UPRVUNL
PANKI THERMAL POWER STATION
1 X 660 MW

TECHNICAL SPECIFICATION FOR DESIGN CONSULTANCY WORKS OF NATURAL DRAFT COOLING TOWER

Specification No. : PE-TS-426-165-N001 (REV. 0)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA - 201301

CONTENTS

1. **INTENT OF ENQUIRY/ SPECIFICATION**
2. **SCOPE OF CONSULTANCY WORK**
3. **BID EVALUATION CRITERIA**
4. **LIQUIDATED DAMAGES**
5. **PERFORMANCE GUARANTEE TESTING**
6. **DRAWINGS/ DOCUMENTS SUBMISSION SCHEDULE**
7. **OTHER TERMS OF CONTRACT**
8. **DOCUMENTS TO BE SUBMITTED WITH BID**

ENCLOSURES:

Annexure-I: Project information

Annexure-II: Mechanical Specification (including Datasheet)

Annexure-III: Civil Specification & Soil Investigation Report

Annexure-IV: Electrical Specification

Annexure-V: C&I Specification

Annexure-VI: Compliance certificate

Annexure-VII: Deviation Schedule

1.00.00 INTENT OF SPECIFICATION:

The intent of this enquiry/ specification is to appoint a design and engineering consultant for 1 number cooling towers (NDCT) of 1 x 660 MW Panki TPS Extn. for complete mechanical, electrical, C&I and civil design, engineering, Preparation of drgs/ docs for execution of NDCT, obtaining approval from BHEL/ Customer/ customer's consultant, Preparation of BOQ, preparation of bought out item specification, procurement assistance, site supervision as specified & as necessary for completeness in all respects and for efficient & trouble free operation for project.

The performance parameters and other particulars of Cooling Tower is detailed in Data Sheet-A for reference.

2.00.00 Complete Scope of Cooling Tower design & engineering shall comprise following

2.01.00 Mechanical

2.01.01 <u>Thermal and Hydraulic design</u>

a) To carry out the thermal & hydraulic design of Natural draft cooling tower to achieve specified cooling tower performance. After approval of thermal design, detail design engineering shall be carried out for further execution of NDCT works by NDCT civil contractor.

b) The thermal and Hydraulic design may result in different diameter & height combination. The detailed calculations/ procedures/ curves/ equations/ reference code extracts shall be furnished for review & approval by BHEL. Optimization shall be carried out to select the optimum diameter & height and their corresponding BOQ. Methodology to carry out optimization and corresponding calculations shall be submitted for BHEL's approval and optimized design to be finalized in consultation with BHEL. No. of iterations as required to be done and included in offer.

c) The thermal and Hydraulic design shall be carried out in such a fashion that Fills, distribution nozzles, drift eliminators from any probable manufacturer shall provide the guaranteed performance of Cooling tower.

2.01.02 <u>Drawings, customer approvals & site support</u>

a) General Arrangement drawing of complete cooling tower (showing plan, front elevation and side elevation) incorporating principal dimensions limits of scope of supply of piping, limits of civil works included, showing extent of platforms, walk ways, handrails, access doors staircase, handling arrangements etc. and the limits of scope of supply of electrical works.

b) General Arrangement drawing of Cooling Tower basin indicating overflow and desludging arrangement.

c) General Arrangement and Sectional Assembly drawings pertaining to the following components of the Cooling Tower.

d) Tower fill with supporting arrangement.

e) Drift eliminator installation and details.

f) Complete hot water distribution system including flow regulating valves, distribution pipes and nozzles etc. The work includes preparation of GA drgs indicating all arrangements in the NDCT.

g) Various drawings, datasheets, calculations, test reports/ certificates, O&M manuals etc.

