Expression of Interest

for

Engagement of Consultant

for

Preparation of

Detailed Project Report
for
R&M of coal fired Thermal Power Plants

February, 2013

Central Electricity Authority

Detailed Expression of Interest from Consultancy firms / Institutions for Empanelment with CEA, Ministry of Power, Government of India to provide consultancy in preparation of Detail Project Report (DPR) for Renovation and Modernisation in respect of Thermal Power Plants of various central / state power utilities.

1. General Information about the Project

1.1. Background

India has 120875 MW of coal-fired power generating capacity (57.3 % of total installed capacity) as on 31st December 2012 of which more than half is owned by state sector utilities. Renovation & Modernization (R&M) of existing plants is in many cases the least cost option for additional generation. Energy Efficiency oriented Renovation and Modernization and Life Extension (EE R&M / LE) of thermal power plants in India which leads to improvements not only with regard to the physical conditions of the plants´ equipment but also to improvements with regard to efficiency and operational behaviour of the whole power plant.

It is estimated that about 30,000 MW of the capacity is in need of R&M for improvement in PLF as well as heat rate by about 10-15 % thereby saving coal and corresponding reduction in CO_2 emission.

In order to determine the necessary and economical viable measures for the R&M/LE of thermal plants and to prepare the execution phase of the R&M/LE program one or several consultants are appointed who carry out feasibility studies and also prepare the Detailed Project Report (DPR) for the best suitable option for taking the R&M/LE interventions.

National Electricity Policy states that renovation and modernisation for achieving higher efficiency levels need to be pursued vigorously and all existing generation capacity should be brought to acceptable performance standards (of efficiency, reliability and environment performance).

In light of large and growing pool of plants requiring R&M, Ministry of Power suggested CEA to prepare a panel of consultants who would be assisting power utilities in undertaking the R&M works.

1.2. Objectives

The main objective of this notice is to prepare a list (Empanelment) of R&M/LE consultants who could be appointed as a consultant by various power utilities for preparing Detailed Project Report (DPR) for R&M/LE projects based on studies like Energy Audit (EA)/ Performance Evaluation Test (PET), Residual Life Assessment (RLA)/ Condition Assessment (CA), Financial Viability etc. during the **Phase-I assignment**. Tentative scope of Energy Audit, RLA/CA, and PET/TPT is furnished in Appendix-I and Appendix - II (Part A to G) respectively.

Further, if the power utility desires, the consultant engaged for Phase-I activity may also be required to assist the utility in preparing Technical specification, Bid Document, Bid evaluation, Order Finalisation for final selection of EPC contractor, Detailed Engineering, preparation of Quality Plan, Erection Supervision and Commissioning etc. for executing the R&M /LE projects during the **Phase-II assignment**.

Brief outline of work for which CEA is looking for consultants for empanelment is mentioned below.

Energy Audit will be done to identify the areas of heat rate degradation and higher APC in all major systems like steam and water cycle, Boiler and auxiliaries, Turbine and auxiliaries, Balance of plant equipments and Electrical systems. Performance assessment of major equipments in the plant will be done to assess the overall plant efficiency.

Identify and recommend proven latest state of the art technologies so as to help in operating the unit with increased efficiency and where ever feasible, up rating of its generating capacity. Proper pay back calculation shall necessarily be made for such recommendation.

2.0 Scope and Content of the Qualification Requirement (QR)

The consultant will conduct, supervise and complete the energy audit in a time bound manner. Presentation of the audit report will be made to the client and a draft copy will be submitted for comments. After incorporation of comments and approved by client the final report will be submitted. No. of copies of final report shall be as per requirement of the customer.

Tentative broad scope of work for Energy Audit of Power plants is as followings:

- Present performance level of all major equipments will be evaluated.
- Controllable losses will be identified.
- Remedial measure to restore the parameters will be suggested.
- Cost benefit analysis and payback period for expenditure incurred on remedial measures will be given.
- EA/RLA under scope of Appendix - I & II .

However, during actual execution of work the scope will be finalised by concerned power utility.

The evaluation of consultants will be done according to the process of post-qualification, i.e. the consultants shall submit the information concerning their qualification together with their main tasks handled over a period fulfilling the desired requirements. The qualification documents shall have the following structure and content:

i) A brief description of the consulting firm and its associates (if any), the corporate profiles and status.

ii) Statement of personnel structure (number and qualifications), summary experience, statement of personnel proposed for key positions for consultancy jobs in R&M / Energy Audits and implementation team with team leader, site manager, details for key personnel who will provide monitoring and back-up services, work experience indicating their specific knowledge and experience in handling the project**.** Curricula vitae of consultant's key personnel who will provide such services including monitoring and back-up services indicating their specific knowledge and experience in handling the project.

iii) Proof, that financial resources are deemed to be adequate in relation to the volume of services required. The consultants must prove that their financial resources are adequate, by presenting balance sheets and profit and loss accounts for the last three years. The consultants who submit no or insufficient documentation will not be considered for evaluation purpose.

iv) An outline of the firm and its associates (if any), recent (5 years) experience on assignments of

similar nature and the firm's working knowledge in India / abroad and summarising the consultants' qualifications and experience. Details on the composition, selection, administration and experience of the proposed team together with description of tasks to be assigned to each associate (if any) and within this to each professional. If firms are bidding jointly a binding declaration must be given who is the lead manager and what form the cooperation will take (joint venture, sub-contracting, other forms). A declaration of associated firms must be enclosed. This applies also to co-operation with local Consultant companies. The sole responsibility for the job lies with the lead manager.

v) Outline of experience on assignments of similar nature especially of 110/200/210 MW steam turbines.

It is required that the consultants shall observe the highest standard of ethics during the selection procedure. Consultants should be aware that any fraudulent or corrupt activity disqualifies them immediately from this project.

3.0 Evaluation of Pre Qualification Requirement (QR)

The selection of the Consulting firm for the empanelment for carrying out Phase-I activities i.e. preparation of the Detailed Project Reports will be made in accordance with the evaluation criterion as mentioned herewith.

3.1 Only those Consultants will be included in the selection whose qualification and financial resources are deemed adequate in relation to the volume of services required. The Consultants must prove that their financial resources are adequate. Consultants who submit no documentation or insufficient documentation on this will not be included in the evaluation process. The following criteria and their individual weightage in points will be considered for evaluation of the qualification documents:

S. No.	Criteria		Points
1.	**Evidence of relevant experience gained in the last 5 years:**		**Max Points: 70**
		i) O&M experience with coal fired power plants with capacity 100 MW and above (10%) ii) Experience in undertaking Energy Audit in the area of both heat rate and APC in coal based TPS 110 MW and above with records of proven implementation of recommendations (20%) iii) Experience in doing RLA / CA studies in coal based TPS 110 MW and above (20%) iv) Experience in preparation of DPR for R&M in coal based TPS 110 MW and above (10%) v) Experience in Financial analysis / Due diligence of R&M/LE and up-rating Projects 50 MW and above (10%) vi) Preparation of technical specifications of R&M projects for coal fired thermal power plants with unit sizes 50 MW & above (10%) vii) Experience of R&M studies with 110/ 200 / 210 MW pertaining to BTG (20%)	

2.	**Suitability for the specific project:**		**Max Points: 30**
	a)	Assessment of available technical expertise specific to this project (30%)	
	b)	Assessment of the personnel structure in regard to the tasks expected (30%)	
	c)	Assessment of the key personnel in permanent employment and always available to monitor the team and provide back-up services from the home office (20%)	
	d)	The form of the application documents: are they complete, concise and related to the project (20%)	
		Total	**100**

3.2 The evaluation of consultants will be carried out exclusively on the basis of the Qualification Documents submitted by them. The qualifying score for empanelment of consultants shall be

minimum to 70 point out of 100 (Max. Point).

4. Eligibility/ Qualification Criteria:

The Consultant intending to be empanelled for such above mentioned tasks should fulfil the following eligibility criteria and shall provide documentary evidence towards the following:-

4.1 The Consultant must be a registered legal entity in India (an organization, which is legally permitted to enter into a contract). Consultants may associate with each other in the form of a joint venture or of a sub-consultancy agreement to complement their respective areas of expertise, strengthen the technical responsiveness of their proposals and make available bigger pools of experts, provide better approaches and methodologies, such an association shall be for long term (independent of any particular assignment). Empanelment of such association shall cease on breach of their association. A binding declaration must be given who is the lead manager and what form the cooperation will take (joint venture, sub-contracting and other forms). A declaration of associated firms must be enclosed. This applies also to co-operation with local Consultant companies. The sole responsibility for the job lies with the lead manager.

4.2 The consultants shall be a approved agency by IBR for carrying out RLA studies. The consultants shall also be well acquainted with the Regulatory environment in the power sector, and functioning of Utility /Central or State Electricity companies, Central/Public Sector Units/ Central or state electricity regulatory commissions and possesses experience in dealing with such similar matters on wide range.
For the purpose of eligibility criterion the same can be demonstrated by submitting testimonials of successful work completion in power sector as a part of its response.

4.3 The Consultant must have completed at least one assignment of consultancy on R&M and Energy Audit in Power Sector with State / Central / CPSUs/ IPPs for value not less than Rs 30.0 lakhs (Rs. Thirty Lakhs only) or two assignments of Rs 15.0 lakhs each or three assignments of Rs. 10.0 lakhs each during the last 3 years ending last day of month previous to the one in which proposals are invited. Documentary evidence of above must be submitted along with proposals.
Assignments of Consultancy in Power Sector especially in field of Thermal Power Station shall only be taken into consideration for meeting up the qualifying criteria.

4.4 The consultant should have a minimum annual turnover of Rs. 50 Lakhs in each financial years of last three consecutive years or total turnover of at least Rs. 2 crores in last three years.

4.5 The Firm must have minimum 05 full time graduate / Post graduate engineers working in the firm out of which at least one must be Certified Energy Auditors. This certified Energy Auditors must have minimum 2 years of post certified energy auditor experience either in
"conducting Energy Audits or conducting performance efficiency testing of thermal power plant's equipment such as Boiler, Steam Turbine, Condenser, Heaters, Pumps and Fans etc." The firm should also have arrangements to get the services of area wise specialists for the purposes of R&M studies of Power plants.

4.6 The responder should submit its valid documentary proof for Sales Tax/ VAT Number, Service Tax registration number (if applicable) and the PAN No. etc.

4.7. A specific technical proposal indicating clear detail of all technical parameters related to the task shall be submitted along with the offer. The technical proposal should contain description of approach, methodology and detailed write up about how the activities can be done along with the case studies.

a. An indicative time schedule for carrying out each element of the task should also be submitted with justification for procedures to be adopted

b. A case study with complete scenario planning of how an agency is going to execute the above mentioned work for a utility should be attached with the proposal covering the scope of work briefly defined for the task as mentioned above.

4.8 Responses of responder (s) not fulfilling the eligibility criteria/pre-qualification conditions given above shall be summarily rejected.

4.9 CEA reserves the right to verify/confirm all documentary evidence submitted by responder(s) in support of above mentioned clauses of eligibility criteria. The consultant has to submit relevant documents to support the credentials, experience etc. Each page of the document should be signed by authorized signatory.

4.10 Empanelment shall be initially for a period of Three years, which may be renewed for further period(s) at the sole discretion of CEA after review of performance and feed back from client.

4.11 Empanelment with CEA does not confer any right to the agencies to be invited for participating in any bids, tenders etc. floated by Utilities.

4.12 CEA reserves the right to accept or reject any or all requests for empanelment without assigning any reason thereof.

4.13 The CEA reserves the right to waive off any shortfalls; accept the whole, accept part of or reject any or all responses to this EOI.

4.14 CEA reserves the right to cancel or annul the Expression of Interest (EOI) at any stage and call for fresh EOI.

4.15 CEA reserves the right to call for fresh tenders at any stage even if the EOI is in evaluation stage or the responders have been empanelled.

4.16 The Utilities reserves the right to procure /to avail services of any items in any task from sources other than those empanelled with CEA during the period of empanelment.

4.17 The responder shall bear all costs associated with the preparation and submission of its response, and CEA will in no case be responsible or liable for these costs, regardless of the conduct or the outcome of the EOI process.

4.18 The consultancy firm shall submit the reports of Energy Audit and RLA study in pre-described format prior approved by the client.

4.19 Submission of EOI Response

1) The consultancy firm/Institution qualifying under the above criteria should submit technical prequalification response containing documents in support of the eligibility criteria as mentioned above along with the following documents:

a) Eligibility Criterion Documents
b) Expression of Interest Performa-Form-I
c) Professional Experiences –Form-II, III & IV
d) Details of Methodology and work plan proposed-Form-V

2) EOI shall be submitted in a sealed cover super scribing "EOI for Empanelment of Consultants for preparation of DPR for R&M of TPS" and also clearly mentioning bidder's name and address.

5. Evaluation of EOIs

CEA will identify the eligible responders based on the evaluation of the technical pre-qualification response.

