

REPORT

PHASE I – REVIEW OF TENDERING PROCEDURES AND DOCUMENTS FOLLOWED BY PUBLIC UTILITIES FOR RENOVATION & MODERNISATION PROJECTS

SUBMITTED BY



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LIST OF ABBREVIATIONS

3D	THREE DIMENSIONAL
ADC	APPLICATION DATA SHEET
AG&SP	ACCELERATED GENERATION AND SUPPLY PROGRAMME
ATRS	AUTOMATIC TURBINE RUN UP SYSTEM
BDS	BID DATA SHEET
BMCR	BOILER MAXIMUM CONTINUOUS RATING
BS	BRITISH STANDARDS
BOP	BALANCE OF PLANT
BOQ	BILL OF QUANTITY
BTG	BOILER TURBINE GENERATOR
CA	CONDITION ASSESMENT
C&I	CONTROL AND INSTRUMENTATION
CC&M	COMMERCIAL, CONTRACTS AND MATERIALS
CEA	CENTRAL ELECTRICITY AUTHORITY
CERC	CENTRAL ELECTRICITY REGULATORY COMMISSION
CFD	COMPUTATIONAL FLUID DYNAMICS
CW	CIRCULATING WATER
DAS	DATA ACQUISITION SYSTEM
DB	DISTRIBUTION BOARD
DCS	DISTRIBUTED CONTROL SYSTEM
DM	DE MINERAL
DPR	DETAILED PROJECT REPORT
EA	ENERGY AUDIT
EER&M	ENERGY EFFICIENCY AND RENOVATION AND MODERNIZATION
EPC	ENGINEERING, PROCUREMENT AND CONSTRUCTION
ESP	ELECTRO STATIC PRECIPITATOR
FD	FORCED DRAFT
GOI	GOVERNMENT OF INDIA
GC	GENERAL CONDITIONS
HIS	HYDRAULIC INSTITUTE STANDARDS
HP	HIGH PRESSURE
HRH	HOT REHEAT LINE
Hz	HERTZ
I&C	INSTRUMENTATION AND CONTROL
IBR	INDIAN BOILER REGULATIONS

ICB	INTERNATIONAL COMPETITIVE BIDDING
IFB	INVITATION FOR BID
IEC	INTERNATIONAL ELECTRO TECHNICAL COMMISSION
IEEE	INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS
IP	INTERMEDIATE PRESSURE
IRR	INTERNAL RATE OF RETURN
ITB	INSTRUCTIONS TO BIDDERS
IS	INDIAN STANDARDS
ITA	INSTRUCTIONS TO APPLICANTS
kfW	Kreditanstalt für Wiederaufbau
Kg	KILOGRAM
KW	KILOWATT
KWH	KILOWATT HOUR
LD	LIQUIDATED DAMAGES
LE	LIFE EXTENSION
LCP	LOCAL COMPETITIVE BIDDING
mg	MILLIGRAM
MT	METRIC TONNE
MU	MILLION UNITS
MVA	MEGA VOLT AMPERES
MW	MEGA WATTS
NCB	NATIONAL COMPETITIVE BIDDING
NDT	NON-DESTRUCTIVE TESTING
NEP	NATIONAL ELECTRICITY POLICY
NIT	NOTICE INVITING TENDER
Nm ³	NOMINAL CUBIC METRE
NO _x	OXIDES OF NITROGEN
O&M	OPERATION AND MAINTENANCE
P&A	PERSONNEL AND ADMINISTRATION
PC	PARTICULAR CONDITIONS
PDR	PROJECT DESIGN REPORT
PFC	POWER FINANCE CORPORATION
PG	PERFORMANCE GUARANTEE
PLF	PLANT LOAD FACTOR
R&M	RENOVATION AND MODERANISATION
RfP	REQUEST FOR PROPOSAL
RfQ	REQUEST FOR QUALIFICATION
RLA	RESIDUAL LIFE ASSISMENT

SBD	STANDARD BIDDING DOCUMENT
SO ₂	SULPHUR DIOXIDE
SPM	SUSPENDED PARTICULATE MATTER
SWAS	STEAM WATER ANALYSIS SYSTEM
T	TONNE
TAC	TARIFF ADVISORY COMMITTEE
TG	TURBO GENERATOR
TOR	TERMS OF REFERENCE
TMCR	TURBINE MAXIMUM CONTINUOUS RATING
TPS	THERMAL POWER STATION
VVF	VARIABLE VOLTAGE FREQUENCY
WACC	WEIGHTED AVERAGE CAPITAL COST

1.0 INTRODUCTION

1.0 INTRODUCTION

1.1 THE NEED FOR R&M

There is considerable gap between demand and availability of power in the country in spite of substantial increases in capacity addition in successive Five Year Plans. With the high cost of new installations, it is essential to maximize generation from the existing power stations by restoring their rated capacity as, also, the efficiency of the power stations. This will involve, necessarily, the replacement of the existing obsolete items of equipment with those with higher efficiencies.

Since the older plants are working with coal qualities much worse than the design values, renovation shall require capacities of raw coal feeding system, pulverizers and primary air fan system to be augmented beyond design values to maintain the rated capacity of the boiler, provided the furnace size is adequate to burn increased quantities of the inferior quality of coal.

The environmental regulations, also, are becoming stricter day by day. Effective environment control may require improving the facilities or complete replacement of existing equipment.

1.2 UNIT SIZES AND AGE

Units sizes in the country range from 30MW to 500 MW. Most of the smaller size units ranging from 30 MW to 100 MW are operating for more than 30 years. Most of these units are non-reheat type with low design efficiency and are operating at poor efficiency and very low plant load factors. Such units are being considered for retirement in a phased manner. The 210–500 MW units have a better track record in terms of their plant load factor and availability. However, many of 200/210 MW units have completed or are near the end of their normal operating life and require inputs for life extension and modernization to upgrade and improve their performance level. The age profile of thermal units is given below:–

Capacity range in MW	> 15 years but < 20 years	> 20 years but < 30 years	> 30 years
<200	8(1)	27(9)	108(46)
200/210	38(3)	74(8)	10(3)
250/300	–	–	–
500	9	6	Nil

Table–1 Breakup of age profile of thermal units as on March, 2009. (Source CEA)

A large number of existing units require attention and there is potential for initiating a large scale Renovation, Modernization and Life Extension Programme at the national level.

1.3 PLANNING FOR R&M

Central Electricity Authority (CEA) has prepared a 5 year plan for the 11th Plan period (2007–2012). The plan wise position is as under.

S. No.	Particulars	7 th Plan (1985– 1990/92)	8 th Plan (1992– 97)	9 th Plan (1997– 2002)	10 th Plan (2002–07)	11 th Plan (2007–12)
1	Thermal Power Stations covered (No.)					
	R & M	34	44	30	12	21
	LE	0	0	7	32	31
2	Thermal Units covered (No.)					
	R & M	163	198	130	35	73
	LE	0	0	28	106	77
3	Expenditure/Estimated Cost (INR Million)					
	R & M	10660	23850	11380	7500	25930
	LE	0	0	17940	92000	161840
4	Total Capacity Involved (MW)					
	R & M	13570	20870	17935	6440	18565
	LE	0	0	1910	10413	11186

Table-2 Plan-wise R&M and LE Works Completed and Envisaged

At present, three power stations namely Bokaro 'B' TPS (3x210MW), Kolaghat TPS (3x210MW) and Nasik TPS Unit-3 (1x210MW) have been identified for efficiency integrated R&M study through bilateral cooperation with Germany. Contract has been awarded for preparation of Feasibility Study for all the above units. Few other units such as Bandel TPS Unit-5 (210MW), Koradi TPS Unit-1 (210MW) and Panipat TPS (2x110MW) have been identified for the efficiency integrated R&M programme with World Bank assistance. NIT for the main plant package for Bandel TPS Unit -5 has been issued. The Energy Efficiency R&M programme (EE R&M) through external assistance is intended to be taken up in some more units

also. The potential units have been identified which may be taken up during 12th Plan period and beyond. A detailed overview of R&M in India based on CEA document may be seen at Annexure 6.

The overall requirements of R&M are roughly assessed to be between 1500–2000 MW per year. The average ordering in the period 2000–2007 has not exceeded 300 MW even though over 2000 MW was tendered. The rest were dropped for one reason or the other. BHEL was awarded 2030 MW through the negotiated route.

1.4 STAKEHOLDERS CONCERNS

The recognition of importance and urgency of R&M program in the National Electricity Plan and Tariff Policy notified by the GOI under the provisions of the Electricity Act, 2003, has focused attention on the subject and, as a result, dialogue has begun between the stakeholders in order to harmonize different interests and develop a pragmatic approach for implementation of the R&M program. The commonly articulated concerns of the different stakeholders are:

Utilities

- Limited agencies to carry out R&M studies competently.
- Lack of competent agencies to carry out R&M works.
- Extended shut down periods required for R&M not acceptable in a period of shortages.
- Lack of internal expertise to evaluate actual condition of equipment and costs for repair/renovation.
- Cost escalation on account of surprises found during project execution and the difficulty to build them into the contract
- Regulatory Aspects – including uncertainty of capital cost approval and reasonableness of tariff for recovery of capital cost.
- Financing arrangements
- Problems of ensuring expected and sustained plant performance after completion of R&M

Bidders

- Time gap between study of RLA and actual initiation of R&M bidding process
- Uncertainty about the exact scope of work which makes it difficult to estimate the actual work to be undertaken
- Unforeseen items/surprises during execution and impact on cost – how to build them into the estimate and how to reduce risk on this account.

- Functional Guarantees which form part of the contract are often difficult to achieve owing to lack of clarity on how verification will be carried out.
- Problem of ensuring a reasonable LD clause
- Delays in payments of invoices
- Fixed Price insisted upon by State Utilities
- Fluctuations in prices of materials especially steel

Funding Agencies

- Accuracy of the estimated costs
- Ensuring a strategy that takes care of unforeseen items/surprises and their impact on project cost and time for execution
- Delays in regulatory clearances
- Lack of appropriate infrastructure for project execution
- Ensuring that the study preceding the preparation of Detailed Project Report reflects actual conditions in the plant
- Credit worthiness of the utilities
- Material market fluctuations

Regulator

The regulator is concerned about the justification of the expenditure on R&M projects and would like to ensure that the investment results in the least additional cost to the public for the power generated after R&M. An objective judgement of the justified expenditure is complicated since it is difficult to establish which portion of the expenditure is based on genuine LE requirements and what is needed to make up for poor O&M practices.

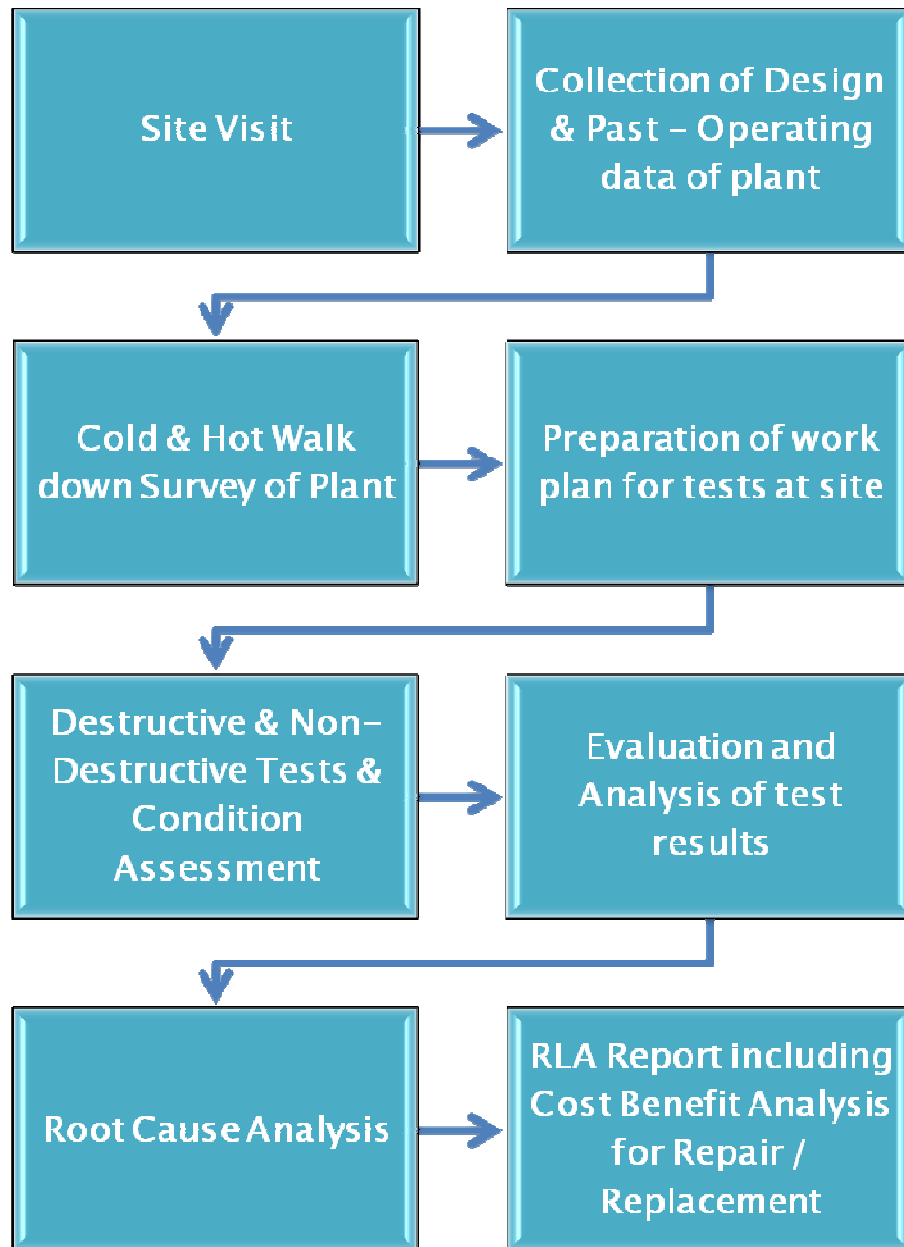
1.5 NEED FOR STANDARDIZATION

The large fleet of 200/210 MW units which are coming up for R&M provides an opportunity to standardize documents for tendering for R&M to ensure acceptable levels of quality and to harmonize the requirements of all the stakeholders to a reasonable level of satisfaction to permit efficient execution of projects in this crucial programme to meet the power needs of India.

