Plant performance.
- v. Installation of Distributed Control System replacing obsolete Analog Control System in unit-1&2 of Kolaghat T.P.P. and for ease of operation and better diagnostics.
- vi. BTPS, KTPS, BkTPP & SgTPP has already obtained Safety Certification and valid up to 20th July, 2017, 30th March,2019, 3rd March,2019 & 4th December,2019 respectively.
- vii. BkTPP & STPP has already been Safety Audited by National Safety Council, Navi Mumbai in the year 2015. SgTPP KTPP & BTPP has already been audited by Regional Labour Institute, Govt. Of India, Ministry of Labour in the year 2015 & 2016 respectively.
- viii. The initial Fire & Safety Recommendations has already been obtain by BTPP, KTPP, STPP, BkTPP & SgTPP from The West Bengal Fire & Emergency Service, Govt. Of

- West Bengal.
- ix. The Plant Level Safety Committee Meetings & Mock Fire Drills are going on as per regulation.
 - x. Onsite Emergency and Disaster Management has already been prepared in station level and circulated as per regulation.
 - xi. Occupational health hazard monitoring is introduced in all plants.
 - xii. All Stations are running with valid Consent to Operate, issued by Pollution Control Board, Govt. of West Bengal. On regular basis, SPM, SO_x, NO_x, etc, and effluent quality monitoring is carried out in all plants.
 - xiii. Commissioning of flame scanners in Kolaghat T.P.S. Unit#3.

b) O&M Procedure

- i. All plants have their dedicated online O&M and inventory management system. Now M/S TCS has been engaged to frame a comprehensive and centralized platform (ERP) for O&M, Inventory, Fuel Management, HR, Finance management etc.
- ii. WBPDCCL has established Central Generation Co-ordination Room (CGCR) to monitor all plants generation and critical parameters and optimization of generation as per ABT regime.
- iii. Freight Operations and Information System (FOIS) portal is linked to all plants and corporate for close monitoring the coal rake movement.

c) Technological Interventions

Strengthening and area wise interventions carried out as suggested by the consultant are as follows.

Table 4.1: Area wise Technological Interventions introduced by WBPDCCL at Bandel TPP

S. No.	Area	O&M Interventions
1	Boiler	Coal nozzle and Burner system modified
2	Coal Mill	Mill capacity increased. Now low quality coal can be used
3	Air Preheater	Air Preheater outlet Flue gas temperature shall be 135°C
4	ID & PA Fans	New ID and PA fans installed
5	ESP	Additional 12 numbers fields are introduced to achieve 90mg/Nm ³ emission level at ESP outlet with worst coal firing of 3300 kCal/kg
6	Turbine	Electro Hydraulic Governor installed
7	BFP	Improved cartridge to reduce auxiliary power
8	HP Heater	New HP heater installed as spiral tube could not be obtained
9	LP Heater	Tube replacement is done suitable to new HBD
10	Generator	Complete replacement of Generator
11	Ash Handling System	Provision of parallel ashing of APH hopper and ESP hopper
12	C&I system	DDCMIS introduced
13	IT System	ERP implemented
14	Safety	OHSAH 18001:2007 Certification done

15	Pollution Control	<p>a. Dust Suppression and Dust Extraction system is introduced in CHP area, Dry Ashing system is renovated,</p> <p>b. Planning is made for installation of parallel plate separator for treatment of surface run-off coal handling plant and discharge from DM plant after neutralization.</p>
----	-------------------	---

d) Trainings of O&M Personnel

- i. Enhancement in technical & managerial skills of O&M personnel infrastructure/facilities improvement by providing them regular training programs/seminars organized in-house and also outside (like IIM, BHEL etc.)
- ii. Simulator Training at Bakreswar Thermal Power Plant of WBPDCCL: For reliable, sustainable & efficient operation and safety of the power plants, a team of properly trained & skilled human resources is required. Conventional On-Job Training does have some constraints and found deficient to develop the true skill of an Operator, whereas simulators have proved as an effective training tool since it gives a feeling of operating a real power plant with no fuel cost, no wastage of time, no losses or repairs. The operators gain quickly Hands-on-Experience both for normal and abnormal/emergency operation of the plant. A Simulator– trained Operator reduces the downtime significantly and runs the plant safely and efficiently. Power Plant Training Simulator at Bakreswar Thermal Station of WBPDCCL is supplied by GSE Power System Inc., USA.
- iii. Trainings to the O&M personnel were imparted by turnkey contractor of EER&M by sending them abroad. Also, in-house trainings were imparted to the personnel at various levels. Details of regular training is mentioned below:-
 - a) The WBPDCCL Training Advisory Committee has fixed the target for generation of training man-days initially at the scale of 2 training man-days per employee per year and gradually increasing to 3 days training per employee per year and so on. Towards implementation of such directives of both Technical and Non-Technical training the guidelines issued by Central Electricity Authority and National Training Policy 2002 would be followed.
 - b) The Internal and External Training programs were conducted on various dates from November, 2012 onwards for the WBPDCCL employees and also for contractors workers by SPC-WB, WEBEL, CBWE, WBSIEDCL, BkTPP Simulator Training Centre, CESC, ATI-Kolkata, RLI-Kolkata, NPTI (Durgapur, Nagpur, Badarpur, Neyveli), BHEL, ESCI-Hyderabad, NTPC-Korba etc.
 - c) From April,2015 to January,2017 ,total 9641 no. of regular employees and 1039 no. of contractors workers were trained creating a total Training man-days of 12328(excluding 1099 man-days for contractors workers) from April,2015 to January,2017.
 - d) For sharing of Knowledge, Workshop is arranged in station level by the employee who attended the training.

4.2.4 Benefits Accrued

- i. Online vibration monitoring system helped in CBM

- ii. Low NO_x burner, modified air register, dynamic classifier were installed which attributed to the benefits in terms of environmental parameters
- iii. Imparting training for enhancement in technical and managerial skills
- iv. Ex-Bus availability increased and Specific Oil consumption decreased

4.2.5 Drawbacks & Shortcomings faced

Drawbacks/ Shortcomings faced in the O&M practices at Bandel TPS by WBPDCCL after implementation of the strengthening interventions.

- i. Grade slippage and erratic supply of coal
- ii. Foreign materials like stones, boulders in huge quantity in Coal inflicting severe damage to the plant machinery
- iii. High Ash Content Coal
- iv. Since Bandel TPS is very old, hence BoP needed to be renovated for meeting techno-economic feasibility.
- v. Proper coal blending is not possible due to absence of Stacker-Reclaimer in coal handling plant.
- vi. Manual PTW system was in use
- vii. LOTO system for HT system was not in use
- viii. SOP and SMP of critical equipments were not available
- ix. Dedicated team not deployed for overhauling

4.3 O&M Strengthening Interventions by MSPGCL, Maharashtra

Before undertaking the strengthening of O&M practices, conventional routine O&M practices were being followed by MSPGCL to meet the requirements. Subsequently, NTPC was appointed on 13th May, 2011 for a period of three years i.e. from 2011 to 2014, as consultant both at Corporate and Power Station level for giving necessary recommendations and guideline for strengthening of O&M practices in the thermal power stations under MSPGCL i.e. Koradi TPS, Nasik TPS, Bhusawal TPS, Parli TPS, Chandrapur TPS, Khaperkheda TPS and Paras TPS and the recommendations were implemented during that period.

4.3.1 Recommendations of the Consultant

Following are their recommendations.

- i. Setup committee and Task Force of suitable staff for performance improvement program
- ii. Develop various methods of performance improvement program
- iii. Implement an online monitoring system for critical condition monitoring of equipments
- iv. Analyse condition monitoring data
- v. Establish trip committee at plant
- vi. Establish energy audit group at plant
- vii. Create panel of experts across various plants on Turbine, Boiler, C&I, Protection etc.
- viii. Quality cell should be setup at corporate level
- ix. Develop analysis of the cases of forced outages

In view of the above various state level performance improvement committees were formed at Power Stations level and Corporate Head Quarter as under:

i) At Plant level

Following committees were formed at plant level.

- a) Coal Mill Committee
- b) Coal Handling Plant (CHP) Committee
- c) Ash Handling Plant (AHP) Committee
- d) Boiler Tube Leakage (BTL) Committee
- e) State Level Heat Rate improvement Committee
- f) Water Treatment Plant (WTP) Committee
- g) Electrical Protection Committee
- h) Knowledge Team recently formed to analyse the BTL problems

ii) At Corporate Level

Following committees were formed at corporate level.

- a) Maintenance Planning Department (MPD) to carry out long term and short term maintenance planning.
- b) Field Quality Assurance Department (FQAD) for Quality checks of incoming materials and work carried out.
- c) Corporate Level teams for Coordination
- d) Performance Optimization Group (POG) for regularly monitoring parameters to achieve better performance of the unit.

All the above committees have been formed from members of various power stations and Corporate Head Quarter. The Committees meetings are being held Quarterly to review the performance in respective areas. The constraints/issues in respective areas along with its time bound action plan are also implemented. The Generation loss, oil consumption, on account of above system, is monitored.

4.3.2 Segment-wise Interventions Undertaken

Segment-wise O&M interventions undertaken by MSPGCL are as follows:

a. O&M Planning

- i. Organizational structure formed for this purpose like setting up a separate Cell for O&M etc.
- ii. At Corporate level, EST (Expert Support Team) Group is established. This group monitors and co-ordinates all the above activities.
- iii. All thermal power stations are certified with ISO.
- iv. SAP is implemented in MSPGCL.
- v. Daily Review Planning meeting are conducted at every power station.
- vi. Various training programmes are arranged at Nasik & Koradi Training Centres. Also, Sub-Training Centres are established at each power station.

b. O&M Procedure

- i. All MSPGCL plants are ISO certified and O&M procedures given by BHEL and other OEM are being followed.
- ii. Regular Operation Review Meetings: Monthly Operational Review meeting is conducted

at head office. Reports and action to be taken are circulated to all power station. Objective of these meetings was to enhance the coordination and to avoid the delay at various stages. Also a close watch on the performance parameters, intimation of the same to the authorities and guidelines to all for corrective actions for improvement, which is achieved to a considerable extent.

- iii. Condition Monitoring Cell: Condition Monitoring Cell is developed at all power stations which periodically conduct-
- Vibration Analysis
 - Thermography
 - Furnace Temperature Mapping etc.

Condition Monitoring is carried out regularly and suitable actions are taken. Also separate condition monitoring cell for vibration of TG & 6.6KV auxiliaries are being maintained at Dy. C.E. (TIC), Nagpur.

Some of the strengthening interventions undertaken by MSPGCL for enhancing O&M practices were taken independently as per decisions taken in committee meetings.

