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.

The stations are included in the following order:

1. Koradi (Units 5-7)
2. Chandrapur (Units 1-7)
3. Khaperkheda (Units 1-4)
4. Nasik (Units 3-5)
5. Bhusawal (Units 2-3)
6. Parli (Units 3-5)

This report pertains to the study of all stations –overall MSPGCL including measures taken up through their HO at Mumbai.

2. STUDY & FIELD VISITS

The study of the MSPGCL is taken up in two stages:

Stage 1: Koradi, Chandrapur & Khaperkheda during January 1st-2nd week 2012.
Stage 2: Nasik, Bhusawal & Parli during January 3rd-4th week 2012.

The HO activies pertaining to implementation of immediate, medium term and long term measures recommended was studied during 25-26 Jan. 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)

Of the total 2939 schemes recommended for all stations of MSPGCL, 1792 schemes were immediate measure schemes (to be implemented within a year). These 1792 immediate measure schemes were segregated by MSPGCL as Non-Financial (934 schemes) and O&M/ Capex (858 schemes) for taking up the implementation.

The energy audit reports of MERC were received by the TPS as follows:

Sl No.	TPS	Date of Receipt of CPRI report from MERC
1	Koradi	12/03/2009
2	Khaperkheda	18/04/2009
3	Chandrapur	18/06/2009
4	Nasik	11/08/2009
5	Bhusawal	14/10/2009
6	Paras	14/10/2009
7	Parli	23/10/2009

The TPS studied the CPRI reports and Action plans were submitted by them as follows:

TPS	Date of receipt of report from MERC	Date of forwarding action plan to RCD for MERC submission	Time taken for study of reports and preparation of action plan by TPS in days
Koradi	12 March 2009	11 June 2009	66.00
Khaperkheda	18 April 2009	22 July 2009	68.00
Chandrapur	18 June 2009	25 September 2009	72.00
Nasik	11 August 2009	22 December 2009	96.00
Bhusawal	14 October 2009	31 December 2009	57.00
Paras	14 October 2009	31 December 2009	57.00
Parli	23 October 2009	31 December 2009	50.00

Corporate directives have been issued to all TPS by Executive Director (O&M) –I vide letter dated 19th Sept-09 for implementation of CPRI recommendations.

The TPS has noted that MERC (18/08/2009 No. 115) decided that as a general rule total capital expenditure and capitalization on non DPR scheme in any year should not exceed 20% of that for DPR schemes during that year. Hence, MSPGCL has decided that non-DPR schemes should be packaged into larger schemes by combining similar or related non-DPR schemes together and converted to DPR schemes for in-principal approval of MERC.

The concept of DPR is new to the TPS engineers so it was decided to avail expert consultancy services for preparation of DPR.

Administrative approval for appointment of Consultant for assistance in preparation of Detailed Project Report (DPR) of Capital Schemes was received in Sept-2009. Through bidding process M/s KPMG was appointed [as per ref Work orders No:-CGM/Works/TRC/16513 dated 19/12/2009].

The DPR of generation side O & M being significantly different from DPRs on the transmission and distribution sectors and without many precedences in the power sector earlier necessitated that M/s. KPMG (with transmission & distribution experience) carry out meetings with MERC, MSPGCL Management as well as TPS engineers.

MAPGCL has identified four pilot DPR schemes one each at Koradi, Khaperkheda, Chandrapur and Nasik and accordingly the DPRs were taken up for preparation.

M/s. KPMG was also entrusted to train the MSPGCL employees for DPR concept & DPR preparations. The in-depth learning of DPR financial model which was having major financial terminology involvement was also essential for MSPGCL engineers and was a component of the training process.

M/s KPMG conducted Training sessions of MSPGCL personnel (TPS engineers & HO staff) at Koradi Training Centre between date 24/02/2010 to 09/03/2010 to expedite the work of DPR preparation.

Corporate office has also pursued the DPR preparation matter vide Chief Engineer (works) letter No 5604 dated 29/03/2010 with all TPS. Initially a lot of deviations in DPR against DPR guidelines were found and DPRs were iterated between TPS & HO for rectification.

