

	TITLE: ANNEXURE- II SUGGESTIVE TECHNICAL SPECIFICATION OF COOLING TOWERS IN NDCT CIVIL CONTRACTOR'S SCOPE	SPEC. NO.: PE-TS-415-165-N001	
		VOLUME: IIB	
		SECTION: C	
		REV. NO. 00	DATE 16.01.2018
		SHEET 1	OF 7
1.00.00	INTENT OF SPECIFICATION:		
1.01.00	This specification is intended to cover the design, manufacture, assembly, inspection and testing at manufacturer's and/or his sub-contractors works, proper packing, delivery at site, transportation, unloading/handling at site, storage at site, site fabrication, site painting, erection including all civil works/ testing/ commissioning at site and performance testing of Natural draft type cooling tower for 1X660MW BHUSAWAL including complete Electrical, C&I and Civil Works as specified and as necessary. The Cement, Structural and reinforced Steels for Cooling tower are excluded from Bidder's scope as they shall be free issue by BHEL. Terms and conditions for free issue items being given along with NIT. However for Bid evaluation of the Cooling Tower, Bidder's total price shall be determined after adding cost of Steel as per the rates specified elsewhere in Bidder's total quoted price for the Cooling Tower. The Natural draft type Cooling Tower covered under this specification is as under. 1 X 660 MW BHUSAWAL – One no Natural draft Cooling Tower The design drawings/details and detailed construction drawings, performance parameters and other particulars of Cooling Tower are enclosed herein.		
2.00.00	SCOPE OF EQUIPMENTS & WORKS UNDER THIS SPECIFICATION:		
	The equipment and works to be provided under this specification shall be as detailed below and as indicated in relevant portion of enclosed documents. The items not specifically mentioned but deemed necessary to make the cooling tower complete in all respects, as self-contained package for reliable and efficient operation shall also be deemed to have been included in the scope of the bidder. The scope of supply/ works including civil works as complete turnkey package includes complete civil works between the terminal points which are stated or unstated but required as per the system requirements except for items specifically mentioned in exclusion list of works. Scope of works includes preparation, obtaining necessary approvals, materials, execution as per codes, specification, best engineering practices and to the satisfaction of BHEL/ Owner for all mechanical, architectural, civil structural, building electrification, etc. BHEL will not bear any liability for any extra work, which might not have been perceived by the bidder but functionally required. The cost of such work will be entirely borne by the bidder. Bidder shall visit and apprise himself fully with existing site conditions including soil condition, rainfall data, availability of all construction materials including backfill, graded material etc. and other aspects for construction of plant, building structures etc. No extra claim whatsoever on any account shall be entertained by BHEL. The bidder shall furnish list of items/ services not included in his scope, otherwise the complete package shall be deemed to be in bidder's scope & Purchaser's interpretation in this regard shall be final & binding on the bidder. The brief scope of supply, services & works for Cooling Tower, complete with hot water distribution system, cold water basin and outlet channels, sludge pit, stair case from ground level to water distribution level & Top of CT and all other equipments and accessories as mentioned herein after. It is not the intent to list all details herein; scope of supply listed is in brief.		
2.01.00	Each Cooling Tower shall be complete with following:		
2.01.01	Scope (Mechanical):		