2.01.03 <u>Tender specification requirement for NDCT execution by BHEL's Civil contractor</u>

a) Preparation of technical specifications for Bought out items e.g. Fills, Drift eliminators, distribution nozzles, Sludge pump, Gates, screens, lifting arrangement, access doors, Hot water distribution pipes etc., any other item not included above but required for the completeness of cooling tower.

b) Preparation of detailed estimate for mechanical portion of work for tendering, bill of quantities & Quality assurance plan for various items.

c) Review of Clarifications/ deviations from Bidders (Civil Contractor).

d) Review of bought out item documents along with QAP from vendors e.g. Fills, Drift eliminators, distribution nozzles, sludge pump, Gates, screens, lifting arrangement, access doors, hot water distribution pipes etc.

e) To witness the inspection of major bought out items (if required) e.g. Fills, Drift eliminators, nozzles etc. along with BHEL inspection agency. Bidder to include the sufficient number of visits in their offer.

2.02.0 Civil

2.02.01 Detailed civil, structural and architectural engineering including static analysis, dynamic/non-linear analysis, concrete / structural design of all the NDCT elements as per relevant IS/applicable codes/Project Owner's specification.

2.02.02 Preparation of detailed document and drawings viz. General Arrangement (GA) drawings, Reinforced Concrete (RCC) drawings, analysis/design documents, bar bending schedules, fabrication drawings, as-built drawings etc.

2.02.03 Conducting wind tunnel model study from a reputed and approved wind tunnel laboratory i.e from IIT. Cost of wind tunnel and cost of visit to be included in total cost.

2.02.04 Preparation of tender document (technical specification, bill of Quantity, tender drawings etc.) required for award of contract to a third party for construction (civil contractor) on item rate basis including providing technical support for civil contractor offer evaluation and contract award.

2.02.05 Any other works as required for successful completion of civil, structural and architectural engineering of NDCT.

2.02.06 For any design requirement which is essential but not mentioned in Project Owner's specification shall be arranged by the bidder. Bidder shall interpret/ analyze all necessary information / data required for successful design of the natural draft cooling tower as per latest Indian codes or any other applicable international codes lies with the bidder.

Structural safety and successful operation of the tower shall be the responsibility of the bidder notwithstanding the approval of the owner.

2.02.07 The complete cooling tower, including the shell, raker columns, ring beam, pedestals and foundation, shall be modelled and structurally analyzed using a globally proven reputed finite element modelling software such as latest version of NISA/ANSYS etc. The design geometric profile, thickness variation and support conditions of shell shall be considered in the structural analysis. NDCT shall be designed for all the critical primary loads and their combinations such as Dead Load, wind Load, Thermal loads, Seismic Loads & Settlement Load etc. Bidder shall forward the soft copy of such analysis file to BHEL and BHEL's customer for review while getting the approvals. Optimization shall be carried out along with BHEL for civil design. No of iterations as required to be done and to be included in the offer.

2.02.08 Topographic survey drawing and geo-technical report carrying bore hole data along with recommended bearing capacity/pile capacity of cooling tower shall be provided to the bidder along-with the bid document by BHEL. In case any change in soil strata is encountered at site during execution of construction activities or due to change in location, bidder has to re-check the design/re-design (if necessary) and get approval from BHEL/BHEL's customer and nothing extra shall be payable on this account.

2.02.09 Bidder has to obtain approval of BHEL/BHEL's customer/ Proof consultant (if required as per BHEL specification) for all works including tender documents (for award of civil contractor for construction), analysis, design, drawings, wind tunnel study, schedules etc. However, hiring of Proof consultant (if any) is not in the scope of Bidder.

2.02.10 While furnishing the drawing/design for BHEL's review/ approval, bidder shall also furnish the design quantities of reinforcement steel (dia-wise), Structural steel (Section-wise), Inserts & Misc. steel (Section-wise) and concrete (Grade-wise including PCC) etc. in each drawing.