Whenever, any Power Utility desires services of empanelled parties would be required, the detailed work requirements along with technical details would be intimated to the empanelled agencies inviting their technical and financial bid. The empanelled agency would also submit their acceptance of the proposal along with terms and conditions / prescribed EMD at the time of submission of technical and financial bid to the utility in two separate envelop put in a single envelop. The utility may follow separate method also.

6. Last date for submission of EOIs :

1. Response should be kept in a sealed envelope, addressed to Chief Engineer, TRM Division, CEA, New Delhi-110019 and shall be dropped in the Tender box, which is placed in the office premises of CEA or may be sent by registered/ speed post in order to reach the CEA office within stipulated date and time. CEA would not be responsible for any misplacement /loss/late receipt of response.
2. Only complete EOI response received on or before the due date and time shall be considered. The EOI received by telegraphic/fax/email mode or incomplete or after due date or time shall not be considered.
3. The responses complete in all respects are required to be submitted latest by on or 31st March, 2013 up to 15:00 hrs and shall be opened on the same day at 15:30 hrs and the agencies or their authorized representative may, if they so desire, be present at the time of opening.

(N.S. MONDAL)
Director , TRM
CEA

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APPENDIX-I

Scope of Energy Audit / Performance Test for major mechanical and electrical equipments:

A) Boiler and its auxiliaries

a) Boiler

For assessment and calculation of Boiler efficiency tests will be made to determine the following:

(i) Steam generating capacity in kg/hr of steam at rated steam parameters at superheater outlet.

(ii) Steam generator efficiency at 100% TMCR (Turbine Maximum Continuous Rating) while firing coal at rated steam parameters.

(iii) Flue Gas velocity & Flue gas temperature shall be measured at various section of the pressure part.

(iv) Heat loss in dry flue gas

(v) Heat loss due to evaporation of moisture and H_2 in fuel

(vi) Heat loss due to moisture in air

(vii) Heat loss due to incomplete combustion

(viii) Heat loss due to un-burnt carbon

(ix) Heat loss in Ash (Bottom + Fly ash)

(x) Heat loss due to blow down

(xi) Heat loss due to radiation and unaccounted losses

(xii) Burner management system, combustion and excess air.

(xiii) Mill reject loss

(xiv) Effect of excess loading / power consumption of ID Fans.

(xv) Quantification of heat loss due to variation in Main & HRH Steam Parameters from Rated Conditions and higher RH / SH Spray.

(xvi) Effect of Coal Quality Variation in boiler efficiency

(xvii) Reasons of Part Load Operation

(xviii) Effect of Aging, if any.

b) Economizer

Effectiveness of Economizer will be checked.

c) Air heater

Monitoring of air pre heater performance involves measurement of several critical parameters to determine air heater gas side efficiency (how well the APH is transferring heat from the gas side to the air side). Following tests/ measurements are suggested:

i) The test shall include measurement of flow and temperature of air and flue gas at inlet & outlet of air-preheater. The test shall also establish air-in leakage in the air-preheater.
ii) Air side and gas side pressure loss across APH.
iii) Gas side efficiency.
iv) Air leakage as percentage of air passing from airside to gas side.
v) X-ratio i.e. heat capacity of air passing through the air heater to the heat capacity of gas passing across the air heater.
vi) Operation of soot blowers.

d) ID, FD, PA and Seal Air fans

Following tests/ measurements will be done:

i) Loading and combine efficiency of fan and motor and their specific power consumption, margins available & head at various points including maximum rating will be calculated.
ii) Performance Evaluation of Fans for comparison with its design and identify energy conservation measures such as Variable Speed Drive (VSD), Inlet guide vanes & Fibre Reinforced Plastic (FRP) Blades etc. and evaluation of fan operating as characteristic curve.

e) Coal mills

The Mill performance / capacity test shall be carried out on one mill of the unit. The test shall be carried out on the mill with max. wear of grinding parts. The test shall clearly establish the max. capacity of mills while maintaining pulverised coal fineness of 70% through 200 mesh. This test shall also record data on hot air condition (flow, pressure, temperature), temperature and coal/air ratio at classifier outlet under test conditions.

The following tests will be carried out for air balancing through the discharge pipes of Mills:

i) Clean air flow test
ii) Dirty air flow test to detect imbalance, if any, in the air and coal flows between the discharges pipes of a Pulverizer.
iii) Collect a representative, iso-kinetic, sample of pulverized coal from different pipes for determination of fineness fractions.
iv) Crosscheck the readings of the station instrumentation e.g. primary airflow through the mill, mill outlet temperature, coal flow through the feeder etc.
v) Accuracy of coal feeders to be measured.
vi) Particle size distribution test and mill efficiency.
vii) The Cold Air Velocity Test (CAVT) test is to be done.
viii) Measurement of Air to coal ratio

ix) Healthy ness of Mill reject system.
x) Study for mill upgradation if necessary.

f) Insulation

Surface temperature measurement at location of damage insulation and hot spot area for upgradation assessment.

g) ESP

Performance of ESP is to be measured.

i) Computational Flow Dynamics (CFD) study for ensuring uniform gas flow distribution with in ESP field.
ii) Optimisation study of TR controller with better control over 'Back Corona' for reduction in electrical energy consumption.
iii) Dust Load distribution study for reduction in outlet emission and improved SPM.

B) Turbine and its auxiliaries

a) Turbine

Performance testing is to be carried out on the following: -
Steam Turbine as per ASME PTC 6S

i) Heat rate.
ii) Turbine cylinder efficiency test by enthalpy method
iii) Capability test.

b) Condenser

Condenser performance test as per ASME PTC code.
This includes flood leak test, air ingress check by helium detection system to identify the reasons for low vacuum and suggest remedial measures accordingly.

c) Boiler feed pump, Condensate Extraction pump, ACW Pumps, DMCW/BCW Pumps

Following parameters will be measured:

(i) Comparing Measurement of flow at operating speed to design speed with that of expected flow.
(ii) Calculation of pump efficiency
(iii) Specific power consumption
(iv) Checking BFP Auto Re-circulation valve for passing during normal operation and for need of their replacement by Multi Stage Pressure reduction Valves
(v) Checking of System leakages, Excess recirculation and Discharge
(vi) The Discharge Head & Flow of the operation points of pumps measured during audit will be plotted on their design QH curves and the extent of deterioration determined for rectification / replacement of impellers

(vii) Study to recommend Energy Conservation measures e.g. use of Variable Frequency Drives (VFDs), Impeller changing.
(viii) Evaluation of pump operating point as per characteristic curve.

d) H P/ LP Feed water heaters

The purpose of Feed water heater tests is to assess the current performance and to provide data to assist in optimization of normal operation of the heater.
The tests will be carried out for HP / LP Heaters as per ASME PTC 12.1.

e) Ejector efficiency (if applicable)

(i) Operating efficiency of ejector will be checked and reasons for deterioration will be identified.

f) Passing of water / steam through valves

(i) Passing of water / steam will be checked using various relevant techniques.
(ii) Passing valves will be identified for rectification / replacement.

g) De-aerator

Deaerator performance to be checked for maximum dissolved oxygen content at deaerator outlet without chemical dosing at all loads. The same shall be determined as per ASTM-D-888 reference method A or indigo carmine method.

h) Vacuum Pump (if applicable)

The performance of vacuum pump and vaccum pulling duration.

i) Insulation

Surface temperature measurement at location of damage insulation and hot spot area for upgradation assessment.

j) General

The following will be checked in TG Cycle which is responsible for deterioration of performance. These may also be ascertained after proper checking of records/ historical data:

- If ejectors are being used for vacuum pulling, the impact of their replacement by Vacuum Pumps will be examined.
- HP / LP Bypass valves' passing
- HP / LP Heaters' individual / Group bypass valves' passing
- Passing of Alternate Drains' to condenser
- Steam / Feed water / Condensate leakages in TG cycle
- Condenser tubes' fouling / satisfactory operation of on line tube cleaning system if employed
- Air ingress to vacuum system
- Increased CW inlet temperature due to cooling tower problems in closed cycle
- Inlet / outlet gasket leaks of HP / LP Heaters
- HP /LP Heaters' tubes' leakages
- Heaters' Extraction / Drain valves' passing / stuck up problems
- Problems in maintaining Heaters levels
- Heaters' Extraction Steam High parameters
- Throttling due to oversize pumps in the system

• Pumps recirculation valve passing
• Insufficient Pumps' NPSH leading to inefficient operation / cavitations
• HP Heaters Outages / Performance Deterioration
• System Valves / Vents Passing
• Steam Leakages / Passing in Turbine Glands / Drain Valves etc
• Condenser Performance Deterioration
• Part Load Operation

C) Balance of plant equipments

a. Coal Handling Plant

i) Power measurement of all equipments like Coal crushers, Coal feeders, conveyers, wagon tippler/ any other unloading system etc.
ii) Idle running analysis

b. Ash Handling Plant

i) Performance test of all pumps by power and flow measurement
ii) Ash water ratio optimization

c. DM plant, Pretreatment Plant & Chlorination plant

i) Performance test of various system and equipment will be done to evaluate healthiness of DM plant, pretreatment plant and chlorination plant.
ii) Performance evaluation of various pump & equipments of water supply system.
iii) Evaluate specific energy consumption (KW/ M^3) of major water pump.

d. Air conditioning and ventilation

i) Performance evaluation of AC Plant with respect to net cooling capacity along with heat load of Air handling unit and energy requirements at the operating conditions vis-a-vis design condition to be determined.

e. Air Compressor

i) Capacity evaluation of compressor.
ii) Volumetric efficiency
iii) Specific power consumption.
iv) Pressure monitoring
v) Identification of leakage

f. Cooling tower :

Cooling Tower performance test will be carried out to determine

i) CW temperature as per design characteristic curve
ii) Healthiness of cooling tower fills, draft elements, water distribution system
iii) Fan efficiency
iv) Fan power consumption.

Recommendations for Energy Conservation measures like FRP fans, On-Off controls &VSD etc.

g. Water Balance Study

Water Balance Study will be done to establish water consumption for different application in Thermal Power Station and to identify and quantify the areas of losses and suggest ways and means for reduction in wastages.

Following assessments will be done:

i) Study of Ash water Consumption.

ii) DM water audit for assessment of loss, suggesting measures for improvement.

iii) Evaluate
- Water loss in the system
- Energy losses in the system
- Specific water consumption (Litre /kWh)

iv) Total water balancing of the plant
- Assessment of waste water quantity and its minimization by recycling, suitable treatment, and reuse in the plant system.
- Plant water consumption per MW of the plant

h) CW, Raw Water Pump

i) Comparing Measurement of flow at operating speed to design speed with that of expected flow.

ii) Calculation of pump efficiency

iii) Specific power consumption

iv) Checking of System leakages

v) The Discharge Head & Flow of the operation points of pumps measured during audit will be plotted on their design QH curves and the extent of deterioration determined for rectification / replacement of impellers

vi) Study to recommend Energy Conservation measures e.g. use of Variable Frequency Drives (VFDs), Impeller trimming / changing.

i) Intake / Raw Water supply system

Healthiness of the system to be assessed.

j) Potable water

Quality of potable water need to be assessed, measures for improvement to be suggested.

k) Electrical system

a) Transformer:-

Assessment of the health & Transformer load of GT, UAT, Station Service transformers etc.

Identification of possible Energy conservation options in this area.

b) Motors:-

i) Assessment of loading condition of HT and LT motors of Boiler area, Turbine area and balance of plant area.

ii) Assessment of operating parameters like load variation, power factor, of HT and LT motors consuming power more than 100 KW.

iii) Assessment of capacitor rating for PF correction of motors. Analysis for use of energy efficient motors.
iv) Identification of possible Energy conservation options in this area (with latest techniques).
v) Assessment of protection system of Generator, GT, UAT, ST, Motor, Feeders, all electrical control panels etc.

c) Plant lighting system
i) A survey of lighting will be done and areas of reducing power consumption for lighting will be identified.
ii) Determine if existing lighting level are higher than required level.
iii) Measurement of Lux level at Work Place to compare with reference standards and recommend energy conservation measures such as use of CFL, HPSV, HF Electronic ballast, Mirror optic luminaries, LED, Efficient lighting system controls, use of Timers / Photo cells / Occupancy sensors etc.
iv) Use of day light where ever and when ever feasible.

APPENDIX-II

SCOPE OF WORKS FOR RLA/CA STUDIES

1.0 Background

For assessment of the condition and remaining life of power plant components operating at high temperatures and at high stresses Residual Life Assessment (RLA) studies need to be carried out at regular intervals with a view to make RUN, REPAIR, REPLACE decisions and to avoid unplanned outages also reduction in planned outages. Residual Life Assessment of Power Plant components based on periodic examination of critical components is to be carried out involving the following :

A. To identify the critical areas where failures are likely to occur and select suitable NDE techniques for detection of such failures. Based on design criticality, past experience and previous failure information, suitable approach in inspection methodologies is adopted.