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	a) Incoming hot water piping, including vertical run, supported on cooling tower, Motorized Butterfly valves on hot water risers. Terminal point for hot water pipe shall be as marked in the tender drawing enclosed at Annexure 1 & 2 to Data Sheet - A. Welding at terminal point shall be in bidder's scope. Bidder shall also supply a Pressure Gauge & Temperature Gauge at the terminal point. Any reducer/ expander required at the terminal point shall also be in the bidder's scope. b) Inlet louvers, tower fills & fill supports, drifts eliminators, including all supporting structures, fastening arrangements & accessories. c) Screens, along with guides embedded in concrete shall be provided at the outlet of cold water channel. d) Sluice gate with mechanical jack arrangement and guides in each of the cold water outlet channel connection from the cold water basin. e) Manually operated chain pulley blocks, together with the monorails and supporting frames for the handling of screen and gates. f) Knife-edge gate valve/sluice valve in each de-sludge connection and also De-sludge piping up to the disposal point at local storm water drain channels. g) Pipe spools to be embedded in sludge pit walls and terminated with flanged end at suitable distance from outer face of respective wall. h) Water Distribution system consisting of troughs/ Pipes. Hangers & pipe supports & anchoring arrangement for all piping coming under the scope of supply. i) Two (2) Nos. (1+1) sludge pumps (submersible type) complete with electric motors, non-return valve, isolation valve, piping supports, hangers etc. for cold-water basin drainage. The bidder shall terminate pump discharge pipe work at a distance of 100 M from sludge pit. j) Counter flanges, bolts, nuts & gaskets for all piping connections in the scope of bidders and also at terminals.	
2.01.02	Scope (Electrical):	
	a) Complete electrical equipment as per specification/ details indicated in Section C2 & D2 shall be in bidders' scope. b) The scope of power & control cables & special cables shall be as per Annexure-1 of section C-2 (electrical). c) Base plate, foundation plates, anchor bolts, sleeves, inserts in concrete work for electrical and mechanical equipment & accessories.	
2.01.03	Scope (C & I):	
	a) Removable type Pitot Tube at each hot water inlet- piping header to measure the flow (during performance Guarantee test only). The Pitot Tube shall be left with customer after the completion of the test . b) One no. Pressure Gauge and One no. Temp Gauge at Hot Water pipe header at T.P. c) One no. of Anemometer for measurement of wind velocity. d) One no. of Psychrometer. e) Local Control Panel for Sump/Sludge Pumps (Submersible type). f) Level switches for sump/tank level high/normal/low/very low interlocks.	

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	g) Actuator for Motorised BFV at inlet of hot water pipes. Refer section-C4.		
2.01.04	Scope (Civil):		
	a) Complete civil works as detailed in Section – C3 including excavation, shoring, dewatering, backfilling, concrete work including shuttering, sand filling, disposal of surplus soil outside plant boundary, formwork including automatic climb form, laser beam survey instruments, fabrication, galvanizing and erection of steel structures and inserts, finishing anchor bolts, RCC sump/duct, laying and testing of hot water pipe line, water proofing, providing PVC water stops and joint fillers, drainage and other ancillary items connected with cooling towers. All faces of concrete structures and steel structures coming directly in contact with water shall be coated with corrosion resistant coating system as approved. The surfaces that would include are inner face of hyperbolic shell, raker column faces, inner faces of cold water basin, fill support structures, hot water distribution ducts & channels, cold water channel etc. The scope of this work shall consist of , but not limited to, the construction of reinforced concrete double curvature hyperbolic shell, ring beams, foundations (including Piling, if required), cold water basins with partition walls, hot water ducts, drain sumps, external drain chamber with associated pipe work, cold water channels with sluice gate up to the terminal point as specified elsewhere, hoists and monorails, primary and secondary hot water distribution troughs, fill support system including columns and beams, drift eliminators, testing of cold water basin for water tightness, external stairs, sludge pit for each basin section, all other staircases/ladders as required, doors and their frames, walkways, platforms, steel fitting, fixture, inserts, including fabrication, hand railing, providing protective measures in concrete and steel materials against effect of water and other chemicals on the completed structure etc. b) Supply & application of painting at site.		
2.01.05	The following are also included in bidder's scope:		
	a) One set of special tools & tackles required for maintenance of equipment & accessories in the cooling towers. b) Various drawings, datasheets, calculations, test reports/ certificates, operation & maintenance manuals including "As built drawings" etc. as specified & as necessary. c) Supply of first fill of lubricants for all equipments under this package including second fill/ replenishments as necessary during & after commissioning till handing over of the plant. d) Supply of commissioning spares on as required basis. e) Scope of services shall include but not limited to erection/ testing/ commissioning/ trial run/ performance testing & handing over of cooling towers. Transportation of equipments, material to site, local clearance, storage at site etc. & supply of all labor including supervision personnel, materials, erection tools & tackles etc. as necessary for expeditious execution of works etc. are also included in bidder's scope. It shall be the responsibility of the bidder to arrange all T & P required for the execution of complete job including erection & civil works.		
3.00.00	Equipment & Services to be provided by Purchaser:		
	a. Supply and erection of incoming hot water piping up to bidder's terminal point. b. Supply & erection of sludge discharge piping beyond the bidder's terminal point, if applicable. c. Cold-water outlet channels for cooling tower beyond the bidder's terminal point. d. For Electrical, Civil and C&I works refer Sections C2/ D2, C3 & C4 respectively enclosed herein.		

