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 Nasik TPS (Unit 3-5).

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

Table 3 gives 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 in Nasik during January 3rd-4th 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 TPS is given as follows:

NFI			FI	
Implementation Status	**Nos**		**Implementation Status**	**Nos**
Implemented.	53		Implemented.	32
Deferred	12		Deferred	28
Implementation in Progress.	5		Implementation in Progress.	19
To be implemented	14		To be implemented	52
Already in practice	12		Already in practice	6
TOTAL	**96**		**TOTAL**	**137**
IMMEDIATE SCHEMES				
NFI			**FI**	
Implementation Status	**Nos**		**Implementation Status**	**Nos**
Implemented.	53		Implemented.	24
Deferred	11		Deferred	20
Implementation in Progress.	5		Implementation in Progress.	10
To be implemented	13		To be implemented	31
Already in practice	12		Already in practice	4
TOTAL	**94**		**TOTAL**	**89**
MEDIUM TERM SCHEMES				
NFI			**FI**	
Implementation Status	**Nos**		**Implementation Status**	**Nos**
Implemented.	0		Implemented.	7
Deferred	0		Deferred	3
Implementation in Progress.	0		Implementation in Progress.	8
To be implemented	1		To be implemented	18
Already in practice	0		Already in practice	2
TOTAL	**1**		**TOTAL**	**38**
LONG TERM SCHEMES				
NFI			**FI**	
Implementation Status	**Nos**		**Implementation Status**	**Nos**
Implemented.	0		Implemented.	1
Deferred	1		Deferred	5
Implementation in Progress.	0		Implementation in Progress.	1
To be implemented	0		To be implemented	3
Already in practice	0		Already in practice	0
TOTAL	**1**		**TOTAL**	**10**

The percentage implementation for non-financial measure is 55 % and for financial measure is 24%.

The benefits accrued by the station are as follows:

- **Installation of belt weighers for all coal conveyors together with instrumentation for integration and measurement of unit wise bunkered coal**
  Bunkered Coal Feed Measurement/ Weighment are achieved.
- **Arresting leakages in Mills.**
  Coal mill environment is improved.
- **Ultrasonic level indicators for all fuel oil tanks**
  Accurate Measurement of FO consumption for station achieved
- **Ready rekoner books of 100-150 pages books may be brought out for Units 1-5 in sufficient copies and distributed to operation and maintenance staff.**
  Hard Copies are available & circulated to sections. Soft copy data is available in LAN.
- **In the heat exchanger replacement process, the station must explore possibilities of material upgradation, material profile improvement, design changes to improve velocity profiles and improved erosion control devices in preference over old design and old material.**
  Life is enhance Plugging of the tubes reduced.
- **"Zero coal leak tolerance" policy**
  Coal mill bay Environment improved .Fire chances due to coal leakages reduced to NIL.
- **Check the end termination temperatures for all joints**
  No abnormal occurrences / failure since Feb 2010.
- **During overhaul all the gas flow guide vanes, direction vanes, diversion baffles are to be inspected. Materials of diversion baffles must use alloy steel with overlay of hard materials like silicon carbide or tungsten carbide.**
  ID fan loading improved
- **Zero coal leak policy may be incorporated to prevent loss of pulverized coal**
  Coal mill bay Environment improved .Fire chances due to coal leakages reduced to NIL.
- **Repair and check of hangers and supports**
  Unit-3,4,5 load hangers healthiness improved.
- **Polyglass coating of the condenser water boxes.**
  Erosion /Corrosion of the Water Box stopped. Life of the equipment improved.-
- **Replacement of tube nest of LP heater 3, and Main ejector 3 B**
  Condensate water Temp. After LPH-3 Improved by 25 Degree Centi.
- **Video conference facilities of MSPGCL to be put to effective usage for HO-station and Station to station meetings/discussions.**
  Saving in time & Money for the organization.
- **Simulator training must be repeated once in 6 months with new learning of fault simulation topics/situations. Under the scheme of training sub center the simulator courses are to be conducted at**

Power Stations,, the process of approval of budget for TSC is under progress.

