1.0 INTRODUCTION

A study was conducted by CPRI for MERC in the years 2008-09 and 2009-10 to assess the level of achievable technical performance parameters for all stations of MSPGCL except the newly installed 250 MW units. CPRI has recommended schemes into three broad categories (based on the time required to implement and the cost involved) to meet the targeted performance parameters:

- Immediate : below 12 months
- Medium term: 2-3 years
- Long Term : over 3 years

The objective of the study is to assess the implementations of various measures for improvements in achievable performance parameters at Maharashtra State Power Generating Company Ltd (MSPGCL) thermal power stations.

This report pertains to the study of Chandrapur TPS (Units 1-7).

1.1 Design unit heat rates (UHR) & station heat rates (SHR)

Table 1 (see Annex 2) gives the design UHRs and SHRs of the station for the units under study. Table 2 (see Annex 2) gives the capacity and age of units.

1.2 Performance against targets

Tables 3 give the petitioned, approved and achieved key performance indices (KPI) including SHR for FY 2009-2010, FY 2010-2011 and FY 2011-2012 (till date) for the station under study.

2. STUDY & FIELD VISITS

The study of the MSPGCL is taken up for Chandrapur TPS during January 1st-2nd week 2012.

3. STUDY & FINDINGS

3.1 Assessment of the overall action plans for implementation of measures and benefits projected and accrued

The measures are classified as:

i. Immediate measures without financial implication (See Annex 3)

ii. Immediate measures with financial implication (See Annex 4)
iii. Medium term measures (See Annex 5)
iv. Long term measures (See Annex 6)

The schemes have been classified into 14 areas for better project management as given in Table 4 (Annex 2).

The summary of the implementation for CTPS is given as follows:

CPRI Recommendations	**Total Nos.**	**Implemented**	**Implementation in progress**	**Differed**	**To be Implemented**
Immediate term - having no financial implications (NFI)	**96**	80	5	7	4
Immediate term - Having financial implication (FI)	**147**	39	42	11	55
Medium term measures	**45**	13	18	3	11
Long term measures	**14**	3	4	3	4
Not indicated	**0**	0	0	0	0
Total	**302**	**135**	**69**	**24**	**74**

The percentage implementation for the total number of measures is 45 %.

The Benefits accrued by the station areas follows:

- **Installations of VFD on conveyer belts:**

  VFD on conveyer belts installations are in progress. Up till now five conveyer belts are mounted with variable speed drives with controlled acceleration. The saving in auxiliary consumption is obtained from 24% to 39% at various load conditions. Simultaneously, the advantage considerably reduction of mechanical failures is also observed, leading to fewer conveyers down time. The conveyer belt life is obtained more than that of the conventional conveyers.

- **Installation of grab crane at wagon tipplers:**

  Grab crane is mounted on the screen of wagon tippler, which covers entire screen grid to remove stone and lumpy coal, which eliminate the breaking of lumps and stone on grill, which is hazardous and eliminate the breaking of coal on grill by electrical or pneumatic hammer.

- **Steam path Audit of Unit – 7:**

  The heat rate deterioration to the tune of 164.24 kcal/kWh is observed during opening of the turbine, out of which, 39.54 % is recovered during overhaul by sand blasting of the rotor and diaphragm and adjusting the inter-stage seal clearances. The power loss to the tune of 12503.7 kW is observed out of which, 46.16% is recovered by conventional O&M practices during overhaul.

- **Replacement of Platen water walls for unit-4, RH platen for unit 5 and 6:**

  No leakage in the replaced zone is observed till date. A Heat exchanger implementation plan has been followed by the task force established for analysis of Boiler Tube Leakages (BTL's).

- **GT secondary energy meter (from GCR) reading:**

  Transformer losses are now included in Aux. Power consumption and transformer losses can be monitored for performance. Net Power sent out is available through GCR metering.
  .

- **Ready reckoner books of 100-150 pages are already brought out by the TPS for 500 MW units and all parameters are readily available. Similar ready rekoner books may be brought out for Units 1-4 (210 MW) in sufficient copies and distributed to operation and maintenance implemented:**

  Useful to access the information at a glance. Very useful for optimization of the parameters and knowing the design parameters.

- **During overhaul all the gas flow guide vanes, direction vanes, diversion baffles are to be inspected:**

  Smooth operation during the tenure between the overhaul is obtained. Ease on optimizing O_2 is observed during varying coal quality condition.