2.02.11 Bill of Quantities for civil, structural and architectural works of NDCT shall be prepared by the bidder. Item-wise BOQ shall be prepared in line with the Project Owner's specification. BOQ items descriptions shall be comprehensive enough, so that the respective activity is complete in all respects and all necessary items are included so that no extra item arise during construction. Bidder to note that enough care shall be taken while preparing the BOQ (items and quantity) so that the quantity furnished against each item shall be as accurate as possible. Bidder shall review the GCC and SCC furnished by BHEL for 'Civil contractor' while preparation of BOQ and should take all necessary actions to avoid any compensatory payments to the 'Civil contractor' due to variation in quantities.

2.02.12 Bidder has to furnish the revised BOQ based on final drawings released for construction.

2.02.13 Bidder has to review and approve erection schemes (including review of design and drawing for the slip form/jump form shuttering etc.) design and drawing for temporary works, construction methods and sequence of construction with time schedule as prepared and submitted by civil contractor.

2.02.14 Bidder shall prepare and keep up to date, a complete set of As Built records of the execution of the works. These records shall be preserved by the bidder and shall be used exclusively for the purposes of the preparation of As built drawing.

2.02.15 **Wind Tunnel Testing**: The wind pressure on the tower shall be assessed on theoretical basis as well as with the help of Model tests in a wind tunnel. For conducting model tests,

bidders should study/assess the whole terrain and make their own assessment of likely critical wind forces & wind structure interaction. The model test shall be carried out in a well reputed institute/testing laboratory approved by BHEL/BHEL's customer. The testing agency selected by the bidder shall have requisite experience and should have successfully carried out tests in the past for at least one cooling tower of similar capacity. The model tests will be duly witnessed and approved by the Owner/consultant. The model test results shall be made available before final approval of the design of NDCT.

.

2.03.0 Electrical

2.03.01 Design & Preparation of Earthing & Lighting Protection & preparation of Drawing.

2.03.02 Design of Lighting System & preparation of the Drawing.

2.03.03 Design of AWL (Aviation Warning Light) & preparation of Drawing.

2.03.04 Cable Tray Layout in Cooling Tower Area.

2.03.05 Preparation of Electrical Equipment GA & Layout Drawing.

2.03.06 Cable Schedule of Cooling Tower.

2.03.07 Preparation of Electrical Load Data.

2.04.0 C & I

2.04.01 Preparation of detailed estimate for C&I portion of work for tendering, bill of quantities & Quality assurance plan for various items.

2.04.02 Preparation of technical specifications for C&I Bought out items.

2.04.03 Review of Clarifications/ deviations from Bidders for Bought out items.

2.04.04 Review of C&I bought out item documents along with QAP from vendors.

2.04.05 To witness the inspection for C&I bought out items.

2.05.0 General

2.05.01 Bidder to furnish the detailed Master drawing list for NDCT for BHEL and UPRVUNL's approval.

2.05.02 To provide technical advice/ recommendations/ solutions regarding site related construction problems as and when required including site visits, participation in meetings with BHEL/ customer/ customer's consultant.

2.05.03 In the event, any contradictions arise between statement / condition / terms stated elsewhere in this section and to that in Project Owner's specification, the more stringent requirement shall prevail.

2.05.04 The bidder is advised to visit and examine the project site and its surroundings and obtain for itself, on its own responsibility, all information that may be necessary for preparing the

bid and entering into the contract. Claims of any kind due to variation or ignorance of site conditions and environmental conditions after award of works will not be entertained.

2.05.05 All revisions/changes required as per BHEL/ Project owners, comments/ requirements, site requirement etc. shall be carried out by the bidder.

2.05.06 Three hard copies of approved documents/drawings shall be submitted by the bidder. Electronic copies shall be submitted in primary original format (e.g. .doc., .xls, .dwg etc.) as well as in printable non-proprietary formats (e.g. .pdf).