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4.00.00	The cooling tower shall comply with standard technical specifications of cooling towers enclosed in section -'D' & data sheet- A. In the event of any conflict between Section -'D' / data sheet-A' & section 'C', the latter shall prevail. Customer specification for cooling tower is enclosed at Section-C and it shall prevail in the event of conflict.	
5.00.00	Thermal Design of Cooling Towers: The owner approved thermal design is enclosed at Annexure-A. The responsibility of cooling Tower performance shall remain with the bidders in all manner and the bidder shall ensure that design offered meets the performance (bidder may cross check the design with his own method for meeting the performance requirements).	
6.00.00	DELETED	
7.00.00	DELETED	
8.00.00	PERFORMANCE TESTING AT SITE	
8.01.00	Scope:	
	To ascertain the fulfillment of guarantees after completion of erection and commissioning of the cooling tower, contractor shall carry out performance test at site of one no. CT in presence of employer / purchaser through CTI approved/licensed testing agency . The performance test of reaming four (4) nos NDCT may be tested by NDCT civil contractor himself or CTI approved/licensed testing agency for demonstration purpose only.	
8.02.00	Codes:	
	The following codes and standards shall be applicable for conducting test unless otherwise modified or supplemented by the enclosed procedure and mutually agreed to between Owner, BHEL and bidder. a) Code ATC-105: Acceptance test code for water cooling towers. (latest Version). b) BS-4485: Specification for Water Cooling Tower. c) BS-1042: Methods for the measurement of fluid flow in pipes. d) BS-3435: Measurement of electrical power and energy in acceptance testing. e) ASME 19.5: Supplements on instruments and apparatus.	
8.03.00	Conductance of tests:	
	Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by the bidder for the design conditions of CW flow, range, ambient WBT as specified	
8.03.01	The bidder shall submit cooling tower performance test procedure as per ATC 105 in consultation with CTI approved testing agency for approval & conduct the test as per the approved procedure, in the event of order.	
8.03.02	The bidder shall be given permission to inspect the Cooling Tower in advance and ready it for the test.	
8.03.03	Cooling Tower performance shall be tested jointly by CTI approved testing agency in presence of the bidder, BHEL and Owner. All the representatives shall jointly record data of test. a) The responsibility for conducting the test will be with the bidder. b) All test instruments required for the PG test will be provided by CTI approved testing agency / or the instruments provided by contractor if the same meets the stipulations of the CTI testing agency and acceptable to testing agency. c) Calibration of instruments to be used in the test shall be carried out by an approved independent agency. Calibration of instruments should be carried out previous to, but not more than six months before the test. The calibration certificate of the instruments should be valid for the period	