- **Policy to go in for digital instrumentation preferably Intelligent electronic devices (IEDs) as preferred mode:**

  All sensors and transmitters after recommendation are procured are smart type. These instruments are giving high reliability and adoptability for wireless data transmission. All sensors and instruments procurement under input source measurements are of SMART type.

- **MS, HRH, HRH drain valves: replace damaged valve stem by stellited seats, valve plug with Inconel 750, plug by Nitronic 60 for Unit 1 to 7:**

Passing of valves are reduced considerably. The valve in total is replaced for 25 Nb and 50 mm Nb size, because of high reliability of new satellite seat valves, the life obtained is more and simultaneously the energy saving is obtained due to non-passing of valves. We have adopted the procedure of checking valve body temperature by infrared pyrometer immediately after rolling and synchronizing of the unit and tracking for next three days for confirmation of passing.

- **Increase of the length of the APH baskets by 10 %, Up-gradation of APH heat exchanger matrix & regenerative dynamic sealing for Unit 5 and 6:**

  Surface area is increase by 10 % in unit 5 and 6. Primary Air Temperature increased from 280 to 300 ^{o}C and Secondary Air heater temperature increase from 260 to 290 ^{o}C.

- **Condenser vacuum problem needs to be attended for unit 5 & 6:**

  Vacuum improved by acid cleaning and subsequently hydro-jetting, but temporarily because of cooling temp mismatch of cooling tower outlet and condenser inlet. The DPR for scheme of cooling tower internal up-gradation and addition of cooling tower cell to mitigate the parameter mismatch is at approval level.

- **Constant and continuous liaison with coal mines for better quality of coal:**

  The quality of lumpy coal and stones are reduced. The coal mix with poor quality coal is reduced.

- **Operating the CHP near to its full capacity:**

  Daily planning meeting is taken rigorously to find out the solution for poor performing auxiliaries. MPD section is formed for tracking the defect during planning meeting. It became helpful for increasing the auxiliaries utilization factor and thus taking the maintenance of standby equipment is possible.

- **While procuring replacement spares, material up gradation and new technology options must be kept in mind:**

  Cost effective solution with reliability in operation is achieved. Material up gradation in done in heat exchanger from T11 to T22. Existing 400 W HPMV high bay lamps are replacement in phase manner by 200 W Induction Lamps. The on line scale removing technology will be tried for critical coolers.

- **For special components which are posing difficulty in obtaining spares, competent agencies for reverse engineering:**

Dependency on OEM is avoided, hence immediate and cost effective solution is possible. ID fan shaft restoration by developed vendor is in service with expected performance, save time and cost of replacement.

- **Development and implementation of major maintenance works standards must be made mandatory for all:**

  Quality checks are carried out during Overhauls and shutdown of unit or critical auxiliaries. Quality plans are the part of technical requirement. Reliability on operation of auxiliaries are observed after carrying out quality checks by established FQAD during overhaul.

- **Overhauling of H_2 Booster pump and DM/GS pump 2 to avoid overloading for U-1 to 4:**

  Energy saving in H_2 booster pump is obtained through maintaining the clearance with in specified limit and replacement of neck rings. The current of remaining pumps are within limit.

- **Existing quality circle movement has majority participation from artisans while the role of engineers is to remain as facilitator/coordinator. Formation of Engineers quality circles is required:**

  Nine analysis committees are formed for obtaining the solution to minimize the failure frequency.

3.2 Assessment of the action plans for implementation of immediate measures (without financial implication) and benefits accrued

The summary of implementation of the immediate measures (without financial implications) are as follows:

CPRI Recommendations	Total Nos.	Implemented	Implementation in progress	Differed	To be Implemented
Immediate term - having no financial implications (NFI)	**96**	80	5	7	4

The percentage implementation for immediate measures (w/o FI) is 84 %.

Operational changes: Operation in sliding pressure operation in normal operation and use of ATRS during starts has been implemented.

Operational optimization: Operational optimization is being done through monitoring the parameters through GCR. A strong program must be launched for operational optimization (OO) for measure-control through operations-control through maintenance-measure based on the PDCA cycle with close intervals of monitoring and control to 4-6 hours. There should also be close monitoring of DM water make up which reflects on the steam lost through the system.

Leak reduction: Leak reduction is a critical area for the station in improving the performance. Importance must be given to quick response to leaks in steam, water, coal, ash, etc.. A strong leak reduction plan must be in place.

Cleanliness: A cleanliness improvement must be put into place to maintain the cleanliness level from coal dust, ash, etc.