1.6 SEQUENCE OF ACTIVITIES FOR R&M STUDY

The flow chart below indicates the major steps in carrying out a comprehensive R&M study.

FLOW CHART FOR R&M STUDY

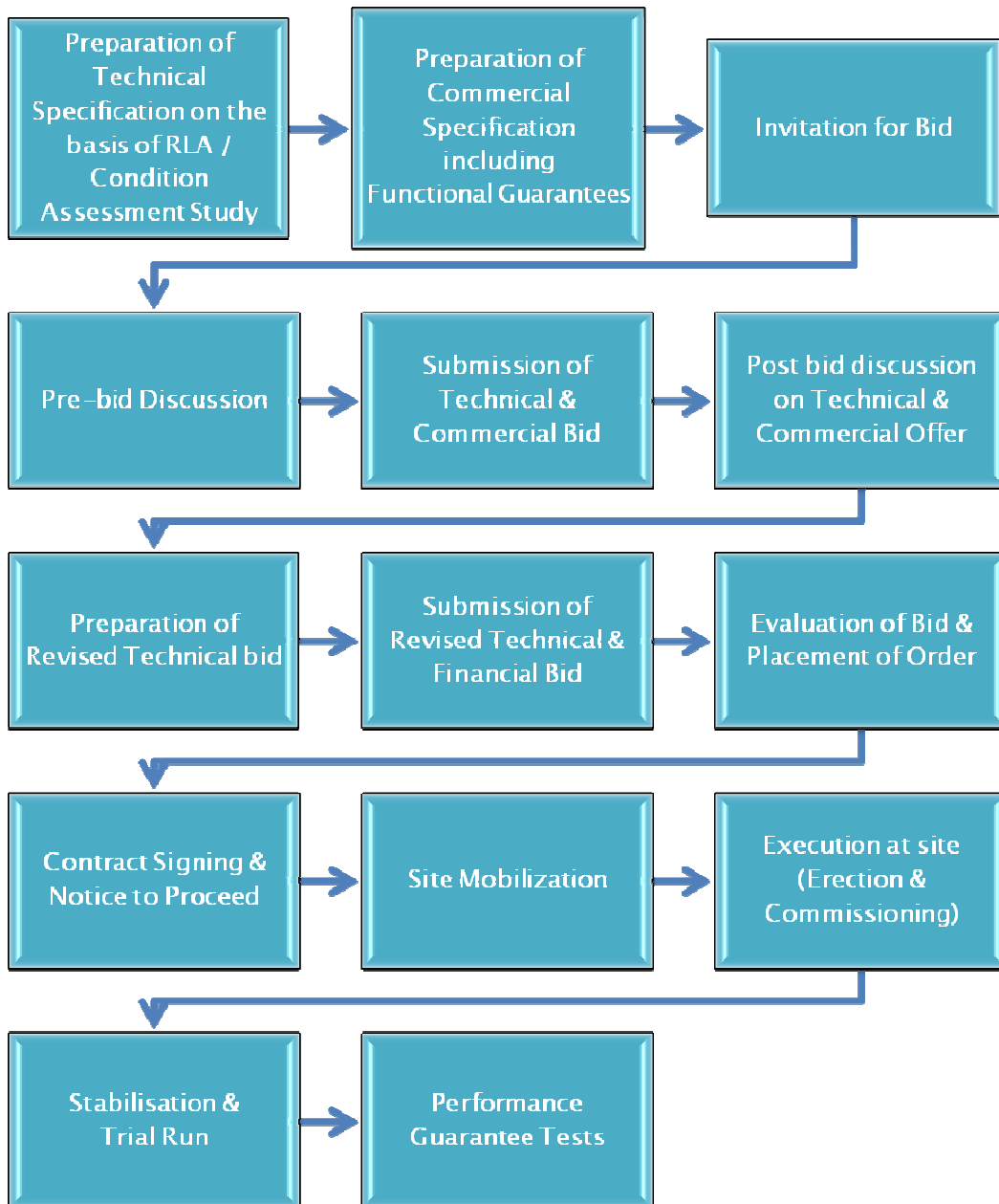


The above steps have to be taken in close coordination with the plant personnel since the historical information and special characteristics of operations need to be factored in while preparing the report.

1.7 ACCEPTANCE OF R&M REPORT

Following the acceptance of the R&M Report by the Owner, the subsequent steps are represented in the flow chart below.

FLOW CHART FOR R&M WORKS



1.8 NEED FOR STANDARDIZATION OF DOCUMENTS

The above sequence of activities bring out the different stages at which documents such as test reports, detailed project reports, technical specifications, tenders and contract become necessary. Lack of standardization of such documents has been seen to impede smooth and quick execution of R&M projects.

Standardization will assist, also, in opening the R&M market in India to International competition and providing the benefits of the latest technologies in the implementation of R&M projects.

Evonik Energy Services GmbH, Germany have constructed several large thermal power plants in Germany and other countries employing latest state of the art technologies. They are operating several plant with high levels of efficiency. Alongwith this involvement in construction and operation they have developed expertise in procurement procedures both for commercial as well as technical aspects of retrofitting older plants with latest developments. This expertise of Evonik Germany will be available for this assignment.

2. THE ASSIGNMENT

2.0 THE ASSIGNMENT

2.1 STRUCTURE

The assignment is structured in the following two distinct phases:

Phase I comprises an assessment of tendering procedures currently being followed by public utilities in India, and a review of the documents used for standard R&M projects and the documents which have already been developed for energy efficient R&M projects, particularly the World Bank financed project. Arising out of the assessment, suggestions for scope of work for Phase-II are to be prepared including model documents for R&M projects.

Phase II comprises the preparation of the respective model documents/templates.

This report covers the scope of work specified under Phase I of the assignment.

2.2 SCOPE OF SERVICES

The task 1 of Phase – I shall include a survey on the general tendering procedures to be followed by Indian utilities, including stipulations regarding requirements for floating tenders, timelines, bid evaluation and approval procedures, contract negotiations and award of contracts. This shall also include the review of typical modes of implementation, e.g. to what extent Consultants are hired to assist during the project preparation (feasibility study, technical specifications) and implementation (supervision), to what extent the utilities carry out works with their own staff and what performance guarantees are typically provided. The Consultant shall also briefly compare Indian and German / European tendering procedures.

The task 2 of Phase – I shall include the review of existing tender documents used by the respective Indian utilities for standard R&M / LE to the extent available. This shall cover technical and economical aspects. The Consultant shall define the areas where adjustments have to be made in order to incorporate energy efficiency aspects. The Consultant shall also define areas which are generally suited for standardization and suggest how a tender containing standardized packages for certain areas and plant-specific packages for the remaining works can be structured.

The task 3 of Phase – I shall include the level of detail to which standardization should be made, and the issues which should be left for a case-by-case

consideration. This will significantly affect the scope of the consulting assignment under Phase II.

The task 4 of Phase – I is to prepare a report which summarizes the results of the Phase I assignment and to suggest scope for Phase II of the study.

2.3 WORK PLAN

The following power utilities were found to have taken up R&M activities and were selected for the survey:

- Maharashtra State Power Generation Company Limited (MAHAGENCO)
- Chhattisgarh State Electricity Board (CSEB)
- Andhra Pradesh Power Generation Company Limited (APGENCO)
- Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVUN)
- Punjab State Electricity Board (PSEB)
- West Bengal Power Development Corporation Limited (WBPDCL)
- National Thermal Power Corporation Limited (NTPC)
- Haryana Power Generation Corporation Ltd.
- Madhya Pradesh Electricity Board
- Tamil Nadu Electricity Board
- Torrent Power Pvt. Ltd.

The available documents were obtained from these utilities with the help of CEA. Since the documents displayed a wide variety of approaches, it became necessary to develop a check list of items based on the procedures which were evolved during Consultant's own work with R&M studies for the World Bank and KfW. The available documents from the Utilities were then scrutinized to see to what extent they conformed to the check list. The results of the analysis are discussed later in this report.

3. TASK 1 – SURVEY

3.0 TASK – 1

3.1 SURVEY OF TENDERING AND CONTRACTING PROCEDURE

3.1.1 Basis of Survey of Tendering for Consultants

7 projects involving R&M & LE were considered in the survey for a detailed analysis of the tendering procedure for appointment of consultants. The procedures applied by the client when appointing Evonik Energy Services as consultant by World Bank and KfW financed projects were also considered even though the projects are still in the planning stages.

3.1.2 Methodology

The methodology followed is briefly stated below:

- Contacting the power utilities to ascertain their R&M & LE projects
- Collection and study of the reports and documents according to the power utilities and their projects.
- Identification of essential elements of the procedures followed. Discussions with concerned officials of the power utilities to gather information on use of Consultants and their views on the procedures and efficacy of methods used to carry out R&M.
- Creation of a checklist to verify the extent to which essential or desirable steps in the procedures were followed.

3.1.3 Consultancy Contracts Reviewed

Consultancy contracts for the following R&M & LE projects were reviewed:

- 3 x 210 MW Bokaro TPS
- 4 x 210 MW Korba West TPS
- 1 x 210 MW Nasik TPS
- 3 x 210 MW Kolaghat TPS
- 1 x 110 MW Bandel TPS
- 1 x 210 MW Koradi TPS
- 2 x 210 MW Patratu TPS

3.1.4 Scope for Consultancy Services

The comprehensive scope of work covers the following main items of work:

- a) RLA of all systems
- b) Condition assessment of all plant and equipment
- c) Energy audit
- d) Project Design Report/DPR
- e) Preparation of technical and commercial specifications
- f) Preparation of bid documents
- g) Assistance to Owner in pre-bid discussions, bid analysis and post bid discussions

In recent cases such as that of Chattisgarh State Electricity Board, the scope of work includes review of detailed drawings and supervision of PG test procedures.

3.1.5 Steps Involved in Appointing a R&M Consultant

- Notice inviting tenders
- Clarifications, modifications & amendments
- Technical bid evaluation procedure
- Financial bid evaluation procedure
- Negotiation
- Approval procedure
- Award of contract
- Contract form
- Signing of contract

The Commercial bidding document lays down the procedures and criteria for evaluation of the bids. These procedures and criteria vary with the Utilities/Owners. An analysis of the procedures may be seen in Annexure 1.

The following information emerges from the analysis:

- a. Expressions of Interest were invited for the World Bank project at Bandel and Koradi since they were on limited tender basis. Others were on open tender basis but the qualification criteria were mentioned in the tender document.

- b. In two cases, the NCB rules was followed. In the others ICB rules were followed. This included World Bank projects.

3.1.6 Extent to which Consultants are used in the Process

Power Finance Corporation (PFC), which was then a leading lending institution for R&M works, insisted on appointment of Consultants in order to take advantage of their specialized knowledge and experience. The State Utilities have, by and large, used these shortlisted Consultants for carrying out RLA, R&M and LE studies

After the reports became available, the State Utilities generally prepared their own technical specifications prior to floating tenders. However, of late, the practice is to have the technical specifications prepared by Consultants.

3.2 SURVEY OF THE PROCEDURES OF TENDERING FOR R&M CONTRACTS

3.2.1 The following Projects were considered in the survey

- 4 x 110 MW Kothagudem TPS
- 2 x 60 MW & 3 x 110 MW Ennore TPS
- 3 x 50 MW (Unit # 1, 3 & 4) Patratu TPS
- 2 x 210 MW (Unit IV & V, Main Plant Package) Badarpur TPS
- 2 x 110 MW (Unit #3 & 4) Bhatinda TPS
- 1 x 210 MW (Unit # V, BTG Package) Bandel TPS

METHODOLOGY

Based on the documents made available from the utilities, a check list was prepared to establish a typical sequence in the procedure for awarding an R&M contract. The procedures followed by the target utilities were then compared with the items on the checklist to analyse to what extent were the steps followed. The results may be seen in Annexure – 2

3.2.2 Results of the Survey

The survey revealed that procedures followed for tendering R&M works in India have evolved over time. Tendering procedures for carrying out R&M works followed by the Utilities varied considerably which included EPC and package

wise types of contracts. However, examples of the following specific methods were found in the survey:

Single Stage Tendering Procedure

- (i) with pre-qualification
- (ii) without pre-qualification

Two Stage Tendering Procedure

- (iii) with pre-qualification
- (iv) without pre-qualification

In the single-stage bidding procedure, bidders submit bids in one envelope containing both the price proposal and the technical proposal. The envelopes are opened in public at the date and time advised in the bidding document. The bids are evaluated, following approval process after which the contract is awarded to the bidder whose bid has been determined to be the lowest among the substantially responsive bids.