It has helped participants to refresh the knowledge of systems in TPS

- **Overhauling of H2 Booster pump and DM/GS pump 2 to avoid overloading**

  Stage-2, DM/DM pump no.2 loading reduced from 80 to 60 A. H2 Booster Pump loading reduced from 156 A to 130 A.
- **Arresting air leakages and flue gas leakages in ducts**

  Implemented. Loading of Fans reduced.
- **Condenser acid tube cleaning followed by bullet shot cleaning followed by Condenser tube surface painting by brushable ceramic coating**

  Vacuum improved from 625 to 660 mmHG.
- **Avoiding overloading of H2 booster pump 1, DM water pump & PCR AC compressor**

  EM: Motor Overloading is avoided by throttling DV. Higher capacity 110 kW instead of 90 kW) motor procurement proposal is under process. TM: Overhauling of the Auxiliaries carried out loading reduced . Pumps running normal
- **Main ejector nozzle and diffuser replacement.**

  Performance of the ejectors improved. Steam consumption reduced as pressure required from 7.5 kg/cm2 to 6 kg/cm2 for maint. vacuum
- **Improving the BFP efficiency by overhauling of pump & motors**

  EM : Due to Overhauling, healthiness of motor is ensured.. TM : Performance & Availability improved
- **Improving the CEP efficiency by overhauling of pump & motors**

  EM : Due to Overhauling, healthiness of motor is ensured. TM : Performance & Availability improved
- **Reducing the air ingress in flue gas duct between APH to ID outlet**

  ID loading reduced.
- **Reducing flue gas pressure across APH**

  Diff. pressure reduced due to choke up removal of baskets.
- **Optimizing the ID fan discharge pressure**

  Unit-3 &4 ID fan efficiency improved.
- **Improving IDF efficiency by overhauling of fan & motors**

  BM : Reliability is increased EM : Due to Overhauling, healthiness of motor is ensured.
- **Replacement of ECO coils.**

  Only one BTL in Unit-3 & No BTL in Unit 4 Economizer zone from installation.

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) is as follows:

NFI	
Implementation Status	**Nos**
Implemented.	53
Deferred	11
Implementation in Progress.	5
To be implemented	13
Already in practice	12
TOTAL	**94**

The percentage implementation is 55 %.

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) is as follows:

FI	
Implementation Status	**Nos**
Implemented.	24
Deferred	20
Implementation in Progress.	10
To be implemented	31
Already in practice	4
TOTAL	**89**

The percentage implementation 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 is as follows:

MEDIUM TERM SCHEMES			
NFI			**FI**
Implementation Status	**NOS**		**Implementation Status**
Implemented.	0		Implemented.
Deferred	0		Deferred
Implementation in Progress.	0		Implementation in Progress.
To be implemented	1		To be implemented
Already in practice	0		Already in practice
TOTAL	**1**		**TOTAL**

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 installed. 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 have not been carried out during COH. The same may be rigorously followed 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 is as follows:

LONG TERM SCHEMES				
NFI			**FI**	
Implementation Status	**Nos**		**Implementation Status**	**Nos**
Implemented.	0		Implemented.	1
Deferred	1		Deferred	5
Implementation in Progress.	0		Implementation in Progress.	1
To be implemented	0		To be implemented	3
Already in practice	0		Already in practice	0
TOTAL	**1**		**TOTAL**	**10**

The percentage implementation is 10 %.

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

Reasons for delay:

- Many recommendations involved adoption of new technology requiring detail study.
  - Hard Coating of wear components.
  - DCS of unit.
  - Smart Soot Blowing.
  - ESP up gradation.
  - Online Condition Monitoring.
- Detailed study for recommendations involving high capital investment.
  - LPT retrofit.
  - DCS of unit.
- No response / Delay from OEM/Suppliers in spite of follow-ups.
  - Energy efficient cartridges, although order is placed on BHEL delay in receipt of material.
- Clubbing of recommendations/schemes in R&M of Units.
  - Since the R & M for unit 3 is in pipeline, many of the schemes are clubbed in R & M for convenience in implementation.
- Conditions of implementation of Scheme only on success at other TPS.
  - Combustion Optimization.
- Implementation of certain schemes only during COH/AOH.
  - Air Heater Work.
  - DCS of units.
  - ESP Improvement.

- Boiler Heat Exchanger replacement.
- Procedural delays due to strategic decisions involving high payback period.
  - Schemes like VFD.

3.7 Avoidable delays in implementation.

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

Manpower management at the station level: Placing persons with aptitude and skill for implementation program or higher rigor of training of the section level engineers in the implementation process in understanding the mechanism of successful implementation of a scheme.