3.3 Assessment of the action plans for implementation of immediate measures (with financial implication) and benefits accrued

The summary of implementation of the immediate measures (with financial implications) are as follows:

CPRI Recommendations	Total Nos.	Implemented	Implementation in progress	Differed	To be Implemented
Immediate term - Having financial implication (FI)	**147**	39	42	11	55

The percentage implementation for immediate measures (with FI) is 27 %.

Hardware changes: many hardware changes like changing of heat exchangers, boiler coils, installation of VFDs, etc., have been successfully implemented.

IEDs: A decision is taken to procure only digital smart and intelligent transmitters and sensors in preference over analog systems. The same is being implemented.

Energy efficient option vs. maintenance comfort: Whenever there is some maintenance inconvenience on account of installation of energy efficiency measures or reduction of additional redundancy, the same may be viewed critically and a balanced view of the benefits vis-à-vis the inconvenience may be taken before a decision is taken on deferment of a measure.

3.4 Assessment of the action plans for implementation of medium term measures and benefits accrued

The summary of implementation of the medium term measures are as follows:

CPRI Recommendations	Total Nos.	Implemented	Implementation in progress	Differed	To be Implemented
Medium term measures	**45**	13	18	3	11

The percentage implementation for medium term measures is 29 %.

Traditional replacements: Replacements must not be based on traditional replacements but energy efficiency options must be used because over a period of 20-25 years many new energy efficient hardware options have been evolved. Replacement of old and obsolete technology may not give the full benefits.

Coal weighment: The in motion weigh bridges are yet to be installed. Since they are low value items, the same may be given priority. The belt weighers are yet to be installed. Since they are low value items, the same may be given priority. The gravimetric feeders of rotary type or belt type are yet to be installed. Since they are high value items, some delay can be expected. However, the same needs to be expedited.

Steam path audits: Steam path audits are carried out during COH to quantify the losses and restore the steam path to normalcy for getting the benefit of improved UHR.

3.5 Assessment of the action plans for implementation of long term measures and benefits accrued

The summary of implementation of the long term measures are as follows:

CPRI Recommendations	Total Nos.	Implemented	Implementation in progress	Differed	To be Implemented
Long term measures	**14**	3	4	3	4

The percentage implementation for long term measures is 21.43 %.

3.6 Reasons for delay, root cause of delay in implementation.

Reasons for delay are as follows:

- Many recommendations involved new technology adoption such as:
    a. Hard coating of the wear components.
    b. Combustion optimization system.
    c. ESP up-gradation.
    d. Water canon furnace cleaning system.
    e. Cooling Tower up-gradation.
    f. Smart Soot Blowing / Water canon system.

    The solution is available through different processes. The activities like market survey, solution providers, expected life of the components after implementation of solution, guaranteed parameters and the cost associated with it, previous experience for such solutions, and reliability of solutions.
- Recommendations having high capital investments such as:
    a. LPT retrofit.
    b. DCS of the units.
    c. On line condition monitoring.

    The compatibility and interfacing capability, long delivery time, very less solution providers, exchanging data for preparation of proposals, feasibility study take more time to obtain the basic data for preparation of DPR and tenders and orders.
- Procedures for proposal for capital Investments:
    a. Fixing the agency of preparing the financial model for Pay back periods
    b. Inability of financial model to absorb the real time advantage other than performance parameters.
    c. Wrong IDC calculation.
    d. Inadequate training of financial model.
    e. No up-gradation / correction done by RC in financial model due to change in normative parameters / financial parameters.
    f. Delay due to approval of QR. (Not standardizing the QR parameters).
- Clubbing of recommendation in R&M of the unit:
    a. The unit No. 1 and 2 of CSTPS are covered under R&M projects, therefore recommendation of these units are clubbed in R&M scope, which are not of NFI nature.

b. Delay in approvals of DPR of Unit 1&2, which can be effectively utilize before the work of R&M.

- Carrying out recommendations during annual / Capital overhauls of the units:

  Many recommendations required the long delivery time and implementations duration of capital / annual overhauls such as:

  a. ESP Improvement
  b. DCS
  c. Air Heater restorations
  d. Boiler Heat exchangers replacement etc.

  Thus if one opportunity, escape due to delay in approval of DPR / QR, it will shift to next Capital Overhaul / Annual Overhaul for ex. – ESP improvement in Unit – 7 to be implemented during capital overhaul.

- Recommendations involving strategic decision and high payback periods:

  The recommendations like coal dome and condition monitoring are restricted due to high investment cost and low pay back period, which will be useful for performance leveling the poor performing part of the year and increasing reliability of the plant respectively.