In the two-stage bidding procedure, bidders first submit their technical proposals, in accordance with the specifications, but without prices. The technical proposals are opened on the date and time advised in the bidding document. The technical proposals are evaluated and may be discussed with the bidders. Any deficiencies, extraneous provisions and unsatisfactory technical features are pointed out to the bidders whose responses are carefully evaluated. The bidders are allowed to revise or adjust their technical proposals to meet the requirements of the Utility/Owner. The objective of this process is to ensure that all technical proposals conform to the same acceptable technical standard and meet the technical requirements of the Utility/Owner. Bidders who are unable or unwilling to bring their bids to the acceptable technical standard could be rejected as non responsive bidders. After the evaluation of technical proposals has been completed, the next stage is to invite bidders to submit price proposals for the revised technical specifications in compliance with the acceptable technical standards which have been established. The revised technical proposals and price proposals are opened in public at a date and time advised by the Utility/Owner. In setting the date, the Utility/Owner allows sufficient time for bidders to incorporate the changes involved in the technical proposals and prepare price proposals. The price proposals and revised technical proposals are evaluated, and following acceptance, the contract is awarded to the bidder whose bid has been determined to be the lowest evaluated substantially responsive bid.

Qualification Requirements of Bidder for R&M Works

Each Utility/Owner adopts different types of Qualification Requirements to be fulfilled by the Bidder according to his own assessment and requirements of the works. In doing so, generally, the following aspects are given due consideration:

- Adequacy of technical knowledge and experience
- Engagement in regular manufacture and supply of equipment of the type specified.
- Continuity of ownership during the proposed period of execution of the works.
- Financial stability and status to meet the financial obligations to execute the works in terms of net worth, average annual turnover and availability of liquidity for the last 3–5 years.
- Capability and capacity to perform the works properly and expeditiously within the specified time schedule including installed manufacturing capacities, existing commitments, latest available technological considerations.
- Field service organization and arrangements to support the execution of the works.
- Quality assurance systems and organization.
- Documents establishing Bidder's eligibility and qualification.
- Documents establishing conformity of goods and services.

For each one of the bidding procedures above, there are two optional procedures for qualifying bidders.

Bidding following Prequalification:

This procedure is used when bidding is preceded by a prequalification exercise. This exercise is ordinarily undertaken for large or complex contracts or turnkey contracts to ensure, in advance of bidding, that invitations to bid are confined to capable firms. Prequalification is followed by a competitive bidding procedure in which only those firms meeting specified prequalification criteria are invited to submit a bid. All applicants meeting the specified criteria are allowed to bid.

Bidding without Prequalification:

For the procurement of smaller contracts the Utility/Owner may generally apply a procedure requiring bidders to submit the information pertaining to their qualification together with their bids. For this purpose, clear-cut, fail-pass

qualification criteria need to be specified by the Utility/Owner in the Bidding Document in order to enable bidders to make an informed decision whether to pursue a specific tender and, if so, either as a single entity or in joint venture.

Based on this analysis the following steps are seen as essential in selection of R&M contractor:

- Prequalification
- Notice Inviting tenders
- Clarifications, modifications & amendments
- Submission & opening
- Technical bid evaluation procedure
- Financial bid evaluation procedure
- Negotiations
- Approval procedure
- Award of contract
- Contract agreement form
- Signing of contract

The Commercial Bidding Document lays down the procedure and criteria for evaluation of the bids. These procedures and criteria vary among the Utilities/Owners. The evaluation procedure normally takes into consideration the following:

- Qualification requirements
- Conformity of the goods and services with the specifications
- Commercial deviations
- Technical deviations
- Work schedule
- Guaranteed declarations.
- Price adjustment on account of deviations
- Price bid evaluation.

4. COMPARISON OF INDIAN AND GERMAN / EUROPEAN TENDERING PROCEDURES

4. COMPARISON OF INDIAN AND GERMAN / EUROPEAN TENDERING PROCEDURES

The approach adopted in India is not comparable to the situation in Germany as continuous refurbishment and modernization is performed in Germany whenever required for reliable or efficient performance. In India, the compulsions for comprehensive R&M arise out of the fact that the plants are now operating on coal which is widely different from the design coal. In some cases the deleterious effect of the lower grade coal combined with neglect of major maintenance has led to a high degree of unreliability. The scope of work needed to restore the plant leads to a comprehensive overhaul and replacement requirement. Given the position, often Owners decide to utilize the opportunity of a long shut down for upgrading the plant's capacity and efficiency. In Europe adopting comprehensive R&M measures after 20 years of operation is not common. Modernisation of sub systems is generally done in packages (e.g. turbine and I&C) whenever economically justifiable.

Thus, tender documents in Germany normally do not cover all the areas of a plant but are specific to individual systems. Samples of such specifications received from our parent company pertain mainly to turbine or FGD retrofit to increase efficiency and to bring about CO₂ reduction.

Discussions with other companies such as EnBW and Eon indicate that renovation is done there on a case to case basis and is carried out in close interaction with a potential contractor who is pre-qualified. Original manufacturers have in some cases gone out of this business but new companies have come into business.

The basic differences between Germany and India in the approach to R&M are:

- (1) the detailed planning exercise done in Germany is undertaken before embarking on a renovation project to reduce plant shutdown to the minimum
- (2) comprehensive plant R&M is not a practice in Germany as it is in India
- (3) there is close association with the EPC contractor to formulate a detailed plan for renovation.

5. REVIEW OF THE SCOPE OF WORK AND TENDER CONDITIONS FOR CONSULTANTS

5. REVIEW OF THE SCOPE OF WORK AND TENDER CONDITIONS FOR CONSULTANTS

The scope of work varied considerably among the 7 projects whose documents were available. The analysis may be seen in Annexure 3.

5.1. The results of the analysis indicate the following:

The Power Finance Corporation (PFC) requires the R&M Consultant to carry out Residual Life Assessment (RLA) and Life Extension studies of boiler and auxiliaries, turbine and auxiliaries, coal handling plant, ash handling plant, water treatment plant, electrical system, control & instrumentation and other miscellaneous mechanical packages. R&M Consultant shall have to review plant history, original design and operational design and operational data, carry out walk down survey, condition monitoring, visual inspection, destructive and non – destructive tests on equipment/components, interpretation/evaluation of test results, root cause, cost benefit analysis and submit comprehensive study recommendations.

In recent projects financed by KfW, the R&M Consultant is required to critically review and update the existing Reports including Mapping Reports and other documentation concerning the operational history and technical condition of the plants. Consultant is required to study the earlier RLA reports, as available, and carry out condition assessment of the components by inspection and testing as applicable. NDT of some specific components shall be carried out in the available shutdown of the units. The Consultant is required to come out with his condition assessment and verify and review the same at the time of available shutdown. The Consultant is required to study the plant in details e.g. working specifications, capacities, limitations, special problems etc. He should have detailed discussions with plant operating and maintenance staff along with middle and top management and understand their problems and views regarding plant renovation. The aim should be to optimize all the technical and commercial aspects and decide a specific line of action for the scope to be finalized for the LE works.

World Bank requires that the R&M Consultant shall do the energy audit / base line assessment for the identified thermal power station. The RLA and R&M studies undertaken in the recent past by Owner/ Consultants shall be reviewed by R&M experts. Consultant has to undertake the non destructive tests for systems under study, unless such tests have been undertaken by

Owner/Consultants in the recent past. The Consultant shall analyze energy audit findings, the results of the past RLA studies along with present RLA/CA and performance test findings. The Consultant shall finalize and identify cause of decrease in efficiency, availability and power output of power plant. Thereafter a Project Design Report will be prepared with technical and financial feasibility options clearly defined in terms of scope and costs. This client is then required to choose an option and technical and commercial specifications are prepared, then, for floating a tender. The Consultant shall assist the Owner in pre and post bid discussions and evaluation of offers.

Chhattisgarh State Power Generation Company Limited requires the Consultant to do comprehensive RLA and CA study including all types of tests including cold and hot walk down survey, visual inspection, non-destructive, destructive, videoscopic / boroscopic testing etc. Evaluation and analysis of tests, root cause analysis and cost benefit analysis shall be done by the Consultant. On the basis of the above assessment and analysis, the Consultant will finalize the scope of R&M works to meet the enhanced plant capacity, efficiency and performance. The Consultant shall do the performance testing of different packages for the thermal power station to analyze the gap between the design parameters and operating parameters.

In general, all Owners use Consultants up to the stage of preparing a project report. The Owner may use the same Consultant for preparing the technical and commercial specifications for floating a tender. The Consultant may be asked, also, to assist the Owner to evaluate the bids and take part in the pre-bid and post-bid discussions. There are two cases where the Consultant has been asked to provide construction supervision services and supervision of the performance guarantee tests.

Since there is considerable variation in understanding of the scope of work involved as activities in preparing the deliverables, the subsequent paragraphs describe the contents of the documents which are the result of the R&M studies.

5.1.1 Contents of Energy Audit

The Consultant has to perform the Energy Audit in the following steps:

- Collection of data/information from the site.
- Review of operating parameters for the past three years and doing the GAP analysis comparing those parameters with the design data.

- Review of the outage and maintenance history and failure analysis data of the plant.
- Cause and effect approach to find out the sub-system defects generated in the GAP analysis.
- Re-engineering and re-powering solutions followed in similar units to avoid problems occurring most frequently.
- Realistic assessment taking into account not only past but future operation of the power plant,
- Energy audit will concentrate on following plant areas or functional units of the power plant:
 - Boiler including electrostatic precipitator, mills, air and flue gas system.
 - Water supply and water treatment.
 - Coal handling system.
 - Ash handling system including ESP.
 - Turbine auxiliary system.
 - Condensate and water system.
 - Cooling water system.
 - Raw water system.
 - Waste water management system.
 - Flue gas and water steam cycle analytical instrumentation.
 - Generator and generator auxiliary system.
 - Auxiliary electrical system.
 - Instrumentation & control system.

The energy audit report is the basis on which the scope for the R&M works is finalized.

5.1.2 Contents of Project Design Report/Detailed Project Report

The Consultant shall submit a detailed project report (DPR) with a root cause analysis in respect of deficiencies / flaws in various systems and shall identify the options for R&M with benefits. The Consultant should perform cost benefit analysis for each identified option. The Consultant should also develop a matrix comparing the different options with impact on parameters such as efficiency, PLF, life of the plant and fixed costs and variable costs. The DPR should clearly define the technical and economic goals of efficiency, availability and power output recovered. The scope of work for R&M works shall be defined in the

detailed project report with necessary broad bill of quantities. The content of the detailed project report should cover the following:

- a) Analysis of the RLA report.
- b) Observations / recommendations.
- c) Root cause analysis.
- d) Identify the option for R&M works.
- e) Cost benefits analysis for each option of R&M work.
- f) Scope of work with broad BOQ to analyse the cost with maximum accuracy.

6. REVIEW OF TENDER CONDITIONS FOR R&M & LE WORK

6. REVIEW OF TENDER CONDITIONS FOR R&M & LE WORKS

- 6.1. An analysis of the tender conditions for R&M works of 7 projects may be seen at Annexure 4.
- 6.2 The scope of work for R&M & LE work contracts indicates considerable variance in the 10 projects which were analyzed which may be seen at Annexure 5.

The results of the analysis indicate the following:

- a. Considerable variations in contract performance guarantee conditions
- b. Technical evaluation guidelines were announced in advance in some cases and in others not leaving scope for subjective assessment
- c. Financial leading was done in some cases without specifying the basis
- d. Variations in period of warranty
- e. In all cases, the actual optimal procedure was not clear since it was not specified

There appears to be considerable scope for standardization of the tender conditions.

7. IDENTIFICATION OF AREAS WHERE ADJUSTMENT NEEDS TO BE MADE TO ENSURE INCLUSION OF ENERGY EFFICIENCY ASPECTS

7. IDENTIFICATION OF AREAS WHERE ADJUSTMENT NEEDS TO BE MADE TO ENSURE INCLUSION OF ENERGY EFFICIENCY ASPECTS

The scope of work requires defining areas where adjustments have to be made for energy efficiency aspects. Given below are some typical measures related to energy efficiency taken up in the R&M works:

Boiler Pressure parts

- The boiler itself may be changed to membrane water wall type.
- Modified furnace bottom sealing system may be retrofitted to avoid air ingress.
- New bottom ash handling system may be retrofitted
- Modified up graded materials have been envisaged to meet better reliability in performance and reduction in boiler tube leakages.
- Better soot blowing system to obtain a clean boiler surface.
- New design coils with fins to minimize flow flue gas velocity to reduce erosion failure.
- Replacement of existing design of economiser coil to provide for better expansion to meet high ash content of presently used Indian coal .

Milling system and combustion control

- Since mills were designed for a better coal and the same coal was not available, major modifications may be carried out in milling system and combustion control equipments to meet the fuel demand and combustion requirements.
- New low Nox burner to meet environmental norms.
- Ceramic lines/ pulverized lines to get better life and reduce the leakages.
- New burners to get better life and utilizing latest technologies.

Flue gas system and Ash handling system

- Since the combustion and quantity of fuel burned has changed due to deterioration in coal quality, modification of flue gas ducts, supports, ash handling system may require to be retrofitted and the sizing of the fans may also be reworked and modified.
- Induced draft fans with either hydraulic coupling or with VVF drives are envisaged.
- Better secondary air control.
- Retrofitting dry ash evacuation system to achieve 100% ash utilization may also be considered.