B. Various NDE techniques for detection of cracks, effects of corrosion / erosion etc. in addition to commonly adopted techniques such as Ultrasonic thickness gauging, Ultrasonic flaw detection, Penetrant testing, Fluorescent magnetic particle testing, Specialised techniques such as assessment of hydrogen damage by Ultrasonic, measurement of steam side oxide scale by in-situ ultrasonic, borosonic inspection of rotors, eddy current examination of rotor blades and root, video probe examination of critical components are employed.

C. Metallurgical tests such as in-situ metallographic using replica method, in-situ chemical analysis by metal spectroscope / X-ray fluorescence method, in-situ hardness measurement etc.

D. Sampling of component specimens for detailed laboratory analysis.

2.0 Intent of Study

The intent of the Residual Life Analysis and Life Extension Study is to achieve overall improvement in availability, reliability, efficiency as well as sustained operation of the plant for a reasonable period of time by carrying out Renovation & Modernisation (repair/ Replacement/ Retrofit/ Refurbishment) work based on the study. Life Extension work will be carried out based on the recommendations of the study and should ultimately help the plant in achieving following parameters.

- Improvement in Plant Load Factor.
- Improvement in Plant availability.
- Improvement of Station Heat Rate.
- Improvement of Turbine efficiency from present.
- Safe and sustained operation of the plant for next 25 years.
- Life extension for a period of 25 years.
- Statutory requirement on environment.
- Upgradation of safety practices.

3.0 Scope :

The scope of RLA / CA studies are given in subsequent chapters – Part "A" to Part "G".

4.0 Plant data and Information

The following data shall be furnished by the power utility:

- Technical particulars of the plant under study.
- Operating history and major events (happenings) from the date of first commissioning till date.

5.0 Responsibility of Owner

- To organize shutdown of the equipment and to arrange access to work site and permit to work.
- To hand over all documents/ log-books/ log-sheets/ drawings/ O&M manuals.
- To appoint coordinators for various areas.
- To provide office space, first aid services, Intercom phone facility to the extent available.
- To provide residential accommodation subject to availability on market rental basis.

6.0 Responsibility of RLA Vendor

- RLA – Vendor shall organize, if necessary, to dismantle the equipment under study, clean and components to the extent required for inspection, take measurements and record, and to assemble back the equipment.
- RLA – Vendor shall submit a detailed testing and inspection plan including destructive and non-destructive tests proposed along with testing procedure evaluation/ analysis criteria and clearance/ preparations required from the owner for the study. As far as possible, these procedures shall be based on Indian standard/ International standards. A recommended list of such standards is given in clause 4.0.
- RLA – Vendor shall ensure deployment of state-of-the art equipment most appropriate for testing and analysis technique being employed. The list of the various equipments proposed to be used by the RLA – Vendor shall be submitted to the owner. The list must give the name, make and sensitivity / accuracy of the equipment together with consumable to be used.
- RLA – Vendor shall be responsible for arranging all the equipments and consumable required during study/ tests.
- RLA – Vendor shall make his own arrangement for any work shop facility requirement.
- RLA – Vendor shall make his own arrangement of water/ power/ air supply to avail from the available nearest point.
- RLA – Vendor shall ensure of calibrated equipment/ instruments only. The calibration procedure followed must ensure the accuracy and reproducibility as per the Original Manufactures Certification and shall be done by the authorized test laboratories personal. The calibration certificates shall be submitted to the Owner.

- The personal/ operators employed for performing various test, checks and examinations shall have adequate qualification, knowledge and experience in their respective fields. The non-destructive testing personnel performing visual, dye penetrant, eddy current, magnetic particle, ultrasonic, radiographic examination shall be qualified and certified as minimum level-II in their respective fields in accordance with American Society of Non Destructive Testing qualification and certification of NDT personnel of SNT – TC – IA. The RLA-Vendor shall provide a list of personnel to be employed for the tests along with their qualification to the owner.
- RLA-Vendor shall carry out destructive and non-destructive tests on all the components as per the approved testing and inspection plan and submit the test results along with the report.
- The test results are to be analysed and evaluated using proper tools/ Computer software to estimate remnant residual life. The test results along with details of calculation should be submitted along with the report to the owner on Completion of the study.
- RLA-Vendor shall organize to take photograph of abnormalities/ defective components and submit the same along with report.
- RLA-Vendor shall be responsible for providing approaches/ platform/ scaffolding for the test portion.
- RLA-Vendor shall be responsible for shifting the equipment/ parts to convenient location for inspection and testing.
- RLA-Vendor shall responsible to cutting the test piece and re-welding work if any.
- RLA-Vendor can use existing EOT Crane subject to availability without any hindrance to TG set capital maintenance works.
- RLA-Vendor shall carrying out all preparation required for testing and to avoid any delay in work execution.
- RLA-Vendor shall make his own arrangement for Telephone, Fax and Transport of Men and Material.

7.0 Schedule of Study

The RLA/CA and Steam Path Audit are required to be carried out/ completed during the planned, capital overhaul of the unit. It is therefore necessary that all the inspections/ testing activities are completed within the specified period so that commissioning schedule of the unit is adhered to as indicated below :

- Outages
  The intended shutdown period will be decided by utility.
- Opening of equipment
  The owner will clearly indicate the schedule and responsibility of opening the equipment for facilitating inspection / tests/ checks by the RLA Vendor.
- Destructive and non-destructive tests
  The schedule of the tests to be performed should be decided appropriately by the RLA-Vendor in consultation with the owner to ensure that it corresponds with the opening of the equipment and is completed within the appropriate time frame.

RLA-Vendor shall commence the work within 5 days of the shutdown of the Unit and complete all the tests and inspection within specified days by utility from the commencement of RLA study.

- Evaluation of the test results / Preliminary Reports

RLA –Vendor shall clearly specify the time frame within which the evaluation of the test / inspection results shall be completed and preliminary reports submitted.

The schedule with macro (system wise) and component / equipment wise schedule shall be submitted by the RLA Vendor seven (7) days before start of test at site along with list of testing equipments and their calibration certificates.

8.0 Recommendations and Deliverables

8.1 Based on the completion of the Residual Life Assessment (RLA) / Condition Assessment (CA) and Performance Tests (PT) for various equipment, system, sub system of the plant as above, the Consultant shall submit a comprehensive 'Report' to the Owner. The report consists of all results, recommendations and improvement proposals, comprising following:-

1. The 'As Found' condition of components and the results of various tests/measurements.

2. Discussion of the test results and assessment of 'Remaining Life' of various components.

3. Recommendations with regard to repair of various components, as considered necessary.

4. Recommendation regarding replacement of various components, wherever considered essential, this recommendation shall be in three parts:

   (a) Components requiring immediate replacements

   (b) Components which will need replacements after Three (3) years

   (c) Components which will need replacements after Six (6) years.

5. Suggest measures for improvement of plant performance and up-gradation needed to achieve the original rated capacity / up-rating considering at least 7,500 hours of operation in a year at full load and extension of life by 25 years after R&M based on recommendations. These proposals shall be subdivided into:

   i) Root Cause Analysis
   ii) Immediate measures
   iii) Measures to be taken in future.
   iv) Improvement / change in O&M practices.
   v) Cost benefits analysis for the proposed measures.

6. The recommendation shall necessarily address the performance which includes to achieve rated or better efficiency, increase plant load factor, unit availability and reliability on sustained basis, reduction in auxiliary power consumption, increase safety of the plant and personnel and to meet current statutory environmental norms, reduction in auxiliary power consumption thereby meeting the overall objectives of RLA/R&M.

7. The recommendation shall cover all areas / limitations being faced by units in order to achieve rated capacity on sustainable basis taking care of specific problems of particular unit /units / system / plant based on performance history, plant operating conditions, records of maintenance, modification work done and of inherent /generic deficiencies being experienced for the last 10 years.

8. The recommendation must include, but not limited to various feasible engineering solution along with broad bill of quantity / scope of work / integration of system/equipment so as facilitate Owner to arrive at viable R&M plan.

8.2 Integrity of Civil foundations checking to be included along with required strengthening mechanisms (if any) in the deliverables.

8.3 Contractor shall carryout the performance testing on any one unit for various equipment / system(s) at the maximum achievable / agreed loads (to be finalized before testing) to assess the performance of the equipment / system.

Back up information justifying the above information as state below:

- Analytical tools used for analyzing the residual life / condition assessment and the report for same.
- Major assumptions made in the analysis.
- Conclusion based on the above analysis.

9.0 Applicable Code/ Acts and Standards

The work shall be performed in accordance with latest editions of applicable codes and standards. The RLA – Vendor shall also be responsible for obtaining all necessary approval/ clearances required under applicable codes / acts.

Applicable Codes/ Acts
Indian Boiler Regulation 1950
ASME Boiler Regulation 1950
ASME 831-1, 1995 for Power Piping code
ASNT-SNT-TC-IA-Qualification and certification of NDT personnel.

10.0 Improvement / change in O&M practices.

The RLA – Vendor during the course of the study shall identify the deficiencies, if any, in the O&M practices that might have resulted in the initiation / propagation of flaws and deficiencies in equipment / components. Accordingly, necessary recommendations shall be given regarding improvement in operation and maintenance (preventive, predictive) practices and re-inspection intervals for various power plant components.

11.0 Upgradation in safety and environmental practices

The RLA – Vendor, during the course of the study shall identify the deficiencies in prevailing environment and safety practices and suggest remedial action in case any deficiency is noticed.

12.0 Final Report.

RLA/CA - Vendor shall analyse the results of various tests conducted, findings and observations and submit 10 sets of final report to the Owner.

The final report shall consists of :

i) Recommendations (with detailed specifications) for upgradation / refurbishment / repair / replacement /retrofit along with cost benefit analysis, equipment wise and expected improvement in terms of Plant Availability, Plant Load Factor, MW Generation and Efficiency.

ii) Examination reports of all Destructive and Non-Destructive tests carried out in field as well as in Laboratory. These reports shall be properly identified so that these could be easily correlated to the component, location and stage of test, Preferably, all NDT reports shall be supplemented with location sketch and a colour photograph.

iii) Details of fundamental techniques, equations and tools/ techniques used in evaluation and analysis of the test results for the purpose of residual life / condition assessment.

iv) All material properties, stress analysis results, fracture mechanics calculation, inputs and assumption used in the analysis.

v) The report should contain recommendations for further inspection plan for critical components and its periodicity, suggestions for improvement on O&M practices.

vi) Justification of all assumptions made in the analysis.

vii) The final report should be formatted / presented in such a manner that all the data, back-up information could be easily correlated with the assessment / evaluation / predictions made.

viii) Copy of all the test standards must be enclosed with the respective test.

Daily progress report (3 copies) shall be submitted during testing at site to owner / retaining consultant.

Preliminary inspection and analysis results shall be provided to the Owner within 1 week after completion of the individual inspection / examination, Original copies of all other data and records that are used or could be used for defect evaluation shall become the property of the owner and shall be included in the preliminary report and in the final report.

Within 20 days of the last test / examination, the RLA – Vendor shall submit 10 copies of the Quality Assurance reviewed draft report for review by the owner. Subsequent to the owner's review (20 days), the RLA/CA – Vendor shall address the owner comments and submit 10 copies of a final report within 10 days.

A summary of findings, recommendations, and result of analysis, description of current condition, and predicted remaining life of each component shall be submitted by the RLA – Vendor. The description shall contain the reason or justification for the recommendation for each component.

Visual inspection (VE) results shall be described with location sketches and photographs (original) in each report as specified herein.

13.0 Further RLA Vendor may also required to suggest their views in the followings:

1. Details of the Energy efficiency improvement proposals with appropriate technology and energy savings in respect of Turbine and it's auxiliaries separately.

2. Expected increase in generation (proposal wise) in terms of million units after carrying out the improvement.
3. Whether the energy savings achieved through the Energy efficiency improvement project can be quantified without incurring any additional expenditure for the entire crediting period of 7-10 years.
4. Details of financial Investment, IRR etc., for implementing the proposals.
5. Details of technological, financial barriers etc., if any.

14.0. Safety Conditions:

1. The contractor shall provide all necessary personal protective equipments (as per ISI standard) to their workers like safety helmets, safety goggles, welding screen, hand gloves, safety belts, safety shoes, face mask etc., depending upon working condition & nature of job/ work and should be worn by the contractor and his workmen while at work.
2. All the appropriate and relevant safety measures stipulated under the factories Act 1948 and State factories rules made there under should be scrupulously complied with by the contractor and his workmen.
3. In case of any accidents/ injuries to the contract workers takes place due to non supply (or) Non-ISI standard safety equipments or due to careless working or due to improper handling of the equipment/ tools the same shall be at the risk and cost of the contractor only. customer will not be responsible in any way either legally or financially to the same and the contractor will have to pay compensation to his labourers in such case.
4. The contractor should not allow his workmen to wear loose garments like lungies, dhotis, and smoke cigarettes, beedies etc., while at work inside the plant premises.
5. No workmen below the completed age of 18 years should be engaged by the contractor for any works inside plant and no women works shall be allowed to work in night hours inside plant except between hours of 6 AM to 6 PM.
6. For any safety violation and non-compliance of the statutory acts and rules prescribed respectively under the factories act, 1948 and state factories rules made these under the contractor is liable for the imposition of penalty as decided by the utility depending upon the severity and gravity of the violation.