- Recommendations to be adopted after successful trial at one place / power stations:

  Some of the recommendations like combustion optimization or Water canon furnace cleaning system systems are decided to be tried at one unit / power station, being the risk of success in Indian environment and bituminous coal fired boiler respectively.

- Recommendations required detail engineering:

  Some of the schemes such as:

  a. Common data acquisition system consist of hard wired, optical fiber connected, Ethernet connected, Free band radio frequency, GSM connected require detail engineering to capture all required data seamlessly, which consumes time as interest of the solution providers are less in involving such complex system for preparation of budgetary offers.
  b. Reducing the pressure drop across ESP and APH
  c. Add on system for bunker level coal feed monitoring.
  d. ESP Improvement.
  e. LPT retrofit.

3.7 Avoidable delays in implementation.

Monsoon preparedness: Better monsoon preparedness could have resulted in some time saving.

Streamlining of purchase cum authorization processes: Streamlining at the station level by cutting across the hierarchy/proper channel route for movement of papers and approvals (within the MSPGCL framework of rules), could have resulted in reduced process time.

Apprehensions of pass through: These have got to be clarified at an early date.

Measures with intangible or tacit benefits: These have suffered the most because of inability to convince the internal controllers. Life cycle approach could be a possible solution.

Uneven inter-station DPR initiating process: Co-ordination of common schemes required at different power stations got delayed because of different times taken by different stations. Some stations have taken almost 6 months more than others. While stations like Chandrapur have shown a proactive stand to implementation stations like Kordi and Parli have been slow which has delayed the program. This has affected Chandrapur TPS.

High processing time: Inspite of considerable improvement in procurement processing, the processing time is still much on the higher side for which station level process of procurement and authorization need to be re-looked. Higher procurement processing time and limited number of items identified under capex has led to avoidable delays.

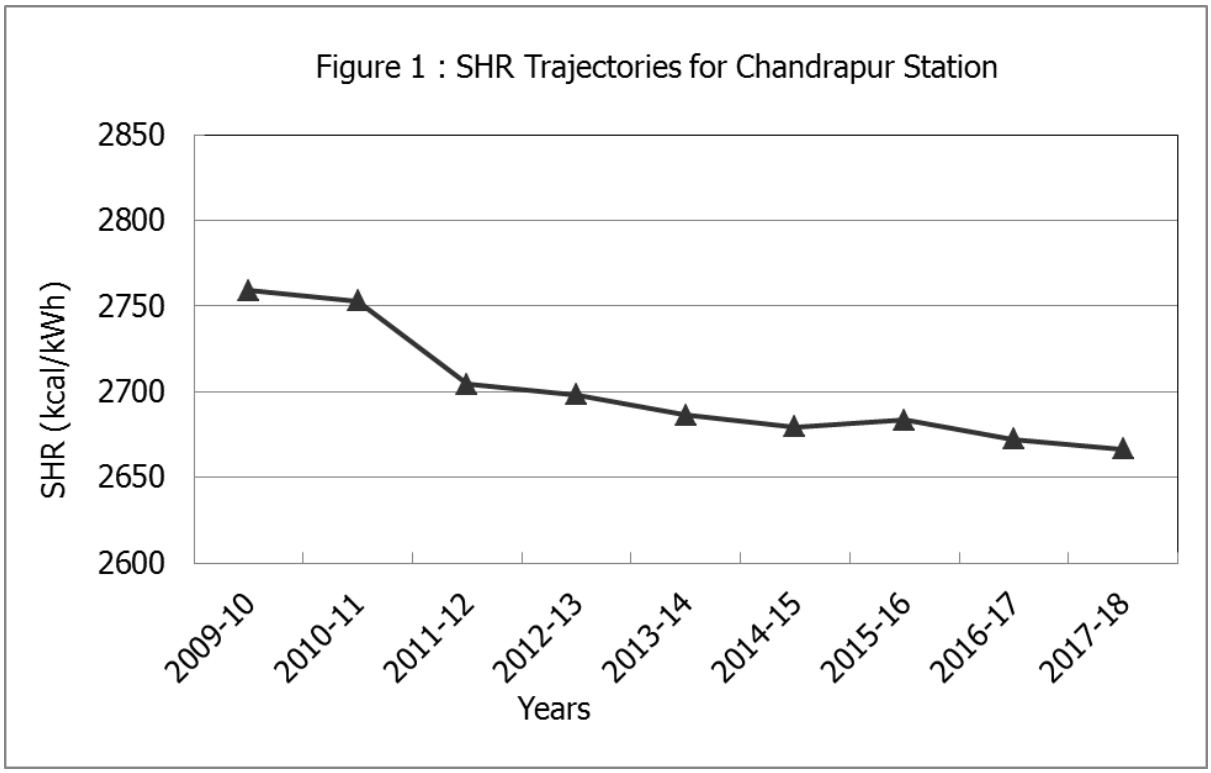
Full time central monitoring and time frames: Though central monitoring was being done to some extent, strong HO monitoring is required for control of the implementation processes with time frameworks. The time frames have not been set or time targets have not been given for implementation of the simple, medium term and long term measures. As a result the progress is differential in different stations.