Condition Monitoring Cell is formed at Plant Level in which various parameters of vibrations and temperatures are monitored with the help of vibration measuring equipment and Thermography Camera. The following equipments are also used for this purpose:

- Vibration Meter/Analyser
- Infra-red imager/thermal vision camera
- Spiro metric gun
- Dirty Pitot tube
- Dissolved gas analyser
- Oil debris analyser
- BDV test kit
- PPM Carl fisher instrument
- Viscometer
- Bomb calorimeter
- Furnace & oven for ash and moisture measurement
- Acoustic meter for bearing vibration measurement

c. O&M Practices

Operational Practices are as follows:

- i. Regular coal sampling is carried out at all thermal power stations. Third party coal sampling is also being implemented at all thermal power stations.
- ii. Proximate and ultimate coal analysis is carried out all thermal power stations.
- iii. To ensure raw & DM water quality, system like SWAS, CPU are used in new units.
- iv. SWAS system is also recommended in some 210 MW units.

d. Preventive Maintenance

Preventive Maintenance Schedules as given by BHEL and other OEMs are being followed. Maintenance practices followed by MSPGCL are as follows:

- i. Reliability Centred Maintenance (a concept used to reduce annual overhaul time of

Units) being carried out.

- ii. Better maintenance systems & procedures based on actual experience and exposure other than recommended in O&M Manuals and Guidelines of the respective OEMs have been adopted.

e. Technological interventions:

Area-wise Technological interventions carried out by MSPGCL as suggested by the Consultant are as under:

Table 4.2: Technological Interventions at MSPGCL

S. No.	Area	O&M Interventions	Remarks
1	Boiler	Zone wise erosion mapping, Low Frequency Electromagnetic Technique (LFET) test of water tubes for internal corrosion, quality monitoring of welding joints, Installation of chloride & sodium analyser etc.	Boiler Tube Leakage (BTL) meetings are conducted regularly. Corporate level monitoring is done by Expert Support Team (EST)
	Coal Mill	Monitoring of mill availability, fineness, load-ability, percentage rejection. Preventive maintenance, package overhauls and Capital overhaul plans are followed.	Corporate level monitoring in process (monthly review). Plans are prepared and monitored at Corporate level.
	Soot Blower	BTL Committee keeps watch on related issue	
	Air Preheater	Detection of leakages to avoid loss	
	ID fans, FD fans & PA fans	Energy Efficient Motors to be used	In process
	ESP	Stack Emission and Ash evacuation activities are monitored	Regularly monitored
2	Turbine	RLA studies carried out	As per RLA study, steps are taken in overhaul
	BFP	To replace the existing BFP Cartridge with Energy Efficient Cartridge	Cartridges procured and replaced
	Condenser	All heat exchangers are to be replaced in phased manner.	In process
	HP Heater		
	LP Heater		
3	Generator	No interventions required	
4	Ash Handling system	No interventions required	

5	C&I system	DCS & VFDs recommended	In process at selected Power Stations
6	Information & Technology System	It is covered under SAP implementation	Implemented all over MSPGCL
7	Safety	Earth fault protection is recommended for all HT motors	
8	Pollution Control	Continuous Ambient Air Quality Monitoring Stations (CAAQMS), SO _x & NO _x Measurement systems to be implemented	DPR is approved. Further work in process

f. Enhancement in Technical and Managerial Skills of O&M personnel

- i. Management Development Programmes at Yashada, Pune are being arranged for senior level executives
- ii. Training Centres at Nasik and Koradi are conducting various technical refresher & managerial skills programme for various work groups
- iii. Executives are also nominated for various Training Programmes conducted by various reputed agencies in India.

g. Improvement in O&M planning/management

- i. Yearly Station wise/Section Wise Budgeting is done
- ii. Consultancy Services in areas like O&M, environment, Ash Utilization, Logistics, Coal etc. are taken as and when required.

4.3.3 Benefits accrued on account of the various Strengthening Interventions in O&M

The following are the benefits accrued by MSPGCL at its various thermal power stations after O&M interventions:

Table 4.3: Performance Parameters of MSPGCL

Parameters	2011-12	2012-13	2013-14	2014-15	2015-16
PLF (%)	65.04	65.27	54.75	58.95	56.02
Forced Outages (%)	5.18	8.02	6.94	5.87	7.3
Availability (%)	85.22	84.31	77.71	78.74	70.12
APC (%)	10.52	10.62	10.58	9.79	9.11
SOC (ml/kWh)	4.19	3.36	3.71	1.2	0.89
Heat Rate (kCal/kWh)	2702	2736	2666	2602	2579

- i) PLF decreased from 65.04% during year 2011-12 to 56.02% during the year 2015-16 taking into account loss due to backing down (7.27%) and due to Coal shortage (10.04%).
- ii) Overall Heat Rate improved from 2702 kCal/kWh during 2011-12 to 2576 kCal/kWh during the year 2015-16.
- iii) Specific Oil Consumption (SOC) improved from 4.19 ml/kWh during the year 2011-12 to 0.89 ml/kWh during the year 2015-16.
- iv) The Auxiliary Power Consumption (APC) improved from 10.52% in 2011-12 to 9.11% during 2015-16.
- v) The Forced Outages increased from 5.18% (2011-12) to 7.3% (2015-16).
- vi) Availability decreased from 85.22% (2011-12) to 70.12% (2015-16).