Corporate office has reviewed DPR progress at field level vide field interaction, various site meetings and corporate meetings to guide and support the DPR efforts. The power stations were grouped under two zones vise Zone-1 of Nasik, Bhusawal, Parli and Zone-2 of Koradi, Chandrapur and Khaperkheda for the purpose of DPR review. The corporate DPR review was taken as follows:

Sr.no	DPR meeting agenda	Date of meeting	Venue
1	DPR review and field interaction/ guidance with consultant KPMG	11th& 12th Jan 10	Chandrapur
2		13th Jan 10	Koradi
3		14th& 16th Jan 10	Khaperkheda
4		21st Jan 10	NasikTPS
5	DPR review of all TPS	30th Jun 10	HO Mumbai
6	DPR review & guest consultation with MERC consultant Shri. Karkhanis, Regulatory Expert	20th Jul 10	HSBC bldg. Mumbai
7	DPR review	03rd Aug 10	HO Mumbai
8	Field interaction and DPR review	24th Aug 10	Khaperkheda
9	Field interaction and DPR review	15th Sept 10	Nasik
10	Field interaction and DPR review	17th Sept 10	Bhusawal
11	Field interaction and DPR review	28th Sept 10	Parli
12	DPR support meeting	18th Nov 10	Nasik
13	Corporate review of DPR process for Zone-2 TPS	30th Apr 11	Chandrapur
14	Corporate review of DPR implementation for Zone-1 TPS	25th May 2011	Nasik
15	Guidance on CPRI recommendations and technical discussion with Shri M Siddhartha Bhatt Additional Director	7th July 11	Corporate office Mumbai

	CPRI.		
16	DPR review through video conferencing for all TPS	11th July 11	GCR Mumbai
17	DPR progress review of zone-2 TPS	17th Sept 11	Koradi

The first set of pilot DPRs were submitted to MERC on:

Sl. No.	Mahagenco TPS	Draft DPR by prepared by KPMG	DPR submitted to MERC on
1	Koradi	29/03/2010	12/05/2010
2	Khaperkheda	06/04/2010	12/05/2010
3	Chandrapur	06/04/2010	12/05/2010
4	Nasik	25/03/2010	12/05/2010

MERC has accorded its in-principle clearance to MSPGCL pilot DPRs after various queries and deliberations on:

SR No	Mahagenco TPS	DPR submitted to MERC on	Date of MERC in-principle clearance
1	Koradi	12/05/2010	16/05/2011
2	Khaperkheda	12/05/2010	24/12/2010
3	Chandrapur	12/05/2010	29/10/2010
4	Nasik	12/05/2010	25/11/2010

Till date 13 Nos of DPR amounting to Rs. 817.05 Cr. DPR's are in-principally approved by MERC, 5 Nos of DPR amounting Rs. 67 Cr are awaiting In-principle approval and 06 Nos of DPR's amounting to Rs 240 Cr are being submitted to MERC very soon. Remaining DPR's are at various stages of approval process.

3.2 Assessment of the action plans for implementation of measures and benefits accrued

The stations were not geared up for taking up rapid improvements in all units simultaneously because of the legacy. The process of taking up steps towards improvements though slow has begun taking shape. The MSPGCL has taken time to

re-organize itself to gear up such challenges. The improvements are being taken up one by one and hence the benefits for one unit are getting divided by the overall station performance thereby not indicating large benefits. However, the MSPGCL has made a strong program for implementation of the measures in all stations. It is being done in small steps but there is steady progress. The benefits of these efforts will be reaped in the coming years especially in the scenario of the units getting older.

The implementation of energy efficiency measures is a new learning for the stations and has not been attempted on this scale earlier in the MSPGCLs history where generation was the primary index of performance. Now, in the regulated environment the station is taking up energy efficiency improvements in the right earnest. Though benefits are not visible in the immediate scenario in terms of KPI, change is noticed in the utility in terms of both engineering and managerial processes. The time constants for procurement processes have shown improvement, many of the HRD measures have been implemented, SAP implementation, a great deal of training has been imparted, etc.. On the engineering side, steam path audits and restoration during the capital overhaul itself, change over to LAN compatible primary instrumentation, software for automation of fuel accounting processes, Variable frequency drives, etc., have been implemented and demonstrated in all stations.

Since the exercise began, we have noticed changes in:

- ✓ Sensitivity and greater awareness to KPI especially heat rate
- ✓ Willingness to implement energy efficiency measures and take up challenges in problem solving
- ✓ Bring in energy efficiency practices such as steam path audits

However, we note that the following programs/areas need to be strengthened:

- ✓ Operational optimization of unit performance
- ✓ Monsoon management
- ✓ Leak reduction
- ✓ Cleanliness

- ✓ Vendor development as a pre-process for successful procurement and implementation
- ✓ COH & AOH must be as per schedules and must be skipped

Since the strategy is implement some of the measures in units one by one, in one station and then in other station, during capital overhauls, etc., the benefits for one unit are getting divided by the station performance thereby showing the lower savings than if it is implemented all in one go.

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

Reasons for delay and the CPRI comments (wherever applicable) on the same are given as follows.