APPENDIX-II - PART -"A"

SCOPE OF WORK FOR RLA/CA STUDY – TURBINE AND ITS AUXILIARIES

1.0 Scope

The scope of study mentioned below is only indicative and in case the RLA- Vendor felt necessary to include test/ work, may do so to complete the Life Extension Study.

1.1 Terminal points

The scope of study shall cover the following equipment/ area.

- Turbine static components.
- HP/ IP/ LP Rotors.
- MSL piping after PRDS tapping upto turbine cylinders including hangers and supports.
- CRH piping from turbine parallel to PRDS tapping including hangers and supports.
- HRH piping from PRDS tapping upto IPT.
- Boiler feed water pipe lines from Deaerator to pump discharge up to PRDS floor including hangers and supports.
- HP/ IP Control Valves, ESV, IV, Quick closing and governing valves.
- HP and LP bypass valves.
- Extraction pipe lines and NRVs.
- All the welding joints in the MSL, HRH, CRH, HP/ IP By-pass in Turbine area including hangers and supports.
- Critical pipelines like MS, CRH, HRH along with Hangers and supports.
- Condenser tubes.

1.2 Review of Records, History of Plant and O&M Manual

The review of following shall be done and observations be recorded in the report.

1.3 Review of O&M manual

- Review of plant layout and equipment details.
- Recommended starting and loading procedure for cold, warm and hot starts.
- Design pressure and temperature.
- Design reactive loading and normal reactive loading.
- Recommended Feed water and superheated steam chemistry.
- Performance test report.
- Original material specification and properties.

1.4 Review of Records

- Log book/ log sheets details including DCS/recorder graphs and printouts.
- Generation, efficiency, plant availability, PLF, auxiliary power consumption, fuel oil consumption, DM water consumption, coal analysis.
- Operating steam temperature and casing metal temperature.

- Starting and loading practice since first commissioning vis-à-vis recommended procedure during cold, hot and warm starts.
- Variation from permissible operating range in respect of live steam temperature and pressure, vacuum, system frequency.
- Any abnormal operation like appreciable unbalance loading, single phasing, motoring.
- Feed water and super heated steam chemistry vis-à-vis recommended values.
- Preventive maintenance practice and record.
- Predictive maintenance practice and record.

1.5 History of Plant

- General behavior of the machine during first commission including abnormalities noticed and corrective actions taken.
- Details of forced outages since inception and reasons thereof, jobs carried out to bring back the machine and behavior of the machine thereafter.
- Past inspection results/ reports.
- Vibration history and records.
- Total operating hours, number of start-up, shutdown and load changes.

1.6 Hot and Cold Walk down Survey of the Plant.

1.6.1 Hot survey

- RLA – Vendor shall record name plate details & general description of all equipment under study.
- RLA – Vendor shall conduct survey of the equipment while in operation to ascertain condition of the machine and to identify problem area for detailed analysis and record all problems/ deficiencies/ abnormalities.
- RLA – Vendor shall interact with O&M personal regarding behavior of the machine and difficulties faced by them during course of operation and if any generic problem observed by them during initial stage of operation.
- Benchmark may be made in typical location piping system, hangers & supports, turbine total thermal expansion, generator rotor expansion to assess change/ travel/ deflection from hot to cold.

1.6.2 Cold Survey

- RLA – Vendor shall carry out inspection of all equipment under study, before dismantling, for detection of any visible abnormalities.
- RLA – Vendor shall carry out inspection of all components of assemblies and sub-assemblies of Turbine and Auxiliaries after those are dismantled, to observe general condition of the equipment/ components and for detection of any abnormalities. In case of detection of any abnormality, the observations shall be recorded in details and photographs be taken.
- RLA – Vendor shall take all important measurements like steam flow path, evaluation of remnant life along with other test results.

1.7 Details of Tests to be carried out :

1.7.1 Steam Path Audit

RLA – Vendor shall examine the entire steam path with a view to identify the reasons and quantify degradation in thermal performance of the Cylinder, heat rate/ efficiency of the turbine resulting from changes in steam seal clearances, changes in flow surface roughness, flow path deposits, solid particle erosion, mechanical damage etc.
The test provides the details of the Steam Path Audit (SPA) as follows:

- Interstage Packing
- Tip Spill Strips
- End Packing
- Steam Seal System Loss
- Cover Deposit
- Flow Path Damage
- Flow Change Impact
- Surface Roughness

1.7.2 Non – Destructive and Destructive Test

The non-destructive and destructive examinations/ tests, inspections, checks to be carried out are broadly indicated in the enclosed **Table – I**. The scope of tests/ inspection may not be limited to these tests/ inspections. The RLA – Vendor is free to add any other tests/ inspections also to judge the actual condition of the plant / equipment / component and to arrive at root causes of the deficiencies detected and correctly predict the residual life.

- Visual Examination (VE)
- Dimentional Measurements (DIM)
- Dye-penerate Examination (DPT)
- Magnetic Particle Inspection (MPI)
- Ultrasonic Examination (UT)
- Eddy Current Test (ET)
- Metallographic Replication including MS & HRH pipe lines (RPL)
- Hardness Measurement (HB)
- In-citu Chemical Analysis (CA)
- Boroscopic test for Turbine Rotors.
- Borosonic test for Turbine Rotors.
- Natural Frequency test on Turbine blades.

1.7.2.1 Visual Examination (VE)

All components shall be visually examined before and after cleaning the surface by using aids like illuminated low magnifying glass, mirror etc. for abnormalities namely, dimensional change, breakage, crack, porosity, erosion, corrosion, pitting deposits, if any on the components shall be collected and analysed for its composition.

1.7.2.2. Dimensional measurements (DIM)

The components liable for deformation or distortion due to wear/ creep namely, parting plane studs/ bolts, valve stem, bushing and bearings etc. shall be thoroughly cleaned and dimensions be measured to compare with original / previous record for any change. Components such as rotor outer diameter for creep and distortion, diametrical measurements on valve stem, bushings, bearings etc. for wear and lengths of fasteners shall be checked.
Accuracy of measurement shall be within 0.02. mm.

1.7.2.3. Dye – penetrant Examination (DPT)

Dye-penetrant Examination using coloured or fluorescent dye shall be used for detection of surface crack/ porosity/ discontinuity. The components subjected to high temperature and / or tensile stress namely, selected area of turbine rotors and casing, diaphragm, steam inlet pipe weld joints, strainer, valve body/ spindle/ seat, babbit bearing, generator rotor fan blades, retaining rings, shall be examined after thorough cleaning by dye-penetrant. Extreme care shall be taken during surface preparation to avoid closing of surface defects.

All relevant indications shall be reported by identifying their location, nature and size, on a sketch and/ or coloured photograph taken.

1.7.2.4. Magnetic Particle Inspection (MPI)

Magnetic Particle inspection using wet fluorescent method shall be employed for detection of surface and sub-surface crack/ discontinuity. The examination shall be conducted using continuous method i.e. the magnetizing field shall remain on while florescent particles are sprayed. These areas shall be examined under ultra violet light of adequate intensity. Magnetisation shall be done at least in two perpendicular directions to ensure detection of discontinues in all possible orientations. In case of detection of any crack, the depth shall be measured with the help of ultrasonic crack depth meter (Kraft Krammer make or equivalent). All relevant indications shall be recorded by identifying their location nature and size on a sketch and / or a coloured photograph taken. Cleaning of areas free from the testing fluid after completion of the test by the bidder.

The components subjected to high temperature and / or tensile stress namely, selected area of turbine rotor and casing (including moving & stationary blades), chest gland, steam inlet pipe weld joints, strainer, fasteners etc. shall be examined by MPI to check for any surface and sub-surface crack/ discontinuity.

1.7.2.5. Ultrasonic examination (UT)

Ultrasonic Examination method shall be employed for detection of sub-surface crack, loose bonding, material defect or any kind of discontinuity to ensure internal soundness of the components for further use. The examination shall be carried out on the

components namely, turbine rotor for bore inspection, for turbine shrunk-on discs in the region of grooves, pockets and key-ways, blade roots and slots in the discs where blades are fitted, generator retaining ring, babbit bearing castings, weld joints etc.

The RLA – Vendor shall submit detailed ultrasonic test and calibration procedure mentioning the instruments and type of standard calibration blocks proposed to be used. The instruments and the procedure proposed to be used must be capable of detecting smallest defects of cracks as small as 1.0 mm.

Prior to actual scanning, the testing system is to be calibrated and its calibration demonstrated to the owner for distance and also using a special bore calibration block containing cylindrical as well as flat bottom holes for amplitude correction.

For IP and LP rotors with shrunk on Discs, the ultrasonic procedure should also take care of fine cracks due to stress corrosion cracking in the region of grooves, pockets and keyways, blade roots and the slot in discs, prone for cracks.

1.7.2.6. Eddy current test :

Eddy current testing can detect very small cracks in or near the surface of the material, the surface need minimal preparation and physically complex geometries can be investigated. In a standard Eddy current testing a circular cell carrying current is placed in proximity to the test specimen. Eddy current testing uses electromagnetic induction to detect flaws in conductive material.

1.7.2.7. Metallographic Replication (RPL)

Metallographic examination by portable optical microscope and by surface replication technique shall be carried out to assess the present micro structural condition of the components namely, turbine casing, rotor, rotor disc, valve body etc. subjected to damage due to creep, temper embrittlement, stress corrosion and thermal fatigue (low cycle fatigue).

Replication technique is applied after preparing the surface at selected locations of the component to reproduce accurately the metallographic features such as distribution, size and morphology of the carbide precipitates and micro voids associated with early stage of creep damage, intergranular/ transgranular cracks typical in stress corrosion and temper embrittlement cases.
The locations selected for examination should be properly polished with portable equipment, etched with suitable chemicals for examination under portable microscope. The reverse image replicas of the metal surface should be taken on a plastic replicating film for detailed laboratory examination under light microscope up to 500 x magnification and scanning election microscope up to 5000 x magnification. The quality and reproducibility of the replicas should be checked at site by a portable optical microscope before sending these to laboratory.

1.7.2.8 Hardness Measurement (HB)

In-situ hardness testing shall be carried out on component operating at high temperature and pressure to examine extent of micro structural degradation due to thermal exposure and creep. The locations for hardness measurements should be selected based on results of various tests and visual examination. The measurements are to be taken using EQUOTIP Portable Hardness Tester or Kraut Krammer make ultrasonic hardness tester or equivalent.

However before using these equipments, their accuracy and reproducibility are to be demonstrated to the owner with the help of calibrated standard hardness test blocks**.**

1.7.2.9. In situ Chemical Analysis (CA)

In situ chemical analysis, a non-destructive technique, is to be employed for determining and categorizing the steel grade, with the help of radioisotope excited x – ray fluorescence analyser. Before using such analysers in field, its accuracy and reproducibility are to be demonstrated to the owner with the help of known chemical composition standard blocks. The RLA – Vendor shall provide details of equipment proposed to be used for chemical analysis along with its test procedure.

1.7.2.10. Natural frequency measurement (NFT)

The turbine blades shall be examined with NFT analyzer to Measure Natural frequency of blades to ascertain healthiness/ rigidity. At least 3 modes of natural frequency of the blades shall be determined/ measured.

1.7.2.11. Boroscope :

Capturing still photos and video from Boroscope inspection allow permanent archival of the inspection result during the nondestructive inspection. Long rigid boroscope of 3-5 Meters lengths are employed for examination of rotor bores for the presence of surface breaking defects.

1.7.2.12. Borosonic test :

A Borosonic inspection incorporate removal of the end plug, sand blasting the bore visual inspection, honing, dismensional testing to determine whether the ovality or tapering is evident, magnetic particle crack detection and an ultrasonic survey of the rotor shaft from within the bore.

1.7.3. Destructive Test (DES)

Destructive tests consisting of various analytical technologies may have to be performed on certain equipments/ components in certain cases. The RLA – Vendor

shall discuss the requirement of performing such tests with the owner and accordingly carry out the same. this may include the application of the following techniques :

- Metallography
- Measurement of significant mechanical properties.
- Microbiological / Bio-Chemical analysis
- Metallurgical Chemistry Analysis
- Atomic absorption
- X-ray diffraction
- Inductively coupled plasma spectroscopy
- Scanning electron microscopy
- Energy dispensive spectroscopy
- Scanning augur microanalysis
- Electron spectroscopy for chemical analysis
- Infrared, organic carbon and Bio-Chemical analysis.

1.7.4. Additional Test

The RLA – Vendor may suggest any additional tests which in their opinion shall be essential / necessary or advantageous in assessment of condition of the Turbine and their auxiliaries including Root cause Analysis and prediction of remaining life without claiming any extra cost.