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	of test. d) List of instruments to be arranged by the bidder along with the calibration certificates of the instruments to be used and psychometric charts and tables should be submitted to CTI/ owner for approval.	
8.03.04	PG test shall be carried out by the bidder after completion of trial operation of the cooling tower and at a time when the atmospheric conditions are within limits of deviation from the design conditions as specified in this section preferably in the period from May to September.	
8.03.05	Performance test shall be carried out based on ambient WBT. The performance curves of the towers showing variation in performance with change in ambient wet bulb temperature, cooling range, relative humidity water loading of the tower etc, required to ascertain the performance of the tower shall be furnished along with the bid. Performance curves applicable to 90%, 100% and 110% of the design water flow rate shall be furnished. Each set shall consist of three or more cooling range curves and at least four relative humidity curves, arranged to show the effects of wet bulb temperature, relative humidity and cooling range on outlet water temperature. The range curves shall be presented in uniform increments of 0.5 deg. C, with sufficient scope to cover approximately $\pm 20\%$ of design range. The relative humidity curves shall be presented for spaced increments to cover the extent of expected conditions such as 5%, 20%, 40%, 60% and 100% relative humidity. The design conditions shall be indicated on the set applicable to design water flow rate. The dry bulb temperature associated with the wet bulb on each fixed relative humidity graph shall be included. The curves shall fully cover (but not necessarily be limited to) the range of variations specified. All performance curves shall be based on ambient wet bulb temperature.	
8.03.06	The guaranteed performance of the equipments shall be demonstrated by the bidder after evaluating the P.G. test should the result of the test deviate from the guaranteed values the bidder shall be given an opportunity to modify the equipment as required to enable it to meet the guarantees. In such cases the PG test shall be repeated within one month from the date on which the equipment is ready for retest and cost of modification, including labour, materials and cost of additional testing shall be borne by the Bidder. The chance for repeat testing will be given only once during the contract period. All the modifications carried out by the bidder in the Cooling Tower to meet the contractual requirements shall be carried out free of cost to the Owner in other towers (if applicable for the package).	
8.03.07	In case the test cold water temperature as determined from the PG test by CTI approved/ licensed testing agency is higher than the predicated value (based on the performance curves). Owner reserves the right to reject/ accept all the towers after assessing the liquidated damages as specified.	
9.00.00	The makes of all the equipments under this specification shall be subject to purchaser's approval in the event of order.	
10.00.00	It is mandatory for the bidder's to furnish along with the bid the deviations if any, whether major or minor in the ' Schedule of Deviations ' only. In the absence of the deviations listed in the ' Schedule of Deviations ', the offer shall be deemed to be in full conformity with the specification notwithstanding anything else stated elsewhere in the offer, data sheets etc. The hidden deviations or stated/ implied deviations in the offer shall not be acceptable and binding on the purchaser.	
11.00.00	PERFORMANCE GUARANTEES AND LIQUIDATED DAMAGES	
	a) Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. 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. In case the test cold-water temperature as determined from the PG test is higher than the predicted value (based on the performance curves). Owner reserves the right to reject the tower. In the event of its acceptance by purchaser liquidated damages as follows shall be Rs.200 lacs for each 0.1 deg C over the guaranteed value. The successful bidder shall demonstrate the above guarantees during PG testing at Site. To	



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

b) The bidder shall guarantee the following, apart from other performance guarantees of the complete package.

- Total CW pumping head within the bidder's terminal points viz. static head & frictional losses for cooling tower.

c) The static head for calculating CW pumping head shall be considered up to top of the top most pipe without any siphon recovery.

Frictional losses for pipes shall be as per William & Hazen formula with $C = 120$. 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: $V = 0.85 \times C \times (i)^{0.54} \times (d/4)^{0.63}$.

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

d) The successful bidder shall demonstrate the above guarantees during performance testing at site.

The purchaser is, however, not bound to accept the equipment and reserves the right to out rightly reject it if the actual values exceed beyond the plant design limits.

12.00.00 INSPECTION AND TESTING:

Purchaser/ Customer or their authorized representatives shall have the right to inspect at any stage of manufacture & construction, all materials, components & workmanship & testing of material. The bidder shall provide all facilities for inspection & testing without any extra cost to the purchaser/ Consultant.

12.01.00 The contractor/ manufacturer shall conduct the following minimum specific tests to ensure that the equipment shall conform to the requirements of this section and in full compliance with the requirements spelt out in applicable codes and standards.

12.02.00 Material identification and testing of regulating valve assemblies, screen assemblies, all supporting structural assemblies, fills, all nuts and bolts, sluice valves, nozzles and all other applicable components constituting each cooling tower.

12.03.00 Hydrostatic testing of hot water distribution piping regulating valves and all other pressure parts at a pressure and duration as spelt out in this specification.

12.04.00 Visual, dimensional checking of all components of each cooling tower.

12.05.00 Material testing of all components, hydrostatic testing of all pressure parts at a pressure and duration in compliance with this specification, static and dynamic balancing tests of all rotating components such as pump shaft, line shaft, impeller etc. and complete performance testing as minimum for each sludge pump in each cooling tower.

12.06.00 Tests for hoists, chain pulley blocks and all other lifting tackle shall be carried out as per relevant Indian/ equivalent international standards.