Sourcing of funds: Since capital outlay required implementing these schemes, MSPGCL has cited that a lead time is required to procure and install the equipment to bring about technical performance up-gradation.

Time needed to check commercial viability of the proposed schemes before implementation: MSPGCL has cited that being directed to work as commercial entity as per the provisions of EA, 2003, MSPGCL might opt to not to undertake the implementation of any scheme if it do not foresee the envisaged benefit from any scheme. MSPGCL has cited that since the economic benefit has not been quantified for each and every measure it needs to check the economic viability of the scheme before implementation. CPRI comments: The time constants for these processes must be reduced through expert groups.

Lead time required for procurement under a government set up: MSPGCL have cited that it needs to take into account practical considerations towards lead time required for procurement under a government set up. MSPGCL has an internal process for approval of any capital expenditure. The Board takes a conscious call on such proposals which essentially includes cost benefit analysis over the balance life of the project. CPRI comments: Apart from the direct quantifiable benefits, the indirect long term benefits to transform the station must be brought out convincingly. Strong monitoring is also called for. Improvement in procurement processing time is essential.

Implementation of capex: MSPGCL has cited that given the vintage of the units, there are practical considerations in implementation of schemes. There could be inherent delays in executing the capex for want of obsolete spares which may be required for the older units. For instance, they have submitted that BHEL takes a time period of around 32 months for arranging spares once complete order is placed along with the advance. CPRI comments: Processes must be accelerated. Strong monitoring from HO is required.

Time lag in seeking MERC approval on the CPRI recommended schemes: With the finalization of the CPRI study, it was believed by MSPGCL that there may not be a requirement of preparation of DPR since the entire cost benefit analysis has been undertaken by the agency and that it was construed as if an upfront approval towards immediate and medium measures will be accorded to MSPGCL. MSPGCL has cited that in the APR Order 2009-10, (September 12, 2010) MERC clarified that MSPGCL needs to go through a formal process of DPR submission for every capex including those under "Immediate" measures which in a way led to some time delay of the entire process of implementation. CPRI comments: MSPGCL liasoning with MERC for obtaining approvals must be strengthened.

MSPGCL might opt to defer implementation of few of schemes: MSPGCL has cited that decision of implementing the capex may have to be deferred based on payback period, non-availability of shut down time, non-availability of spares. Payback period is used as a criterion which may not be quantifiable in all cases. Hence, there is delay in clearance for some of the proposals. In such a case, the technical improvements should not be considered on a deemed basis. Rather the actual completion of schemes should be considered for the benefits. ***CPRI comments:*** Besides the formal payback period criterion other tacit benefits must also be considered before deferment decisions. Decision on choice of energy efficiency measure need to be on the overall benefits to the station. Purely going by the financial payback period criterion may not be possible to be quantified because the benefits are indirect. Many measures have been held up for want of financial viability. In case there is a clear cut case of the measure being uneconomical on the basis of cost vis-à-vis the benefits, only then it must be differed. In clear cut cases of uneconomical viability the measures must be differed. In cases where there is ambiguity in quantifying and computing the benefits which are indirect then an overall and holistic view must be taken rather than turning down the measure.

Apprehension on whether the funds will be reimbursed in the form of pass through: MSPGCL has expressed apprehension on whether the funds will be reimbursed or not; and whether the benefits of heat rate will be deducted in the event of not achieving the desired result. CPRI comments: Clarifications must be obtained at the earliest.

Quality of coal to be factored in the performance trajectory: MSPGCL has cited that the coal quality on which the tests were conducted has largely deteriorated and is not getting factored in the current trajectory. However, coal quality is uncontrollable and therefore it is difficult to achieve PLF of 80%. MSPGCL has expressed that in case envisaged improvement is not achieved even on implementation of CPRI recommended schemes partly because of uncontrollable parameters like coal quality. **CPRI observations on Coal quality degradation:** The station is having problem of coal quality degradation which is resulting in reduction in PLF and other parameters. In view of this, balancing of the coal GCV through the use of imported coal and use of washed coal may be considered (to the maximum extent allowed by Central Norms) for not allowing the further deterioration of coal quality.