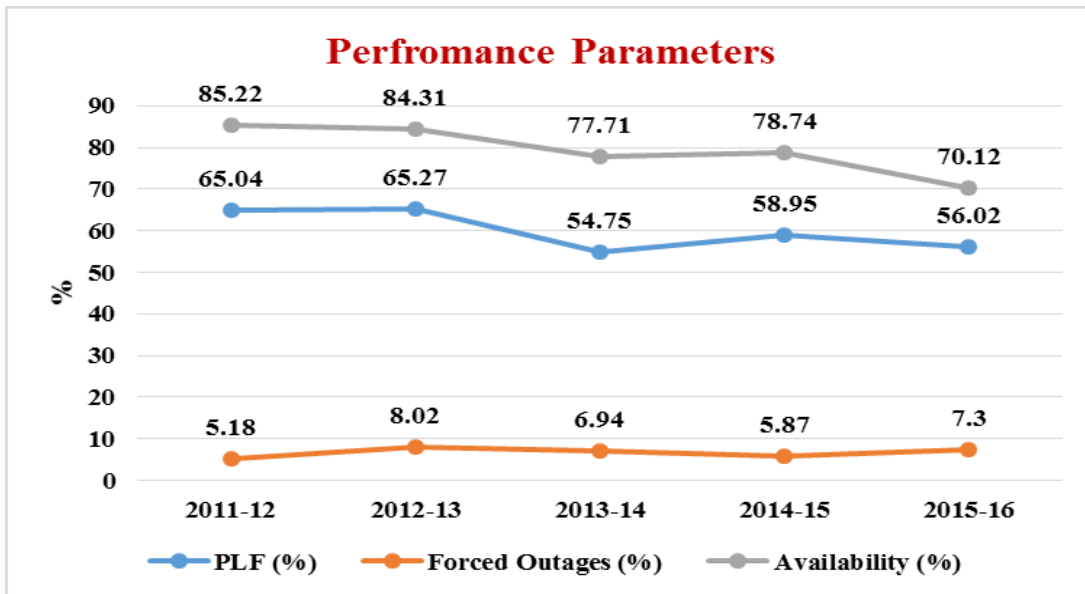


Fig. 4.1: Performance Parameters

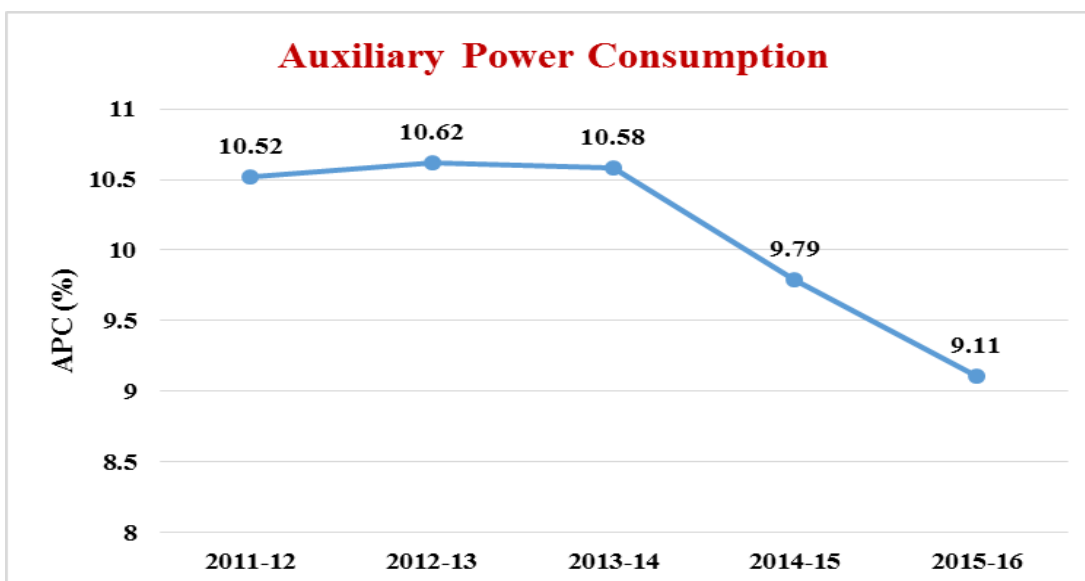


Fig. 4.2: APC

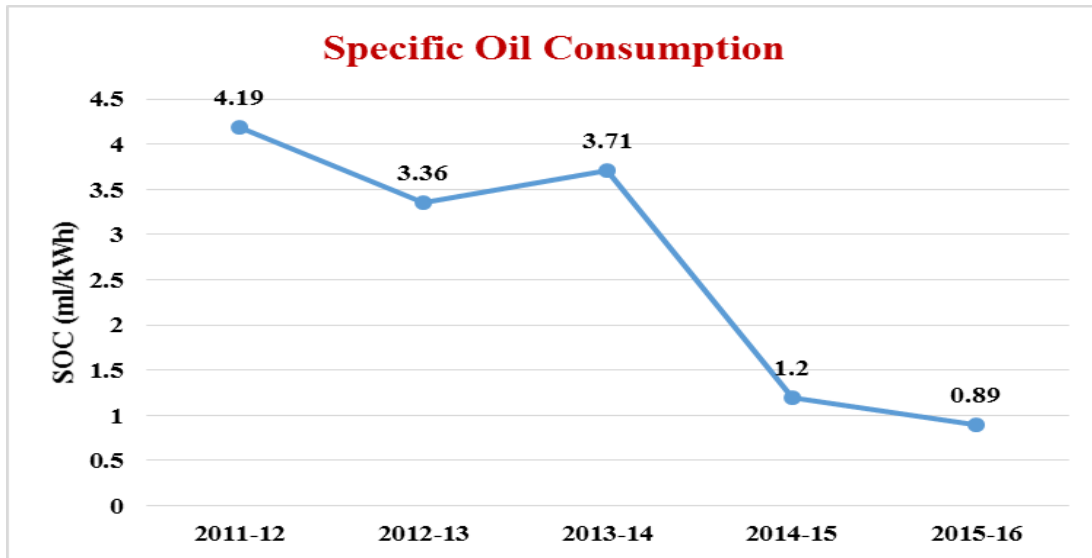


Fig. 4.3: SOC

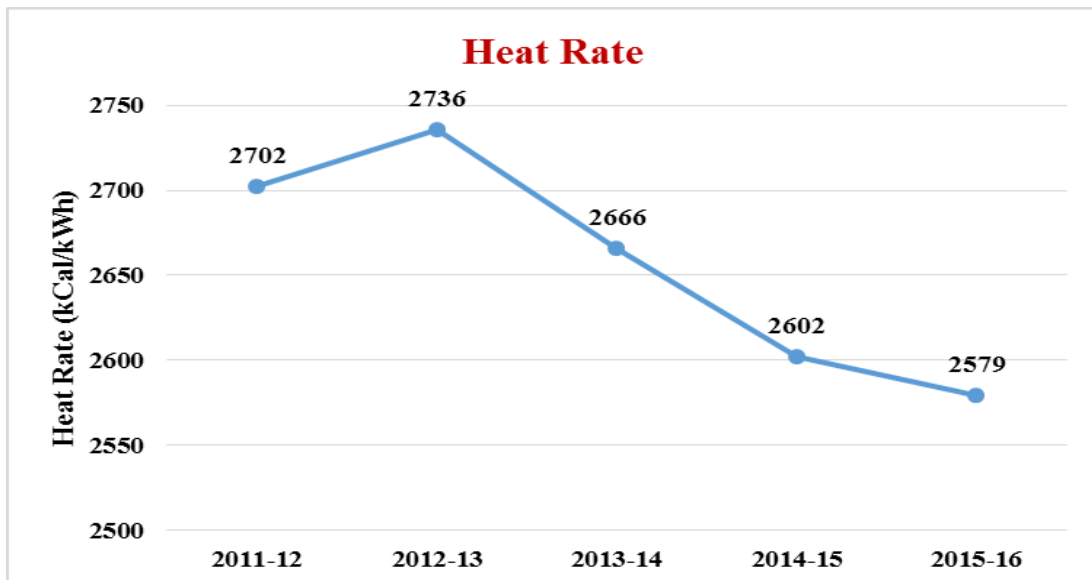


Fig. 4.4: Heat Rate

In addition to above the following benefits have also accrued on account of various strengthening interventions in O&M:

- Increased awareness about better O&M practices
- Availability of common platform for various problems
- Step towards reduction in auxiliary consumption e.g. Energy Efficient BFP cartridge.

However, it has been observed from the data supplied that availability has decreased from 85.22% during the year 2011-12 to 70.12% during the year 2015-16. During the same period the forced outages have also increased from 5.18% to 7.3%.

However, it has been observed that whereas there has been improvement in APC, SOC and Heat Rate but PLF and Availability have decreased and Forced outages have increased mainly

because of back down and coal shortages

4.3.4 Drawbacks and Shortcomings faced in O&M Practices

- Improper utilization of resources
- Correct parameters are not maintained
- Start-up & Shut down time not monitored
- O₂ level at air heater inlet not monitored for optimum Air flow to furnace
- Improper loading of Coal Mill
- Inaccurately maintaining MVAR
- Auxiliary Power Consumption not monitored
- Unburnt Coal in Fly Ash & Bottom Ash not monitored
- 100% availability of guns not ensured
- Manual PTW system was in use
- LOTO system for HT system was not in use
- SOP and SMP of critical equipments were not available
- Dedicated team not deployed for overhauling

Chapter-5

Analysis & Review of Strengthening of O&M Practices

Operational practices among power generation utilities in India vary from state to state. Some of the Utilities are better managed with better systems and procedures, whereas most of the others are lagging in several key operational areas. This state of affairs is leading to reduced plant performance in terms of availability, generation, energy efficiency and increased oil/coal consumption as well as increased auxiliary power consumption. Most utilities still do not pay the required attention to energy efficiency aspects. Energy audits are not carried out in most cases. Heat rate and specific oil consumption targets are not fixed and monitored for the station as a whole. As such unit-wise energy efficiency aspects are not identified and addressed. Auxiliary power consumption is not measured on actual basis and it is generally computed by deducting sent out energy from the total energy generated. In the absence of any proper analysis, measures for improvement are not identified.

Technical problem areas generally experienced in State Sector thermal power stations are as follows:-

- Poor condition of boiler pressure parts overheating, external corrosion, oxide deposits, weak headers etc.
- Poor water chemistry has affected the condition of boiler and turbine in many cases.
- Poor performance of air pre-heaters due to blocked elements and high seal leakage.
- Poor performance of the milling system resulting in high un-burnt carbon.
- Poor condition of Electrostatic Precipitators (ESPs) resulting in high emissions.
- Problems of high axial shift, vibrations and differential expansion in Turbines
- Low vacuum in condenser due to dirty/ plugged tubes, air ingress and tube leakages.
- High vibrations in Boiler Feed Pumps and Condensate pumps and passing of recirculation valves, resulting in low discharge.
- High pressure heater not in service in most of the units, directly impacting the energy efficiency performance.
- Deficiencies in electrical systems including High HT and LT motor failures, poor condition of DC system, non-availability of Unit Auxiliary Transformer etc.
- Poor condition of Balance of Plant (BoP) resulting in under-utilization of capacities.

5.1 Strengthening Interventions Undertaken by the Utilities

Based upon the data/information supplied by HPGCL, WBPDCCL & MSGPCL utilities and interaction with the concerned officers, analysis/review was carried out. The improvements carried out by different Utilities are as under:

5.1.1 Infrastructure/Facilities Improvement

Proper Infrastructure/facilities play very important role in running the plants efficiently. Some of the improvements carried out by different Utilities are given as under.

a. HPGCL

To carryout strengthening of Fire Fighting System of Coal Handling Plant II at PTPS.

b. WBPDCCL

Installed Distributed Control System (DCS) replacing obsolete Analog Control System which resulted into ease in operation and better diagnostics.

c. MSPGCL

- i. Old Fuel unloading system for 1400 KL Capacity which was taking unloading time of 24 hrs. was upgraded to New System for 3000 KL with unloading time of 10 hrs.
- ii. Complete renovation of Fuel Oil Tanks was carried out by reinforcing with 20mm thick peripheral base plate & additional skirting plate including complete heating coil replacement.
- iii. Tank reinforcement was done by complete peripheral RCC foundation support & channel drains.
- iv. Earthing system improvement.

5.1.2 O&M Planning

In order to strengthen the planning activities for O&M practices, following measures were taken by HPGCL, WBPDCCL & MSPGCL respectively.

a. HPGCL

- i. M/S PWC has been engaged as a consultant for developing Standard Maintenance Practices for various power stations. The work is under progress.
- ii. Computerized Maintenance Management System (CMMS) will be implemented with ERP.

b. WBPDCCL

Utility is undertaking planning for Unit Overhauling, Equipment Maintenance and Opportunity-cum-Condition based Maintenance. Following steps have been taken in this connection:

- i. New Operation and Efficiency (O&E) department formed to monitor plant performance parameters such as Heat Rate, APC, Oil/Coal consumption, PLF, Generation etc. at plant level and Operational Services (OS) department at corporate level.
- ii. Monthly Operation Review (MOR) meetings started to review the tripping of units, spares management, strategy planning etc.
- iii. Maintenance planning is followed on daily basis, as well as for overhauling and opportunity based maintenance required.
- iv. In-house analysis of system/equipment failures started to find out causes and to increase Mean Time Between Failures (MTBF).

c. MSPGCL:

- i. New committees were formed at plant and corporate level for smooth operation of the utility.
- ii. Condition monitoring practices started like vibration monitoring, thermography and furnace temperature mapping etc.
- iii. Regular Operation Review (OR) meetings started monthly to enhance coordination and to reduce delays at various stages apart from having a close watch on performance parameters etc.
- iv. Coal sampling and its analysis was started, Condensate Polishing Units (CPU) were used to maintain the quality of DM water.
- v. Reliability centered maintenance practices were started.
- vi. Inventory/spares management started using SAP for reduction in operation/maintenance cost.
- vii. Expert Support Team [EST] formed which monitors coal, water and other consumables and also guides the O&M personnel whenever required.

It is observed that both WBPDCCL and MSGPCL engaged Consultancy service of NTPC.

5.1.3 O&M Procedures**a. Boiler**

- i. Ensuring availability of critical coal mill spares, worm shaft, worm wheel, bearing & other spares
- ii. Pipes & bends of coal mill are being maintained in stock to ensure its availability

b. Turbine

- i. Replacement of old fasteners by correct sizes & material
- ii. Consistent follow up for required spares
- iii. Dummies/fixtures: - readiness during overhaul
- iv. Attending any Oil, water, steam, air, H₂ and Gas leakages.

c. Operation

- i. Daily monitoring of scanner intensity and frequency
- ii. Daily checking of ESP field voltage and current
- iii. Weekly operation and checking of Hydro motor valves
- iv. Daily moisture draining from actuators of Pneumatic valves
- v. Daily checking of HP/LP & PRDS system
- vi. Maintaining auto control loops availability

d. Outdoor Plant

- i. Critical spares of Booster Pump & Slurry Pump are procured from OEM only & maintained in stock
- ii. Regular preventive maintenance of Slurry & Booster pump, HP & LP pumps

e. Coal Handling Plant

- i. Reduction in Rake unloading time through automatic weighing system software.
- ii. Bunkers are designated for SECL/WCL/Imported coal
- iii. Separate stacking of indigenous and imported coal where blending is done.

f. General

- i. Introduction of area-wise technical audits
- ii. Formulation of possible solutions
- iii. Implementation and review

5.1.4 Condition Monitoring

Since most of the plants in the Utilities are relatively old and do not have adequate measuring equipments/instruments, regular and proper condition monitoring of the major equipments is not being done, leading to reactive maintenance practices rather than proactive maintenance practices.