2.05.07 Co-ordination with construction agency/ BHEL/ Customer/ customer's consultant.

2.05.08 Detailed erection/ installation procedures for all mechanical/ Electrical/ C&I/ Civil works.

2.05.09 10 nos of visits of minimum 3 days each are envisaged to BHEL-PEM/ BHEL site/ BHEL's customer/ customer consultant's offices for drgs/docs approval and same to be quoted in price schedule. Visits in addition to the above shall be applicable with the above quoted price on pro-rata basis.

2.05.10 3 nos visits of minimum 3 days each are envisaged for supervision of erection of mechanical items and same to be quoted in price schedule. Visits in addition to the above shall be applicable with the above quoted price on pro-rata basis.

2.05.11 3 visits of 3 days each are envisaged for supervision of Civil works at site and same to be quoted in price schedule. Visits in addition to the above shall be applicable with the above quoted price on pro-rata basis.

2.05.12 Consultant shall furnish monthly rolling plans and also the list of inputs required to achieve the objective. The detailed Engineering progress report shall include contents as mutually agreed Detailed Design Personnel Forecast, Detailed Engineering Delivery Plan, Lead Technical interface with the inputs.

2.06.0 Thermal Design of Cooling Towers:

The thermal design of cooling towers shall fulfill following design criteria.

2.06.01 Sensible heat of evaporated water shall be taken into account for calculating the air flow requirement, as per the following equation.

$$G*H = L (T1-T2) + (E*V*T2)$$

Where

L = Water flow rate in Kg/hr.
T1 = Water inlet temperature to the tower in Deg.C
T2 = Water outlet temperature to the tower in Deg.C
EV = Evaporation loss in Kg/hr. at RH (as specified in Data Sheet-A)
G = Air flow rate in Kg/hr.
H = Change in enthalpy of air in Kcal/kg.

2.06.02 For the specified design conditions of water rate, range, approach, wet bulb and dry bulb temperatures Bidder shall calculate and furnish the duty coefficient "D". A nomogram indicating the ratio of water rate and duty coefficient, re-cooled water temperature and other thermal conditions specified shall be furnished with the bid. The nomogram shall cover the entire operating range and shall extend up to a wet bulb temperature of as specified in Data Sheet-A.

Along with the thermal design calculations as specified above, bidder has to submit the calculations for:

Total height of Natural Draft Cooling Tower
Basin sizing
Height of the hot water distribution header
Drift Eliminator sizing
Inlet Louver Sizing
Sludge pit sizing

2.06.03 Based on the duty co-efficient and performance characteristics of the fill the bidder shall furnish an equation expressing the relationship between the plan area of packing and the square root of tower height.

2.06.04 Bidder shall furnish performance characteristic curves for following variations in design parameters.15%, 25%, 60%, 70%, 80%, 90%, 100%.

Bidder shall also clearly identify various “Guaranteed Zones” as per the requirement of code.

2.06.05 The tower configuration shall be such that it shall offer minimum restriction to air flow.

2.06.06 The Cooling Tower Thermal design calculations shall be got vetted and approved by bidder from any of the IIT’s (Indian Institutes of Technology) in the event of order along with the related CT drawings for fill arrangements etc. and charges for same shall be included in the bidder’s base price itself.

2.06.07 The Purchaser/ Customer however also reserve the rights to check the detailed calculations in the event of order and their interpretation shall be final in the event of any conflict.

2.06.08 The total CW Pumping head (MWC) within bidder’s terminal points shall not exceed the respective maximum limits specified in Data Sheets A/finalized during detailed design.

The static head for calculating CW pumping head shall be considered up to top of the water level in the hot water duct.

Frictional losses for pipes shall be as per William & Hazen formula with C = 100. Frictional losses for various valves & fittings e.g. Miter bends, valves, tees, reducers etc. shall be as per crane handbook. Ft Value

for fitting friction drop calculation to be considered as 0.012 for all sizes greater than 600NB. The frictional losses shall be computed considering 10% margin on same.

William & Hazen formula: V = 0.85 X C X (i) 0.54 X (d/4) 0.63.