R & M of old 210 MW units: MSPGCL has conveyed that CEA has identified few units of 210 MW capacity of MSPGCL for EE-R&M (Energy Efficient Renovation and Modernization) and LE as the units have completed 25 years of service life. Schemes as recommended by CPRI might get implemented during this R&M activity. MSPGCL has reported shift in implementation schedule for some medium as well as long term recommendation against EE-R&M of those units. During discussion it was also informed that EE-R&M process is progressing at various stages but need for concentrating effort in EE-R&M area is essential failing which *achieving those trajectories will became difficult* and MSPGCL's decision to shift implementation of major CAPEX through EE-R&M must take into consideration the long term performance trajectories also. Considering large scope of EE-R&M as well as its commercial performance impact, MSPGCL has to evolve this huge activity with greater efforts and resources to focus following areas:

i. Engineering focus : MSPGCL must develop the engineering focus team for EE-R&M which shall identify:
   - ✓ Technical objectives of EER&M
   - ✓ The chronic problems in present unit / system
   - ✓ The avenues of performance improvement
   - ✓ The cost economic solutions available in the markets
   - ✓ Technological up-gradation like scope for improvement in Working pressure/ temperature in system
   - ✓ Arresting avoidable losses with new solution like steam loss at tracing lines

i. Implementation focus: timely as well as successfully implementation the solution should became integral responsibility of Implementation focus team. The team should be well trained and be equipped with consulting support to achieve timely success.

ii. Processing Focus: present team which has main focus on processing be strengthened for earliest processing that cost escalation can be contained and timely implementation could be supported.
iii. Contingency preparedness: Contingency preparedness for technical manpower as well as technology providers has to be greatly evolved. Heavy personnel reliance or solution provider reliance may risk the EER&M process in long run.

3.4 Avoidable delays in implementation.

Procurement process: At the HO office level the process has been improved and streamlined and there is considerable reduction in time lag. Procurement process simplification/acceleration had been suggested at the station level for reducing in steps and procedural time. This needs to be implemented at the station level with immediate effect. Otherwise, it will be difficult with antiquated processes to keep up with the present day time schedules.

Authorization and approval processes: At the HO level there are some improvements in the process steps, streamlining and reduction in the process time. However, at the station level, the process times for these antiquated processes need to be improved through shorter and more direct processes by critical review of redundance in the processes.

Uneven 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, Khaperkheda and Nasik have shown a proactive stand to implementation stations like Kordi and Parli have been slow. Bhusawal has shown moderate interest due to its limited no of units and due to E- R & M program.

Delay in obtaining regulatory clearances: Strengthening of the liasoning efforts with regulator regarding approvals for schemes and proactively answering the queries could have reduced the cycle time.

Strong central monitoring: Strong central HO level monitoring would reduce delays in implementation.

Capex: MSPGCL has a big fleet of old units which are having age over and above 25 years mainly 210 MW LMZ units. Going by concept the old units requires CAPEX to maintain the performance trajectory of the unit apart from regular maintenance. MSPGCL practices are found to be high reliance on OPEX as well as comfort level in old time tasted solutions. The CAPEX delays area are as follows:

i. **Procedural & system delay**: MSPGCL has reported various reasons for delay in CAPEX implementations but prominent one is the inculcation of new practice for CAPEX approval as well as large time for the CAPEX processing. Moreover as reported at various TPS the limitation of item in CAPEX list prepared by MSPGCL also possesses the difficulty in CAPEX proposal preparation. MSPGCL should improvise its CAPEX item list. The Capex list (on which items constitute capex) be enlarged. Presently capex list consists of only 20 items and all items outside the list are likely to be rejected internally. The Capex list of national operators (consisting of around 550 items) may be adopted.

ii. **Green channel clearance:** The procedural delay must be shortened for prominent CAPEX schemes. MSPGCL may explore possibility of setting up green channel clearance system for major CAPEX proposals and present such proposals with the regulator on merit of the schemes so that speedy implementation is achieved. MSPGCL must rework on its CAPEX decision making system and focus should be shifted from pay back period to life cycle costing.

iii. **Prioritization**: CAPEX implementation must gain a place in MSPGCL's priority list and to establishment of good and successful CAPEX scheme must be linked up with performance appraisal of maintenance engineers, section head as well as group head. Separate KPI also must be included for successful CAPEX implementation, performance demonstration, benefit recording & reporting. MSPGCL may share successful implementation of CAPEX at one TPS with the peers giving due reward-cum-recognition to successful implementers.

iv. **Awareness**: Many CAPEX recommendations were reported to be delayed because of poor efforts in exploring solution through market search. In Many cases it was heavy reliance of OEM has been reported and delay was attributed for non-responsive OEMs. A special awareness must be evolved for market research, new technology introduction, reverse engineering, etc area so that CAPEX delay could be avoided as well as efficient advanced technology could be utilized.