In this regard, it has been observed that WBPDCCL generally carries out monitoring of vibrations, 3rd Harmonic current, Debris in Lube Oil, Motor Current signature, Thermography of Outdoor electrical equipments, Boiler Insulation and Ducting, Electrostatic Liquid Cleaner [ELC] for HP/LP Bypass] and RLA of old Equipments before Unit Overhauling etc. In MSPGCL, condition monitoring cell has been formed at plant level in which various parameters of vibrations and temperature are monitored with the help of vibration measuring equipments and thermography camera, respectively.

The preventive maintenance practice followed by different utilities are given below:

- a) WBPDCCL have evolved their preventive maintenance practice based on the performance degradation of the various equipments in the plant.
- b) In case of MSPGCL, all their plants are ISO certified and preventive maintenance schedules for various equipments given by BHEL and other OEMs, are being followed.
- c) In case of HPGCL, preventive maintenance activities are mainly carried out based on individual plant experience and assessment and is outsourced. Further, there is no standard equipment checklist. However, checklist is being developed. Further, their consultant have recommended Computerized Integrated Plant Management System (CIPMS) to streamline preventive maintenance procedure.

5.1.5 Area-wise Technological Improvements

The Utilities have taken certain measures and carried out some special activities to strengthen O&M practices and achieve better Unit efficiency. The area-wise steps taken in this direction by WBPDCCL & MSPGCL on the basis of recommendations of their consultant i.e. NTPC are listed below:

Table 5.1: Technological Interventions at different Utilities

S. No.	Area	O&M Interventions	
		WBPDCCL	MSPGCL
1	Boiler	Coal nozzle and Burner system modified	Zone wise erosion mapping, LFET test of water tubes for internal corrosion, quality monitoring of welding joints, Installation of chloride & sodium analyser etc. [BTL meetings are conducted regularly.

			Corporate level monitoring is done by EST group]
	Coal Mill	Mill capacity increased now low quality coal can be used	Monitoring of mill availability, fineness, load ability, percentage rejection. Preventive maintenance, package overhauls and Capital overhaul plans are followed. [Corporate level monitoring being done (monthly review). Plans are prepared and monitored at Corporate Office]
	ID & PA Fans	New ID and PA fans installed	Energy Efficient Motors are under process of installation
	ESP	Additional 12 nos. fields are introduced to achieve 90mg/Nm ³ emission level at ESP outlet with worst coal firing of 3300 k Cal/kg	Stack Emission and Ash evacuation activities are monitored
2	Turbine	Electro Hydraulic Governor installed	RLA studies carried out and necessary steps are taken to overhaul the same accordingly.
	BFP	Improved cartridge to reduce auxiliary power	To replace the existing BFP Cartridge with Energy Efficient Cartridge
	HP Heater	New HP heater installed as spiral tube could not be obtained	All heat exchangers are to be replaced in phased manner.
	LP Heater	Tube replacement is done suitable to new HBD	All heat exchangers are to be replaced in phased manner.
3	Generator	Complete replacement of Generator	No interventions carried out
4	CHP	Installation of Dust Suppression & Dust Extraction System to control pollution	No interventions carried out
4	Ash Handling System	Provision of parallel ashing of APH hopper and ESP hopper	No interventions carried out
5	C&I system	DDCMIS introduced	DCS & VFDs recommended and in process of installation at selected Power Stations
7	Safety	OHSAH 18001:2007 Certification done	Earth fault protection is recommended for all HT motors
8	Pollution Control	Dry Ashing System is renovated,	CAAQMS, SO _x & NO _x Measurement systems to be implemented for which DPR is approved. Further work in process

5.1.6 Skill Development

The Utilities have undertaken following measures for skill development:

i. HPGCL:

Training on simulator is being organised periodically.

ii. WBPDCCL:

- Regular training programs/seminars both in-house & outside (NPTI, BHEL etc.)
- Simulator training (at BkTPP)

iii. MSPGCL:

- Arrange Interactive seminar & Training for updates on new technology and knowledge amongst employees by In-house and external agencies.
- Using expert service for proper alignments, tolerances, clearance, interference and fitting as per OEM standards.
- On job training to maximum staff

5.2 Benefits accrued on account of the various strengthening interventions in O&M practices undertaken at Thermal Power Stations

The benefits accrued to WBPDCCL & MSPGCL are as below.

a. HPGCL

- Recommendations of consultant are being implemented in phased manner. As such no feedback has been received.

b. WBPDCCL

- Increase in Ex-Bus availability
- Reduction in Specific Oil Consumption

c. MSPGCL

- Improvement in Heat Rate
- Reduction in Auxiliary Power Consumption
- Reduction in Specific Oil Consumption

Benefits have accrued to WBPDCCL in the form of increase in Ex-Bus availability and decrease in Oil Consumption. MSPGCL have indicated improvement in performance.

5.3 Drawbacks and Shortcomings faced in O&M Practices**a. HPGCL**

Recommendations of consultants are still under implementations and necessary feedback is not available.

b. WBPDCCL

- Grade slippage of Coal
- Receipt of Foreign materials like stones, boulders in huge quantity in coal leading to severe damage to the plant machinery
- Non-cooperation from OEM (M/s Dong fang) leading to Problems in maintaining Optimum inventory for essential spares (Arbitration in process)
- High Ash optimum inventory
- Manual PTW system was in use
- LOTO system for HT system was not in use
- SOP and SMP of critical equipments were not available
- Dedicated team not deployed for overhauling

c. MSPGCL

- Improper utilization of resources
- Correct parameters are not maintained
- Startup & Shut down time not monitored
- O₂ level at air heater inlet not monitored for optimum Air flow to furnace
- Improper loading of Coal Mill

- Inaccurately maintaining MVAR
- Auxiliary Power Consumption not monitored
- Unburnt Coal in Fly Ash & Bottom Ash not monitored
- 100% availability of guns not ensured
- Manual PTW system was in use
- LOTO system for HT system was not in use
- SOP and SMP of critical equipments were not available
- Dedicated team not deployed for overhauling

Chapter-6

Suggestions

The strengthening interventions already adopted and being followed by three utilities i.e. HPGCL, MSPGCL and WBPDC, either fully or partially based on their own experience and recommendations of their respective consultants, have been discussed in chapter-4. However, from a review of practices being followed by these utilities, it has been observed that there have been some gaps which can be bridged by the addition of some more steps to further strengthen the O&M measures for achieving higher efficiencies and still better performance of the plants. In this regard, following recommendations are made for the respective utilities, keeping in view the areas which have not been fully covered and can be further strengthened.

1) HPGCL:

The additional measures required to be taken by this utility are given below:

- a) Online vibration and temperature measuring system for major load bearing equipment should be introduced which would help in timely detection of rise in vibration, temperature of equipment, for taking timely preventive actions.
- b) Relays based on analog system wherever installed in old units, should be replaced with Digital Control System.
- c) Monthly operation review (OR) meetings should be held at plant to discuss plant performance and other critical issues.

2) MSPGCL:

The additional measures required to be taken by this utility are given below:

- a) Computerized PTW system should be introduced. Lock out Tag out (LOTO) system should be followed in HT system for safety of personnel and equipment. It should also include recording of defects of equipment, breakdown history of equipment.
- b) Comprehensive ERP system with various essential modules should be introduced.
- c) Standard Operating Practice (SOP) and Standard Maintenance Practice (SMP) should be prepared in consultation with OEM and concerned O&M manuals for various critical equipment, checklist etc. may be developed and followed properly.
- d) System of scheduled equipment changeover must be followed regularly to avoid imbalance of equipment running which could affect in preventive maintenance schedules and even lead to unnecessary breakdown of concerned equipment.
- e) Software packages, for online performance of equipments and unit Heat Rate, should be installed for evaluation of that performance.
- f) A dedicated overhauling team should be formed for the overhaul, coordination and re-commissioning of the unit. This will also ensure the monitoring of the progress of work and its quality.
- g) Monthly Operation Review (OR) meetings should be held at plant to discuss plant performance and other critical issues.

3) WBPDCCL:

The additional measures required to be taken by this utility are given below:

- a) Computerized PTW system should be introduced under ERP system. Lock out Tag out (LOTO) system should be introduced in HT system for safety of personnel and equipment. It should also include recording of defects of equipment, breakdown history of equipment.
 - b) Standard Operating Practice (SOP) and Standard Maintenance Practice (SMP) for various critical equipments, checklist etc. may be developed and followed properly.
 - c) System of schedule of equipment changeover must be prepared and followed regularly to avoid imbalance of equipment running which could affect in preventive maintenance schedule and even lead to unnecessary breakdown of concerned equipments.
 - d) Software packages, for online performance of equipment and Heat Rate, should be installed for evaluation of performance of equipments.
 - e) A dedicated overhauling team should be formed for the overall coordination and re-commissioning of the unit. This will ensure the monitoring of the progress of work and its quality.
- 4) Apart from above recommendations some more recommendations, common for all three utilities, are made, as under:
- a) Auxiliary Power Consumption should be calculated unit-wise.
 - b) Key process diagrams and technical parameters hand-book be made available to the concerned operation personnel for better operation efficiency.
 - c) Key logic diagrams for interlocks, protections and connected C&I details should be made available in the main control room for ready reference.
 - d) Checking of interlocks and protection systems should be entrusted to single agency, for better coordination.
 - e) A pool of technical experts should be developed in the utility for different areas i.e. turbine, boiler, C&I etc. to provide in-house consultancy to technical problems at any location.

Appendix-I

Terms of Reference

1. Background

- 1.1 India currently has an installed generation 173,626 MW (as on 31.03.2011), of which 93918 MW (54 percent) is coal-fired contributing major share of total generation. While much of the 1970s (and older) vintage units have been or need to be retired, many of the coal-fired power plants (NTPC as well as state utility owned plants) that were commissioned in and before early 1980s are now due for rehabilitation and life extension.
- 1.2 CEA has prepared a National Perspective Plan for facilitating the R&M (Renovation & Modernization) and L.E. (Life Extension) works at various thermal power stations in the country. Through the Perspective Plan, efforts would be made to facilitate rehabilitation of the old thermal plants with an objective of efficiency enhancement, life extension, up-rating and reduction in Greenhouse Gases emissions by repair, replacement, modification and technology up gradation. Fifty three (53) units with a total capacity of 7318 MW of Life Extension (LE) works & seventy six (76) units with a total capacity of 18965 MW for R&M works have been identified for the 11th Plan. Similarly for the 12th Plan, LE works on seventy two (72) thermal units of total capacity 16532 MW and R&M works on twenty three (23) units of total capacity 4971 MW have been identified under the above National Perspective Plan.
- 1.3 The World Bank has financed the “Coal-Fired Generation Rehabilitation Project” for demonstrating energy efficient rehabilitation and modernization (EE R&M) of coal fired generation units through rehabilitation of 640 MW of capacity across three states- West Bengal, Haryana and Maharashtra. The project would also address critical barriers to large scale EE R&M in India. The project would be funded through IBRD loan of US\$ 180 million and GEF grants of US\$ 45.4 million. The project has two components:-

Component-1: Energy Efficiency R&M Pilots Using US \$ 180 million of IBRD loan and US \$ 37.9 million of GEF grants:

This component would fund Energy Efficient R&M of 640 MW capacity comprising Bandel TPS Unit-5(210 MW) of WBPDC, Koradi TPS Unit-6(210 MW) of Mahagenco and Panipat TPS Unit-3&4 (2x110 MW) of HPGCL. The World Bank has earmarked US\$ 180 million of IBRD loan and US \$ 37.9 million of GEF grants for the Component-1.