Air preheater

- Retrofitting of latest technology with more advanced design
- In place of tubular, modular design is now preferred.
- Better flow modelling to achieve uniform velocity.
- Separation of primary air and secondary air to gain the better heat requirements.
- Rotary air heater with modified sector plates
- Better static seals
- Double lip rotary seal
- More expansion and better sealing to cater for load variation
- Better flow modelling to avoid flow channelling
- Better expansion joints to avoid excessive ID fan loading

Electro static precipitators

To meet the latest environmental norms for Suspended Particulate Matter (SPM):

- New modified ESP to be retrofitted
- New fields to be added
- Advance corona based microprocessor based control system to be introduced
- Advanced rectifiers to collect more ash
- Increase the retention time to achieve better efficiency
- Retrofitting new advanced spike electrodes, rotating electrodes to achieve the environmental norms

Turbine and feed water system

- Steam turbine efficiency improvement has been incorporated in R&M projects by introducing advanced blade design to reduce the surface and exit losses, modified shaft sealing, reduction in bearing losses and optimization of admission and exhaust sections, improvement in regenerative feed water heaters and control valves.
- New turbine internals with modified blades or the retrofitting of LP turbine may be considered.
- There can be an increase of about 1.8 to–3.8 MW increase by retrofitting the LP turbine by utilizing the thermodynamic energy of buoyancy steam.
- In order to attain the best result in the LP turbine, latest design tapered and forward leaning guide blades have been used which help to avoid the flow separation in the root area and lead to better output.

- By redesigning the exhaust, the exit pressure losses have been reduced and better output has been achieved.
- Technologically the cylindrical design blades i.e. with a constant profile over the entire length of blades are retrofitted with newly developed 3D blades using CFD modelling.
- This development of blade profiles has led to reduction in secondary losses and increase in power output and efficiency– these blades are known as Tx blades.
- The frequency control regime would require frequent load variation capability. The control system (electro–hydraulic control system) has been modified.
- Modification or re–tubing of condenser and introducing online tube cleaning mechanism are recommended.

Generator

- Normally, rewinding is considered with class F insulation to meet new temperature limits

Control system

- New control valves and actuators retrofitting
- Incorporation of new DCS system
- Retrofitting the On–line optimization system

Modification of BOP

- Necessary modifications to ensure system compatibility

8. THE AREAS WHERE STANDARDIZATION IS POSSIBLE AND WHAT NEEDS TO BE LEFT TO A CASE-TO-CASE BASIS

8. THE AREAS WHERE STANDARDIZATION IS POSSIBLE AND WHAT NEEDS TO BE LEFT TO A CASE-TO-CASE BASIS

Our study and review of the available project reports and tendering documents of the various utilities suggest that the level of detail to which standardization could be made and the issues which should be left for a case-by-case preparation need to be considered as under:

First – Essentials of the R&M Works to be undertaken become known only after and on the basis of the completion and findings of the studies such as Energy Audit, RLA, CA studies and these studies are to be done necessarily by specialized and experienced consultancy firms. This would ensure that the status is examined fully and the recommendations focus on the latest available technologies.

Second – There is enough scope for standardization of Terms of Reference (TOR) including Scope of Work of Consultant to be engaged by the Utilities intending to undertake R&M Works.

Third – Essentials of R&M Works are bound to vary depending on site conditions. The scope of works in a given bidding document, accordingly, needs to be adjusted to suit the requirements of each unit on the basis of the findings of the studies. However, given the large fleet of 200/210 MW units which require R&M, there is scope to have standard technical specifications particularly for the ‘Turbine retrofit’ and ‘C&I’ since this can be managed in about 3 or 4 options. The work pertaining to boiler varies considerably in scope and while there exists a case for some level of standardization; this can be left by and large to individual utilities to develop. A similar situation exists for balance of plant. However, there is enough scope for standardization of formats for Technical Specifications to be followed by the Utilities / Consultants for R&M Works.

Fourth – There is scope for reasonable level of standardization of the formats of the reports of the studies to be undertaken such as EA, RLA, CA, PDR/DPR, financial analysis etc. based on the studies conducted and reports available.

Fifth – There is a strong case for standardization of the various key issues such as Qualification requirement, Performance Guarantee requirement, Performance test procedures, Liquidated damages, Penalties & Bonus conditions, Shut-down requirement (time-line), which leads to delay in most of R&M tenders.

Sixth– There is a strong case for development of a standard commercial document for selection of R&M Contractor. The World Bank has published Standard Bidding Document in this regard and the same format could be considered as a guide.

The approach suggested above will help in the development of uniform documents and should be carried out in consultation with financial institutions such as World Bank, KfW and PFC in order that there is broad acceptability which would facilitate funding of R&M works.

9. SUMMARY OF RESULTS OF PHASE – I

9. SUMMARY OF RESULTS OF PHASE-I

The survey has indicated that the sample size for comprehensive R&M study is limited. There also appears little attempt in the past to bring about standardization of the procedures, scope of work and formats. R&M activities have been taken up primarily because the units were reaching a stage in which they could not be operated efficiently or reliably. In most cases, these were caused as a result of not receiving coal of the design value and in some cases out of sustained lack of maintenance. R&M was seen as a way to restore a unit at least to its rated capacity and by replacing or renovation to bring about reliable operation for the next 15 to 20 years.

The first comprehensive study of R&M needs was carried out at 2x210 MW Ropar TPS of the Punjab State Electricity Board. Thereafter World Bank has initiated studies in which the scope was based on the Ropar pattern . The additional features were those related to a more rigorous financial analysis and introducing provisions to cover the risks arising out of the surprises which may arise after the unit is dismantled. Similar approaches have been introduced by the Kfw funded projects coordinated by CEA for 3 sites.

The results of the survey of the documents related to appointment of consultants and the scope of work indicate a clear need to standardize procedures for appointment of consultants, the scope of work to be undertaken in the study and in presentation of the results including the financial analysis.

The results of the study of the documents related to the award of R&M works and the conditions of contract also point to the need to standardize the procedures particularly the commercial documents. A number of formats could be developed so that key issues are not lost sight of and bidders do not have to spend time and energy discussing the issues with each utility. Likewise the utilities , who are not all uniformly equipped to deal with the complicated commercial issues, would be relieved to have documents and formats which would comprehensively address the specific needs of R&M projects.

There does also appear to be no planned sharing of knowledge on the different aspects outlined above. Recent attempts by GTZ , Kfw and the World Bank in close coordination with CEA have clearly shown the potential which exists for knowledge sharing and developing common approaches for strategies for the large R&M challenges which exist in

India. Close to 2000MW should be addressed each year and with limited contractors to carry out the work in India, there exists a case to bring together all stake holders on a regular and urgent basis to make it an attractive market.

The implications that the R&M measures have on energy efficiency makes investment in the sector attractive from the point of the positive impact it has on climate change issues. This then is also an area to be addressed.

There is clearly a dearth of consultants equipped to competently analyse the inputs needed for R&M projects. It would be advisable to make the bidding process less cumbersome and define the scope of work clearly and also have a process in place to evaluate the competence of the bidders. In order to attract international players there is need to have a national mission on R&M setting targets for the next 10 years and making it obligatory for the stations to operate at a predefined minimum level of efficiency or else to phase out the units. At present only a fraction of the target plants are renovated and the planning in place does not indicate that there is a solution to fit the size of the problem.

The next section deals with the suggestions for studies to be undertaken in phase 2 of the project to deal with issues which have been uncovered by the Phase One study.

10. SUGGESTIONS OF WORK TO BE TAKEN UP IN PHASE – II

10. SUGGESTIONS OF WORK TO BE TAKEN UP IN PHASE – II

The following are the suggestions for work to be taken up in Phase – II:

- a. Standardization of documents relating to tendering and scope of work and commercial conditions for R&M consultancy and contracts
- b. Standardization of the technical and commercial specifications
- c. Standardization of the documents related to R&M works
- d. Study on the redesign of boilers to deal with the existing coal
- e. Study on the monitoring systems to ensure optimized operation of the plant after renovation
- f. Study on the human resource developments needs of the utilities to deal with the new technologies which need to be adopted to bring about greater energy efficiency
- g. Study to evaluate the mechanisms needed to bring all stakeholders to a common understanding of the challenges and the solutions to ensure that the target of renovating about 2000 MW each year is met at least cost .

A detailed note has been placed below regarding the scope for Standardization of documents. With regard to other studies, it is suggested that there should be focus group meetings with the concerned experts to develop terms of reference.

10.1 Standardization of Documents

A large number of 200/210/250 MW units are seen as ready for consideration for renovation since they have crossed 15 years of life. Subsequently a number of 500 MW units will become due for R&M. Given the potential, there is need to standardize procedures and documents.

The following procedures and documents are suggested to be considered for standardisation during the Phase–II activities:

1. **Request for Qualification (RfQ)** for Consultancy Services for R&M and LE Studies. This document should include standard formats for the following:

1.1 Prequalification Procedures

- 1.1.1 Letter of invitation
- 1.1.2 Instructions to applicants (ITA)

- 1.1.3 Qualification and evaluation criteria
 - 1.1.4 Application data sheet (ADS)
 - 1.1.5 Application forms
2. **Request for Proposal (RfP)** from qualified bidders including, in particular, the following:
- 2.1 Letter of invitation
 - 2.2 Instructions to Consultants
 - 2.3 Qualification and evaluation criteria
 - 2.4 Data sheet
 - 2.5 Technical proposal – standard forms
 - 2.6 Financial proposal – standard forms
 - 2.7 Terms of reference including plant data and information
 - 2.8 Standard forms of contract and annexure including:
 - Form of contract
 - General conditions of contract
 - Special conditions of contract
 - Appendices.
3. **Standard formats** may be developed for the following reports to be submitted by R&M Consultant:
- 3.1 RLA & LE /CA Report**
- 3.1.1 Feedback from plant operators system wise
 - 3.1.2 Failure record and trend analysis of last 10 years
 - 3.1.3 Major replacements in last 10 years.
 - 3.1.4 Condition assessment of each system and major equipment.
 - 3.1.5 Steam path audit of turbine.
 - 3.1.6 List of obsolete systems and equipment
- 3.2 Energy Audit (EA)**
- 3.2.1 Power consumption of all major equipment
 - 3.2.2 Performance check of all major equipment
 - 3.2.3 Efficiency calculation of all major equipment as per standard code
 - 3.2.4 Calculation of heat and mass balance
 - 3.2.5 Calculation of emission
- 3.3 Detailed Project Report (DPR)/Project Design Report (PDR)**
- 3.3.1 Chapterisation of the Technical volume
 - 3.3.2 Chapterisation of the Financial volume

4. **Standard Bidding Procedure** for engagement of R&M Works Contractor where:
 - 4.1 Single Stage Bidding Procedure is most suitable
 - 4.2 Two Stage Bidding Procedure is most suitable
 - 4.3 Prequalification is suitable
 - 4.4 Prequalification is not required
 - 4.5 For which International Competitive Bidding (ICB) is suited
 - 4.6 For which Local Competitive Bidding (LCB) is suited.
 - 4.7 For which combination of ICB and LCB is suited.

5. **Request for Qualification (RfQ)** for R&M Works Contractor where prequalification is considered suitable including, in particular, format for the following
 - 5.1 Prequalification procedures
 - 5.1.1 Letter of invitation
 - 5.1.2 Instructions to applicants (ITA)
 - 5.1.3 Application data sheet (ADS)
 - 5.1.4 Qualification criteria
 - 5.1.5 Application forms

6. **Request for Proposal (RfP)** for R&M Works Contractor including, in particular, the following:
 - 6.1 For single stage bidding
 - 6.1.1 Invitation for bid (IFB)
 - 6.1.2 Instructions to bidders
 - 6.1.3 Bid data sheet
 - 6.1.4 Evaluation and qualification criteria (following prequalification)
 - 6.1.5 Evaluation and qualification criteria (without prequalification)
 - 6.1.6 Owner's requirements
 - 6.1.7 Conditions of Contract and contract forms
 - General conditions (GC)
 - Special conditions (SC)
 - Contract forms.
 - Performance Security
 - Functional guarantees and liquidated damages

 - 6.2 For two stage bidding
 - 6.2.1 Invitation for bid (IFB)
 - 6.2.2 Instructions to bidders
 - 6.2.3 Bid data sheet

- 6.2.4 Evaluation and qualification criteria (following prequalification)
 - 6.2.4 Evaluation and qualification criteria (without prequalification)
 - 6.2.5 Bidding forms
 - 6.2.6 Eligible countries
 - 6.3 Owner's requirements
 - 6.6 Conditions of contract and contract forms
 - General conditions (GC)
 - Special conditions (SC)
 - Contract forms.
 - Functional guarantees and liquidated damages
7. Technical Specifications may be standardized to the extent given below:
- 7.1 Chapterization of boiler specification
 - 7.2 Standard specifications for turbine retrofit options to enhance efficiency/
output particularly for 210 MW LMZ turbines
 - 7.3 Grouping into appropriate contract packages with due consideration to: -
 - Complex nature and technically compatible aspects.
 - To ensure that the package can attract competitive response.
 - 7.4 General Technical Conditions
8. The Consultant should also prepare a matrix of options which the Owner can consider based on applicable conditions for each individual case and the objectives to be achieved. This would permit a phased program of renovating a particular unit since comprehensive R&M is seen as an option which requires huge investment and long duration of shut down - upto a year at times.
- In each sub system 3/4 options and benefits need to be considered. Indicative options are described below but Consultant may consider other options.
- 8.1 Boiler
 - 8.1.1 Minimum requirements applicable to all options.
 - 8.1.2 Option 1 - to regain original capacity, efficiency and improve availability
 - 8.1.3 Option 2 - Option 1 + improved efficiency
 - 8.1.4 Option 3 - Option 2 + increased generating capacity + extension of life by 20 years

8.2 Likewise, there should be a minimum of 3/4 options (including the common requirements for all options) based on the requirements to either restore or increase capacity/efficiency and extend life by 20 years for the following.