Monsoon dip in thermal power plant performance: MSPGCL power plants are facing a big performance dip in Monsoon. The phenomenon is regular since last 2-3 Monsoons. The sharp performance dip is mainly attributed to sticky coal with a clayey background which becomes difficult to unload as well as transfer to furnace zone. This Monsoon problem has affected effect in all KPIs (like SOC, SHR, PLF, and AP). Detailed recommendations on monsoon management have been given in the CPRI reports during the energy audit. It is recommended to have a strong monsoon preparedness plan in place well before the monsoon actually occurs. Further, to tackle the Monsoon situation, MSPGCL has to focus on:

- **Ensuring availability of non-sticky / dry coal:** To ensure dry coal availability in monsoon, it was earlier recommended for construction of coal dome which was reported to be techno-economically unviable, however MSPGCL has to explore other alternatives which are techno-economically viable to ensure dry coal stock availability. Apart from above

MSPGCL must identify sources of sandy coal / non-sticky coal and efforts be made to improve supply of such coal in Monsoon season.

- **Ensuring coal quantity at TPS :** TPS must have stock of dry coal stacked in pre-monsoon month and preserved properly for Monsoon period. The concentrated efforts to improve the coal stacking practices for Monsoon preparedness are essential which MSPGCL could focus more attention on.

- **Operational practices must be improved to handle Monsoon :** MSPGCL has the simulators for 210 MW as well as 500 MW units which must be provided with Monsoon period condition simulation (like intermittent coal flow, feeder choke-up, wet coal effect etc) so that operators are better trained for such challenges and control over specific oil consumption can be achieved. At present the simulators do not simulate the effect of poor fuel quality.

- **Outages be shifted to Monsoon seasons:** Widening vendor base (service providers for overhauls) shall improve possibility of shifting maximum outages in Monsoon period. The one unit outage shall ease out coal shortage at other running unit and improve loadability of running units.

- **Commercial viability of running plant in Monsoon be critically reviewed:** Many incidences of very high specific oil consumption in Monsoon period are reported during past performances. High specific oil consumption badly affect commercial performance hence MSPGCL's commercial wing must closely monitor Monsoon period performance and advise TPS towards commercial viability during every Monsoon period.

- **Unusual monsoon period issues be regularly reported with top management and regulator:** Practice must be evolved to report unusual monsoon issues promptly. Practice of expecting true-up at the end of financial year does not augur well in public reporting as well as regulatory regime.

- **Coal study support :** MSPGCL must perform detail coal study for Monsoon period and identify as well as categorize the coal sources with difficulties during unloading, transferring and combustion.

- **Liasoning:** Special liasoning efforts are required during the Monsoon period to minimize problems due to problematic coal sourcing.

4. REVISION OF PERFORMANCE TRAJECTORIES

4.1 Test SHRs and degradation rates measured and revised performance trajectories.

	BHUSAWAL		CHANDRAPUR		KHAPERKHEDA		KORADI		NASIK		PARLI	
Year	CPRI CALCULATED	ACHIEVED BY TPS	CPRI CALCULATED	ACHIEVED BY TPS	CPRI CALCULATED	ACHIEVED BY TPS	CPRI CALCULATED	ACHIEVED BY TPS	CPRI CALCULATED	ACHIEVED BY TPS	CPRI CALCULATED	ACHIEVED BY TPS
2009-10	2856	3013	2759	2760	2675	2811	3056	3245	2842	3070	2919	3093
2010-11	2864	2882	2753	2764	2683	2658	2834	3126	2851	2907	2826	3056
2011-12	2808	2960	2704	2669	2650	2608	2830	2848	2769	2887	2831	3052
2012-13	2792		2698		2613		2826		2756		2805	
2013-14	2764		2686		2606		2835		2736		2779	
2014-15	2743		2680		2607		2814		2719		2778	
2015-16	2739		2684		2607		2761		2715		2787	
2016-17	2717		2672		2606		2770		2685		2750	
2017-18	2682		2666		2614		2780		2655		2677	

4.2 Test auxiliary power measured and revised performance trajectories

	BHUSAWAL		CHANDRAPUR		KHAPERKHEDA		KORADI		NASIK		PARLI	
Year	CPRI CALCULATED	ACHIEVED BY TPS	CPRI CALCULATED	ACHIEVED BY TPS	CPRI CALCULATED	ACHIEVED BY TPS	CPRI CALCULATED	ACHIEVED BY TPS	CPRI CALCULATED	ACHIEVED BY TPS	CPRI CALCULATED	ACHIEVED BY TPS
2009-10	11.00	10.63	9.16	8.47	9.80	9.5	10.89	11.85	11.51	9.86	11.99	11.2
2010-11	11.07	11.44	9.06	10.03	9.80	9.76	10.89	12.75	11.68	10.56	13.14	11.74
2011-12	11.14	11.41	9.01	10.28	9.80	9.82	10.89	12.09	12.44	11.02	13.46	12.99
2012-13	11.20		8.91		9.77		10.81		12.77		13.76	
2013-14	11.15		8.84		9.74		10.81		13.35		14.02	
2014-15	11.10		8.75		9.71		10.51		13.48		14.21	
2015-16	10.29		8.71		9.70		9.91		13.41		14.57	
2016-17	10.36		8.46		9.70		9.91		13.24		14.34	
2017-18	9.53		8.25		9.70		9.91		13.07		14.10	