Component-2: Technical Assistance to address Critical Barriers to EE R&M:

The World Bank has earmarked US \$ 7.5 million GEF Grant for the Component-2. The sub-components for the technical assistance program would cover:

- i. Support for design of Energy Efficient R&M projects.

- ii. Support for implementation of demonstration of EE R&M investments funded under Component-1 of the project.
 - iii. Support for addressing barriers to EE R&M projects.
 - iv. Support for strengthening of institutional capacities of utilities.
- 1.4 Under the sub-component (iii) of the component-2 (Technical Assistance) around US\$ 1.1 million of GEF Grants are being made available to provide technical support to CEA aimed at addressing barriers to implementation of R&M in India. This component would be implemented through the Central Electricity Authority through appointments of Consultants including Implementation Support Consultant (ISC) to carry out following studies –
 - i) Review of Institutional Capacity and Implementation of Capacity Strengthening Interventions at CEA
 - ii) Reduction of barriers to R&M interventions in thermal power plants in India;
 - iii) Developing markets for implementation of R&M scheme in thermal power stations in India;
 - iv) Review of experience from Pilot R&M interventions in thermal power stations in India.
- 1.5 Ministry of Power, GOI vide letter No. 10/1/2009-IC dated 07.01.2009 have conveyed in-principle approval for the above proposed project under the title "National Programme for R&M". CEA has been identified as the Project Implementing Agency for sub-component (iii) of Component -2 for Technical Assistance. The sub-component (iii) would be implemented under the title **“Technical Assistance to CEA for Addressing the Barriers to Energy Efficiency R&M of Coal Fired Generating Units in India”**.
- 1.6 CEA has already appointed Implementation Support Consultant who is assisting CEA in appointing the Consultants for the above four studies and in co-ordination amongst CEA & various Consultants and monitoring of Consultant’s works & Pilot R&M projects funded by World Bank.
- 1.7 The World Bank is supporting pilot energy efficiency focused R&M interventions at Unit-5 of Bandel TPS, Unit-6 of Koradi TPS (Maharashtra State Power Generation Company Limited) and Units 3 & 4 of Panipat TPS. In addition, similar pilots are also being taken up under KfW funding at Nasik TPS (Maharashtra), Bokaro ‘B’ TPS (Damodar Valley Corporation) and Kolaghat TPS (West Bengal) under Energy Efficiency R&M Programme under Indo-German Energy Forum. The National Electricity Policy envisages that Renovation & Modernization (R&M) for achieving higher efficiency levels needs to be pursued vigorously and all existing generation capacity should be brought to minimum acceptable standard. Hence, the Pilot energy efficiency focused R&M projects have been facilitated to gain an experience from these Pilot R&M projects and to implement the same at other thermal power stations in India.

2. Assignment & Broad Scope of Work

The main objective of the assignment is to procure Consultant who inter-alia would review the experience of the activities which have been carried out in the Pilot R&M Projects during different stages of preparation and implementation of these projects and would prepare reports for dissemination of the experience across Utilities in India. The consultant will also review the implementation experience at other R&M projects taken up by the utilities during 11th Plan and 12th Plan.

The main task of the Consultant would be to facilitate CEA in sharing of experience on Pilot R&M projects and other R&M/LE projects taken up during 11th plan and 12th plan. For this, CEA would require support from the Consultants in the following manner but not limited to:

- a) Review of Procurement Experience including preparation of DPR, Bidding documents, etc.;
- b) Review of R&M Implementation Experience;
- c) Review of Experience in Strengthening of O&M Practices;
- d) Review of Post-R&M Experience in O&M;
- e) Dissemination of Learnings from Pilot R&M Interventions.

3. Detailed Description of Tasks

Work would be undertaken in the manner as given below:

3.1 Review of Procurement Experience for Pilot R&M Projects

- a) The Consultant shall analyse and review the procurement experience in awarding R&M works for Pilot R&M projects funded by the World Bank and KfW. The Consultant shall, especially, look into the DPR, Bidding documents, Qualification Requirements, Performance Guarantees and Project Schedule. The Consultant shall also review the Evaluation Criteria including Project Schedule and Performance Parameters and the impact of these on the overall level of competition and price bid discovery. For review of the procurement experience, the Consultant shall cover all the R&M related procurement activities completed till May 2014 at the identified thermal power stations as part of study.
- b) The Consultant shall carry out analysis of bidding process followed by the power generating companies in selection and procurement of consultants/suppliers to undertake the required R&M interventions. The Consultant shall also analyse and review the key steps undertaken to ensure competitiveness in the bidding process and suggest the possible options to improve the competitiveness in the bidding process.
- c) The Consultant shall examine the various other factors that may have affected the procurement outcome at the Pilot R&M Projects of World Bank and KfW; and also analyse the problems faced while finalizing the contract(s) for Pilot R&M Projects.

- d) The Consultant is required to visit the selected thermal power stations to collect and compile the relevant information and document to undertake the desired review and analysis.
- e) The Consultant shall prepare and submit a report on learnings from the procurement experience from the Pilot R&M Projects of the World Bank and KfW projects for dissemination purposes for future R&M projects.
- f) The review exercise will be limited to the thermal power stations as mentioned in the **attached list of projects as Annexure I.**

3.2 Review of R&M Implementation Experience

- a) The Consultant shall review the available R&M Implementation Experience at thermal units in various thermal power stations as **mentioned in Annexure-II.** . Broadly, the review would include inter-alia the time and cost aspects, technical surprises, contractual arrangements and the performance achieved. The Consultant shall cover R&M Implementation Experience available at the above mentioned thermal power stations till two months before the scheduled timeline for submission of Draft Final Report on this activity.
- b) The review of the R&M Implementation experience shall also include the analysis of project management process and identify the areas where the actual project implementation deviated from desired objectives and analyse the reasons for such deviations.
- c) The Consultant is required to visit the selected thermal power stations to collect and compile the relevant information & documents to undertake the desired review and analysis.
- d) Based on the review of R&M implementation experience, the Consultant shall prepare a report on R&M/LE Implementation Experience which may be helpful to the generating companies for carrying out the R&M works in future.

3.3 Review of Experience in Strengthening O&M Practices

- a) The Consultant shall review the interventions of Operations & Maintenance (O&M) strengthening practices undertaken by the concerned power generating companies – WBPDC, MSPGCL and HPGCL.
- b) The Consultant shall review the strengthening interventions undertaken by the utilities for enhancing O&M practices across the various facets including technology, O&M planning, conditional monitoring, preventive maintenance, O&M procedures, enhancement in technical & managerial skills of O&M personnel and infrastructure/facilities improvement etc.

- c) The Consultant shall indicate the benefits accrued on account of the various strengthening interventions in O&M practices undertaken at these thermal power stations.
- d) The Consultant shall list out the drawbacks/shortcomings faced in the O&M practices followed by power generating companies after implementation of the strengthening interventions and suggest possible measures for further improvements.
- e) The Consultant may be required to undertake visits of above mentioned power generating companies for the purpose of the review of the experience in strengthening O&M practices.
- f) Based on the review and discussion with the generation utilities, the Consultant shall prepare a report on strengthening of Operation & Maintenance (O&M) practices followed by these power generating companies for the purpose of sharing the learnings/experience.

3.4 Review of Post - R&M Experience in O&M

- a) The Consultant shall review and share the Post - R&M Experience in O&M after the plant has been in operation for a considerable time (say about six months) after completion of R&M works at the thermal power stations as **mentioned in Annexure III**. The review will include Post -R&M review of the operational performance of the generating units where R&M interventions have been undertaken **till eight months before the scheduled timeline for submission of Draft Final Report** and indicate the improvements in their operational performance.
- b) The Consultant shall list out the problems/challenges faced in O&M of thermal unit after implementation of the R&M interventions and suggest suitable measures for further improvements in the units.
- c) The Consultant may be required to make visits to listed thermal power stations for the purpose of review of the Post- R&M experience in O&M.
- d) Based on the review of O&M experience, the Consultant shall prepare a report on Post R&M experience in O&M at the listed thermal power stations for the purpose of sharing the experience for future R&M units.

3.5 Dissemination of Learning from Pilot R&M Interventions and other R&M Projects

- a) The Consultant in association with CEA will conduct One (01) workshop in Delhi for sharing of experience with different stakeholders on R&M activities carried out at Pilot R&M projects and other R&M Projects.
- b) The Consultant shall submit Fifty (50) copies and soft copies in CD's of all Final Reports to CEA for sharing experience with the future R&M projects.

4. Deliverables and Tentative Time Schedule for completion of task

4.1. The contents and break-up of the deliverables/reports will have to be agreed with CEA. The assignment is likely to commence in May 2012 and the tentative time schedule for completing the various activities is as under:

S.No	Deliverable	Timeline (Tentative)
1.	Inception Report	June 2012
2.	Draft Report on review of procurement experience (available till the timeline) at Pilot R&M Projects	December 2012
3.	Draft Report on review of Experience (available till the timeline) in Strengthening O&M practices	July 2013
4.	Draft Report on review of R&M Implementation experience (available till the timeline) at Pilot R&M Projects and other R&M projects	December 2013
5.	Draft Report on review of Post - R&M experience in O&M of the thermal power stations	April 2014
6.	Draft Final Report on review of procurement experience available at Pilot R&M Projects ¹	June 2014
7.	Draft Final Report on review of Experience in Strengthening O&M practices ²	June 2014
8.	Draft Final Report on review of R&M Implementation experience available at Pilot R&M Projects ³	July 2014
9.	Draft Final Report on review of Post - R&M experience in O&M of listed thermal power stations ⁴	July 2014
10.	Conduct Workshop for sharing of experience on Pilot R&M Projects with Stakeholders	September 2014
11.	Final Report on review of procurement experience available at Pilot R&M Projects	October 2014
12.	Final Report on review of Experience in Strengthening O&M practices	October 2014
13.	Final Report on review of R&M Implementation experience available at Pilot R&M Projects	October 2014
14.	Final Report on review of Post R&M experience in O&M of the listed thermal power stations	October 2014

Note:

- 1 The Draft Report shall include the experience in procurement available at the R&M projects till the indicated timeline. The rest of the experience in procurement at the R&M projects available during the period between submission of the Draft Report and Draft Final Report shall be included in the Draft Final report.
- 2 The Draft report shall include the experience in strengthening O&M practices available at the R&M projects till the indicated timeline. The rest of the experience in strengthening O&M practices at the R&M projects available during the period between submission of the Draft Report and Draft Final Report shall be included in the Draft Final Report.
3. The Draft report shall include the experience in implementation available at the R&M projects till the indicated timeline. The rest of the experience in implementation at these R&M projects available during the period between submission of the Draft Report and Draft Final Report shall be included in the Draft Final Report.
- 4 The Draft report shall include the Post- R&M experience in O&M till the indicated timeline. The rest of the experience in the Post- R&M experience in O&M available during the period between submission of the Draft Report and Draft Final Report shall be included in the Draft Final Report.