12.07.00 Any other tests deemed necessary for safe, reliable and satisfactory operation of the equipment.

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13.00.00	QUALITY PLAN:		
13.01.00	The inspection & testing of the cooling towers & its various components shall be as per quality plans approved by the purchaser/ Customer. Bidder shall submit the quality plans based on the guidelines given in specification & quality plans enclosed herein. The customer hold points of BHEL/ Customer/Customer nominated agency shall be marked in the QP at the contract stage, in the event of order & inspection/ testing shall be carried out as per same apart from various test certificates/ inspection records etc. Following standard QP are enclosed for bidder's guidance: • Cooling tower • Pipes, fittings & pipe work • BF Valves • Chain Pulley Blocks • Gate/ Globe Valves • Submersible Pumps		
13.02.00	The quality plans for various electrical, C&I and Civil works are enclosed in respective sections for bidder's compliance.		
13.03.00	For equipments not covered above, bidder shall submit QP's for same on the basis of similar guidelines & submit for approval in the event of order.		
14.00.00	Tests at Site:		
14.01.00	After completion of erection and commissioning of the cooling tower, supplier in accordance with cooling tower Institute Bulletin No ATC-105 "Acceptance Test Procedure for Industrial Cooling Tower" shall carry out performance tests of each cooling tower.		
14.02.00	Necessary correction curves shall be furnished by the supplier for approval along with the proposed test procedure for correcting the test results for any difference between test and guarantee design conditions.		
14.03.00	All mounting and calibrating instruments required for site performance tests shall be arranged by the cooling tower supplier without any extra cost.		
15.00.00	DRAWINGS, CURVES AND INFORMATION REQUIRED: DELETED		
16.00.00	Successful bidder in the event of award of contract shall furnish the drawings/ documents as listed in Data Sheet-C. Distribution of various documents shall be as per the Annexure to Data Sheet-C:		

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1.0	GENERAL INFORMATION		
	No. of Cooling Towers required	:	One (01) No.
	Location		Out door
	Duty		Continuous
	Type		Natural draught Counter flow with PVC Film fill type
	Finished ground level		EL (-) 0.5 M
	Basin Kerb level (Basin Sill Top level)		EL 0.0 M
2.0	DESIGN PERFORMANCE FOR EACH COOLING TOWER		
2.1	Design Cooling water flow	:	74000 M ³ /hr.
2.2	Design ambient wet bulb temp.	:	27.0 °C
2.3	Design inlet air wet bulb temperature.	:	27.0 °C
2.4	Approach w.r.t. design inlet air wet bulb temperature (viz. 28.0°C)	:	5.0 °C
2.5	Cold water temperature	:	32 °C
2.6	Hot water inlet temperature	:	42 °C
2.7	Cooling Range	:	10 °C
2.8	Design ambient Relative Humidity	:	40 %
2.9	Liquid Handled	:	Clarified Water (refer details of cooling water analysis at Annexure-3)
	a) Total CW Pumping head permissible viz. static head plus frictional losses as below: - Static head w.r.t. FGL - Frictional losses within bidders T.P. with 10% margin - Velocity head	:	Not to exceed 13 MWC
2.10	Maximum permissible drift loss	:	Max. 0.01 %
2.11	Design pressure for hot water distribution system	:	6.2 kg/cm ² (g)
2.12	Maximum foundation Diameter (outermost edge of foundation)	:	NA
2.13	Minimum Basin Diameter	:	140 M

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2.14	Maximum Cooling tower flow capacity to be considered for design of hot water distribution and cold water channel	:	Min 120% of design CW flow.
3.0	SPECIAL FEATURES		
3.1	Basin type		Sectionalized (two compartment) by partition wall. Each basin chamber shall have overflow arrangement and sludge pit end with necessary dewatering arrangement.
3.2	Whether fills are removable	:	Yes
3.3	Fills supporting by nailing acceptable	:	NO
4.0	Cold Water Basin Details		
4.1	Finished ground level	:	EL (-) 0.5 M
4.2	Maximum water level	:	EL (-) 0.3 M
4.3	Min. Water level	:	EL (-) 1.7 M
4.4	Storage capacity between Normal and minimum water levels.	:	16 minutes (Between Max. & Min. Water Level) of Cooling tower design Flow.
4.5	Invert level of CT Basin	:	EL (-) 2.2 M
4.6	Invert level of CW Channel near CT level	:	EL (-) 5.35 M
4.7	a) Depth of Sludge pit	:	Suitable for complete dewatering. To include sludge pump submergence & clearance depth below basin/channel invert level
	b) Submersible type sludge pumps	:	1 working + 1 standby (Min capacity of 200 cub M / hr)
4.8	Number of sludge pits	:	Sludge pit with isolating valves, and spool pipe shall be provided for individual basin chambers for connection to drainage pipe.
4.9	Number of cold water outlet channels	:	One for each compartment of CW basin. Cold water outlet shall be designed for flow velocity through them within 1.2 M/sec during the rated flow from cooling tower, with the minimum water level in the cold water basin. At T.P Bidder to match same as per T.P. Drawing.
4.10	Depth of CW channel		4.85 M from FGL (Ref Annexure-1)
4.11	Number of screens and gates in common outlet channel	:	One for each compartment of CW basin
4.12	Maximum allowable effective velocity through Cold water channel at Min. Water Level	:	1.2 M/Sec.
4.13	Maximum allowable effective velocity		1.2 M/Sec.