1.8 Evaluation and Analysis of Test Results

RLA – Vendor shall carry out detailed evaluation of various tests/ inspections/ check performed by him to quantify the following information:

- Extent of damage/ level of flaw currently in the equipment/ component.
- The rate of damage accumulation / flaw propagation.
- The extent of damage required (additional operating hours, cycles) to cause failure of the equipment/ component.

TABLE -1

LIST OF TESTS / INSPECTION/CHECKS TO BE CARRIED OUT ON TURBINE AND ITS AUXILILARIES

List of indicative only and bidders / Consultants need to substantiate it wherever necessary to ascertain health of the component /equipment

Item No.	Components / location	NDES										DES	AT
		VE	DIM	DPT	MPI	UT	ET	RPL	CA	HD	FFT	HT		
1	MS &RH Steam Piping (bends)	x		x	x	x	x	x	x	x		x		
2	ESV (Steam side)- Body	x		x	x	x		x	x	x				
3	Stem & Bushing	x	x	x	x									
4	Valve cone & seat	x		x	x									
5	Strainer body	x			x	x		x						
6	Strainer element	x		x										
7	CV (steam side) – Body	x		x	x	x		x	x	x				
8	Stem & bushing	x	x	x	x									
9	- Valve cone & seat	x		x										
10	-Girth welds	x		x	x			x						
11	Extraction valves	x	x											
12	Turbine casing	x	x	x	x	x		x		x				
13	-casing welds	x		x	x			x						
14	Inlet nozzles chamber	x		x	x			x						
15	-Flange Ligaments	x		x	x									
16	-Parting Plane Fastener	x	x		x			x	x	x			x	
17	Lub oil holes in pedestals	x		x										
18	Turbine internals- liner	x	x		x									
19	-Diaphragm	x	x	x	x			x	x	x				
20	-Gland casing	x	x		x									
21	-Steam flow path	x	x											
22	Cross over pipe	x												
23	Turbine Rotor –Forging	x			x			x	x	x			x	
24	-HP gland area	x		x	x									
25	-Journal	x	x	x										
26	-Disc	x				x		x						
27	-Lacing Wire	x												
28	-Lacing wire brazing	x		x										
29	-Stellited tips	x		x										
30	-Locking slots	x						x		x				
31	-Key ways	x						x		x				
	Blade	x		x	x	x								
32	-overall surface													
33	-Tangential / Axial							x		x				

Item No.	Components / location	NDES											DES	AT	
		VE	DES	DPT	MPI	UT	RPL	HD	HV	ET	IMP	IR/PI	DCR	WTT	ELCID
34	-Blade attachments														
35	-Blade to blade attach area				x		x	x	x						
36	Tenon to shroud Attachment areas	x		x	x	x									
37	-Stationery blades	x		x		x									
38	Bearing	x	x	x		x									
39	Coupling bolts	x	x	x											
	Governing system elements														
40	-Main Shaft Pump	x	x												
41	-Aux. Shaft pump	x	x												
42	-Speed governor	x	x												
43	-Speed governor pilot stock	x	x												
44	-Intermediate pilot valve	x	x												
45	-Differentiator	x	x												
46	-Load Limiter	x	x												
47	-CV Servo Motor	x	x												
48	-Interceptor valve servomotor	x	x												
49	-Emergency governor	x	x												
50	-Emergency Gov. pilot valve	x	x												
51	-ESV Servomotor	x	x												
52	-ESPUG	x	x												
53	-EHT	x	x												
54	Condenser									x					

Non Destructive Test (NDES)

VE- Visual Examination
DIM- Dimensional Measurements
DPT- Dye-Penetrant Examination
MPI- Magnetic Particle Inspection
UT- Ultrasonic Examination
ET- Eddy Current Test
RPL- Metallographic Replication
RT- Radiographic Test
HD- Hardness Measurement
CA- In-situ Chemical Analysis
FFT- Natural Frequency Measurement
ELCH- Core Flux test/ Core lamination imperfection detection test
TDT- Tan-Delta Test
HV- High Voltage

Destructive Test (DES):

Metallography
Measurement of mechanical properties
Microbiological / Bio-Chemical analysis
Metallurgical Chemistry Analysis
Scanning Electron Microscopy
Creep / Stress Rupture testing
X-ray diffraction analysis
Electron Spectroscopy for chemical analysis

APPENDIX-II - PART -"B"

SCOPE OF WORK FOR RLA / CA STUDY – BOILER AND ITS AUX.

The broad but not limited to scope of study for boiler are as follows:

1.0 Boiler

Sl.No.	Component	Type of Test / Inspection	Location & Number of Tests
1.	Economiser System		
1.1	Feed Water Piping	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - In-situ Metallography and Hardness Measurement (HB) - Cold & Hot Walk Down Checks on Hangers - Metallographic Replication (RPL)	As prescribed by the customer
1.2	Eco inlet Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - DPT on Hand Hole Plate Welding	As prescribed by the customer
1.3	Economiser coils (Upper Bank & Lower Bank)	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - Tube sample at inlet section for checking internal tube Condition	As prescribed by the customer
1.4	Eco Intermediate Headers	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - DPT on Hand Hole Plate Welding	As prescribed by the customer
1.5	Eco Outlet Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - LPI/MPI on Specific Weld Joints	As prescribed by the customer

Sl.No.	Component	Type of Test / Inspection	Location & Number of Tests
		- LPI on Hand Hole Plate Welding	
1.6	Link Pipe from Eco Outlet Header to Boiler Drum	- Visual Examination of pipe support (VE-E)	As prescribed by the customer
2.	Circulation System		
2.1	Boiler Drum- Steam Drum Water Drum	- Visual Inspection - Ultra Sonic Testing - Liquid Dye Penetration Inspection - Replication - Deposit Analysis - Outside Diameter and thickness measurement - Hardness - Circular and longitudinal seam weld (UT-S)	As prescribed by the customer
2.2	Downcomer Pipes to Bottom Headers	- Visual Examination (VE-E)	As prescribed by the customer
2.3	Water Wall Ring Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - DPT on Hand Hole Plate Welding - Internal Inspection by Videoprobe (FO)	As prescribed by the customer
2.4	Water Wall Panel and Furnace Bottom Hopper Zone	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - Tube Sample for Metallurgical and Deposit analysis - Internal Inspection by Videoprobe (FO) - Thickness Measurement (UT-T) of Water Wall - Hydrogen Embrittlement	As prescribed by the customer
3.	Superheater System		
3.1	Radiant Roof Tubes	- Visual Examination (VE-E)	As prescribed by the customer
3.2	Second Pass Roof and SCW Rear	- Visual Examination (VE-E) - Thickness Measurement of SCW Rear (UT-T)	As prescribed by the customer

Sl.No.	Component	Type of Test / Inspection	Location & Number of Tests
3.3	Second Pass SCW Front and Sides	- Visual Examination (VE-E) - Thickness Measurement (UT-T)	As prescribed by the customer
3.4	Extended SCW	- Visual Examination (VE-E)	As prescribed by the customer
3.5	LTSH Inlet Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - DPT on Hand Hole Plate Welding - Internal Inspection by Videoprobe (FO) - Ultrasonic testing - Replication - Hardness	As prescribed by the customer
3.6	LTSH Coils	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - Tube samples of Metallurgical Analysis & Deposit Analysis. - Hardness - Non Destructive Oxide Thickness Inspection	As prescribed by the customer
3.7	LTSH Outlet Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - DPT on Hand Hole Plate Welding - Internal Inspection by Videoprobe (FO) - Ultrasonic testing - Replication - Hardness	As prescribed by the customer
3.8	SH DESH and its Links (Attemperator)	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints DPT on Hand Hole Plate Welding - Internal Inspection by Videoprobe (FO) - Ultrasonic testing	As prescribed by the customer

Sl.No.	Component	Type of Test / Inspection	Location & Number of Tests
		- Replication - In-situ Metallography and Hardness Measurement (HB) - Swell Measurement.	
3.9	PLSH Inlet Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - DPT on Hand Hole Plate Welding - Internal Inspection by Videoprobe (FO) - Ultrasonic testing - Replication - Hardness	As prescribed by the customer
3.10	PLSH Panels	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT on Dissimilar welds - Tube Sampling for Metallurgical Analysis - Tube Sampling for Creep Rupture Test at Outlet Section - DPT on Roof Seal Band Welds - Hardness	As prescribed by the customer
3.11	PLSH Outlet Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - Internal Inspection by Videoprobe (FO) - Ultrasonic testing - Replication - In-situ Metallography and Hardness Measurement (HB) - Hanger and Support Checking	As prescribed by the customer
3.12	Link Pipes to Final SH	- Visual Examination (VE-E) - In-situ Metallography and Hardness Measurement (HB)	As prescribed by the customer
3.13	Final SH Inlet Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints	As prescribed by the customer

Sl.No.	Component	Type of Test / Inspection	Location & Number of Tests
		- DPT on Hand Hole Plate Welding - Internal Inspection by Videoprobe (FO) - Ultrasonic testing - Replication - In-situ Metallography and Hardness Measurement (HB) - Hanger & Support Checking - Swell Measurement.	
3.14	Final SH Coils	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - Tube Sampling for Metallurgical Analysis (At Outlet Sec.) - NDT on Attachment Welds - Internal Inspection by Videoprobe (FO) - Hardness	As prescribed by the customer
3.15	Final SH Outlet Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - DPT on Hand Hole Plate Welding - Internal Inspection by Videoprobe (FO) - Ultrasonic testing - Replication - In-situ Metallography and Hardness Measurement (HB) - Hanger & Support Checking (VE-E) - Swell Measurement.	As prescribed by the customer
3.16	SHH Headers	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - DPT on Hand Hole Plate Welding - Internal Inspection by Videoprobe (FO) - Ultrasonic testing - Replication	As prescribed by the customer

Sl.No.	Component	Type of Test / Inspection	Location & Number of Tests
		- In-situ Metallography and Hardness Measurement (HB) - Hanger & Support Checking (VE-E) - Swell Measurement.	
3.19	Main Steam Piping Up-to Main Steam Stop Valve	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - Replication - In-situ Metallography and Hardness Measurement (HB) - Hanger & Support Checking (VE-E)	As prescribed by the customer
3.20	PRDS Piping	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - Replication - In-situ Metallography and Hardness Measurement (HB) - Hanger & Support Checking (VE-E)	As prescribed by the customer
4.0	Re-heat System		
4.1	RH Inlet Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - DPT on Hand Hole Plate Welding - Internal Inspection by Videoprobe (FO) - Ultrasonic testing - Replication - In-situ Metallography and Hardness Measurement (HB) - Hanger & Support Checking (VE-E) - Swell Measurement.	As prescribed by the customer
4.2	RH Inlet Coils	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - Tube Sampling for Metallurgical	As prescribed by the customer

Sl.No.	Component	Type of Test / Inspection	Location & Number of Tests
		Analysis - NDT on Attachment Welds by LPI & MPI - Internal Inspection by Videoprobe (FO) - Hardness	
4.3	RH Outlet Coils	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT on Roof Seal Bend Weld - DPT on Dissimilar Weld - Tube Sampling for Metallurgical Analysis - Tube Sampling for Creep Rupture Test - Hardness	As prescribed by the customer
4.4	RH Outlet Header	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - DPT on Hand Hole Plate Welding - Internal Inspection by Videoprobe (FO) - Ultrasonic testing - Replication - In-situ Metallography and Hardness Measurement (HB) - Hanger & Support Checking (VE-E) - Swell Measurement.	As prescribed by the customer
5.0	Piping System		
5.1	Main Steam Piping	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - In-situ Metallography and Hardness Measurement (HB) - Cold & Hot Walk Down Checks on Hangers - Metallographic Replication (RPL)	As prescribed by the customer
5.2	Re-heater Piping (HRH)	- Visual Examination (VE-E) - Dimensional Measurements (DIM)	As prescribed by the customer

Sl.No.	Component	Type of Test / Inspection	Location & Number of Tests
		- DPT/MPI on Specific Weld Joints - In-situ Metallography and Hardness Measurement (HB) - Cold & Hot Walk Down Checks on Hangers - Metallographic Replication (RPL)	
5.3	Re-Heater Piping (CRH)	- Visual Examination (VE-E) - Dimensional Measurements (DIM) - DPT/MPI on Specific Weld Joints - In-situ Metallography and Hardness Measurement (HB) - Cold & Hot Walk Down Checks on Hangers - Metallographic Replication (RPL)	As prescribed by the customer
6.0	General		
6.1	Supporting Structure & Ceiling Girders	- Visual Examination (VE-E)	As prescribed by the customer

2.0 ESP

Following are necessary to restore rated efficiency, design parameters, mechanical Healthiness for life extension and overall performance improvement of the ESP:

(i) Accessing / checking the present condition of supports structure of the ESP inlet funnel.
(ii) Checking for the proper orientation of the slide supports with reference to the fixed Supports to allow expansion in the correct directions.
(iii) Checking of wall panels, hoppers, roof panels and supporting members of the ESP Casing including checking for the longitudinal roof beam (LRB) and transverse roof beam for straightness, sweep and welding.
(iv) Checking of hopper assemblies including welding of the hopper assembly with the Ridges to with stand normal operational, wind loads as well the loads from being Field with ash.
(v) Checking for the EPS columns, welding for their healthiness.
(vi) Checking for welding of the horizontal and diagonal bracings between the columns. Accessing / checking for welding and structure life of gas distribution housing, insulator Supporting panels with roof beams.
(vii) Accessing the life of insulator housing assemblies.
(viii) Checking of all the collecting electrode suspension frames, emitting frames part top, Emitting frames part middle & emitting frames parts bottom for important dimensions and healthiness.