4.3 Factors beyond the control of TPS

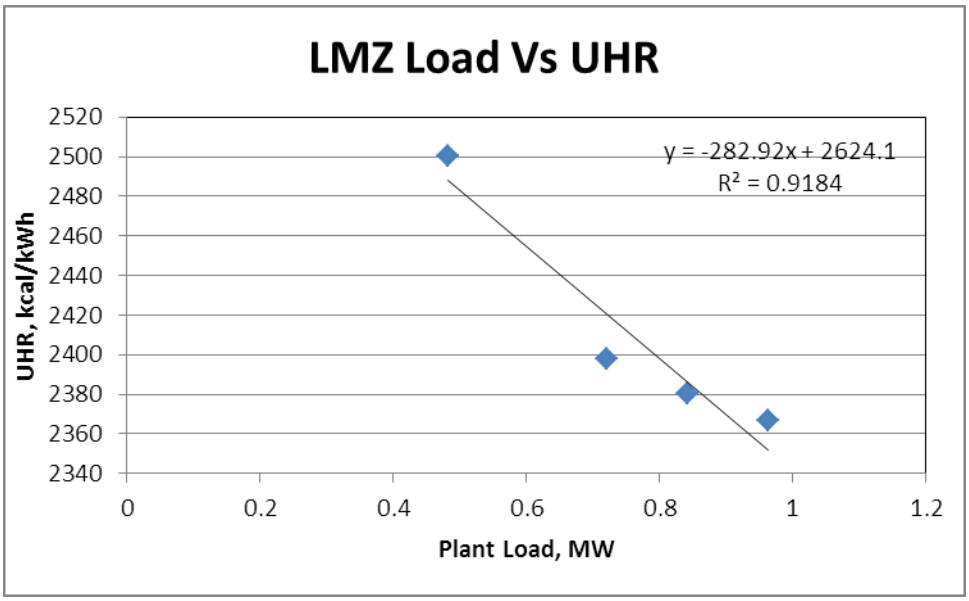
All the TPS studied herein expressed that the SHR were calculated in fair season and two factors which are beyond their control have adversely affected then, viz., heavy rains during 2010-2011 and low GCV of coal during 2011-2012. They have mentioned that the effect is by way of drop in PLF which has resulted in increased SHR, increased specific oil consumption and increased auxiliary power. While the actual drop in SHR or increased AP or SOC cannot be computed by any simulation process, except through performance testing of the units under similar conditions, an approximate simulated computation has been made to quantify the effects on the performance parameters.

Heavy rains

All the TPS have expressed that due to heavy rains during 2010-2011, the KPI are adversely affected and they are not able to achieve the set parameters. It was ascertained that the rainfall was high during the year (typically on a cycle of 5-6 years) under consideration which affected the station operations.

The quantification of the effect of heavy rain period is as follows:
SHR

i. The variation of the design THR with PLF is obtained from the heat balance sheet and divided by the boiler efficiency to obtain the DHR. The sensitivity index of the UHR to PLF is given by 2.829 kcal/kWh per 1 % PLF change.



Load, MW	PLF	HR-TG	UHR
202.2	0.9629	2039	2366.8
176.6	0.841	2051	2380.7
151.4	0.721	2066	2398.1
101.2	0.4819	2154	2500.3

ii. The fair season PLF (8 months) and rainy season PLF (4 months) (excluding planned outages) is computed. The difference between these PLFs is multiplied by sensitivity factor of 2.829 to give the increase in SHR. The same is multiplied by a factor of (4/12) to give the impact on annual SHR.
iii. Similarly, the difference between the specific fuel oil consumption (SOC) in fair season and rainy season are taken to obtain the difference in (SOC) which is multiplied by the GCV of fuel oil (9.5 kcal/ml) and a factor of (4/12) to obtain the impact on annual SOC.
iv. The sum of the above two gives the impact of rains on annual SHR.

Auxiliary power

i. The difference between the fair season PLF (8 months) and rainy season PLF (4 months) (excluding planned outages) is multiplied by the sensitivity index of auxiliary power vs. PLF from the plant's data (0.091 % auxiliary power per 1 % change in PLF) and further multiplied by (4/12) to obtain the impact on annual AP as a % of the gross power.