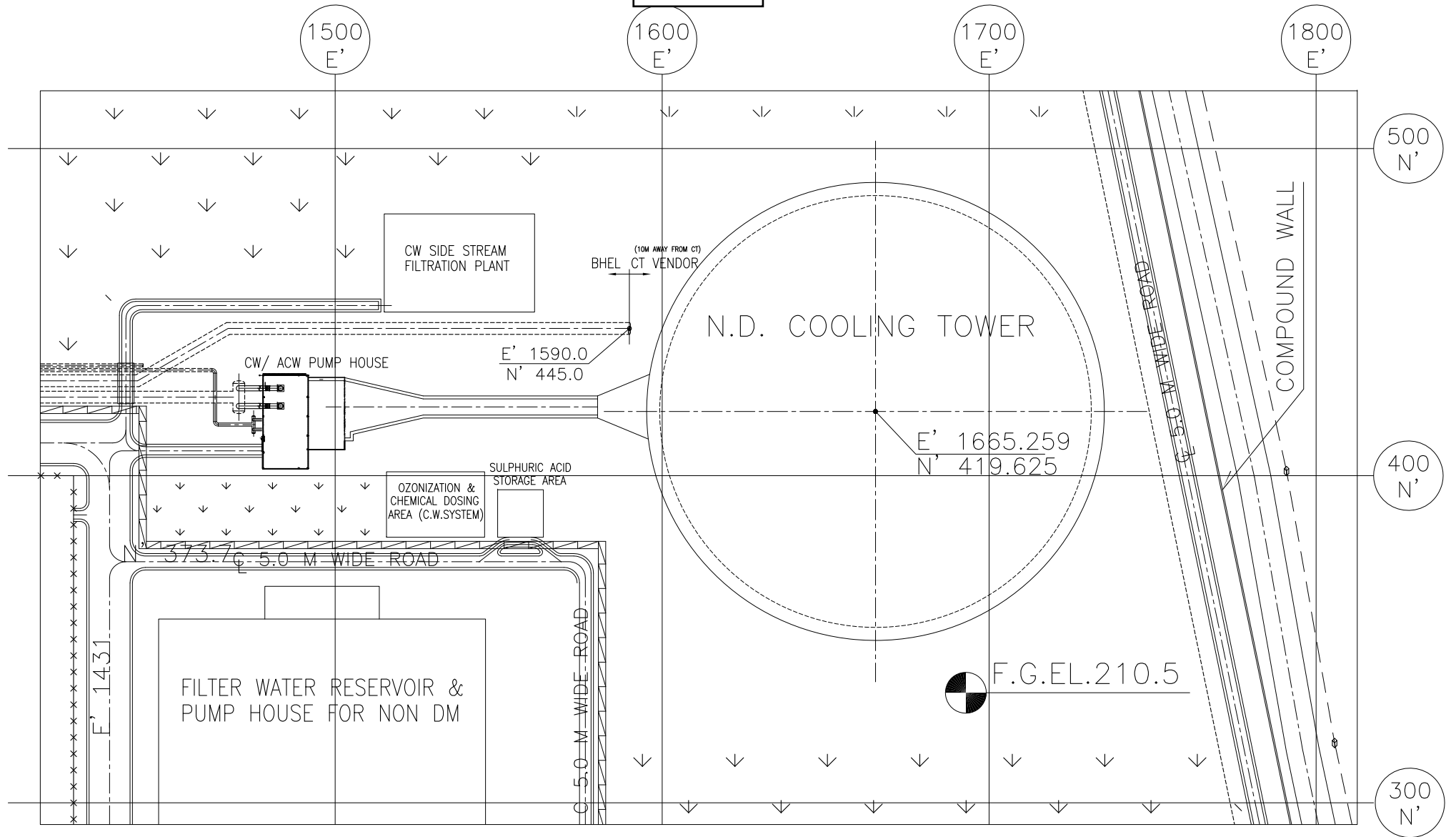
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	through gates at Min. Water Level	:	
4.14	Max. allowable effective velocity through screens at Min. Water Level	:	1.2 M/Sec.
4.15	Length of outlet channel including expansion joint in bidder's scope	:	As per terminal point details in Section C1 and details as shown in the enclosed Annexure-2.
5.0	COOLING TOWER ACCESS DETAILS		
5.1	Required number of stair cases from ground level up to hot water inlet for convenient access to top & interiors of Cooling tower	:	Two (2) Nos.
5.2	Number of cage ladders from ground floor to cooling tower top.	:	Minimum Four (4) Nos.: Two from reinforced concrete stairs to platform at the top of the tower and other two shall be from ground level itself.
5.3	Internal walkway of platform with hand rails	:	Walkways and platforms shall be provided inside the tower at distribution pipe level. These walkways and platforms shall provide safe and clear access to all sprayers and all distribution pipes. Clear width of walkways shall be 1.5M.
5.4	External walkway platform	:	1.2 M width around the circumference at top and at each aviation lamp levels
5.5	Platform for access of BFV	:	To be Provided by Bidder
6.0	HOT WATER SUPPLY HEADER TERMINALS	:	As per terminal point Annex-2 enclosed. CW piping in BHEL scope 3440mm X 20mm thk. shall be terminated with centre line of pipe elevation as shown in sketch. Further Piping from T.P. with isolating Motorized B.F. Valves in each riser shall be in bidder's scope.
7.0	SCOPE OF SUPPLY :		
7.1	Cooling tower basin outlet channels/ sump and sludge pits	:	Yes
7.2	Hot water piping to distribution Duct	:	Yes
7.3	Hot water header isolation valves(motorised) on risers	:	Yes
7.4	Flanges/counter flanges for all flanged connections with bolts, nuts & gaskets etc.	:	Yes
7.5	Screen & guide for each cold water outlet sump/ channel	:	Yes
7.6	Stop Log gate with guides and sealing device for each cold water outlet sump/ channel.	:	Yes – Sluice gate / butterfly valve with complete head stock arrangement is required
7.7	Isolation valves in sludge pit	:	Yes