(ix) Checking for the collecting electrode suspension such that the shock bars tend to lean towards the rapping mechanism.
(x) Checking of uniformity of electrode spacing.
(xi) Checking of Collecting and Emitting rapping system
(xii) Conduct flow model test (study), it is for obtaining better air distribution patterns of the ESP and associated ducting, optimize pressure drop which will result in a reduction in the operation of the boiler system.
(xiii) Testing of EHV TR sets
(xiv) To perform Air Leak Test
(xv) To conduct Air Load test of fields
(xvi) To check functioning of HV TR set controllers, feed back circuits, rapper controllers and Setting of different parameters.
(xvii) Checking of hopper heaters, suspension insulation heaters, shaft insulator heaters etc. and ash level indicator (if applicable)
(xviii) Computational fluid dynamics (CFD) analysis of the ESP and the duct between APH Outlet to ESP inlet (funnel) and rectification according to the analysis study results.

APPENDIX-II - PART -"C"

RLA / CA SCOPE FOR GENERATOR & ITS AUXILIARIES

A) VISUAL INSPECTION

(A-1) STATOR WINDING
1) Stator wedges and bar vibration in stator bore for Presence of any dust, greasy product or fretting product on stator bore and finding the cause of the same
2) Stator bar insulation by Videoscopic inspection of stator bar through ventilation ducts (particularly the end packets region) to evaluate the condition of insulation and to detect evidence of following things.
a) Ground wall insulation partial discharge
b) Mechanical wears of insulation
c) Any dust or grease buildup including deterioration of varnish quality, peeling and blistering of paint
d) Puffing or bulging of insulation
e) Insulation crack, aberration or migration
f) Filler migration
g) Deterioration of stress grading system
3) End winding and connection
a) Inspection of end winding, support, ties and support fixing bolts for presence of any fretting product like grease, dust indicating end winding looseness and vibration, damaged spacers or supports.
b) Inspection of bar displacement/ deformation, excessive side clearance, broken ties.
c) Visual and Videoscopic inspection of end winding to evaluate the condition of insulation and to detect i) Partial discharge ii) Deterioration of stress grading semi conducting varnish quality iii) Puffing or bulging of insulation iv) Insulation crack, aberration or migration
A-2) STATOR CORE
1) Visual inspection of core for the presence of any contamination like paste normally indicates core/bar looseness
2) Inspect the core for any mechanical damage of stamping or ventilation spacers
3) Inspect the core for any overheating or burning mark Inspect the core for any looseness
4) Videoscopic Inspection of the ventilation ducts for any blocking or mechanical defect
5) Inspect the core for displacement of stamping
6) Inspect core bars to detect overheating mark on core bar if feasible.
7) Inspect core bar and bore ring for looseness and presence of fretting products if feasible.

8) Check core fingers, core clamping plate, core bolts and shield plate for proper fitting, presence of cracks or distortion, displacement from its position, overheating mark, presence of fretting products
9) Inspect area between casing and core for accumulation of dust, foreign material etc.
A-3) SUPPORT SYSTEM
1) Inspect core bar, bore ring, support spring, cooler supports for presence of any fretting product indicating looseness and differential movement
2) Inspect core bar, bore ring, core bolts for over heating mark
3) Inspect support system for any welding crack
4) Inspect all locks and bolts for looseness, damages, displacement or presence of any fretting products
A-4) STATOR CASING
1) Inspect the stator casing fixing arrangement for mechanical damage, looseness of trunion/foundation bolts
2) Inspect welding of casing and end shield for defect
A-5) BUSHING
1) Check all the bushing for any cracks, presence of fretting products or evidence of looseness or defects
2) Check for electrical tracking
3) Check for any overheating mark on busing insulator or electrical current carrying parts.
A-6) ROTOR
1) Visual and videoscopic inspection of accessible part of the winding for coil displacement or deformation, contamination or copper dust generation, turn/slot insulation displacement, arcing/burning marks, overheating marks, mechanical damage, wedge looseness, any missing or loose parts.
2) Inspection of rotor wedges including wedges below retaining ring for looseness, overheating marks, mechanical damages or contamination.
3) Inspection of rotor cooling path and ventilation hole for contamination, insulation shifting, blockage.
4) Inspection of all bolts and fasteners, wedge locking grub screws, balancing bolts for their intactness, tightness and proper locking
5) Inspection of balance weight for their intactness.
6) Inspection of condition of shaft journal.
A-7) SLIP RING & FIELD LEADS
1) Check slip ring surface for groove depth, uniformity of surface wear, overheating/ burning, any mechanical damage etc.
2) Inspection of CC bolts, D- lead thread damage etc. if CC bolt is removed from position.
A-8) FORGING
1) Check forging for crack, overheating, rust, fretting, contamination, mechanical damage

2) Check for evidence of overheating, any soot deposit on rotor body,
3) Check for overheating, burning or arcing mark
A-9) RETAINING RING AND SECURING NUTS
1) Visual inspection of retaining ring to detect cracks, fretting, shifting of shrink fit, etching, burning mark/over heating mark, mechanical damage etc.
2) Inspection of retaining rings, retaining ring nuts for proper positioning, shifts from position or looseness
A-10) FANS
1) Inspect for crack, contamination, Mechanical damage, missing components, defective locks, deformation, displacement/ looseness etc of fan and fan blades.
A-11) HYDROGEN COOLERS
1) Inspect coolers for chemical corrosion, deposit, discoloration, tube plugging, tube vibration, deformation, damaged fins etc.
A-12) HYDROGEN SEALS
1) Inspect hydrogen seal for rubbing, damaged locking arrangement, cracks, mechanical damages, electrical pitting
2) Inspect insulation of seal body for mechanical damage and electrical tracking mark

(B) TESTING

B-1) STATOR WINDING
1) IR and PI measurement
2) DC high voltage withstand test
3) Partial discharge test to detect deterioration of winding insulation and presence of voids and surface discharge
4) Capacitance & Power factor/tan δ measurement from 0.2 Un/√3 to Un/√3 in steps of 0.2Un and calculating power factor/ tan δ tip up.
5) Winding resistance measurement
6) Wedge tightness/deflection test
7) NFT of end winding
B-2) STATORE CORE
1) ELCID test
3) Checking core looseness by “Knife test”
4) Checking of RTD and thermocouple (both core and winding)
B-3) CASING, END SHIELD AND SEAL BODY
1) MPI of end shield machined surface
B-4) ROTOR
1) DC resistance of rotor winding
2) AC impedance of rotor winding in steps
3) Measurement of Insulation Resistance of rotor winding

4) RSO of rotor winding at stand still
5) DPT/UT of retaining ring, retaining ring nut, fan blades, coupling bolts, & Journal
6) MPI of fan hub
7) Gas tightness test
8) Purge test
B-5) SEAL RING AND BEARING
1) DPT and UT of babitted surface
2) MPI of bearing housing and seating surface

APPENDIX-II - PART-"D"

RLA STUDY OF POWER TRANSFORMERS (GEN, UAT + STATION)

1. Test on Transformer Solid Insulation: -
   - Insulation Resistance (IR).
   - Polarization Index (PI)
   - DC Absorption Test.
   - DP of Paper.
   - Capacitance & Tan Delta Test.
   - Leakage Current Test.
   - Step up Voltage.

2. Tests on Transformer Conductor and OLTC: -
   - DC Winding Resistance at all Taps.
   - Ratio Test and Phase Angle Error Test.
   - Floating Neutral Point Measurement.
   - Short Circuit Test at Low Voltage.

3. Tests on Transformer Core: -
   - Excitation Current Test (at High Voltage)
   - Magnetic Current Test.
   - Magnetic Balance Test.
   - Frequency Response Analysis (FRA).

4. Tests on Transformer HV Bushings: -
   - Capacitance & Tan Delta Test.
5. Tests on Transformer Oil (OLTC/Top/Bottom): -
   - Interfacial Tension.
   - Neutralization Number.
   - Moisture Content.
   - Flash Point.
   - Sludge.
   - Dielectric Dissipation Factor.
   - Dielectric Strength.
   - Resistivity.
   - Kinematics Viscosity.
   - Pour Point.
   - Density.
   - Dissolved Gas Analysis
     - ❖ Methane.
     - ❖ Ethane.
     - ❖ Ethylene.
     - ❖ Acetylene.
     - ❖ Carbon Dioxide.
     - ❖ Carbon Monoxide.
     - ❖ Hydrogen.

- ❖ Total Gas Content.

- Furan Analysis
- Short circuit test at low voltage.
- Regular tests of transformers oil as per IS 1866-2000 or latest.
- DGA & Furan Analysis tests.
- Frequency response analysis test.
- Measurement of Tan δ of bushings & windings.
- DP of paper.
- Magnetic Balance Test.
- Short circuit test at low voltage.
- Excitation current measurement test at high voltage.
- Insulation resistance measurement.
- Polarization index measurement.
- Step voltage test.
- Tan delta measurement on winding insulation & bushings.
- Winding resistance measurement at all taps.

APPENDIX-II - PART -"E"

RLA / CA OF HT MOTORS, HT / LT SWITCH GEAR PANELS, CIRCUIT BREAKER, CABLES, UPS, LIGHTING, DG SET, SWITCHYARD, CONTROL AND INSTRUMENTATION.

Studies / test / physical inspection / condition assessment etc. required to be conducted on different equipment's are listed below:

1) HT MOTORS

- Testing of IR and PI with and without cables of motor stator winding.
- Stator winding's AC high voltage test.
- Stator winding's tan delta test.
- Stator winding's resistance measurement.
- RTD resistance measurement.
- Measurement of vibration and noise levels when the motor is coupled to the load and also when the motor is in uncoupled condition.
- Ring flux test.
- Winding temperature measurement.
- Checking of hot spot.
- Shock pulse test.
- Air gap measurement.
- Ultrasonic test on rotor bars.
- Dye penetration test of rotor bars and end rings.

2) 6.6 kV SWITCHGEARS

- Check the name plate details according to the approved drawings, any physical damages, tightness of all bolted connections, earth connections, Cleanliness and moving parts for proper lubrication etc.
- General condition assessment of the panel, wiring, TBs, connectors, doors, locks, Panel illuminations, Space heaters, test plugs, relay's covers, ferruling of wires, painting, etc.
- Listing of make and type of all protection relays, auxiliary relays, timers, meters, etc. and Physical inspection and general assessment to determine the equipment condition based on past performance and operating data including non availability of spares shall be brought out
- Condition assessments of the relays along with relay coordination.

3) CIRCUIT BREAKERS

- Test for insulation resistance, contact resistance of breaker poles, breaker opening and closing time, simultaneous operation of breaker poles and dielectric strength of the insulating medium.
- All contact joints in the bus bar should be tested for hot spots by Thermo vision technique.
- Insulation resistance testing and HV testing of all switch gear bus bars.

- Testing of CTs, PTs and instruments for accuracy, resistance and Knee point.
- Testing / checking of various bus transfer schemes and interlocks.
- Check alignment of breaker truck for free movement.
- Check correct operation of shutters.
- Trip fee & anti pumping operation.
- Earthing, rear cover / door, mechanical Interlocks (if applicable).

4) L.T. SWITCHGEAR

- Check the name plate details according to the approved drawings, physical damages, tightness of all bolted connections, earth connections, cleanliness and moving parts for proper lubrication.
- General condition of the panel, wiring, TBs, connectors, doors, locks, Panel illuminations, Space heaters, test plugs, relay's covers, ferruling of wires, painting, etc.
- Listing of make and type of all protection relays, auxiliary relays, timers, meters, etc. and Physical inspection and general assessment to determine the equipment condition based on past performance and operating data including non availability of spares shall be brought out
- Condition assessments of the relays along with relay coordination.

5) D.C. SYSTEM AND UPS

- General condition of the battery , charger, panel components, wiring, TBs, connectors, doors, locks, panel illuminations, space heaters, test plugs, relay's covers, ferruling of wires, painting, ventilation system of the room, etc.

6) DG SET

- Check the name plate details, physical damages, earth connections, cleanliness etc.
- General condition of the DG set panel, wiring, TBs, connectors, doors, locks, Panel illuminations, Space heaters, test plugs, relay's covers, ferruling of wires, painting, etc
- Capacity adequacy of the DG set to meet the emergency requirement.
- Auto and manual operation checks.