Specific fuel oil consumption (SOC)

i. The difference between the specific fuel oil consumption (SOC) in fair season and rainy season are taken to obtain the difference in (SOC) which is multiplied by a factor of (4/12) to obtain the impact on annual SOC.

Significant degradation in coal quality

The TPS has expressed that due to drop in GCV of receipt coal during 2010-2011 & 2011-2012, the SHR are affected in a negative way. It is ascertained that the drop in receipt/bunkered coal GCV was high during the year under consideration which affected the station operations.

The quantification of the effect of drop in GCV is as follows:
SHR

i. The variation of the design THR with PLF is obtained from the heat balance sheet and divided by the boiler efficiency to obtain the DHR. The sensitivity index of the UHR to PLF is given by 2.829 kcal/kWh per 1 % PLF change.
ii. The difference between the boiler efficiency for the normal coal (2009-10) and degraded coal is taken to obtain the factor of increase of SHR since the turbine heat rate is unaffected by coal GCV. The constants for the boiler efficiency variation are taken from the station's sensitivity of boiler units to coal GCV.

The computation procedure is given in Tables 1-5 in Annex 2 of the report.

The computed effects of the heavy rains and the low GCV are given as follows for the year 2010-11 and 2011-12 for the six TPS.

Calculated SHR increase with Factors due to heavy rains and low GCV of receipt coal for all stations.						
	BHUSAWAL	CHANDRAPUR	KHAPERKHEDA	KORADI	NASIK	PARLI
Rainy season 2010-11	113.60	49.20	17.79	32.81	70.81	77.47
Low GCV 2010-2011	14.31	18.96	25.77	36.95	20.37	17.29
Low GCV 2011-2012	23.84	33.50		45.31	27.18	44.11

SHR of all Stations without the factors –deviations (plus indicates the station achieved SHR is higher; minus indicates that station achieved SHR is lower) between achieved SHR of TPS and computed as per CPRI test annual figure + degradation						
	BHUSAWAL	CHANDRAPUR	KHAPERKHEDA	KORADI	NASIK	PARLI
2009-10	158	1	136	189	228	174
2010-11	***18***	***11***	***-25***	***292***	***56***	***230***
2011-12	***152***	***-35***	***-42***	***18***	***118***	***221***

Analysis of the increase in SHR due to heavy rains and due to drop in GCV of coal.

2010-2011

1. The SHR achieved by the TPS and CPRI test data with degradation are tallying within +18 to -25 kcal/kWh for BTPS, CHTPS and KhTPS.
2. In 2010-2011 in the case of NTPS an increase in SHR of 56 kcal/kWh between the CPRI test data and SHR achieved by TPS is noted.
3. In 2010-2011 in the increase in SHR between SHR achieved by TPS and the CPRI test data was 292 kcal/kWh for Koradi and 230 kcal/kWh for Parli TPS.
4. The effect of heavy rains and low GCV of coal is computed as 32.81 kcal/kWh and 36.95 kcal/kWh respectively for Koradi TPS. The same effects are computed at 77.47 & 17.27 kcal/kWh respectively for Parli TPS. In the case of Nasik the two effects are computed as 70.81 & 20.37 kcal/kWh respectively.

2011-2012

1. In 2011-2012, without calculation of these effects the SHR achieved by the TPS is lower than the SHR as per CPRI test data with degradation by 35-42 kcal/kWh in the case of KHTPS and CHTPS.
2. In 2011-2012, SHR achieved by TPS is higher by 18 kcal/kWh in the case of Koradi TPS.
3. In 2011-2012, in the case of Bhusawal, Nasik and Parli, the SHR achieved by the TPS is higher (poorer performance with increased SHR) by 97 kcal/kWh, 118 kcal/kWh and 211 kcal/kWh respectively.
4. The effect of low GCV of coal calculated is around 24, 28 and 44 kcal/kWh for the three TPS respectively.