- 4.2. The Consultant will be required to submit monthly and quarterly progress reports to CEA.
- 4.3. The Consultant shall submit 10 copies of Inception Report, 10 copies of all Draft Report, 10 copies of all Draft Final Report and 50 copies of all Final Reports.
- 4.4. All deliverables/reports shall be prepared in hard form and also in electronic form (Word, Excel, Power Point, pdf files etc.). The reports shall be submitted on A4 Size paper with adequate size of alphabets/symbol & line spacing.

5. Support/Inputs to be provided by CEA

- 5.1. CEA will be the Employer of the Consultant and will nominate a Project Manager. Project Manager will act as liaison officer to the Consultant's team. He will be the point of contact and initial addressee for all aspects of the works.

- 5.2. The CEA will provide all existing information, data, reports and maps as available and will assist the Consultant in obtaining relevant information and materials from government institutions and state authorities to the extent possible.
- 5.3. CEA will not provide any space for office.
- 5.4. Personal Computers, Laptops, printers, photocopier, stationery items etc. will be arranged by the consultant.

6. Consultant Skill Sets and Team Composition

The Consultant team should have an appropriate mix of experience and expertise in India and abroad in respect of Renovation & Modernisation of thermal power plants and Power Sector Policy /Regulations. The Key Professional Staff in the Consultant team are expected to be from technical background and also having the knowledge of Indian Power Sector, especially with regard to Operation & Maintenance of thermal power stations and R&M/LE programme implementation. The team of the Consultant shall comprise a Team Leader, one R&M Expert, one O&M Expert, one Commercial Expert & one Environment Expert. The Key Professionals would be spending their time depending on requirement of the assignment during the entire duration of the assignment. The Consultant should have an in depth knowledge of the current R&M/LE guidelines/policies and regulatory frameworks for thermal power plants in India. The Consultant should also have expertise in assessing environmental impact/benefits of the R&M/LE projects. The Consultant may propose additional members in their team to provide required expert services in other areas / tasks identified by them. The required qualification & experience is given in the table below:

S. No.	Key Position	Minimum Qualification and Experience	
1.	Team Leader	B.E. / B. Tech	Team Leader shall have minimum fifteen years (15 years) professional experience in Power Sector including ten years' experience in O&M / R&M of coal fired thermal power stations having units of capacity of 110 MW and above.
2.	R&M Expert	B.E. / B. Tech.	R&M specialist should have minimum ten years (10 years) experience in Power sector including two years' experience in R&M of coal fired thermal power stations having units of capacity of 110 MW and above.
3.	O&M Expert	B.E. / B. Tech.	O&M specialist should have minimum ten years (10) years' experience in Power sector including five years' experience in O&M/ R&M of coal fired thermal power stations having units of capacity of 110 MW and above.

S. No.	Key Position	Minimum Qualification and Experience	
4.	Commercial Expert	MBA/B.E. / B. Tech.	Commercial expert should having minimum ten years (10 years) experience in contract management in Infrastructure sector including three years (3 years) experience on contract management in R&M/O&M of coal fired thermal power stations.
5.	Environment Expert	Graduation / Post Graduation Degree in Environment.	Environment Expert should have minimum ten years (10 years) experience in assessing the environmental aspects of infrastructure projects.

ANNEXURE-I

**List of Units to be considered for review of Procurement Experience
for Pilot R&M projects**

Sl No	Unit No	Capacity (MW)	Name of Thermal Power Station (TPS)	Name of Utility/State	Executing Agency	Completion of LE Works/Status
1	6	1X210	Koradi TPS	MSPGCL/Maharashtra	Yet to be awarded	DPRs are under finalisation
2	5	1 x 210	Bandel TPS	WBPDC/ West Bengal	Yet to be awarded	DPRs are under finalisation
3	1, 3 & 4	2x110, 1x110	Panipat	HPGCL/ Haryana	BHEL, Yet to be decided	DPRs are under finalisation
4	4 & 5	2x210	*Badarpur	NTPC	Yet to be awarded	DPRs are under finalisation
5	6,7&8	3x110	*Kothagudem	APGENCO, Andhra Pradesh	Yet to be awarded	DPRs are under finalisation
6	3	1x210	Nasik TPS	MSPGCL/Maharashtra	Yet to be awarded	DPRs are under finalisation
7	1 & 2	2x120	*Amarkantak	MPPGCL	Yet to be awarded	DPRs are under finalisation

* As per the meeting held at CEA on November 08, 2012 and Minutes of Meeting communicated by CEA vide their letter no. 2/52/TRM/CEA/2012/1888 dated 21.11.2012, Chandrapur TPS Units 1&2(1x210MW), Parli TPS Units 2&3 (1x 210 MW) and Kolaghat TPS Unit 3 (1x 210MW) have been replaced by Badarpur TPS Units 4&5 (2x210MW), Kothagudem TPS Units 6,7 and 8 (3x110MW) and Amarkantak TPS Units 1,2 (2x120 MW) respectively for Review of Procurement Experience for Pilot R&M projects (completed till May 2014).

ANNEXURE-II

List of Units to be considered for review of R&M Implementation Experience

Sl No	Unit No	Capacity (MW)	Name of Thermal Power Station (TPS)	Name of Utility/State	Executing Agency	Completion of LE Works/Status
1	1 & 2	2x120	Ukai TPS	GSECL/Gujarat	BHEL	Unit 1- Unit was synchronized on 24 May 2008 after LE works Unit 2 - Unit was synchronized on 24 February 2010 after LE works
2	9 & 10	1 X210	Obra	UPRUVNL/ Uttar Pradesh	BHEL	Unit 9- Synchronized in September 2010. Unit is under stabilization after R&M Unit 10 - Shut down is expected in October 2011. LE works to be completed in 2012-13
3	3 & 4	2 x 110	Bhatinda TPS	PSPCL/Punjab	Unit 3 - BHEL,	Unit 3- Unit is expected to be Synchronized by November 2011 Unit 4- LE works to be taken after stabilization of Unit-3
4	1	1x110	Muzaffurpur	KBUNL/Bihar	BHEL	Expected date of Completion November 2011 after LE works
5	5	1 x 210	Bandel TPS	WBPDCL/West Bengal	Yet to be awarded	DPRs are under finalisation
6	1	1X210	**Talcher TPS	Odisha	Yet to be awarded	DPRs are under finalisation
7	1, 3 & 4	2x110, 1x110	Panipat	HPGCL/ Haryana	Unit 1- BHEL, Unit 3&4- Yet to be awarded	Unit 1- Unit was synchronized on 4 November 2008 after LE works Unit 3 - DPRs for LE works is under finalisation Unit 4 - DPRs for LE works is under finalisation

** As per the meeting held at CEA on November 08, 2012 and Minutes of Meeting communicated by CEA vide their letter no. 2/52/TRM/CEA/2012/1888 dated 21.11.2012, Koradi TPS Unit 6 (1x 210 MW) has been replaced by Talcher TPS Unit 1 (1x 210 MW) for review of R&M Implementation Experience.

ANNEXURE-III

List of Units to be considered for Review of Post-R&M Experience in O&M

S I N o	Unit No	Capacity (MW)	Name of Thermal Power Station (TPS)	Name of Utility/State	Executing Agency	Completion of LE Works/Status
1	1& 2	2x120	Ukai TPS	GSECL/Gujarat	BHEL	Unit 1- Unit was synchronized on 24 May 2008 after LE works Unit 2 - Unit was synchronized on 24 February 2010 after LE works
2	1 & 2	2x120	Amarkantak Exten TPS	MPPGCL/Madhya Pradesh	BHEL	Unit 1- Expected date of Completion by October 2011 Unit 2 - Unit was synchronized on 26 October 2010
3	9 & 10	1 X210	Obra	UPRUVNL/ Uttar Pradesh	BHEL	Unit 9- Synchronized in September 2010. Unit is under stabilization after R&M Unit 10 - Shut down is expected in October 2011. LE works to be completed in 2012-13
4	3 & 4	2 x 110	Bhatinda TPS	PSPCL/Punjab	Unit 3 -BHEL,	Unit 3- Unit is expected to be Synchronized by November 2011 Unit 4- LE works to be taken after stabilization of Unit-3
5	1	1x110	Muzaffarpur	KBUNL/Bihar	BHEL	Expected date of Completion is November 2011 after LE works
6	7	1x110	Barauni TPS	BESB/Bihar	BHEL	Completion of LE works is expected in 2012-13
7	5	1 x 210	Bandel TPS	WBPDC/ West Bengal	Yet to be awarded	DPRs are under finalization
8	6	1X210	Koradi TPS	MSPGCL/Maharas htra	Yet to be awarded	DPRs are under finalization

APPENDIX-II



Government of India
Central Electricity Authority
Thermal Renovation & Modernisation Division
Sewa Bhawan, 9th Floor, North Wing
R. K. Puram, New Delhi -11 00 66

Fax: 011-2618 6904

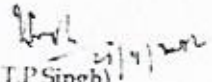


No. 2/52/TRM/CEA/2012/ 1808

Dated: 21.11.2012

Subject: Minutes of the meeting held at CEA on November 08, 2012 to discuss the progress of various consultancy assignments awarded under the Project "Technical Assistance to CEA for Addressing the Barriers to Energy Efficient R&M of Coal Fired Generating Units in India" funded by World Bank. reg.

Enclosed please find herewith the Minutes of the Meeting held at CEA on November 08, 2012 to discuss the progress of various consultancy assignments awarded under the Project "Technical Assistance to CEA for Addressing the Barriers to Energy Efficient R&M of Coal Fired Generating Units in India" funded by World Bank.


(T.P. Singh)

Chief Engineer (TRM) Div.