8.2.1 Turbine

8.2.2 Generator

8.2.3 Instrumentation and control

8.2.4 Balance of plant

ANNEXURES

ANNEXURE-1: ANALYSIS OF THE PROCEDURES FOR APPOINTMENT OF R&M CONSULTANTS

Sl. No	Item Description	Bokaro TPS, 3X 210 MW	Korba West TPS 4X 210 MW	Nasik TPS, 1X 210 MW	Kolaghat TPS 3X210 MW	Bandel TPS 1X 110 MW	Koradi TPS 1X210 MW	Patratu TPS 2 X 110 MW
1.0	Qualification Requirements					√	√	
	Description of the consulting firm	√	√	√	√	√	√	√
	Experience statement of the personnel in key positions	√	√	√	√	√	√	√
	Financial strength	√		√	√			√
	Experience in similar nature of job. / Handled the task assigned	√	√	√	√	√	√	√
	In case of JV, binding declaration is required.	√		√	√			
2.0	Notice Inviting Tenders							
2.1	Open Tendering	√	√	√	√			√
2.2	Limited Tendering					√	√	
3.0	Funding from own resource, loan/grant from bilateral, multilateral source, grant /loan from PFC / REC and others and from GOI.	grant from bilateral sources	own resources	grant from bilateral sources	grant from bilateral sources	PHRD grant from Govt. of Japan through GOI, & World	PHRD grant from Govt. of Japan through GOI, & World Bank	own resources

Sl. No	Item Description	Bokaro TPS, 3X 210 MW	Korba West TPS 4X 210 MW	Nasik TPS, 1X 210 MW	Kolaghat TPS 3X210 MW	Bandel TPS 1X 110 MW	Koradi TPS 1X210 MW	Patratu TPS 2 X 110 MW
						Bank		
4.0	TOR							
4.1	Objective	√	√	√	√	√	√	√
4.2	Method of Bidding							
4.2.1	NCB		√					√
4.2.2	ICB	√		√	√	√	√	

ANNEXURE-2: ANANLYSIS OF THE PROCEDURES FOR AWARDING OF CONTRACTS FOR R&M WORKS

Sl. No	Item Description	Kothagudem TPS, 4X 110 MW	Ennore TPS 2X 60 MW & 3X 110 MW	PATRATU TPS, 3X 50 MW (Unit No. 1, 3 & 4)	BadarpurTPS 2X210 MW (Unit IV & V), Main Plant Package	Bhatinda TPS 2X 110 MW (Unit No. 3 & 4)	Bandel TPS 1X210 MW (Unit - V), BTG Package
1.0	Qualification requirements						
1.1	Bidder to arrange loan for the Utility	√	√	X	X	X	X
1.2	The bidder should have at least executed refurbishment work and achieved specified output on the identical size or higher size elsewhere in India or anywhere in the world.	√	√	X	X	X	X
1.3	Profile of company	√	√			√	
1.4	Networth	√	√	√	√	√	√
1.5	Balance sheet / Turn Over	√	√	√	√	√	√
1.6	Reference list of similar work	√	√	√	√	√	√
1.7	Methodology	√	√	X	X		
1.8	Source of procurement of additional equipment, if any	√	√	X	X		
1.9	Manufacturer	X	X	√	√		√
1.10	EPC contractor	X	X	√	√	√	√
1.11	JV	√	√	√		√	√
1.12	IT clearance			√		√	

Sl. No	Item Description	Kothagudem TPS, 4X 110 MW	Ennore TPS 2X 60 MW & 3X 110 MW	PATRATU TPS, 3X 50 MW (Unit No. 1, 3 & 4)	BadarpurTPS 2X210 MW (Unit IV & V), Main Plant Package	Bhatinda TPS 2X 110 MW (Unit No. 3 & 4)	Bandel TPS 1X210 MW (Unit - V), BTG Package
1.13	History of non-performing contracts						√
1.14	Pending litigation						√
1.15	Current /ongoing assignment					√	√
2.0	Method of Bidding						
2.1	NCB	√	√			√	
2.2	ICB			√	√		√
3.0	Tendering Stages						
3.1	Single Stage Bidding	√	√	√		√	
3.2	Two Stage Bidding	X	X		√		√
4.0	Notice Inviting Tenders						
4.1	Open Tendering	√	√	√	√	√	√
4.2	Limited Tendering WITH QUALIFYING REQUIREMENTS						

ANNEXURE-3: ANALYSIS OF THE SCOPE OF WORK AND TENDER CONDITIONS FOR CONSULTANTS

Sl. No	Item Description	Bokaro TPS, 3X 210 MW	Korba West TPS 4X 210 MW	Nasik TPS, 1X 210 MW	Kolaghat TPS 3X210 MW	Bandel TPS 1X 110 MW	Koradi TPS 1X210 MW	Patratu TPS 2 X 110 MW
1.	Task of the Consultant defined							
1.1	Review the past History, Data, Analysis & reports	√	√	√	√	√	√	√
1.2	RLA, CA study	√	√	√	√	√	√	√
1.3	Energy audit	√	√	√	√	√	√	√
1.4	Evaluation of EA	√	√	√	√	√	√	√
1.5	Recommendation of R&M scope / DPR / Feasibility report including uprating	√	√	√	√	√	√	√
1.6	Support the other Consultant, like Environment Consultant, CDM etc.					√	√	√
1.7	Preparation of Tender documents		√			√	√	√
1.8	Assist client during bidding process		√			√	√	√
1.9	Bid evaluation		√			√	√	√
1.10	Supervise & evaluate PG test to be undertaken by R&M contractor.		√			√	√	√
2.0	Clarification /modification prior to	√		√	√	√	√	√

Sl. No	Item Description	Bokaro TPS, 3X 210 MW	Korba West TPS 4X 210 MW	Nasik TPS, 1X 210 MW	Kolaghat TPS 3X210 MW	Bandel TPS 1X 110 MW	Koradi TPS 1X210 MW	Patratu TPS 2 X 110 MW
	submission of bid							
3.0	EMD		√					√
4.0	Proposal format for Scope of services	√	√	√	√	√	√	√
5.0	Financial Proposal format	√	√	√	√	√	√	√
6.0	Terms of Payment	√	√	√	√	√	√	√
7.0	Time schedule	√	√	√	√	√	√	√
8.0	Evaluation of Tenders							
	Technical evaluation procedure	√		√	√	√	√	
	Financial evaluation procedure	√	√	√	√	√	√	√
9.0	Security		√					√
10.0	Deliverables	√	√	√	√	√	√	√
11.0	LD on account of delay	√	√	√	√	√	√	√
12.0	Availability of Contract Agreement form	√	√	√	√	√	√	√
13.0	Termination of contract	√		√	√	√	√	√

ANNEXURE-4: ANALYSIS OF TENDER CONDITIONS FOR R&M WORKS

Sl. No	Item Description	Kothagudem TPS, 4X 110 MW	Ennore TPS 2X 60 MW & 3X 110 MW	PATRATU TPS, 3X 50 MW (Unit No. 1, 3 & 4)	BadarpurTPS 2X210 MW (Unit IV & V), Main Plant Package	Bhatinda TPS 2X 110 MW (Unit No. 3 & 4)	Bandel TPS 1X210 MW (Unit - V), BTG Package
1.0	Bid security						
1.1	Fixed amount	√	√	√	√	√	√
1.2	% of estimated cost						
1.3	Exemption to Govt. Org.						
2.0	Validity of the tender						
2.1	120 days	√	√				
2.2	180 days			√	√	√	√
2.3	Additional time to on requested of utility, if required					√	
3.0	Contract performance Guarantee						
3.1	5%			√			
3.2	10 %	√	√		√		√
3.3	15%					√	
3.4	or more						
3.5	Valid upto	the Warranty Period with a claim period of Six months	the Warranty Period with a claim period of Six months	the Guarantee period & the same be released after 30 days.	90 days after the schedule defect liability period	90 days after the warranty period	The warranty / defect liability period

Sl. No	Item Description	Kothagudem TPS, 4X 110 MW	Ennore TPS 2X 60 MW & 3X 110 MW	PATRATU TPS, 3X 50 MW (Unit No. 1, 3 & 4)	BadarpurTPS 2X210 MW (Unit IV & V), Main Plant Package	Bhatinda TPS 2X 110 MW (Unit No. 3 & 4)	Bandel TPS 1X210 MW (Unit - V), BTG Package
		thereafter	thereafter				
4.0	Time Line						
4.1	Specified	√	√	√	√	√	√
4.2	Estimated						
5.0	LD on account of delay	√	√	√	√	√	√
6.0	Tender proposal format						
7.1	Experience,	√	√	√	√	√	√
7.2	Financial strength	√	√	√	√	√	√
7.3	Deviation	√	√	√	√	√	√
7.4	Price	√	√	√	√	√	√
8.0	Clarifications / modifications & amendments (Tech / Comm.)						
8.1	After Pre bid	√	√	√	√	√	√
8.2	On bidders query	√	√	√	√	√	√
8.0	Owner may modify at its own prior to submission of bid					√	
9.0	Submission & Opening						
9.1	Same day			√	√		
9.2	Different day	√	√			√	√
10.0	Technical Bid Evaluation Procedure for						

Sl. No	Item Description	Kothagudem TPS, 4X 110 MW	Ennore TPS 2X 60 MW & 3X 110 MW	PATRATU TPS, 3X 50 MW (Unit No. 1, 3 & 4)	BadarpurTPS 2X210 MW (Unit IV & V), Main Plant Package	Bhatinda TPS 2X 110 MW (Unit No. 3 & 4)	Bandel TPS 1X210 MW (Unit - V), BTG Package
	Single Stage						
10.1	Specific marking methodology specified	✓	✓				
10.2	General guideline on Owner's view for responsiveness			✓		✓	
11.0	Technical Bid Evaluation Procedure for two Stage						
11.1	Specific numbering methodology specified						
11.2	General Method on Owner's view for responsiveness				✓		✓
12.0	Financial Bid Evaluation procedure						
12.1	Without loading on completion cost basis.	✓	✓				
	Loading on certain parameters like			✓	✓	✓	✓
13.0	Warranty						
13.1	12 months after completion	✓	✓	✓		✓	
13.2	18 months				✓		✓
13.3	or more						
14.0	Provision of Negotiation						
14.1	Available						

Sl. No	Item Description	Kothagudem TPS, 4X 110 MW	Ennore TPS 2X 60 MW & 3X 110 MW	PATRATU TPS, 3X 50 MW (Unit No. 1, 3 & 4)	BadarpurTPS 2X210 MW (Unit IV & V), Main Plant Package	Bhatinda TPS 2X 110 MW (Unit No. 3 & 4)	Bandel TPS 1X210 MW (Unit - V), BTG Package
14.2	Not available	✓	✓	✓	✓	✓	✓
15.0	Approval Procedure						
15.1	Available						
15.2	Not available	✓	✓	✓	✓	✓	✓
16.0	Award of contract						
16.1	On price evaluation	✓	✓	✓			
17.2	Total tender evaluation (two stage)				✓	✓	✓
17.0	Standard contract agreement form available	✓	✓	✓	✓	✓	✓

ANNEXURE-5: SCOPE OF WORK AS GIVEN IN TECHNICAL SPECIFICATIONS FOR R&M WORKS

S.No.	Particulars	Identified Projects/ Thermal Power Station									
		Kothagudem Thermal Power Station 4x110 MW (APGENCO)	Patratu Thermal Power Station 3x50 MW(JSEB)	Amarkantak Thermal Power Station 2x120MW(MPEB)	Koradi Thermal Power Station 1x120 MW (MAHAGENC O)	Talchar Thermal Power Station Stage-1 (3X62.5 MW, NTPC)	Bhatinda Thermal Power Station 1x110 MW (PSEB)	Refurbishment of Obra Thermal Power Station 5x50 MW (UPSEB)	Badarpur Thermal Power Station (NTPC)	Ennore Thermal Power Station 2x60.3 MW (TNEB)	Bandel Thermal Power Station 1x210 MW (WBPDCI)
	Boiler and Aux.										
1	Boiler Drum internals	x	X	X	√	√	√	√	√	x	√
2	Low Temp Header	√	√	X	√	√	√	√	√	x	√
3	High Temp Headers	√	√	X	√	√	√	√	√	x	√
4	De-superheaters & attemperators	√	√	X	√	√	√	√	√	√	√
5	Air Preheater	√	√	X	x	√	√	√	√	√	√
6	Coal burners with air cooled burners	√	√	X	x	√	√	√	√	√	√
7	Slag Hoppers	√	√	X	x	√	√	x	√	√	√
8	Economiser Coils	√	√	X	√	√	√	√	√	√	√
9	Economiser Walls	√	√	X	√	√	√	√	√	√	√
10	Super Heater Tubes	√	√	X	√	√	√	√	√	√	√
11	PC Pipe	√	√	X	x	√	√	√	√	√	√
12	Raw coal feeder	√	√	x	x	√	√	√	√	x	√
13	seal air fan	√	√	x	x	√	√	√	√	x	√
14	Sling and Screen Tubes	√	√	X	√	√	√	x	√	x	√