7) SWITCHYARD

- Condition of conductor tap off connectors, clamps, insulators etc. (TEE, PG, other connectors etc.) - To be checked by thermo vision camera.
- Condition of insulator strings - Visual checks for surface tracking, flashover marks on all.
- Earthing (value of earth resistance, check for remaining cross section at sample places under ground), also pipe type earthing at transformer earth points. - Roads, drain, fence. - Visual condition
- Cable trench and trench covers, buried pipe. - Visual Condition.
- Direct stroke lightning protection - Method (LM/Shield wire) and coverage.
- Fire protection, hydrant for transformers. - Condition (working/nonworking).

- General condition of control cubicles/Marshalling Box /CT junction box and associated wirings.
- Compressed air system - Functioning
- Condition evaluation. - Gravel Spreading and Thickness and type of gravel.

8) CONTROL & INSTRUMENTATION

The study for the C&I systems/equipments shall be for the total plant as specified under Scope of work in the specification. The study should include the following systems as a minimum:

8.1 Control & Instrumentation of Boiler and its auxiliaries including requirement of comprehensive boiler protection and operation.

8.2 Control & Instrumentation of Turbine, Generator and their auxiliaries including requirement of comprehensive turbine-generator protection and operation.

8.3 Control & Instrumentation System of all the Off site plants and facilities as per the scope of work for which RLA /CA is to be carried out.

8.4 Availability / assessment of requirement of boiler flame monitoring system, safe start-up/shut down of oil/mill for the boiler including FSSS or BMS including SADC & Burner tilt control.

8.5 The study of ATRS including electro hydraulic governing System (EHC). The study shall include assessment of healthiness of turbine governing system and changes recommended for implementation of coordinated / turbine follow / boiler follow mode of operation.

8.6 The services for Condition assessment and individual item assessment for the C&I systems shall necessarily include but not be limited to examining the following :

- Primary Instruments including Transmitters, switches, analyzers, temperature elements, flow elements etc.
- Installation arrangement
- Condition of associated Impulse piping, valves and fittings Root valves, thermo wells etc for corrosion, leakages, damages etc.
- Condition of flow element, the integrity of DP Vs Flow curve used for measurement.
- Calibration reports and frequency of calibration.
- Adequacy of instruments w.r.t. to the redundancy requirement for protection and control.
- Protection system / Open loop / Closed loop controls
    - Availability and operatability right from the man machine interface to the final control element including the interface with primary and secondary instrument and associated protection and interlock signal interface in Auto as well as manual mode and from Local as well as from control Room panels/ desks.
    - whether all the protections are wired or bypassed with respect to the original design philosophy and current practices
    - Adequate redundancies are built up in the primary sensing devices.

- Whether the protections act in reliable manner including the primary sensors , operator interface devices like PBs/ CRT operation etc.
- Availability of relays and timers for protection / interlock and alarms
- Analyse the trips and faults occurred in the plant

- Modulating control System check
  - Availability and operability right from the man machine interface to the final control element , including the interface with primary and secondary instrument and associated signal interface in Auto as well as manual mode.
  - Steady state and transient Response of Loops under full and partial load and analysis of the result w.r.t original design performance
- Final control element including control Valves , actuators Pneumatic Power Cylinder, positioners there of, Positioners feedback transmitters, E/P converters etc.
  - Proper operation
  - Mechanical linkages
  - Leakages
  - Response times measurement
- Power Supply systems
  - Power supply regulation
  - Healthiness of batteries as defined in Electrical scope.
  - Adequacy of monitoring of power supply
  - Fuse and MCB status etc
- Annunciation system
  - Operatability and functionality of Installed system
  - Adequacy of the alarms for safe and efficient operation
- Power supply and control cables
  - Visible damages
  - Insulation testing of approx. 20 % cables of each type depending on results Impulse pipes fittings , valves and stubs
  - Examine for leakages , corrosion , damage
- Maintenance and calibration equipments
  - Adequacy of the existing equipment w.r.t to maintenance requirement at present and in future
  - Calibration records & procedures.
- Secondary Instruments like indicators, recorders Pushbutton and Lamps, control switches etc
- Desk and panels
- Public address System
- Communication system
- Motorized Valves and Pneumatic Valves

- Fire sensing device of Rotary Air Pre heater and Rotor stop annunciation
- Quality of Instrument Air.

8.7 Contractor shall examine and give his recommendation for

1 All the control and Instrumentation devices / systems for obsolescence / replacement/ up-gradation.

2 Adequacy of the installed automation including the protections , monitoring, and controls and also indication /meas. of various parameters in line with the current practices. In case a particular monitoring / control system is not installed desirability and feasibility of installing such systems, equipments shall be brought out modernization and upgrade of any system if required shall also be brought out.

3 If any mechanical or electrical system is recommended for upgrade / replacement etc, Its Control monitoring and interface aspects shall also be brought out.

4 For the Control systems / Equipments recommended for replacement / upgrade the associated requirements of power supplies , cables , signal interface , environmental condition suitability etc shall be brought out

8.8 The recommendations shall include complete details so that employer is able to finalize the scope of work for R&M.

8.9 Contractor shall examine the adequacy of the installed power supply system for the instrumentation system that are installed and also recommend if any changes/ enhancements are required due to R&M proposed for the plant.

8.10 Contractor shall provide following detailed reports /lists, as minimum, after the RLA /Condition assessment study.

1. Primary Instruments- Process Transmitters , Process switches , Temp Elements ,Analytical instruments , Flow elements, pressure / temp. gauges etc

- List of instruments /transmitters etc that are installed
- List of additional instruments /transmitters etc required for the parameters that are currently not being monitored and should be monitored
- List of additional instruments /transmitters etc that are required to be installed to meet the criteria for redundancies in measurement protection of the equipment
- Availability of tapping points for the additional instruments recommended as above
- For Temperature elements the report shall also include the list of T/E where new Thermowells are also required to be replaced.
- For Process switches the report shall also include the recommendation for those process switches that can be replaced with Process transmitters, due to retrofitting of R&M recommendation for the control and monitoring system

2. Steam , water , Flue gas , waste treatment Analysis

- Contractor shall provide list of additional analytical measurements to be provided to meet the requirement of maintaining proper chemistry regime in the operation of Boiler, Turbine, DM and PT water streams etc.

- Requirement for additional analytical measurements required to meet the environmental and statutory requirements
- The study shall clearly bring out the Sample conditioning requirements , availability of tapping points for on line continuous sampling , space for keeping the sample conditioning equipment

3. Protection System and modulating control system

- List of all the drives (On off or modulating), presently controlled through Local panels and remotely through the control room.
- List of all the devices that are presently controlled manually and should be made automated through local or controlled through remote.
- List of drives that are presently local controlled and should be changed to remote controlled.
- List of all the devices / drives that were installed as per original design and the drives / lines have been removed during the life of the plant. Contractor shall give his recommendation for restoring such lines /devices.
- Contractor shall also give recommendation about the changes required w.r.t the type / medium of control to enhance the safety/ availability of the control system , that is Electrical motor / single or Dual coil solenoid / AC or DC power/ Pneumatic/Hydraulic control should be retained or changed.

4. Final control Elements drives, Solenoid valves, pneumatically controlled power cylinders.

- List of all the Control valves, on / off valves that are mal functioning or not good to be retained.

5. While recommending for the renovation for control system and power supply system the report shall bring out following specific aspects

- Adequacy of space for new panels due to recommendation of change in control / protection system
- Adequacy of space for the new / replacement batteries for UPS / DC system power supply requirements
- Adequacy of space for SWAS conditioning panels, chiller unit etc due to recommended R&M of Analysis system.
- Adequacy of space for new / revamped unit control Board (UCB)
- Adequacy of space for cable routing in the existing cable galleries
- Effect on requirement of air conditioning due to recommended C&I R&M
- Effect on requirement of Service air and Instrument air capacity and quality requirement due to recommended C&I R&M.
- Effect on control room illumination
- Recommendation for the instrumentation and control cable to be retained or Replaced
- Adequacy of the cable laying space in the cable galleries and Trunk route cable trays.

6. List of Maintenance and calibration equipments required for ease in maintenance and increasing the availability of the system.

APPENDIX-II - PART -"F"

RLA / CA OF MATERIAL HANDLING SYSTEM

A. Coal Handling System

The scope of work for coal handling plant shall include the condition assessment of all the equipment's by visual inspection and performance test of coal handling plant and adequacy of the plant with present & future coal condition as specified herein:

01. Condition Assessment

Condition Assessment shall be conducted by the Contractor on major equipment of the coal handling plant for abnormalities, breakage, crack, erosion, corrosion, pitting and availability etc. In his report the Contractor shall clearly identify the components/areas for repair/replacement giving details of present condition and reasons for repair/replacement along with BOQ of the total quantity, quantity available and quantity to be provided new / overhauled / repaired.

02 Performance Tests

Performance tests shall be carried out on the equipment/system in order to assess suitability of the equipment/system for meeting the R&M objectives for the unit. The Contractor shall furnish performance test procedure for Owner approval.

On completion of the test as per above, Contractor shall review the capacity of coal handling plant and other tests as specified below and shall submit the test report to Owner within one (1) month of the completion of the test.

S No	ITEM / EQUIPMENT/ SYSTEM / SUB SYSTEM	TESTS ENVISAGED
1.	Entire CHP	(i.) Performance Test Including Capacity Test, Vibration Test, Smooth Operation, Interlocks
2.	Wagon Tippler (Including Train Positioning Equipment	Performance Test (i.) Tippling Capacity (Tonnage / No of Tips / Hour) (ii.) Smooth Operation Without Jerks (iii.) Vibration (iv.) Power Consumption (v.) Bearing & Bearing Assembly Check (vi.) Visual Inspection & Condition Assessment • Platforms, supporting structures and frame • Grill
3.	Vibrating Feeder For WT/Crusher/ Reclaim Hopper	Performance Test

		(i.) Smooth Operation (ii.) Vibration Amplitude/Stroke Adjustment Mechanism (iii.) Power Consumption (iv.) Bearing & Bearing Assembly Check Visual Inspection & Condition Assessment • Deck, deck liners • Structural supports • Gear box
4.	Crusher	Performance Test (i.) Load Test (ii.) Smooth Operation (iii.) Vibration, Noise (iv.) Power Consumption (v.) Bearing & Bearing Assembly Check Including Temperature Rise Visual Inspection & Condition Assessment • DPT on Welds of casing • DPT on Rotor Shaft (10%) • UT on Rotor Shaft
5.	Vibrating Screens	Performance Test (i.) Smooth Operation (ii.) Vibration Amplitude/Stroke Adjustment Mechanism (iii.) Bearing & Bearing Assembly Check Visual Inspection & Condition Assessment • Deck and liners • Structural supports • Gear box
6.	Stacker Cum Re-claimer	(i.) Visual inspection and condition assessment of parts / sub-assemblies (ii.) Performance Testing • Stacker -reclaimer capacity • Smooth operation
7.	Magnetic Separator	(i.) Performance Test (ii.) Visual Inspection (iii.) Condition Assessment
8.	Coal Sampler	(i.) Performance Test (ii.) Visual Inspection (iii.) Condition Assessment
9.	Belt Weigher	(i.) Performance Test

		(ii.) Visual Inspection (iii.) Condition Assessment
10.	Idler	(i.) Smooth Running (30%) (ii.) Visual Inspection (iii.) Condition Assessment
11.	Belting	(i.) Visual Inspection (ii.) Condition Assessment
12.	Dozer	(i.) Performance Test (ii.) Visual Inspection (iii.) Condition Assessment
13.	Chutes	(i.) Visual Inspection (ii.) Condition assessment
14.	Flap Gates	(i.) Performance Test (ii.) Visual Inspection (iii.) Condition Assessment
15.	R P. Gate	(i.) Performance test (ii.) Visual Inspection (iii.) Condition assessment
16.	Safety Switches	(i.) Performance Test (Random) (ii.) Visual Inspection
17.	Piping/Technological Supports/Equipment Supports including Deck plates & seal Plates of conveyors, Gratings, etc.	(i.) Condition Assessment (ii.) Visual Inspection (iii.) Condition Assessment (iv.) Thickness test for piping (v.) Check for pipe supports
18.	Valves	(i.) Visual Inspection (ii.) Condition Assessment
19.	Pumps & fans(including sump pumps)	(i.) Running Test (ii.) Visual Inspection (iii.) Condition Assessment (iv.) Bearing & Bearing
20.	Tripper	(i.) Performance Test (ii.) Visual Inspection (iii.) Condition Assessment (iv.) Bearing & Bearing Assembly Check & rail alignment check
21.	Pulleys of Conveyor	(i.) Visual Inspection (Incl. Rubber Lagging) (ii.) Condition Assessment (iii.) DPT on Welds

		(iv.) Bearing & Bearing Assembly Check
22.	Drives of Conveyor & All Equipment's including accessories like brakes, etc.	(i.) Performance Test (ii.) Visual Inspection (iii.) Condition Assessment (iv.) Bearing & Bearing Assembly Check
23.	Gear Box	(i.) Performance Test (ii.) Visual Inspection (iii.) Condition Assessment (iv.) Bearing & Bearing Assembly Check
24.	Dust suppression system	(i.) Performance test (ii.) Condition assessment of nozzles
25.	Ventilation system	(i.) Performance test (ii.) Condition assessment of ducting and accessories & structural supports.
26.	Locomotives	(i.) Condition assessment
27.	Paddle feeders	(i.) Condition Assessment (ii.) Visual Inspection (iii.) Check of rail alignment

B. Ash Handling Plant

The scope of work for Ash handling plant shall include the condition assessment on major equipment of the ash handling system for abnormalities, breakage, crack, erosion, corrosion, pitting and system availability etc. For ash pond/dyke condition assessment to include visual inspection of ash dyke condition, assessment of present ash pond capacity, ash slurry pumps discharge end condition, ash pond water extraction/recovery status etc. Condition assessment studies to include the following::

- Study of the system as designed/existing.
- Performance with respect to its rated parameters.
- Problem in operation and maintenance at rated capacity and maintaining the system as intended/erected.
- Review of operation and maintenance history.
- Review of aux power consumption.
- Status of control& instrumentation.