To

S/Shri

- C. Subramaniam, Senior Power Engineer, South Asia Sustainable Development-Energy, The World Bank, Hindustan Times House, 18-20, Kasturba Gandhi Marg, New Delhi-110001, Fax NO. 49247639
- Mr. Suresh Gehani, Director, ABPS Infrastructure Advisory Pvt. Ltd., 309, A-Wing, Kohinnor City, Kiroi Road, OFF LBS Marg, Kurla (West), Mumbai - 400 070. (Fax-022 - 61240499)

-
- Mr. Vivek Srivastava, Technical Director, KPMG Advisory Services Pvt. Ltd., Building No 10, 8th Floor, Tower-B, DLF Cyber City, Phase-II, Gurgaon - 122002(India). (Fax: 0124-2549101)
 - Mr. Anish De, Chief Executive Officer, AF - MERCADOS EMI, 1202, Millennium Plaza, Tower B, Sector - 27, Gurgaon(Haryana) - 122 002. (Fax : 0124-424-1751)
 - Ms. M. Vanisree, Dy. Chief Engineer (Elect-I), WAPCOS Limited, 76-C, Sector - 18,Gurgaon (India), Pincode -122 015. (Fax: 0124-2349449)

Copy for information to :

1. SA to Chairman, CEA
2. SA to Member (Thermal), CEA
3. SA to Member (E&C),CEA

Minutes of the Review meeting held at CEA on November 08, 2012 to discuss the progress of various consultancy assignments awarded under the Project "Technical Assistance to CEA for Addressing the Barriers to Energy Efficient R&M of Coal Fired Generating Units in India" funded by World Bank.

A meeting was held on November 08, 2012 at CEA to discuss the progress of various consultancy assignments awarded under the Project "Technical Assistance to CEA for addressing the barriers to Energy Efficient R&M of Coal Fired Generating Units in India" funded by World Bank.

At the outset, Chief Engineer (TRM), CEA, Shri T.P Singh welcomed the representatives of World Bank and representatives from Consultancy Organisations.

Present:

The following representatives attended the meeting:

CEA:

- Sh. T.P Singh Chief Engineer (TRM) Div.
- Sh. Bhai Lal, Director, (E and R&M) Div.
- Sh. J. N. Prasad, Dy. Director, TRM Div.
- Sh. Anis Ahmad, Dy. Director, TRM Div.

World Bank:

- Sh. B. John Hamso, Senior Energy Economist
- Sh. C. Subramaniam, Senior Power Engineer
- Smt. Mani Khurana, Energy Economist

ISC (ABPS Infra):

- Sh. Suresh Gehani, Director
- Sh. Himanshu Agarwal, Deputy Manager

Mercados Energy Markets (India) Pvt. Ltd

- Sh. Anish De, Chief Executive Officer
- Sh. Vikas Gaba, Senior Manager
- Sh. Saurabh Gupta, Senior Consultant
- Sh. Rajarishi Goswami, Consultant

KPMG Advisory Services Pvt. Ltd. :

- Sh. Ashutosh Kumar, Manager
- Sh. Gaurav Goyal, Consultant

WAPCOS

- Smt. M. Vanisree, Addl. Chief Engineer, Power
- Sh. N.S Chauhan, Consultant

The summary of the discussions held during the meeting are as follows:

1. **Progress Review of Study on "Review of Institutional Capacity and Implementation of Capacity Strengthening Interventions at CEA"**
 - a. The representatives of M/s KPMG Advisory Services Pvt. Ltd. briefed about the status of Study on "Review of Institutional Capacity and Implementation of Capacity Strengthening Interventions at CEA" and submitted that Focussed Group Discussions with the Wing Nodal Officers and Special Assistants to the Members of 29 divisions of CEA have been undertaken as required for submission of report on Assessment of Institutional Capacity of CEA. Further, the Draft Questionnaire for undertaking the customer expectation surveys has been prepared and circulated to the Wing Nodal Officers and Special Assistants to the Members for comments. In this regard, World Bank representatives suggested KPMG to circulate Questionnaire to World Bank once it is finalised after incorporating the comments on the questionnaire.
 - b. M/s KPMG also discussed the list of stakeholders for undertaking customer expectation survey. With regard to the list of stakeholders, World Bank suggested to include SJVNL (Satluj Jal Vidyut Nigam Limited), Torrent Power and CESC (Calcutta Electric Supply Corporation) as a backup, in case consent for survey from any of the listed stakeholders is not obtained.
 - c. World Bank representatives further suggested that the CEA shall provide the letter addressed to Ministry of Power, Planning Commission, Ministry of Coal, Ministry of Environment & Forest etc. either of Member/Chairman of CEA to M/s KPMG Advisory Services Pvt. Ltd. to obtain the good response from customers.

2. Progress Review of Study on "Reduction of barriers to R&M interventions in thermal power plants in India"

- a. The representatives of M/s Mercados Energy Markets (India) Pvt. Ltd. briefed about the status of Study on "Reduction of barriers to R&M interventions in thermal power plants in India" and submitted that the following Draft guidelines have already been submitted to CEA:
- Draft Guidelines for Risk Identification and Mitigation in R&M Projects
 - Draft Guidelines for Early Identification of Potential Technical Surprises in R&M Projects and ways of addressing them.
- b. M/s Mercados submitted that the next deliverable of "Draft Report on study for identifying the potential reduction in Green House Gas (GHG) emissions on account of R&M and suggesting possible framework for monetizing the GHG reduction" will be submitted during the week starting November 19, 2012.
- c. M/s Mercados further requested CEA to extend the date of submission of "Draft Report on study of International best practices in R&M projects" as they are planning to visit some of the R&M projects implemented in other countries to obtain the first-hand international experience of Pilot R&M projects. M/s Mercados suggested to submit the Draft report on the same by first week of January. World Bank and CEA both agreed for the request and suggested M/s Mercados to submit report by first week of January.
- d. World Bank suggested that the Draft Guidelines prepared by M/s Mercados should be sent to major Suppliers/Consultants/Utilities/Funding Agencies, which are playing vital role in R&M of thermal power stations for their comments, before these are discussed in the Task Force Meeting.

3. Progress Review of "Study for Developing Markets for Implementation of R&M scheme in thermal power stations in India"

- a. The representatives of M/s Mercados Energy Markets (India) Pvt. Ltd. briefed about the status of "Study for Developing Markets for Implementation of R&M scheme in thermal power stations in India" and submitted that the Draft Excel based model for estimating the R&M Potential Assessment of coal based thermal power stations in India is almost prepared. M/s Mercados further informed that their team would like to have a discussion with CEA on the Model during the week starting November 19,

2012. Accordingly, based on discussions the Draft Report for the "Study with the aim of developing markets to meet the impending demand of R&M in India" will be submitted to CEA.

- b. M/s Mercados further informed that they are planning to have Workshops/Road Shows on the draft report during the month of January 2013. Thereafter, the final Report for "Study with the aim of developing markets to meet the impending demand of R&M in India" will be submitted to CEA.

4. Progress Review of Study on "Review of Experience from Pilot R&M Interventions in Thermal Power Stations in India"

- a. M/s WAPCOS Ltd. briefed that the revised Inception Report has been submitted to CEA and it will be finalised after incorporating CEA's comments on the same. Further M/s WAPCOS informed that site visit to Panipat Thermal Power Plant has been conducted.
- b. During the meeting, the list of Plants selected for reviewing the various experience of R&M was discussed and it was decided to make the following replacements in the list of Power Plants selected for review of the "Procurement Experience for Pilot R&M Projects (completed till May 2014)" and "R&M Implementation Experience" considering the fact that desired experience may not be available at the power plant during the course of the study.

Table: List of the Power Plants to be replaced

S.No.	Existing Power Plants in the List	Replaced New Power Plants in the list
Procurement Experience for Pilot R&M Projects (completed till May 2014)		
1.	Chandrapur TPS, Units 1&2 (1x210 MW), Maharashtra	Badarpur TPS, Units 4 & 5 (2 x 210 MW), NTPC
2.	Parli TPS, Units 2&3 (1x210 MW) Maharashtra	Kothagudem TPS, Units 6, 7 & 8 (3 x 110 MW), APGENCO
3.	Kolaghat TPS, Unit 3 (1x210 MW), West Bengal	Amarkantak TPS, Units 1,2 (2 x 120 MW), MPPGCL
R&M Implementation Experience		
1.	Koradi TPS, Unit 6 (1x210 MW) Maharashtra	Talcher TPS, Units I (1x210 MW)

5. Task Force Meeting

It was discussed to schedule the next meeting of Task Force for Promoting Renovation & Modernisation(R&M) of Thermal Power Stations in India to December 17, 2012. Further it was discussed that during the next Task Force meeting, major Utilities/Suppliers/Consultants those are active in the field of R&M of thermal power stations, should also be invited to discuss the Guidelines prepared under the study Reduction of Barriers, i.e., "Draft Report and Guidelines for Risk Identification and Mitigation in R&M Projects" and "Draft Guidelines for Early Identification of Potential Technical Surprises in R&M Projects and ways of addressing them".

6. Hosting on Draft Guidelines on CEA Website

It was discussed that CEA may host "Draft Guidelines for Risk Identification and Mitigation in R&M Projects" and "Draft Guidelines for Early Identification of Potential Technical Surprises in R&M Projects and ways of addressing them" on its website for obtaining the comments of various stakeholders.

The meeting ended with a vote of thanks to the Chair.

Annexure – III (a)

Questionnaire

Format for Data/Information required for the Study Report on Strengthening of O&M Practices. [HPGCL]

A. O&M Practices followed by HPGCL

1 Where strengthening of O&M Practices undertaken?

Name of the Plant & Capacity.

Name of Consultant appointed, for O&M Practices:

Important points recommended by consultants for Assessment & strengthening O&M practices.

Start of Implementation of the activities:

Completion of implementation activities:

Whether special O&M Team formed at Plant/Utility for implementation:

Please give Organizational structure and strength of

O&M Team in the Plant

Information on funding of activities

2. Improvement in O&M Planning/Management

i. Details of the consultants hired (including cost)

ii. Strengthening & area wise Interventions carried as suggested by the consultants.