S.No.	Particulars	Identified Projects/ Thermal Power Station									
		Kothagudem Thermal Power Station 4x110 MW (APGENCO)	Patratu Thermal Power Station 3x50 MW(JSEB)	Amarkantak Thermal Power Station 2x120MW(MPEB)	Koradi Thermal Power Station 1x120 MW (MAHAGENC O)	Talchar Thermal Power Station Stage-1 (3X62.5 MW, NTPC)	Bhatinda Thermal Power Station 1x110 MW (PSEB)	Refurbishment of Obra Thermal Power Station 5x50 MW (UPSEB)	Badarpur Thermal Power Station (NTPC)	Ennore Thermal Power Station 2x60.3 MW (TNEB)	Bandel Thermal Power Station 1x210 MW (WBPDCCL)
15	Cage Tubes	√	√	X	√	√	√	x	√	x	√
16	Reheater	√	√	X	√	√	√	√	√	√	√
17	Water Walls	√	√	X	√	√	√	√	√	√	√
18	Down comers	√	√	X	√	√	√	√	√	√	√
19	Ghoose Neck	√	√	X	√	√	√	√	√	x	√
20	Phosphate Dozing line	√	√	X	x	√	√	√	√	x	√
21	Sampling Lines	√	√	X	x	√	√	√	√	x	√
22	Recirculation line	√	√	X	x	√	√	√	√	x	√
23	Critical Piping(MS, HRH & CRH piping) between Boiler & Turbine	√	√	X	√	x	√	x	√	x	√
24	Hanger supports (MS, HRH & CRH piping)	√	√	X	√	x	√	x	√	x	√
25	Feed Water line	√	√	X	√	√	√	√	√	x	√
26	Soot blower piping	√	√	X	√	√	√	√	√	x	√
27	Valves(MS Stop valve, feed line valves and spray water valves)	√	√	X	√	x	√	√	√	x	√
28	Flue Gas Duct	√	√	X	x	√	√	√	√	x	√
29	Secondary Air Dampers	√	√	X	x	√	√	√	√	x	√

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30	Pulverizers	√	√	X	x	√	√	√	√	x	√
31	Milling System	x	√	X	x	√	√	√	√	√	√
32	HP/LP Bypass System	√	√	X	x	x	√	√	√	√	√
33	Fans (PA, ID & FD)	X	√	X	X	√	√	X	√		√
34	Fuel Firing System	X	√	X	X	√	√	X	√		√
35	Turbine and Aux.	√	√		√	X			√	x	√
36	Gland Steam System	√	√	√	√	X	√	√	√	x	√
37	Condensate System	√	√	√	√	X	√	√	√	x	√
38	HP Heater	√	√	√	√	X	√	√	√	x	√
39	Condenser	√	√	√	√	X	√	√	√	x	√
40	Aux. Steam System	√	√	√	√	X	√	√	√	x	√
41	Heat Exchangers	x	√	√		X	√		√	x	√
42	LP Heaters	x	√	√	√	X	√	√	√	x	√
43	HP Heaters	x	√	√	√	X	√	√	√	√	√
44	Vapour condensors	x	√	√	√	X	√	√	√	x	√
45	Deaerator	x	√	√	√	X	√	√	√	x	√
46	Generator	√	√	√	√	X	√		√		√
47	Automatic Voltage Regulator	√	√	√	√	X	√	√	√	x	√
48	DM Plant	√	x	X	√	X	X	x	x	x	x

S.No.	Particulars	Identified Projects/ Thermal Power Station									
		Kothagudem Thermal Power Station 4x110 MW (APGENCO)	Patratu Thermal Power Station 3x50 MW(JSEB)	Amarkantak Thermal Power Station 2x120MW(MPEB)	Koradi Thermal Power Station 1x120 MW (MAHAGENC O)	Talchar Thermal Power Station Stage-1 (3X62.5 MW, NTPC)	Bhatinda Thermal Power Station 1x110 MW (PSEB)	Refurbishment of Obra Thermal Power Station 5x50 MW (UPSEB)	Badarpur Thermal Power Station (NTPC)	Ennore Thermal Power Station 2x60.3 MW (TNEB)	Bandel Thermal Power Station 1x210 MW (WBPDCCL)
49	C & I	√	√	X	√	X	√	x	√	x	√
50	Air Conditioning System	√	√	X	√	X	X	x	x	x	√
51	Compressor and Services	√	x	X	√	X	√	x	x	x	x
52	Ventilation system		√						x		√
53	ESP	√	√	X	√	√	√	√	√	x	√
54	Water Impounded Hopper	√	x	X	x	X	X	x	x	x	x
55	Reblading & Reconditioning/Re placement of Turbine Internals	√	√	X	√	X	√	x	√	x	x
56	Uprating the 110 MW units to 120 MW units	√	x	X	√	X	X	x	x	x	x
57	Generator Stator Rewinding	√	√	√	√	x	√	√	√	x	√
58	Condenser	√	√	√	√	x	√	√	√	√	√
59	CHP and RC Bunkers	x	√	X	√	x	X	x	x	x	x
60	Electrical	x	x	√	√	√	√	√	√	x	x
61	CW system	x	x	X	√	x	√	x	x	√	x
62	cooling towers	x	x	X		x	X	x	x	x	x
63	Water Treatment	x	x	X	√	x	X	x	x	x	x

S.No.	Particulars	Identified Projects/ Thermal Power Station									
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	plant										
64	Structures	x	√	X	√	x	X	x	√	x	x
65	Ash handling System	x	x	X	x	x	√	x	x	√	x
66	Civil structures and architectural	x	√	X	x	√	√	x	√		x
67	Fire detection and protection system	x	√	x	x	x	x	x	x		√

X - Replacement / Modification / Upgradation is not required.

√ - Replacement / Modification / Upgradation to be considered.

Annexure 6: Overview of R&M in India

OVERVIEW OF R&M IN INDIA

6.1 GENESIS

The earliest coal fired units of 30/60/100/110 MW capacity and units of 200/210 MW size designed in the period 1960–1975 had certain design deficiencies and were less efficient. Additionally coal quality differed considerably from the designed value. This affected the performance and efficiency of these plants. The environmental pollution in and around the plant area increased because of high ash content and less efficient mechanical/electrostatic precipitators originally installed in these power stations. The R&M programs, therefore, initially addressed these problems related to poor performance arising out of the operating conditions.

6.2 STRATEGY

Phase-1 R&M Programme

The entire programme covering core activities for improving the performance was spread over 34 power stations. The neglect in maintenance and the deteriorating quality of coal led to a series of modifications and retrofitting on units of sizes 50/60/100/110/120/140 and a few 200/210 MW units. The core activities of boilers, turbines, control and instrumentation, various unit auxiliaries like mills, HP heaters, HP valves, etc., including station auxiliaries like coal handling plant, water treatment, ash handling plant CW system, etc., were covered for implementation. The programme was successfully completed during 7th Plan period. The R&M works related to environmental improvement were accorded high priority and about 47% of the total investment was made on environmental pollution control.

The salient features of the programme were :

- | | |
|---------------------------------|----------|
| • Total power stations covered | 34 |
| • Total thermal units covered | 163 |
| • Total power capacity involved | 13570 MW |
| • Average PLF before R&M | 46% |

• Anticipated additional generation per annum after completion	7000	MU
• Year of completion	1990-91	
• Total expenditure involved	Rs.1066 crores	
- Central loan assistance	Rs.402 crores	
- State plan resources	Rs.684 crores	
• Actual addition of generation achieved per annum	1000	MU
• Actual PLF achieved	56%	

The details of the units covered under the scheme are given in Annexure 7.

Phase-II R&M Programme

Encouraged with the results of Phase-I R&M programme, 44 thermal power stations in the country were taken up in the year 1990-91 for Phase-II of the programme. After detailed discussions with power plant operators and manufacturers of equipment, R&M schemes were firmed up for implementation.

The financing was transferred to the Central agency, Power Finance Corporation (PFC) who was assigned with responsibility to provide loan assistance to Power Utilities under a set of guidelines and financial norms. While Phase-I R&M programme covered the activities which arrested the deterioration of equipment due to neglected maintenance, Phase-II gave direction to select R&M activities on a more scientific basis and sound investment decisions. The salient features of the programme were:

Thermal power station covered	44
Thermal units covered	198
Total capacity involved	20870 MW
Estimated cost	Rs.2385 crores
Additional anticipated generation per annum after completion	7864 MU
Total expenditure incurred up to March 1997	Rs.862 crores
Additional anticipated generation per annum after partial completion of works (50%)	5000 MU/annum
Capacity taken up for life extension works	300 MW

The details of the units covered under Phase - II R&M in 7th Plan are given in Annexure 8.

The progress of works during the initial period was slow as poor financial health of power utilities could not qualify them for financial loan assistance from PFC.

R&M Programme during 9th Plan (1997–2002)

The pending works of R&M Phase-II and some additional works subsequently identified were covered in this programme. Details may be seen in Annexure 9.

Concerted efforts were made to cover more units for life extension (LE) programme based on RLA studies to ensure life extension.

The salient features of the programme were :

SI. No.	Particulars	R&M	LE
1.	Power stations covered	30	7
2.	Units covered	130	28
3.	Estimated cost	Rs.1138crores	Rs.1794 crores
4.	Power capacity involved	17935 MW	1910 MW
5.	Expected capacity after LE	–	1981 MW
6.	Average PLF of the units before R&M/LE	60.5%	48%
7.	PLF anticipated after completion	62%	75%
8.	Anticipated additional generation per annum	2350 MU	4500 MU
9.	Total expenditure covered till March 2002	Rs.651 crores	Rs.1028 crores
10.	Life extension works already completed	–	1343.5 MW

The details of the units covered under R&M and life extension programme in the 9th Plan are given in Annexure 10.

National Perspective Plan for R&M and Life Extension of Thermal Power Stations

With long-term planning in view, a National Perspective Plan up to 2012 for R&M and life extension of thermal power stations has been formulated. Based on the life of the plants, their past performance and the present condition, 35 thermal units have been identified for R&M and 106 thermal units for LE. These

are to be undertaken during 10th Plan. The details of these units are given in Annexure 11 and 12 respectively.

The cost and benefits from these units are given below:

Sl. No.	Particulars	R&M	LE
1.	Number of thermal stations	12	32
2.	Number of thermal units	35	106
3.	Estimated cost	Rs.750 crores	Rs.9200 crores
4.	Total capacity involved	6440 MW	10413 MW
5.	Average PLF before R&M/LE programme	58.5%	49%
6.	Anticipated PLF after completion	63.5%	75%
7.	Anticipated additional generation per annum	2800 Mu	23700 Mu
8.	Capacity expected after completion of life extension works	-	10747 MW

Similarly during the 11th Plan, 31 units with a capacity of 7090 MW would be taken up for R&M programmes to sustain the performance and 34 units with total capacity of 6000 MW are expected to be taken up for LE. The details of these units are given in Annexures 13 and 14 respectively. This would involve an expenditure of Rs.751 crores for R&M and Rs.6000 crores for LE programme.

6.3 INITIATIVES

Briefly stated, the initiatives taken by the Government of India (GOI), Central Electricity Authority (CEA) and Central Electricity Regulatory Commission (CERC) are as follows;

- Policy Guidelines on Privatized Renovation and Modernization of Power Plants issued by the Ministry of Power in October, 1995.and further request to the States made in July, 1996 for according highest priority to attract investment for renovation and modernization programme
- Guidelines for undertaking Renovation and Modernization and Life Extension works in respect of Thermal Power Plants issued by the Ministry of Power in January/February, 2004.

- The National Tariff Policy of the Government of India notified in February, 2005 noted that all the existing generation capacity should be brought to minimum acceptable standards and, for projects performing below acceptable standards, R&M should be undertaken as per well defined plants featuring necessary cost-benefit analysis.
- Draft Revised Guidelines for Renovation and Modernization/Life Extension Works of Coal (Lignite) based Thermal Power Station issued by the Central Electricity Authority in October, 2008.
- CERC (Terms and Conditions of Tariff) Regulations, 2009 notified in January, 2009 which covered provisions regarding renovation and modernization.

6.4 FUNDING SUPPORT

GOI initiated R&M activities during the 9th Plan which envisaged only short term measures. These activities were funded initially by CEA and later by Power Finance Corporation (PFC). Accelerated Generation and Supply Programme (AG&SP) undertaken by PFC during the 9th Plan included funding of R&M/Life Extension/Rehabilitation activities at concessional interest rate.

GOI considered that R&M offered a much cheaper and quicker way to add capacity in contrast to green field projects which involved long gestation period. R&M programme, therefore, needed to be given high priority. CEA and PFC continued to accord special attention and due priority for the Life Extension and R&M of older thermal units in the country during the 10th plan. International Funding Agencies such as World Bank, KfW also started showing interest for funding RLA and R&M activities of the old thermal units in the country. GOI National Electricity Policy (NEP), 2005 noted that all the existing generation capacity should be brought to minimum acceptable standards and R&M should be undertaken according to well defined plans featuring necessary cost benefit analysis.

6.5 CURRENT STATUS

There is a growing awareness of the need for renovation particularly after the unbundling of the State Electricity Boards resulting in more profit centre approach of the generating companies.

KfW and the World Bank have already gone a step further in identification of the projects and making specific allocation for R&M projects.