Higher involvement of top management or mentoring by seniors to juniors: Mentoring would have reduced some delay.

4. REVISION OF PERFORMANCE TRAJECTORIES

4.1 Test SHRs and degradation rates measured and revised performance trajectories

Station	Overall Station
Degradation rate as per CPRI test TG HR	
	%/year
Chandrapur	0.33

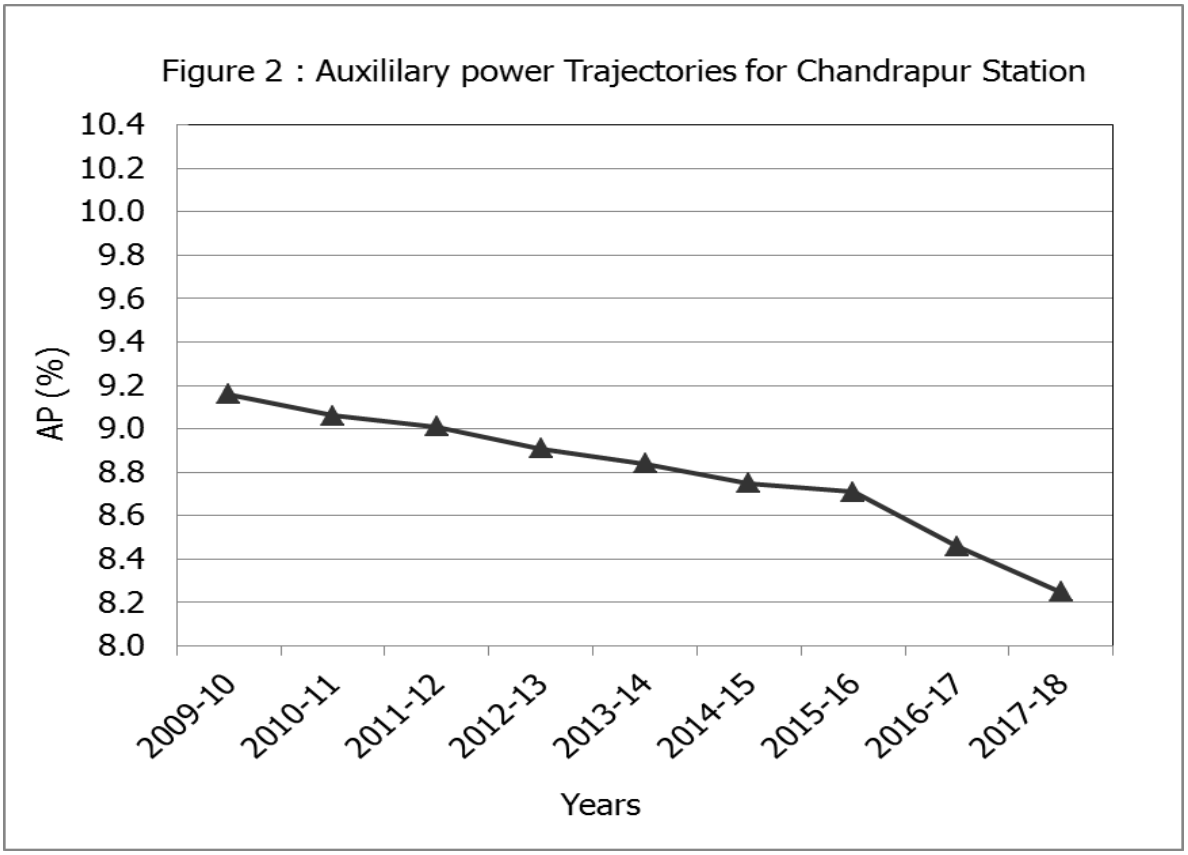


CHANDRAPUR								
Year	Previous year heat rate, kcal/kWh	Degradation @ 0.33 % / year	Immediate measures	Medium term measures	Long term measures	EER&M benefit on SHR, kcal/kWh	Annual overall SHR, kcal/kWh	Comments
2009-10	2759						2759	[1]
2010-11	2759	9.1	-15.0				2753	[2]
2011-12	2753	9.1	-50.0	-8.0			2704	[3]
2012-13	2704	9.1	-15.0				2698	[4]
2013-14	2698	9.1	-15.0	-6.0			2686	[5]
2014-15	2686	9.1		-12.0	-4.0		2680	[6]
2015-16	2680	9.1			-5.0		2684	[7]
2016-17	2684	9.1			-5.0	-15.3	2672	[8]
2017-18	2672	9.1				-15.0	2666	[9]

Comments	Comments
[1]	Date of test on 02 - 04 - 2009
[2]	
[3]	
[4]	
[5]	
[6]	Additional cell of cooling towers - unit 5& 6
[7]	LPT retrofit of unit 3
[8]	Unit -1 R&M, LPT retrofit of Unit - 4
[9]	Unit- 2 R&M

		R & M		**CHANDRAPUR**	
		2016-2017			
Unit No.	UHR	Unit Size	Months		
1	2513	210	12	6332760	
2	2684	210	12	6763680	
3	2684	210	12	6763680	
4	2684	210	12	6763680	
5	2684	500	12	16104000	
6	2684	500	12	16104000	
7	2684	500	12	16104000	
		2340		2668.65	-15.35
		2017-2018			
1	2672	210	12	6734414.6	
2	2513	210	12	6332760	
3	2672	210	12	6734414.6	
4	2672	210	12	6734414.6	
5	2672	500	12	16034320	
6	2672	500	12	16034320	
7	2672	500	12	16034320	
		2340		2658.08	-14.30

4.2 Test auxiliary power measured and revised performance trajectories



Year	Previous year AP, %	Immediate measures	Medium term measures	Long term measures	EER&M benefit on AP, %	Annual overall AP, %	Comments
2009-10	9.16					9.16	[1]
2010-11	9.16	-0.1				9.06	[2]
2011-12	9.06	-0.05				9.01	[3]
2012-13	9.01		-0.1			8.91	[4]
2013-14	8.91		0.02	-0.09		8.84	[5]
2014-15	8.84			-0.09		8.75	[6]
2015-16	8.75			-0.04		8.71	[7]
2016-17	8.71			-0.04	-0.21	8.46	[8]
2017-18	8.46				-0.21	8.25	[9]