What if ? –apprehension: The fear of things going wrong and individuals not taking responsibility was present for some period. Now, MSPGCL has formed groups/ expert teams, etc. for different schemes rather than laying onus for implementation on individuals. Many more such groups/ expert teams cutting across the stations of MSPGCL need to be formed to collectively involve in implementation of the schemes in areas of boiler, turbine, C & I, etc., through technology assessment and technology evaluation.

Management model: The management model for implementation involved the traditional procedures which take time. Procedural delays could be minimized by operating in the ***fast track*** or ***mission mode*** for implementation, demonstrating and achieving the objectives of the schemes.

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.

Vendor development program: A strong vendor development program involving a search for prospective vendors, study of the technological options available in the market, preparation of generalized specifications without giving undue advantage to any one vendor, detailed study of costs including POs issued to the vendor from other organizations, etc., needs to be in place for successful procurement and implementation. Haphazard vendor development has resulted in time delay in the actual procurement process in the form of non-responsiveness, non-conformance, re-tendering, etc.. This results in process delay.

Apprehensions of pass through: These have got be to 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.

AOH & COH: These must be done as per schedule at the frequency of annually and once in five years respectively or as per any drawn out schedule. Skipping of overhauls results in degradation.

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 Nasik have shown a proactive stand to implementation stations like Kordi and Parli have been slow thereby increasing the total time.

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.

Ambiguity created by E-R & M: The decisions to go in for E-R & M has created an ambiguity whether to continue with the medium term and long term measures in the present or to club it with E-R & M. In cases where E-R & M is envisaged, it is clubbed with E-R & M.

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.

Co-ordination in implementations between two sections: In the case of technologies which involves implementation between two or more sections and their integration or inter-section co-ordination was not done by any one section, as a result of which the implementation was one sided.

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

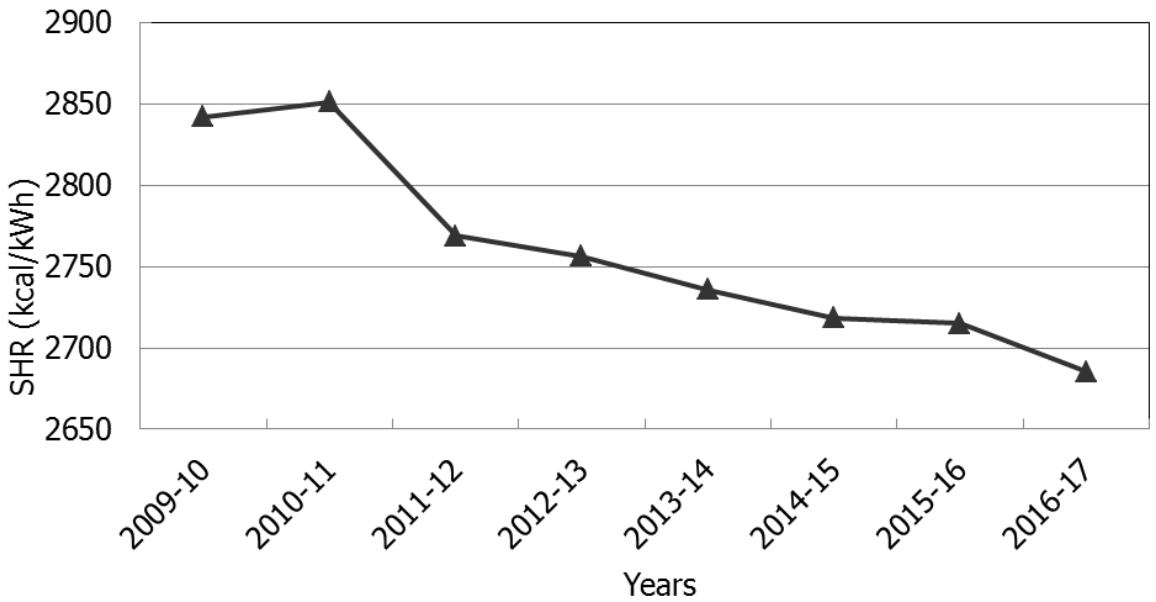
4. REVISION OF PERFORMANCE TRAJECTORIES

4.1 Test SHRs and degradation rates measured and revised performance trajectories

Annual overall station heat rate			
Unit No.	**Capacity**	**Annual UHR**	**UHR x C**
	MW	**kcal/kWh**	
1	125	3188.1	398511
2	125	2928.9	366114
3	210	2786.2	585105
4	210	2767.1	581085
5	210	2676.2	562005
Station	SHR	kcal/kWh	**2832.7**
Stage 2		`	2743.2