Annexure 7 : Details of units covered under phase-I R&M programme (7th Plan)

SI No	Board/ Utility	Name of station	Units & their capacity (MW)	Cost of completion (Rs. in lakhs)		
				CLA	State plan	Total
1	NTPC	Badarpur	3x100+2x210	0.00	3384.21	3384.21
2	DESU	IP	1x35+3x62.5+1x60	1301.86	3844.00	5145.86
3	HSEB	Faridabad	3x60	856.45	1351.86	2208.31
4	HSEB	Panipat	2x110	817.02	999.26	1816.28
5	PSEB	Bhatinda	4x110	2167.06	2180.50	4347.56
6	UPSEB	Panki	2x32+2x110	2514.00	1952.00	4466.00
7	UPSEB	Obra	5x50+3x100+5x200	4070.00	2700.00	6770.00
8	UPSEB	Harduaganj	3x30+2x50+4x60+1x110	3655.04	4639.96	8295.00
9	MPEB	Korba'E'	1x10+3x30+4x50+2x120	324.56	1461.47	1786.03
10	MPEB	Amarkantak	2x30+2x120	122.46	1277.26	1339.72
11	MPEB	Salpura	5x62.5+1x200+1x210	1752.68	2029.34	3782.02
12	GEB	Gandhinagar	2x120	902.14	788.07	1690.21
13	GEB	Dhuvaran	4x63.5+2x140	511.61	1134.26	1645.87
14	GEB	Ukai	2x120	544.59	1105.52	1650.11
15	MSEB	Koradi	4x120	966.88	1844.87	2811.75
16	MSEB	Nasik	2x140	462.62	113.03	575.65
17	MSEB	Bhusawal	1x62.5	61.63	8.97	70.60
18	MSEB	Paras	1x30+1x62.5	40.11	46.56	86.69
19	APSEB	Kothagudem	4x60+4x110	3042.00	6213.00	9255.00
20	APSEB	Ramagundam"B"	1x62.5	0.00	416.58	416.58
21	TNEB	Ennore	2x60+3x100	2698.35	9309.93	12008.28
22	TNEB	Tuticorin	3x210	645.00	216.00	861.00
23	NLC	Neyveli	6x50+3x100	0.00	5112.00	5112.00
24	OSEB	Talcher	4x62.5	2261.27	765.94	3027.21
25	DVC	Chandrapura	3x140+3x120	2125.00	4432.00	6557.00
26	DVC	Bokaro	3x50+1x55	1088.00	184.00	1272.00
27	DVC	Durgapur	2x55'+1x140	208.42	330.58	539.00
28	BSEB	Patratu	4x50+2x100+2x110	1149.24	4333.91	5483.15
29	BSEB	Barauni	2x15+2x50	1123.99	859.20	1983.19
30	BSEB	Karbigahia	2x1.5+1x3+1x7.5	500.76	84.17	584.93
31	WBSEB	Santaldih	4x120	1371.10	425.78	1796.88
32	WBSEB	Bandel	4x80	723.02	1984.12	2707.14
33	DPL	Durgapur	2x30+1x70+2x75	2154.75	100.80	2255.55

SI No	Board/ Utility	Name of station	Units & their capacity (MW)	Cost of completion (Rs. in lakhs)		
				CLA	State plan	Total
34	ASEB	Namrup	3x23+1x12.5+1x30	0.00	798.94	798.94
		Total	163 units (13570.5 MW)	40161.61	66428.11	106589.72

Source: CEA

Annexure 8 : Details of units covered under Phase-II R&M programme

SI No	Board/ utility	Name of station	Units & their capacity (MW)	Total capacity (MW)	Total estimated cost (Rs. lakhs)
1	NTPC	Badarpur	1-5(3x95+2x210)	705	14018.00
2	DVB	LP.	1-5(1x30+3x62.5+1x60)	277.5	1744.00
3	HPGCL	Faridabad	1-3(3x55)	165	1050.00
4	PSEB	Panipat	1-2(2x110)	220	1658.00
5	PSEB	Ropar	1-2(2x210)	420	2494.65
6	PSEB	Bhatinda	1-4(4x110)	440	2340.84
7	RSEB	Kota	1-2(2x110)	220	3904.00
8	UPRVUNL	Obra	1-13(5x50+3x100+5x200)	1550	14367.00
9	UPRVUNL	Panki	1-4(2x32+2x110)	284	2570.00
10	UPRVUNL	Harduaqanj	1-8(1x30+2x40+4x60+1x105)	455	3320.00
11	UPRVUNL	Parichtia	1-2(2x110)	220	1734.00
12	MPEB	Amarkanlak	1-4(1x30+1x20+2x120)	290	3674.00
13	MPEB	Korba (E)	1-6(4x50+2x120)	440	7710.00
14	MPEB	KorbaFW)	1-2(2x210)	420	940.00
15	MPEB	Satpura	1-9(5x62.5+1 X200+3X210)	1142.5	17707.17
16	GEB	Ukai	1-5(2x120+2x200+1x210)	850	3090.00
17	GEB	Gandhinaqar	1-2(2x120)	240	346.00
18	GEB	Dhuvaran	1-6(4x63.5+2x140)	534	2724.00
19	GEB	Wanakbori	1-3(3x210)	630	1544.00
20	MSEB	Koradi	1-7(4x115+1x200+2x210)	1080	6765.00
21	MSEB	Nasik	1-5(2x140+3x210)	910	12122.00
22	MSEB	Bhusawal	1-3(1x58+2x210)	478	4179.00
23	MSEB	Chandrapur	1-4(4x210)	840	4348.00
24	MSEB	Parli	1-5(2x30+3x210)	690	5416.00
25	MSEB	Paras	2(1x58)	58	998.00
26	TNEB	Ennore	1-5(2x60+3x110)	450	6486.00
27	TNEB	Tuticorin	1-3(3x210)	630	1043.00
28	TNEB	Mettur	1-4(4x210)	840	312.00
29	APGENCO	Kothagudem	1-4(4x60)	240	14171.00
		A' (OECF)			
	APGENCO	Kothagudem	1-4(2x105+2x110)	430	2903.00
		B' & 'C			
30	APGENCO	Nellore	1(1x30)	30	1385.00

SI No	Board/utility	Name of station	Units & their capacity (MW)	Total capacity (MW)	Total estimated cost (Rs. lakhs)
31	NLC	Neyveli	1-9(6x50+3x100)	600	25000.00
32	WBSEB	Kolaqhat	2-3(2x210)	420	2000.00
33	WBSEB	Santalditi	1-4(4x120)	480	8490.00
34	DVC	Chandrapura	1-6(3x120+3x140)	780	2722.00
35	DVC	Durgapur	1-4(2x75+1x140+1x210)	500	36481.00
36	DVC	Bokaro	1-3(3x50)	150	284.00
37	BSEB	Patratu	1-10(4x40+2x90 +2x105+2x110)	770	7583.00
38	BSEB	Barauni	1-4(2x50+2x105)	310	1577.00
39	BSEB	Muzaffarpur	1-2(2x110)	220	292.00
40.	ASEB	Bonaigaon	1-4(4x60)	240	880.00
41	ASEB	Chandrapur	1(1x30)	30	252.00
42	ASEB	Kalhaiguri & Golekv	1-7(3x2.705+4x2.705)	18.93	633.00
43	ASEB	Lakwa	1-4(4x15)	60	1777.00
44	ASEB	Namrup	1-5(3x23+1x12.5+1x30)	111.5	3268.00
	Total		198 unite	20869.4	238303.00

Source: CEA

Annexure 9 : Details of R&M schemes under implementation during 9th Plan

Sl. No	Name of the station	Units and their capacity (MW)	Total derated capacity (MW)	Total No. of units
1	2	3	4	5
1	Delhi			
2	Badarpur	1 to 5 (3x95+2x210)	705	5
3	I.P.	2 to 5 (3x62.5+1x60)	247.5	4
4	Haryana			
5	Faridabad	1 to 3 (3x55)	165	3
6	Panipat	1.3&4(3x110)	330	3
7	Punjab			
8	Ropar	1 to 6 (6x210)	1260	6
9	Rajasthan			
10	Kota	1 to 4 (2x110+2x210)	640	4
11	U.P.			
12	Obra	1 to 13 (5x40+3x94+5x200)	1482	13
13	Anpara	1 to 3 (3x210)	630	3
14	Maharashtra			
15	Nasik	1 to 5 (2x140+3x210)	910	5
16	Koradi	1 to 7 (4x115+1x200+2x210)	1080	7
17	Chandrapur	1 to 4 (4x210)	840	4
18	Bhusawal	1 to 3 (1x58+2x210)	478	3
19	Parli	1 10 5(2x30+3x210)	690	5
20	Khaperkheda	1 & 2 (2x210)	420	2
21	Paras	1 (1x58)	58	1
22	Chhattisgarh			
23	Korba (East)	3 to 6(2x40+2x120)	320	4
24	Korba (West)	1 to 40 (4x210)	840	4
25	Madhya Pradesh			
26	Satpura	1 to 9 (5x62.5+1x200+3x210)	1142.5	9
27	Amarkantak	1 to 4	290	4

Sl. No	Name of the station	Units and their capacity (MW)	Total derated capacity (MW)	Total No. of units
		(1x30+1x20+2x120)		
28	Gujarat			
29	Ukai	1 to 5 (2x120+2x200+1x210)	850	5
30	G. Naraq	1 & 2 (2x120)	240	2
31	Dhuvaran	1 to 6 (4x63.5+2x140)	534	6
32	Wanakbori	1 to 6 (6x210)	1260	6
33	Tamilnadu			
34	Tuticorin	1 to 3 (3x210)	630	3
35	Nellore	1 (1x30)	30	1
36	Karnatka			
37	Raichur	1 to 4 (4x210)	840	4
38	West Bengal			
39	Santalidih	1 to 4 (4x120)	480	4
40	Durgapur	3 & 4 (1x140+1x210)	350	2
41	Assam			
42	Chandrapur	1 & 2 (2x30)	60	2
43	Namrup	1 to 6 (3x23+1x12.5+1x30+1x22)	133.5	6
	Total		17935.5	130

Source: CEA

Annexure 10 : Life extension (LE) programme during 9th Plan

(A) LE works completed

Sl. No	Name of utility	Name of TPS	Unit No.	Capacity before LEP (MW)	Capacity achieved/ expected after LEP (MW)	Name of agency
1	APGENCO	Kolhagudem	1	60	60	M/s Mitsui & Co.
			2	60	60	
			3	60	60	
			4	60	60	
			5	105	120	M/s PPIL
2	TNEB	Ennore	3	110	110	M/s BHEL
			4	110	110	M/s Skoda Export and L&T
			5	110	110	
3	NLC	Neyveli	3	50	50	M/s Siemens-BHEL & M/sTPE-ABL
			4	50	50	
			5	50	50	
			6	50	50	
			7	100	100	
4	DPL	Durgapur	1	30	30	M/s PPIL
			2	30	30	
			3	70	77	
			4	75	77	
			5	75	77	
5	NTPC	Talcher	4	60	62.5	M/s Mitsui babcock
	Total		19	1315	1343.5	

(B) LE works completed

Sl. No.	Name of utility	Name of TPS	Unit No.	Capacity before LEP (MW)	Capacity achieved/ expected after LEP (MW)	Name of agency
1	APGENCO	Kothaqudem	6	105	120	M/s PPIL
			7	105	120	
			8	105	120	
2	TNEB	Ennore	1	60	60	M/s Skoda Export and M/s L&T
			2	60	60	
3	NTPC	Talcher	1	60	62.5	M/s Mitsui Babcock
			2	60	62.5	
			3	60	62.5	
4	HPGCL	Panipat	2	110	110	M/s ABB and M/s BHEL
5	CSEB	Korba (East)	1	40	50	M/s Alstom Power India Ltd.
			2	40	50	
			3	120	120	M/s PPIL
			4	120	120	
Total			9	1045	1117.5	
G.Total			28	2360	2461	

Source: CEA

Annexure 11 : Thermal units identified for R&M during 10th Plan

Sl. No.	Name of utility/ board	Name of station	Unit No.	Capacity (MW)	Make		Year of commissioning	Average PLF of years 1996-97 to 2000-01 (%)
					Boiler	TG		
1	2	3	4	5	6	7	8	9
1	UPRVUNL	Parichha	1	110	BHEL	BHEL	1984	26.82
2			2	110	BHEL	BHEL	1985	38.69
3	MSEB	Chandrapur	1	210	AVB	BHEL	1983	71.14
4			2	210	AVB	BHEL	1984	69.95
5			3	210	BHEL	BHEL	1985	74.64
6			4	210	BHEL	BHEL	1986	78.29
7	MSEB	Parli	4	210	BHEL	BHEL	1985	68.81
8			5	210	BHEL	BHEL	1987	72.64
9	MSEB	Khaperkheda	1	210	BHEL	BHEL	1989	75.91
10			2	210	BHEL	BHEL	1990	83.71
11	CSEB	Korba (West)	1	210	BHEL	BHEL	1983	60.50
12			2	210	BHEL	BHEL	1984	57.04
13			3	210	ABL	BHEL	1985	50.33
14			4	210	ABL	BHEL	1986	50.99
15	MPSEB	Satpura	6	210	BHEL	BHEL	1979	76.95
16			7	210	BHEL	BHEL	1980	65.01
17			8	210	BHEL	BHEL	1983	76.00
18			9	210	BHEL	BHEL	1984	74.48
19	KPCL	Raichur	1	210	BHEL	BHEL	1985	77.18
20			2	210	BHEL	BHEL	1986	75.77

21	WBDCL	Kolaghat	1	210	AVB	BHEL	1990	57.52
22			2	210	AVB	BHEL	1985	54.47
23			3	210	AVB	BHEL	1984	58.91
24			4	210	BHEL	BHEL	1993	53.85
25			5	210	BHEL	BHEL	1991	55.93
26			6	210	BHEL	BHEL	1993	58.73
27	DVC	Bokaro	5	210	ABL	BHEL	1986	43.13
28			6	210	ABL	BHEL	1990	48.15
29			7	210	ABL	BHEL	1993	20.33
30	JSEB	Patratu	9	110	BHEL	BHEL	1984	30.46
31			10	110	BHEL	BHEL	1986	25.83
32	BSEB	Muzaffarpur	1	110	BHEL	BHEL	1985	10.50
33			2	110	BHEL	BHEL	1986	20.50
34	ASEB	Bongaigaon	3	60	BHEL	BHEL	1985	14.76
35			4	60	BHEL	BHEL	1986	9.77
Total			35	6440				58.50