The bidder shall substantiate the CW pumping head with calculations in the event of order and same shall be subject to approval.

2.06.09 The CW pumping head specified limit is inclusive of static head plus frictional losses including 10% margin on frictional losses.

2.06.10 The bidder's Cooling Tower thermal design shall take care of above aspects including maximum permissible plan dimensions indicated in Data Sheet A.

2.07.0 Specific Requirements:

2.07.01 In addition to the salient technical requirements stipulated in Section "D", the bidder may note specific requirements detailed herein for design of the cooling towers

2.07.02 No wood/ timberwork shall be used in any component of the cooling tower.

2.07.03 The quality of water in CW sump shall be clarified water with analysis as given in data sheet-A of Section. D.

a) The COC in CW System shall be '5'.
b) Control of biological / algae is envisaged in purchaser's scope.

2.07.04 The location, orientation, wind rose, scope demarcation, water levels etc. for the cooling tower shall be as per the sketch enclosed at Annexure – 1 & 2.

2.07.05 Fills shall be PVC Splash V bars Type of approved make in easily removable sections.

2.07.06 PVC Drift eliminator blades shall be of three-pass full wave type supported on concrete framework & shall limit the drift losses to a value not greater than 0.002 % of the design water circulation rate.

2.07.07 All parts subjected to periodical maintenance & inspection such as Inlet louvers, fills, drift eliminators etc. shall be readily accessible.

2.07.08 Access doors shall be provided for entry into cooling water distribution level. The doors shall have easily operable shutter of leak proof design & shall be of MS construction with 2 coats of red oxide zinc chromate primer and anti-corrosive coating.

2.07.09 Two R.C.C. staircase for approach to hot water distribution level & aviation warning lamp etc.

2.07.10 Min. two (2) external cage ladders for approach to top of cooling tower from ground level.

2.07.11 Access platforms and walkways with handrails for inspection and maintenance of hot water distribution system and Aviation Warning Lamp etc.

2.07.12 All steel parts in direct contact with water or humid air shall be of SS 316. All other steel parts not in direct contact with water/ humid air shall be galvanized steel. No hardware shall be of Cu or Cu based alloys. Material of construction shall be as indicated in Datasheet "A". Wherever the material of construction for any component is not given, same shall be suitable for the intended service & shall be subject to purchaser's approval during detailed engineering stage in the event of order.

2.07.13 The sizing of the hot water distribution system shall be done by limiting the velocity through the pipes to a maximum of 2.0 m/sec.

2.07.14 Piping for sizes above 150 Nb Carbon steel plates to IS 2062, rolled and welded as per IS 3589.

2.07.15 Piping up to and including 150 Nb shall be IS 1239 (Heavy Grade).

Required wall thickness for Hot Water riser and Distribution piping shall be as follows:

NB	OD	THK
1400	1422.00	12.0
1800	1829.00	16.0
1900	1936.00	16.0
2500	2540.00	18.0
2700	2740.00	18.0
3800	3840.00	18.0

2.07.16 The buried piping in bidder's scope shall be steel pipe. Welding of pipe header with Purchaser's pipe at terminal point shall be in bidder's scope. The thrust block etc. shall also be in BHEL's civil contractor's scope.

2.07.17 Provision of at least 2 nos. welding sockets at water distribution level shall also be in BHEL's civil contractor's scope.

2.07.18 Motor Operated B.F. valves shall be provided in hot water distribution riser.

2.07.19 The cold-water basin of cooling tower shall be provided with a partition wall to facilitate isolation of each half of CW basin whenever required through isolating gates viz. minimum two nos. gates shall be provided for each cooling tower. CT basin shall be provided with adequate slope (Min slope of 1:120) towards the sludge sump for drainage purpose.

2.07.20 Under each valve, flange joint & such other items prone to gland/ joint leakage, suitable trays/ channels shall be provided so that any leakage water does not spread on the surroundings. This is also applicable for any air release valve that has to be mounted on hot water riser top. Erection of such air release valves has also to be done by the bidder.