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

Figure 1 : SHR Trajectories for Nashik Station

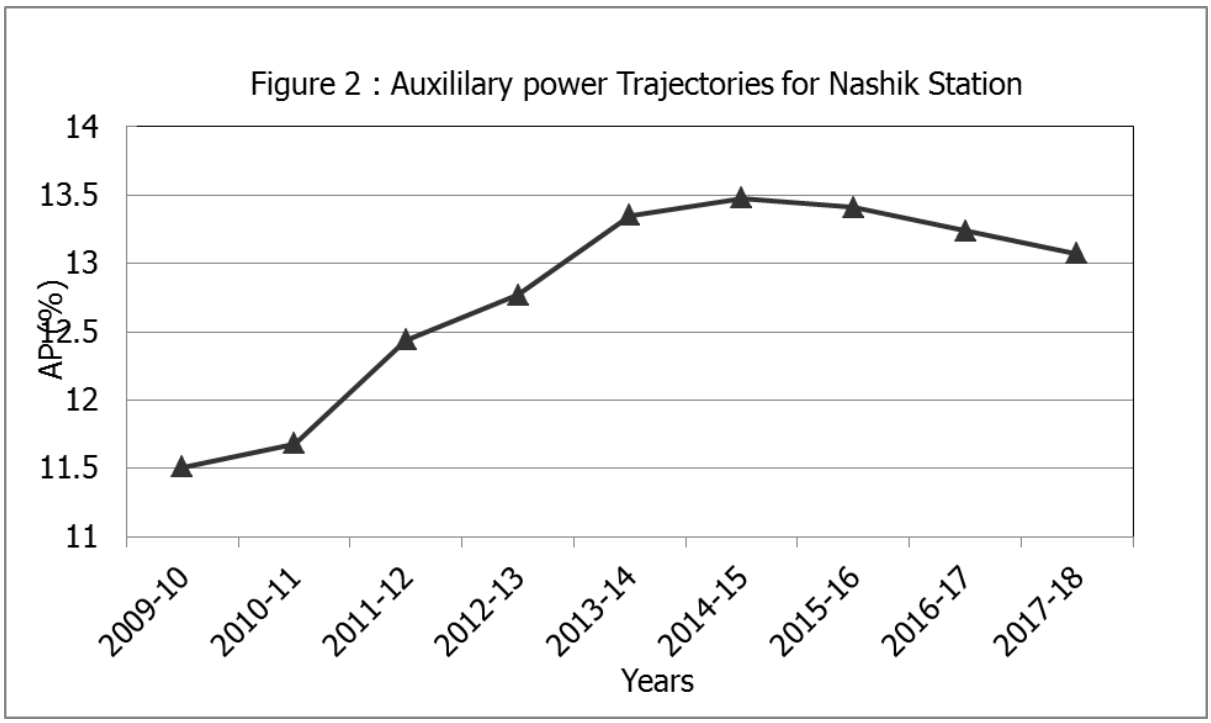


Year	Previous year heat rate, kcal/kWh	Degradation @ 0.33 % / year	Immediate measures	Medium term measures	Long term measures	EER&M benefit on SHR, kcal/kWh	Annual overall SHR, kcal/kWh	Comments
2009-10	2832.7	9.3					2842	[1]
2010-11	2842.0	9.3					2851	[2]
2011-12	2761.8	9.3	-2				2769	[3]
2012-13	2769.1	9.3	-22				2756	[4]
2013-14	2756.5	9.3	-30				2736	[5]
2014-15	2735.8	9.3				-26.6	2719	[6]
2015-16	2718.6	9.3				-12.7	2715	[7]
2016-17	2715.3	9.3				-39.3	2685	[8]
2017-18	2685.3	9.3				-39.3	2655	[9]