Source: CEA

Annexure 12 : Thermal units identified for life extension during 10th Plan

Sl. No.	Name of station	Unit No.	Present rated capacity (MW)	Capacity expected after LEP (MW)	Make		Year of commissioning	Average PLF of years 1996-97 to 2000-01(%)	Status
					Boiler	TG			
1	2	3	4	5	6	7	8	9	10
1	Badarpur	1	95	100	BHEL	BHEL	1973	74.24	RLA studies completed
2		2	95	100	BHEL	BHEL	1974	77.28	
3		3	95	100	BHEL	BHEL	1975	74.96	
4		4	210	210	BHEL	BHEL	1978	76.18	NIT published for R&M works
5		5	210	210	BHEL	BHEL	1981	77.90	
6	Panipat	1	110	110	BHEL	BHEL	1979	34.60	RLA studies completed
7		3	110	110	BHEL	BHEL	1985	33.21	
8		4	110	110	BHEL	BHEL	1987	48.06	
9	Faridabad	1	55	60	BHEL	BHEL	1974	56.10	RLA studies completed
10		2	55	60	BHEL	BHEL	1976	48.48	
11		3	55	60	BHEL	BHEL	1981	58.45	
12	Bhatinda	1	110	110	BHEL	BHEL	1974	68.90	RLA studies completed R&M works completed by M/s NASL
13		2	110	110	BHEL	BHEL	1975	72.04	
14	Bhatinda	3	110	110	BHEL	BHEL	1978	66.54	R&M works under execution by M/s
15		4	110	110	BHEL	BHEL	1979	69.47	

									BHEL
16	Obra	1	40	50	KKBW	LMW	1967	00.0	Unit-I der shut down 1 LOI placed with M/s TPE, Russia for LE works
17		2	40	50	KKBW	LMW	1968	29.10	
18		3	40	50	KKBW	LMW	1968	30.11	
19		4	40	50	KKBW	LMW	1969	33.45	
20		5	40	50	KKBW	LMW	1971	33.76	
21		6	94	100	BHEL	BHEL	1973	23.66	
22		7	94	100	BHEL	BHEL	1974	24.84	
23		8	94	100	BHEL	BHEL	1975	25.60	
24	Obra	9	200	200	BHEL	BHEL	1980	41.93	R&M works under execution by M/s BHEL
25		10	200	200	BHEL	BHEL	1979	36.58	
26		11	200	200	BHEL	BHEL	1977	37.84	
27		12	200	200	BHEL	BHEL	1981	37.36	
28		13	200	200	BHEL	BHEL	1982	52.29	
29	Panki	3	105	110	BHEL	BHEL	1976	38.61	
30		4	105	110	BHEL	BHEL	1977	48.78	
31	Harduaganj	1	40	50	ENE- RGO	ENE- RGO	1968	13.00	Unit 7 work awarded on M/s BHEL
32		3	60	60	BHEL	BHEL	1972	28.29	
33		4	60	60	BHEL	BHEL	1972	34.47	
34		5	60	60	BHEL	BHEL	1977	22.72	
35		7	105	110	BHEL	BHEL	1978	30.43	
36	Nasik	1	140	140	BA	CEM	1970	67.56	
37		2	140	140	BA	GEM	1971	63.47	
38	Paras	2	58.5	62.5	Polan d	IGE	1967	56.84	
39	Bhusawal	1	58	62.5	Polan d	Sieme ns	1968	54.72	
40	Koradi	1	115	120	AVB	Elekri m	1974	66.31	
41		2	115	120	AVB	Elekri m	1975	66.19	
42		3	115	120	AVB	Elekri m	1976	48.82	
43		4	115	120	AVB	Elekri	1976	48.44	

						m			
44	Parli	1	30	30	ITALY	BHEL	1971	82.80	
45		2	30	30	ITALY	BHEL	1972	75.11	
46	Kobra (East)	3	40	50	TAG	LMW	1968	74.96	Work executed by M/s Alstom Power Ltd.
47		4	40	50	TAG	LMW	1976	70.15	
48		5	120	120	AVB	BHEL	1976	55.99	Work executed by M/s PPIL
49		6	120	120	AVB	BHEL	1981	49.92	
50	Satpura	1	62.5	62.5	AVB	IGE	1967	78.06	
51		2	62.5	62,5	AVB	I6E	1968	74.26	
52		3	62.5	62.5	AVB	IGE	1968	66.85	
53		4	62.5	62.5	AVB	IGE	1968	73.35	
54		5	62.5	62.5	AVB	IGE	1970	69.44	
55	Amarkanta k	1	30	30	SG	AEG	1965	47.57	
56		2	20	30	SG	AEG	1965	38.71	
57		3	120	120	AVB	BHEL	1977	25.66	Work under execution on package base R&M
58		4	120	120	AVB	BHEL	1978	31.32	
59	Gandhi- nagar	1	120	120	BHEL	BHEL	1977	48.97	Work under execution by M/s BHEL
60		2	120	120	BHEL	BHEL	1977	48.14	

61	Dhuvaran	1	63.5	63.5	FW	IGE	1965	61.45	
62		2	63.5	63.5	FW	IGE	1965	61.30	
63		3	63.5	63.5	FW	IGE	1965	56.95	
64		4	63.5	63.5	FW	IGE	1965	59.34-".	
65		5	140	140	B&W.	IGE	19721	50.32	
66		6	140	140	B&W. US	IGE	1972	48.58	
67	Ukai	1	120	120	BHEL	BHEL	1976	38.07	Work under execution by M/s BHEL
68		2	120	120	BHEL	BHEL	1976	44.88	
69	Ennore	1	60	60	BHEL	BHEL	1970	62.75	Work executed by M/s Skoda Export and L&T in year 2002-03
70			60	60	BHEL	BHEL	1971	49.09	
71	Tuticorin	1	210	210	BHEL	BHEL	1979	68.78	
72		2	210	210	BHEL	BHEL	1980	82.85	
73		3	210	210	BHEL	BHEL	1982	83.26	
74.	Vijayawada	1	210	210	BHEL	BHEL	1979	86.96	
75		2	210	210	BHEL	BHEL	1980	85.67	

76	Kothagudem	6	105	120	BHEL	BHEL.	1974	56.90	Work executed by M/s PPIL
77		7	110	120	BHEL	BHEL	1977	61.08	
78		8	110	120	BHEL	BHEL	1978	59.96	
79	Santalhaldirih	1	120	120	AVB	BHEL	1974	34.57	
80		2	120	120	AVB	BHEL	1975	11.62	
81		3	120	120	AVB	BHEL	1978	36.40	
82	Bandel	1	80	82.5	B&W. US	WH. USA	1965	36.70	
83		2	80	82.5	B&W. US	WH. USA	1966	42.38	
84		3	80	82.5	B&W. US	WH. USA	1966	43.38	
85		4	80	82.5	B&W. US	WH. USA	1966	36.59 "	
86	Chandrapura (DVC)	1	130	140	CE. USA	IGE. USA	1964	36.72	
87		2	130	140	CE. USA	IGE. USA	1965	25.66	
86		3	130	140	CE. USA	IGE. USA	1968	44.43	
89		4	120	120	AVB	BHEL	1974	28.46	
90		5	120	120	AVB	BHEL	1975	20.91	
91		6	120	120	AVB	BHEL	1979	0.00	
92	Durgapur-DVC	3	140	140	B&W. US	GE.USA	1966	49.93	
93	Bokaro	1	45	57.5	CE. USA	GE.USA	1953	40.97	
94		2	45	57.5	CE. USA	GE.USA	1953	44.80	
95		3	45	57.5	CE. USA	GE.USA	1953	7.76	

96		4	40	50	TAG	LMW	1969	0.00	Under shut down w.e.f. 10/95
97		5	90	100	TAG	LMW	1971	37.97	
98	Patratu	6	90	100	TAG	LMW	1972	0.00	Under shut down w.e.f. 10/95
99		7	105	110	BHEL	BHEL	1977	15.05	R&M
100		8	105	110	BHEL	BHEL	1978	14.68	Consultancy in progress by M/s Evonik
101	Barauni	4	50	50	Poland	Poland	1969	0.68	Under shut down w.e.f. 4/96
102		5	50	50	Poland	Poland	1971	10.68	Under shut down w.e.f. 3/95
103	Chandrapur ASEB	1	30	30	MHI	MHI	1972	7.91	Under shut down w.e.f. 5/99
104	Namrup	1	23	23		USA	1965	39.61	
105	Bongaigaon	1	60	60	BHEL	BHEL	1981	0.00	Under shut down w.e.f. 6/91
106		2	60	60	BHEL	BHEL	1982	10.57	
	Total	106	10413	10747				48.80	

Source: CEA

Annexure 13 : Thermal units expected to be taken up for R&M during 11th Plan

Sl. No.	Name of utility/board	Name of station	Unit No.	Capacity (MW)	Make		Year of commissioning
					Boiler	TG	
1	2	3	4	5	6	7	8
2	MSEB	Chandrapur	5	500	BHEL	BHEL	1991
3			6	500	BHEL	BHEL	1992
4	MSEB	Parli	4	210	BHEL	BHEL	1985
5			5	210	BHEL	BHEL	1987
6	GEB	Gandhinagar	3	210	BHEL	BHEL	1990
7			4	210	BHEL	BHEL	1991
8	GEB	Wanakbori	4	210	BHEL	BHEL	1986
9			5	210	BHEL	BHEL	1986
10			6	210	BHEL	BHEL	1987
11	TNEB	Tuticorin	4	210	BHEL	BHEL	1992
12			5	210	BHEL	BHEL	1991
13	TNEB	Mettur	1	210.	BHEL	BHEL	1987
14			2	210	BHEL	BHEL	1937
15			3	210	BHEL	BHEL	1989
16			4	210	BHEL	BHEL	1990
17	NLC	Neyveli M/C	1	210	TE	TE	1988
18			2	210	TE	TE	1987
19			3	210	TE	TE	1986
20	TNEB	North Madras	1	210	BHEL	BHEL	1995
21			2	210	BHEL	BHEL	1995
22			3	210	BHEL	BHEL	1996
23	APGENC	Vijayawada	3	210	BHEL	BHEL	1989

Sl. No.	Name of utility/board	Name of station	Unit No.	Capacity (MW)	Make		Year of commissioning
					Boiler	TG	
1	2	3	4	5	6	7	8
24			4	210	BHEL	BHEL	1990
25			5	210	BHEL	BHEL	1994
26			6	210	BHEL	BHEL	1995
27	KPCL	Raichur	3	210	BHEL	BHEL	1991
28			4	210	BHEL	BHEL	1994
29	DVC	Mepa	1	210	BHEL	BHEL	1996
30			2	210	BHEL	BHEL	1997
31	TVNL	Tenughat	1	210	BHEL	BHEL	1994
32			2	210	BHEL	BHEL	1996
33		Total	31	7090			

Source: CEA

Annexure 14 : Thermal units expected to be taken up for LEP during 11th Plan

Sl. No	Name of utility/ board	Name of station	Unit No.	Capacity (MW)	Make		Year of commi- ssioning
					Boiler	TG	
1	2	3	4	5	6	7	8
1	PSEB	Ropar	1	210	BHEL	BHEL	1984
2			2	210	BHEL	BHEL	1985
3	RRVUNL	Kota	3	210	BHEL	BHEL	1988
4			4	210	BHEL	BHEL	1989
5	UPRVUNL	Paricha	1	110	BHEL	BHEL	1984
6			2	110	BHEL	BHEL	1985
7	UPRVUNL	Anpara	1	210	BHEL	BHEL	1986
8			2	210	BHEL	BHEL	1987
9			3	210	BHEL	BHEL	1988
10	MSEB	Nasik	5	210	BHEL	BHEL	1981
11	MSEB	Koradi	6	210	BHEL	BHEL	1982
12			7	210	BHEL	BHEL	1983
13	MSEB	Chandrapur	1	210	AVB	BHEL	1983
14			2	210	AVB	BHEL	1984
15	MSEB	Bhusawal	3	210	BHEL	BHEL	1982
16	MPSEB	Salpura	6	210	BHEL	BHEL	1979
17			7	210	BHEL	BHEL	1980
18	CSEB	Kobra (West)	1	210	BHEL	BHEL	1983
19			2	210	BHEL	BHEL	1984
20	GEB	Ukai	3	210	BHEL	BHEL	1979
21			4	210	BHEL	BHEL	1979
22			5	210	BHEL	BHEL	1985
23	GEB	Wanakbori	1	210	BHEL	BHEL	1982
24			2	210	BHEL	BHEL	1983
25			3	210	BHEL	BHEL	1984
26	WBPDC	Santaldih	4	120	AVB	BHEL	1984
27	WBPDC	Bandel	5	210	AVB	BHEL	1982
28	DVC	Durgapur	4	210	BHEL	BHEL	1981

Sl. No	Name of utility/ board	Name of station	Unit No.	Capacity (MW)	Make		Year of commi- ssioning
					Boiler	TG	
1	2	3	4	5	6	7	8
29	JSEB	Patratu	1	40	TAG.USSR	TAG.USSR	1966
30			2	40	TAG.USSR	TAG.USSR	1967
31			3	40	TAG.USSR	TAG.USSR	1968
32	BSEB	Barauni	6	105	BHEL	BHEL	1983 "
33			7	105	BHEL	BHEL	1985
34	BSEB	Muzaffarpur	1	110	BHEL	BHEL	1985
		Total	34	6000			

7th Plan: 1985-1990/92

8th Plan: 1992-1997

9th Plan : 1997-2002

10th Plan: 2002-2007

11th Plan : 2007-2012

Source: CEA