2.07.21 Bidder to note that all sub vendors shall be subject to BHEL/ Customer approval in the event of order.

3.00.00 BID EVALUATION CRITERIA

Bidders should quote prices as per format (price schedule) enclosed in the tender document. Bids shall be evaluated based on the total price quoted for design consultancy work as per this specification.

4.00.00 PERFORMANCE GUARANTEE TESTING AT SITE

To ascertain the fulfillment of guarantees after completion of erection and commissioning of the cooling tower, BHEL's civil contractor shall carry out performance test at site in presence of employer / purchaser/ consultant through CTI approved testing agency. Bidder may witness the performance test of NDCT on his own cost (if required).

4.01.00 Performance guarantees of Cooling Tower:

The cold-water temperature as specified in the specification shall be guaranteed by bidder for the design conditions of CW flow, range, ambient WBT as specified.

To ascertain the fulfillment of guarantees of the cooling towers, the test results of the tower tested through CTI approved testing agency shall be considered for PG test evaluation and based on the test result, the liquidated damage shall be levied.

5.00.00 DRAWINGS/ DOCUMENTS SUBMISSION SCHEDULE:

Following Basic drgs/docs to be submitted within 3 weeks from LOI date.

1. DESIGN BASIS REPORT
2. GA OF NDCT
3. THERMAL SIZING & PUMPING HEAD CALULATIONS
4. TECHNICAL DATASHEET

Remaining following Primary drgs/docs to be submitted progressively within 16 weeks from LOI date. This is not an exhaustive list of drg/ doc for NDCT package. Bidder shall furnish all applicable drg/doc required for successful execution of NDCT works by BHEL's civil contractor.

5. FOUNDATION DRGS/DOCS
6. RAKER COLUMN DRGS/DOCS
7. BASIN FLOOR DRGS/DOCS
8. SHELL DRGS/DOCS
9. GRILLAGE COLUMN AND BEAM DRGS/DOCS
10. CT OUTLET, CT SLUDGE PIT, CT STAIRCASE DRGS
11. ELECTRICAL DRGS/DOCS
12. C&I DRGS/DOCS
13. HOT WATER DISTRIBUTION DRGS (EXTERNAL & INTERNAL)
14. FILL INSTALLATION DRGS

NOTE:

a. Subsequent revisions of above drgs/docs to be submitted within 7 days of comments received from BHEL.
b. Drawings submitted shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays to bidder's account.

6.00.00 OTHER TERMS OF CONTRACT

6.01.00 The contract will be awarded on Lump Sum Basis and no claims will be acceptable due to any reason whatsoever. The design and drawings prepared by the consultant may be required to be revised / modified due to various reasons including site condition, vendor inputs, layout changes and UPRVUNL's requirement. The quoted rate shall be inclusive of additional effort to take care of such revisions.

6.01.01 In case the guaranteed NDCT performance parameters are not met during PG testing of NDCT, 10% of contract value shall be deducted.

6.01.02 Bidders quoting for this tender shall not be eligible to bid for 2nd contract (civil execution contractor).

7.00.00 <u>Documents to be submitted along with Bid</u>

a) Compliance certificate duly signed and stamped (enclosed herein).

b) General arrangement drawing for cooling tower, incorporating all relevant dimensions, Fill layout, water distribution layout, cold water channels / sludge chamber/ screens/ gates in the cold water channel, staircase etc.
c) Pumping head calculations.
d) Thermal design calculations (NDCT diameter & height calculation).
e) Tower performance curves.
f) Civil DBR
g) Guarantee Schedule duly signed and stamped (enclosed herein)
h) Technical deviation schedule (if reqd.) (enclosed herein)

Apart from above no other drgs./docs./data sheets etc. are required to be submitted at bid stage and even if furnished shall not be taken cognizance of.