Comments	Comments
[1]	Date of test on 29 - 05 - 2009
[2]	Stage 1 units in service
[3]	Stage 1 (2 X 125MW) units decommissioned
[4]	Stage 2 2 years degradation considered;U-5 COH:- AH Basket replacement, Insulation, Steam path audit, LPH4 tube nest replacement, Condenser descaling. High energy drain all units..
[5]	U-4 COH:- Insulation, Steam path audit, Condenser descaling. High energy drain all units..
[6]	Unit-3 RM - Dec2013 - June-2014
[7]	Unit-4 RM - Sep2015 - Feb-2016
[8]	Unit-5 RM - Jul2016 - Dec-2016
[9]	

NASIK	R & M	PROJECTIONS	
Unit No.	2014-2015		
3	2618	7	
4	2736	12	
5	2736	12	
		2709.23	-26.61
Unit No.	2015-2016		
3	2618.0	12	
4	2735.8	12	
5	2735.8	12	
		2696.56	-12.67
Unit No.	2016-2017		
3	2618.0	12	
4	2618.0	12	
5	2735.8	12	
		2657.28	-39.28
Unit No.	2017-2018		
3	2618.0	12	
4	2618.0	12	
5	2618.0	12	
		2618.000	-39.28

4.2 Test auxiliary power measured and revised performance trajectories



Year	Previous year AP, %	Immediate measures	Medium term measures	Long term measures	Miscellaneous factors	EER&M benefit on AP, %	Annual overall AP, %	Comments
2009-10	11.51						11.51	[1]
2010-11	11.51				0.17		11.68	[2]
2011-12	11.68	-0.05			0.81		12.44	[3]
2012-13	12.44	-0.10			0.43		12.77	[4]
2013-14	12.77	0.15			0.43		13.35	[5]
2014-15	13.35				0.43	-0.3	13.48	[6]
2015-16	13.48				0.43	-0.5	13.41	[7]
2016-17	13.41				0.43	-0.6	13.24	[8]
2017-18	13.24				0.43	-0.6	13.07	[9]

Note :- Also actually measured GT losses after installing ABT meters at GT output is 0.69 % while CPRI test results has computed based on loading of GT is 0.26%. To arrive at actual GT losses 0.43% is added for the auxiliary power

Comments	Comments
[1]	Present calculations are based on metering at LT end for GTR this does not includes GTR losses which are worked out to be @0.26% of the total auxiliary power during the CPRI energy audit. After commissioning of ex-bus ABT meters this is likely to be reflected in the form of higher auxiliary power. Both Stage 1 old units were are in operation.
[2]	same as above;
[3]	No. of loads such as domestic water, Admin & service bldg. security, fire fighting, lighting loads, coal testing lab, workshop, Heavy Vehicle Maintenance shop etc. was shared by both stages. Now after decommissioning of stage1 units, this load is being shared by the stage2 only which works out to be 0.21 % of loading. Also actually measured GT losses after installing ABT meters at GT output is 0.69% while CPRI has computed based on loading of GT is 0.26%. To arrive at total GT losses 0.43% is added for the auxiliary power
[4]	U5 DVR, BFP- Cartridge, BFP RVs, VFDs; 0.21 % loading as above
[5]	BFP- Cartridge, BFP RVs, VFDs; 0.21 % loading as above
[6]	Unit-3 RM - Dec2013 - June-2014; 0.21 % loading as above
[7]	Unit-4 RM - Sep2015 - Feb-2016; 0.21 % loading as above
[8]	Unit-5 RM - Jul2016 - Dec-2016; 0.21 % loading as above
[9]	

NASIK			
Unit No.	2009-2010		
1	11.830	140	1656.2
2	11.150	140	1561
3	11.610	210	2438.1
4	11.250	210	2362.5
5	11.690	210	2454.9
	11.508462	910.00	10472.70
NASIK			
Unit No.	2009-2010		
1			
2			
3	11.610	210	2438.1
4	11.250	210	2362.5
5	11.690	210	2454.9
	11.516667	630.00	7255.50

5. CONCLUDING REMARKS

i. Nasik TPS has shown initiative in implementation of many of the energy saving measures.

ii. For many schemes implementation is done in one unit in a station as a pilot or one pilot station elsewhere, 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 be difficult to sustain.

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

v. 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.

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

vii. The implementation program needs constant mentoring and monitoring by senior engineers in the plant and from the HO to maintain its good pace.

viii. 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 these schemes.