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7.8	Drain Piping from sludge pit to terminal point	:	Yes
7.9	Pulley block for lifting each screen and stop log gate in cold water outlet sump/ channel	:	Yes
7.10	All necessary supports, hangers	:	Yes
7.11	Base plates, foundation plates, anchor bolts, sleeves, inserts, bolts, nuts for all equipment supplied	:	Yes
7.12	Drift Eliminator	:	Yes
7.13	Electrical		
	As per electrical plant specification	:	Yes
7.14	All related Civil works included	:	Yes
8.0	MATERIAL OF CONSTRUCTION		
8.1	Cold water basin, outlet channel/ sump & sludge pit.	:	R.C.C.
8.2	Shell/Casing & Superstructure	:	R.C.C
8.3	Basin partition wall	:	R.C.C
8.4	Internal walk way	:	R.C.C.
	External walkway platform		R.C.C
8.5	Staircase/Ladders	:	R.C.C./ HDG Steel
	Hand rail		Hot dip galvanized steel
8.6	Supporting structures	:	R.C.C.
	Hot water distribution basin	:	R.C.C
8.7	Hot water distribution nozzles	:	High Density Polyethylene or polypropylene or approved equal
8.8	Fills	:	PVC Film Fill
8.9	Fill support col, beams & trusses	:	R.C.C
8.10	Louvers	:	R.C.C.
8.11	Drift eliminators	:	PVC UV Stabilised
8.12	Fasteners/wetted parts	:	SS-316
8.13	Piping	:	Above 150 Nb : Carbon steel plates to IS 2062 internally lined with anticorrosive coal tar epoxy paint of min. 200 Microns DFT, rolled and welded as per IS 3589 Below and 150 Nb : IS 1239 (Heavy Grade)