Comments	Comments
[1]	
[2]	Water shortage Problem considered already (Due to low PLF)
[3]	10.17 % is up to Dec 2011. Likely to reduce up to 9.8 % for 2011-12
[4]	CT Fan Blade replacement from GRP to FRP of 210 MW units
[5]	VFD for CHP belt weighers
[6]	Additional cell of cooling towers for unit 5 and 6, BFP cartridge Replacement at 210 MW Units
[7]	LPT retrofit of unit 3.
[8]	Unit -1 R&M, LPT retrofit of Unit - 4
[9]	Unit- 2 R&M

5. CONCLUDING REMARKS

i. Chandrapur TPS has taken great interest in implementation of the measures and has implemented and demonstrated a number of measures such as VFDs, energy efficient lighting, restoration of steam paths, grab cranes, ready rekoner books, energy efficient overhauls, etc.

ii. For many schemes implementation is done in one unit in a station as a pilot the benefits are divided by the overall station performance and hence show smaller savings.

iii. Measures of a non-financial nature such as operational optimization, leak reduction, minimizing DM water make up, cleanliness in the power house, etc., need to be taken more seriously and with vigour to achieve and sustain the heat rates. Otherwise the trajectories will not be achieved.

iv. The installation of in-motion weigh bridges needs to be expedited.

v. The detailed progress and the trajectories are given in the text.

vi. The reasons for delay are due to initial time lost in gearing up for the program and uncertainties regarding the program. Now, the processes of implementation of schemes have been streamlined and progress is expected to be achieved. Strong monitoring would help in reduction of implementing time.

vii. The performance is not as per the original trajectories because the implementation program has been taken up on a pilot basis for one unit or unit station in many cases and afterwards proposed to be taken up in other units. Also, many medium and long term measures have been clubbed with R & M schemes which are going to be taken up in next few years. Hence the trajectories will be linked with R & M schemes.