Analysis of increase in AP and SOC

1. In 2010-2011, AP achieved by the TPS was lower than the CPRI calculated test values, except in the case of Bhusawal TPS, Koradi TPS and CHTPS where it is higher by 0.37 %, 1.86 % and 0.97 % respectively.
2. In 2010-2011, the computed increase in AP values due to heavy rains are 0.97 % for Bhusawal TPS, 0.74 % for Chandrapur TPS and 0.35 % for Koradi TPS.
3. In 2010-2011, the SOC achieved Nasik and Bhuasawal TPS increased by around 7+ ml/kWh above the limit of 2 ml/kWh.
4. In 2010-2011, The SOC achived by Koradi & Parli increased by 6.3 ml/kWh.
5. In 2010-2011, CHTPS achived an increased SOC above the limit by 2.5 ml/kWh.
6. In, 2010-2011, KhTPS was below the limit of 2 ml/kWh.
7. In 2010-2011, the computed increase in SOC due to heavy rains was highest for Bhusawal (8.8 ml/kWh), 5.6-5.8 ml/kWh for Nasik and Parli, 2.3-3.1 for Koradi & ChTPS and 0.4 for
8. KhTPS.

CPRI Observations in the matter of heavy rainfall effects and low GCV of coal:

1. The exact quantification of the effects of heavy rains and low GCV of coal is possible only through experimental studies.
2. The comparison of the monthly KPI especially PLF and AVF during the previous years (2008-2009) and subsequent years (2011-2012) do not show clear trends of drop in PLF and AVF. Hence, because of the scatter of the data, no clear cut conclusions can be arrived at for the effect of heavy rainfall and drop in GCV during the years 2010-2011 and 2011-2012 respectively.
3. In a few of the stations a portion of the shortfall in performance can be explained through these factors. In other stations the station performance

(without considering these factors) is nearly tallying or better than the prediction by CPRI test values with degradation (in case of SHR). Hence the results cannot be applied uniformly for all parameters and all stations. The results can find selective usefulness based on: (a) whether a particular station has brought out the shortfall in performance due to this reason already in its submissions at that particular period of time, (b) the performance index in question of a given station vis-à-vis its achieved result in that year.

4. According to a sample power purchase agreement of Govt of India, MoP, Relief for Natural force majeure events under the power purchase agreements can be sought only if the AVF of the TPS goes below 60 % for two consecutive months and the relief can be in the form of capacity charges. It is presumed that the relief is not sought by the TPS under these, ether for high rains for low GCV of coal.
5. It is also not clear whether low/wet GCV of coal qualifies under a natural force majeure event, since the TPS has other options of sourcing better coal such as storage of dry coal, coal yard management, washing of coal, import of coal, use of sandy coals, blending of coals, etc.
6. Hence we are of the opinion that the situation can be viewed under two scenarios:
   Scenario 1: While the effects of heavy rainfall can be selectively applied on a case to case basis for stations like Koradi and Parli where the substantial difference in SHR (200+ kcal/kWh) exists.
   Scenario 2: Since these is a scatter in the data and no clear cut trend is seen, these effects cannot be accurately quantified without experimental studies, is beyond or outside the scope of the present study and hence cannot be considered.

5. CONCLUDING REMARKS

i. The MSPGCL was not geared up for taking up rapid improvements in all units simultaneously because of the legacy. The process of taking up steps towards improvements though slow has began taking shape steadily.

ii. The improvements are being taken up unit by unit and hence the benefits for one unit are getting divided by the overall station performance thereby not indicating large benefits. However, the MSPGCL has made a strong program for implementation of the measures in all stations. The benefits of these efforts will be reaped in the coming years especially when the units are getting older.

iii. Of the total 2939 schemes recommended for all stations of MSPGCL, 1792 schemes were immediate measure schemes (to be implemented within a

year). These 1792 immediate measure schemes were segregated by MSPGCL as Non-Financial (934 schemes) and O&M/ Capex (858 schemes) for taking up the implementation.

iv. Till date 13 Nos of DPR amounting to Rs. 817.05 Cr. DPR's are in-principally approved by MERC, 5 Nos of DPR amounting Rs. 67 Cr are awaiting In-principle approval and 06 Nos of DPRs amounting to Rs 240 Cr are being submitted to MERC very soon. Remaining DPRs are at various stages of approval process.

v. The time constants for procurement processes though not optimal have shown some improvement, many of the HRD measures have been implemented, SAP implementation, a great deal of training has been imparted as steps towards progress. Best practices such as steam path audit are being implemented.

vi. While few stations like Chandrapur, Khaperkheda and Nasik are proactive in implementation others like Koradi and Parli are slow. Bhusawal is moderate.

vii. The prime reasons for delay are slow authorization and procurement processes at the station level and the need for a strong central HO level mentoring and monitoring.

viii. The installation of in-motion weigh bridges in all stations for receipt coal measurement needs to be expedited.

ix. Strengthening of the liasoning efforts with regulator regarding approvals for schemes and proactively answering the queries could have reduced the cycle time.

x. The detailed trajectories of SHR and AP are given in the individual reports. It is concluded that the progress though slow and in small steps is positive and the organization has shown signs of reorientation for the better.