In his report the Contractor shall clearly identify the components/areas for repair/replacement giving details of present condition and reasons for repair/replacement along with BOQ of the total quantity, quantity available, quantity to be provided new / overhauled / repaired. Following major equipment/ system shall be inspected / assessed as a part of condition assessment.

S No	ITEM	TESTS ENVISAGED
1.	Ash Handling Plant	○ System adequacy & performance Whether ash evacuation, Conveying and ash slurry disposal is effectively achieved.
2.	Ash Slurry Pump	○ Performance test ○ Condition assessment ○ Visual inspection
3.	Sump & sump liners	○ Visual inspection ○ Condition assessment
4.	Scraper Conveyors	○ Performance/condition assessment ○ Visual inspection
5.	BA /dry hoppers Incl. Refractory	○ Visual Inspection ○ Condition assessment ○ Leakage from halls
6.	Clinker grinders	○ Performance Test ○ Visual inspection ○ Condition Assessment
7.	Ash slurry trench & Liners	○ Visual inspection ○ Condition Assessment
8.	Valves & Isolation gate	○ Visual Inspection ○ Condition assessment
9.	Flushing apparatus	○ Performance tests ○ Visual inspection ○ Condition Assessment
10.	Water pumps & drain pump	○ Performance Test ○ (one per type and size) ○ Visual Inspection ○ Condition assessment
11.	Pipe, bends & fittings	○ Visual Inspection ○ Condition assessment ○ Ultrasonic thickness Check

APPENDIX-II - PART -"G"

RLA / CA OF BALANCE OF PLANT

A. CW System:

Condition and Performance Assessment of CW system consisting of CW pumps, piping, discharge ducts, valves, etc. as per following:

1. Condition assessment/visual inspection of the entire CW system including all pumps, ducts, piping, valves, fitting, expansion joints etc.

2. Condition Assessment of bearing cooling water pumps and details such as No of pumps (Working+ Standby), flow, head, power consumption etc.

3. Inspection of complete assembly of two nos. CW Pump.

4. Thickness measurement of CW piping at discharge end of CW pumps for all the pumps.

5. Condition assessment of CW chlorination plant and its dosing system.

6. Inspection of all air release valves provided in the system and recommendation regarding their modification/replacement.

7. Performance assessment of CW system such as

    - CW pumps flow and head (of each pump),
    - CW motor power consumption
    - Cold water temperature
    - Hot water temperature

B. Compressed Air System

Condition Assessments of Compressed Air System comprising of Plant and Instrument air compressors, Air Drying Plant, compressed air piping, Valves, Air receiver's etc. status of control & instrumentation.

C. Low Pressure Piping

Condition assessment of Bearing cooling water, clarified water, potable water, service water, fire water, Instrument air, plant air, DM make up water etc.

Visual examination of the entire piping network for all the plant services as mentioned above and report for any corrosion/defects, etc. In addition, measurement of the pipe thickness at no. of locations as prescribed by owner.

Preparation of the scheme and layout drawing for Bearing cooling water, clarified water, potable water service water, fire water, instrument air & plant air, DM make up water etc. Quantification of piping and valves requirement for each service based on the condition assessment.

D. Hydrogen Generation Plant

Condition Assessment and Performance to be carried out for the entire Hydrogen Generation Plant as detailed below:-

a)	Electrolyser	○ Condition Assessment with regards to electrode, gas manifold and associated instruments. ○ Visual Inspection
b)	Rectifier Unit	○ Condition Assessment
c)	Hydrogen Compressor	○ Visual Inspection ○ Performance with regards to maximum pressure developed. ○ Condition Assessment of various parts such as Piston, Diaphragm, Relief Valves etc.
d)	DM water Tank and Pumps	○ Visual Inspection ○ Condition Assessment
e)	Alkali Storage Tank and Pumps	○ Visual Inspection ○ Condition Assessment
f)	• Gas Washing Tank, • Hydrogen gas holders, • De-oxy unit, • Drying Unit for	○ Visual Inspection ○ Condition Assessment

	Hydrogen gas • Inert Gas system, • Cylinder filling manifold • Piping, Fitting and valves	
g)	Details of existing Control system and its condition	
h)	Overall Performance of the Hydrogen Plant with respect to	(a) Total Hydrogen plant capacity (b) Hydrogen purity at gas manifold (c) Moisture contain in hydrogen

APPENDIX-II - PART -"H"

CIVIL & STRUCTURES REMAINING LIFE ASSESSMENT:

Normally, for steel and concrete structures the tests shall be carried out in about 2-5% of the area of the structure, particularly in the area in which visual observations indicate damages/distress. The results are then considered on the whole for condition assessment and remnant life assessment.

Sl.No.	Description	Type of test for RLA
01	Concrete works (general)	VI, CST, HT
02	Machine foundations	VI, CST, HT, CMT, UPVT
03	Steel Structures	VI, DPT, TM

Abbreviations :

CST	Core Sample Test (including UPVT testing sample for crushing strength, pH, Cl, SO4, Carbonation etc.)		Ultrasonic pulse velocity test
CMT	Cover Meter Test	TM	Thickness measurement
DPT	Dye Penetration test	VI	Visual inspection
HT	Hammer test		

Contractor should assess the structural stability of steel and concrete support structures and foundations with the overall objectives of the study. The civil structure/ foundations (concrete and steel work) shall be studied considering the type of tests mentioned in the table above. The tests as specified shall be carried out on all the cracks/distress areas observed. Scope of work shall be defined by the owner.

APPENDIX-III

Scope of Performance Evaluation Test / Thermal Performance Test :

1. Objective of Study:

   (a) To assess the present condition of the equipments under study and provide detailed PET study report upon availability, reliability, usability of equipments

   (b) To identify actual Heat rate of the Turbine and further to find overall heat rate of plant and Specific Coal Consumption

   (c) Coal Sample analysis. (Proximate & Ultimate Analysis)

2. Intent of Specification:

The intent of this specification is to identify systems/equipment/component efficiency vis-a vis design condition, further to **provide measures to correct the same and provide a base line report of the health of the unit.**

Based on the results, detailed PET reports are to be provided to customer for the components under study.

3. Scope of work :

The scope of work shall be as follows:
The PET will be done as per standards viz. ASME Power Test Codes of respective Package / equipment as desired by utility.

(a) ASME PTC codes to be followed, hence all the work will be as per code only and the Bid should be submitted in line covering all aspects of the said codes.

(b) All measurement systems and instruments will have to be calibrated at Govt. approved laboratory preferably NABL accredited. All Calibration certificates shall be submitted prior to start of the test well in advance to allow sufficient cushion to set right the deficiencies, if any, before taking up the test.

(c) Test will be conducted for the following equipments :

   (i) Turbine (with generator as per standard Code)

   (ii) Boiler (conducting performance test for finding boiler efficiency)

   (iii) Finding unit overall heat rate and there by specific coal consumption

   (iv) Coal sample collection and analysis either directly or through reputed third party lab

   The vendor, at its own cost, should bring all the portable meters and instruments as required depending upon the quantum of work.

   On completion of test (Boiler, Turbine, Heaters, condenser, cooling tower, air preheater etc.) the vendor should suggest the possible improvements and actions. While carrying out the tests the unit will be tested with zero blow down as well as with 3% blow down as mentioned hereinafter. Also, in regard to coal consumption, additional performance calculations have to be done based on hourly average readings for 3 full days to arrive at the coal consumption rate for the unit.

4. Programme outline / steps involved :

Phase-I **:** On site inspection on the adequacy of existing provisions for carrying out the PET as per applicable PTC and to take corrective measures if there is a shortfall

Phase-II: On site PET testing.
Phase-III: Analysis of data.
Phase – IV: Draft Report Submission and approval from customer.
Phase-V: Final Report submission to customer thereby for acceptance.

5. Deliverables:
The vendor should submit the following reports/deliverables :

Sl. No	Description	Programme
1	Daily Progress report	During testing at site, It shall contain details of "Daily activities over components under study".
2	Preliminary Inspection Report	It shall be compilation of daily reports along with preliminary observations after due value addition 1 no. of Hard copies after completion of the unit Test (PET)
3	Final Report	04 nos. of Hard copies 01 nos. of soft copies (CD)

6. Number of Test Runs :

Trial test run / preliminary test shall be carried out to check the reliable / correct measurements by the test instruments and duplicate test run will be performed for each test.

7. Methodology of conducting performance tests :

As one of our aims is to improve the Energy Efficiency of the units, it is essential that present performance level i.e. efficiency of each of the main equipments and auxiliaries is determined by following the best practices as recommended by ASME test codes and also utilizing the most accurate and calibrated instruments meeting ASME standard accuracies. Basic objective of using highly accurate and calibrated instruments and following test code practices is to eliminate any doubt on measurements for fruitful and reliable analysis of the equipment performance.

The procedure guidelines and accuracy of instrumentation recommended in present ASME power test codes (PTCs) for the main and auxiliary plant equipments shall be followed.

FORM-I
Responder's Particulars

To
Chief Engineer,
TRM Division,
Central Electricity Authority
Sewa Bhawan, R,K, Puram,
New Delhi- 110 066.

Sir,

We wish to apply for empanelment with CEA for Task _____for EOI Dt._____ as per details enclosed.

1. Name of Organization

2. Address & Contact No. with Name of Contact Person

3. Legal Status of the organization

4. Professional Experience of the consultant – to be enclosed as per Form II

5. Year of Establishment

6. Total Personnel (Professionals only) (CVs as in form IV)

7. Range of Services Offered (To be enclosed separately in not more than two pages).

8. Brief of Major Assignment: To be enclosed as per Form-III

9. Annual Turnover (last 3 financial years)

10. Latest Audited Annual Accounts :

11. Service Tax Registration Copy : To be enclosed

12. PAN Number : To be enclosed

13. Sales Tax/ Vat Number : To be enclosed

14. Name of the Authorized Signatory, who is authorized to respond to this EoI

15. Additional information if any :

(Authorized Signatory on & behalf of the organization)

FORM-II

SUMMARY OF PROFESSIONAL EXPERIENCE OF THE FIRM

Experience in years :

Collaborations/JVs (If any)* :

Areas of Professional experience :

Experience in India:
No of Assignments undertaken in R&M of TPS :

List of assignments with clients' name, location :
Duration in months

Experience in Abroad:
No of Assignments undertaken in Power Sector :

List of assignments with clients name & location
against each assignment, duration in Months. :

(Authorized Signatory on behalf of the organization)

* Please enclose details of the collaboration agreement.

FORM-III

BRIEF ON MAJOR ASSIGNMENTS (Separate sheet for Each Assignment)

Undertaken for electric power Generation utilities (copy of the Letter of award, experience certificate etc. to be enclosed)	:
Name of assignment	:
Name of Client	:
Location of Assignment	:
Originally agreed time to complete the Assignment in months	:
Actual time taken to complete the Assignment in Months	:
Scope of work of assignment in detail (may attach sheets)	:
Deliverables of the assignment	:

(Authorized Signatory on behalf of the organization)

FORM-IV
BRIEF CVs OF KEY PERSONNEL

(Separate sheet for each key personnel)

Name	:
Date of Birth	:
Educational Qualification	:
Total experience in Number of years	:
(Whether certified Energy Auditor (Yes/ No) If yes, give experience details as certified energy auditor	:
Experience (last 10 years) (List of positions held, giving dates / duration, names of organizations and brief responsibilities)	:
Assignments in the Power Sector along with title of assignment, client's name, location & scope of work in not more than two lines each.	:

(Authorized Signatory on behalf of the organization)