S. No.	Area	O&M Interventions	Remarks
i.	Boiler		
	Coal Mills		
	Soot Blower		
	Air Preheater		
	ID Fans, FD Fans & PA Fans		
	ESP		
ii.	Turbine		
	BFP		
	Codenser		
	HP Heaters		
	LP Heaters		
iii.	Generator		
iv.	Ash Handling System		
v.	C&I System		
vi.	Information & Technology System		
vii.	Safety		
viii.	Pollution Control		

- iii. Organisational structure formed for this purpose [like setting up a separate Cell for O&M etc.]
- iv. Whether Integrated Management System [IMS] introduced, if so, give status of its implementation
- v. Introduction of System Administrative Programme [SAP] and status of its implementation.
- vi. Daily Review/planning meetings
- vii. Skill development of O&M Personnel

2. O&M Procedures

Please provide information on the followings:

Condition Monitoring of equipments

Reliability-Centric Maintenance

Preventive Maintenance

Proactive/Predictive Maintenance

3.1 List of all new departments/cells set up for this purpose

- i. Objectives of the new departments/cells
- ii. Benefits accrued there of

3.2 Regular Operation Review Meetings.

Schedule and Format of daily/weekly/Monthly Review & Planning Meetings

Please give following information:

- a. Were these meetings started across all stations of your Utility?
- b. What was the objective of these meetings and how successful was Utility in achieving the same.

3.3 Were strengthening interventions undertaken by HPGCL for enhancing O&M Practices across the various facets taken independently or did they partner with someone like NTPC or they hired experts.

4.0 O&M Practices.

4.1 Operational Practices.

- i. Quality of Coal used before & after implementation of O&M strengthening Practices any change in practice to accommodate the variation in the coal quality.
- ii. Steps to ensure quality of Raw and D.M water.

4.2 Maintenance Practices.

- i. Details of Condition Monitoring of equipments being done.
- ii. Whether reliability centred maintenance [a concept used to reduce annual overhaul time of Units] being carried out.

- iii. Whether Proactive Maintenance being done.
 - iv. Has HPGCL adopted some better maintenance systems & Procedures, based on actual experience and exposure, other than recommended in O&M Manuals and Guidelines of the respective OEMs.
 - v. Details of Inventory Management being done.
 - vi. Source of Budget of O&M expences.
- 5. Developments in O&M infrastructure.**
- 6. Benefits accrued on account of the various strengthening interventions in O&M**
- 7. Please give the following Plant Parameters for a period of 2 years before undertaking O&M strengthening and for 2 years after completing O&M strengthening.**
- i. Plant Load Factor
 - ii. O&M Expenses per Unit [Rs. / kWhrs]
 - iii. Annual Overhaul Time [Unit-wise]
 - iv. Details of Forced Outage [Unit-wise] and reasons
 - v. Unit/Plant Availability
 - vi. Station Heat Rate
 - vii. Secondary Fuel Oil Consumption [Unit-wise]
 - viii. Auxiliary Consumption [Unit-wise]
 - ix. Bus Availability
- 8. Drawbacks/shortcomings faced in the O&M practices after implementation of the strengthening interventions**
- 9. Possible measures for further improvements.**

Annexure – III (b)

Questionnaire

Format for Data/Information required for the Study Report on Strengthening of O&M Practices. [MSPGCL]

A. O&M Practices followed by MSPGCL

1 Where strengthening of O&M Practices undertaken?

Name of the Plant & Capacity.

Name of Consultant appointed, for O&M Practices:

Important points recommended by consultants for Assessment & strengthening O&M practices.

Start of Implementation of the activities:

Completion of implementation activities:

Whether special O&M Team formed at Plant/Utility for implementation:

Please give Organizational structure and strength of

O&M Team in the Plant

Information on funding of activities

2. Improvement in O&M Planning/Management

i. Details of the consultants hired (including cost)

ii. Strengthening & area wise Interventions carried as suggested by the consultants.

Sr No	Area	O&M Interventions	Remarks
i.	Boiler		
	Coal Mills		
	Soot Blower		
	Air Preheater		
	ID Fans, FD Fans & PA Fans		
	ESP		
ii	Turbine		
	BFP		
	Codenser		
	HP Heaters		
	LP Heaters		
iii.	Generator		
iv.	Ash Handling System		
v.	C&I System		
vi.	Information & Technology System		
vii.	Safety		
viii.	Pollution Control		

- iii. Organizational structure formed for this purpose [like setting up a separate Cell for O&M etc.]
- iv. Whether Integrated Management System [IMS] introduced, if so, give status of its implementation
- v. Introduction of System Administrative Programme [SAP] and status of its implementation.
- vi. Daily Review/planning meetings
- vii. Skill development of O&M Personnel

2. O&M Procedures

Please provide information on the followings:

Condition Monitoring of equipments

Reliability-Centric Maintenance

Preventive Maintenance

Proactive/Predictive Maintenance

3.1 List of all new departments/cells set up for this purpose

- i. Objectives of the new departments/cells
- ii. Benefits accrued there of

3.2 Regular Operation Review Meetings.

Schedule and Format of daily/weekly/Monthly Review & Planning Meetings

Please give following information:

- a. Were these meetings started across all stations of your Utility?
- b. What was the objective of these meetings and how successful was Utility in achieving the same.

3.3 Were strengthening interventions undertaken by HPGCL for enhancing O&M Practices across the various facets taken independently or did they partner with someone like NTPC or they hired experts.

4.0 O&M Practices.

4.1 Operational Practices.

- i. Quality of Coal used before & after implementation of O&M strengthening Practices Any change in practice to accommodate the variation in the coal quality .
- ii. Steps to ensure quality of Raw and D.M water.

4.2 Maintenance Practices.

- i. Details of Condition Monitoring of equipments being done.
- ii. Whether reliability centred maintenance [a concept used to reduce annual overhaul time of Units] being carried out.

- iii. Whether Proactive Maintenance being done.
 - iv. Has HPGCL adopted some better maintenance systems & Procedures, based on actual experience and exposure, other than recommended in O&M Manuals and Guidelines of the respective OEMs.
 - v. Details of Inventory Management being done.
 - vi. Source of Budget of O&M expenses.
- 5. Developments in O&M infrastructure.**
- 6. Benefits accrued on account of the various strengthening interventions in O&M**
- 7. Please give the following Plant Parameters for a period of 2 years before undertaking O&M strengthening and for 2 years after completing O&M strengthening.**
- i. Plant Load Factor
 - ii. O&M Expenses per Unit [Rs. / kWhrs]
 - iii. Annual Overhaul Time [Unit-wise]
 - iv. Details of Forced Outage [Unit-wise] and reasons
 - v. Unit/Plant Availability
 - vi. Station Heat Rate
 - vii. Secondary Fuel Oil Consumption [Unit-wise]
 - viii. Auxiliary Consumption [Unit-wise]
 - ix. Bus Availability
- 8. Drawbacks/shortcomings faced in the O&M practices after implementation of the strengthening interventions**
- 9. Possible measures for further improvements.**
- 10. Strengthening interventions undertaken for enhancing O&M practices across various facets i.e. Technology, O&M Planning preventive maintenance etc.**
- Boiler maintenance Procedures
 - Planned maintenance/capital overhauling of mills
 - Turbine maintenance procedures
- b) Testing (Instrumentation & Control)
- Frequency of monitoring of scanner intensity
 - Frequency of checking ESP field voltage & current
- c) Improvement of Infrastructure/facilities
- Improvement in fuel oil unloading system

Annexure – III (c)

Questionnaire

Format for Data/Information required for the Study Report on Strengthening of O&M Practices. [WBPDC]

A. O&M Practices followed by WBPDC

1 Where strengthening of O&M Practices undertaken?

Name of the Plant & Capacity.

Name of Consultant appointed, for O&M Practices:

Important points recommended by consultants for Assessment & strengthening O&M practices.

Start of Implementation of the activities:

Completion of implementation activities:

Whether special O&M Team formed at Plant/Utility for implementation:

Please give Organizational structure and strength of O&M Team in the Plant

Information on funding of activities

2. Improvement in O&M Planning/Management

i. Details of the consultants hired (including cost)

ii. Strengthening & area wise Interventions carried as suggested by the consultants.

Sr No	Area	O&M Interventions	Remarks
i.	Boiler		
	Coal Mills		
	Soot Blower		
	Air Preheater		
	ID Fans, FD Fans & PA Fans		
	ESP		
ii	Turbine		
	BFP		
	Condenser		
	HP Heaters		
	LP Heaters		
iii.	Generator		
iv.	Ash Handling System		
v.	C&I System		
vi.	Information & Technology System		
vii.	Safety		
viii.	Pollution Control		

iii. Organizational structure formed for this purpose [like setting up a separate Cell for O&M etc.]

- iv. Whether Integrated Management System [IMS] introduced, if so, give status of its implementation
- v. Introduction of System Administrative Programme [SAP] and status of its implementation.
- vi. Daily Review/planning meetings
- vii. Skill development of O&M Personnel

2. O&M Procedures

Please provide information on the followings:
Condition Monitoring of equipments
Reliability-Centric Maintenance
Preventive Maintenance
Proactive/Predictive Maintenance

3.1 List of all new departments/cells set up for this purpose

- i. Objectives of the new departments/cells
- ii. Benefits accrued there of

3.2 Regular Operation Review Meetings.

Schedule and Format of daily/weekly/Monthly Review & Planning Meetings
Please give following information:

- a. Were these meetings started across all stations of your Utility?
- b. What was the objective of these meetings and how successful was Utility in achieving the same.

3.3 Were strengthening interventions undertaken by HPGCL for enhancing O&M Practices across the various facets taken independently or did they partner with someone like NTPC or they hired experts.

4.0 O&M Practices.

4.1 Operational Practices.

- i. Quality of Coal used before & after implementation of O&M strengthening Practices any change in practice to accommodate the variation in the coal quality.
- ii. Steps to ensure quality of Raw and D.M water.

4.2 Maintenance Practices.

- i. Details of Condition Monitoring of equipments being done.

- ii. Whether reliability centered maintenance [a concept used to reduce annual overhaul time of Units] being carried out.
 - iii. Whether Proactive Maintenance being done.
 - iv. Has HPGCL adopted some better maintenance systems & Procedures, based on actual experience and exposure, other than recommended in O&M Manuals and Guidelines of the respective OEM.
 - v. Details of Inventory Management being done.
 - vi. Source of Budget of O&M expenses.
- 5. Developments in O&M infrastructure.**
- 6. Benefits accrued on account of the various strengthening interventions in O&M**
- 7. Please give the following Plant Parameters for a period of 2 years before undertaking O&M strengthening and for 2 years after completing O&M strengthening.**
- i. Plant Load Factor
 - ii. O&M Expenses per Unit [Rs./kWhrs]
 - iii. Annual Overhaul Time [Unit-wise]
 - iv. Details of Forced Outage [Unit-wise] and reasons
 - v. Unit/Plant Availability
 - vi. Station Heat Rate
 - vii. Secondary Fuel Oil Consumption [Unit-wise]
 - viii. Auxiliary Consumption [Unit-wise]
 - ix. Bus Availability
- 8. Drawbacks/shortcomings faced in the O&M practices after implementation of the strengthening interventions**
- 9. Possible measures for further improvements.**