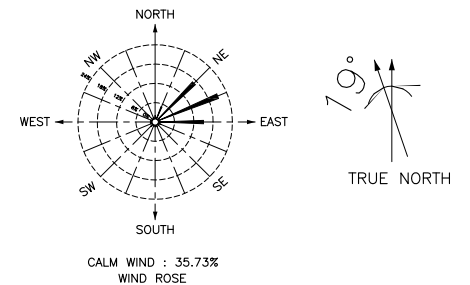
	TITLE: TECHNICAL SPECIFICATION COOLING TOWER 1X660MW BHUSAWAL DATASHEET - A		SPEC. NO.: PE-TS-415-165-N001
			VOLUME: II B
			SECTION: D1
			REV. NO. 0 DATE 16.01.18
			SHEET 5 of 6
8.14	Hot Water Distribution Pipes (Inside CT)	:	HDG Steel / PVC
8.15	Hot water line valves	:	
	a) BF Valves	:	Body: CI as per IS-210, FG-260 Shaft: SS304 as per ASTM A-479 Test pressure & duration shall comply with AWWA C504
	b) Sludge pit isolation valves	:	
	Body	:	CI as per IS-210, FG-260
	Spindle & Trim	:	SS
8.16	Sludge outlet pipe	:	CI IS-1536, LA
8.17	Submersible Pumps	:	Casing: CI as per IS-210, FG-260 Impeller: Stainless Steel
8.18	Sluice gates with rubber seals in cold water outlet channel	:	As per appropriate class of IS: 3042, all mild steel parts to be galvanised.
8.19	Guide for stop log gates	:	SS- 304L
8.20	Screen	:	SS 304L
8.21	Guide for Screen	:	SS- 304L
8.22	Bolts, buts & other hardware	:	SS-316 (for wetted) and MS for other
Note:			
(a) Carbon /Mild steel parts or structures used in Cooling Tower or its vicinity shall be Heavily Galvanised.			
(b) Material of construction for items not specified shall be subject to purchaser's approval during detailed engineering stage, in the event of order.			
9.0	Pipe work Painting / Protection of Pipes:		
9.1	Internal surface	:	Surface preparation : Sand blast to SA 2.5 Internal Paint: Application of adequate nos of coats Epoxy resin based red oxide primer paint or approved equal so as to achieve the required minimum 140 DFT. Inner surface painting shall be applied at the fabrication yard before laying the pipes in position, leaving about 200 mm at both ends for welding of joints. This portion shall be painted after completion of laying and jointing.
9.2	External surface – over ground piping	:	Surface preparation : Sand blast to SA 2.5 External Paint: One coat of coal tar primer before dispatch from fabrication yard. After installation, the part of the pipe line from where priming coat has been rubbed off shall be retouched with primer. Then two coats of synthetic enamel paint of approved quality and colour shall be applied. The paint must be compatible with applied coal tar primer.

	TITLE: TECHNICAL SPECIFICATION COOLING TOWER 1X660MW BHUSAWAL DATASHEET - A		SPEC. NO.: PE-TS-415-165-N001
			VOLUME: II B
			SECTION: D1
			REV. NO. 0 DATE 16.01.18
			SHEET 6 of 6
9.3	External surface – Burried piping	:	Surface preparation: Sand blast to SA 2.5 External Paint: One coat of coal tar primer of approved quality followed by coal tar based synthetic primer and single layer of 4 mm coal tar tape conforming to AWWA-C-203: 2002/IS-15337:2003. The pipes that will be buried underground shall be spark tested after completion of wrapping of each sections/ field jointing to check the quality of insulation that has been provided in the pipe.
	INSPECTION AND TESTING		
10.0	Quality Surveillance by	:	Manufacturer, purchaser and customer
10.1	Material testing and identification	:	Required
10.2	Stage inspection to be witnessed by Purchaser and customer	:	Yes
10.3	Hydrostatic test for piping & valves required	:	Yes
10.4	Hydrostatic test to be witnessed by Purchaser and customer	:	Yes
10.5	Field performance test of individual items and the cooling tower as a whole required	:	Yes
10.6	Field performance test to be done by	:	CTI approved / licensed agency along with bidder
10.7	All tests on the Butterfly valves at manufacturer's works to be witnessed by Purchaser	:	Yes
10.8	All testing instruments by supplier	:	Yes
10.9	Commissioning at site by	:	Bidder
10.10	Mandatory spares	:	NA
Attachments: a) Sketch showing details CT and CW Channel Levels. Annexure-1. b) Key Plan showing Terminal Points- Annexure-2. c) Cooling water Analysis – Annexure-3			

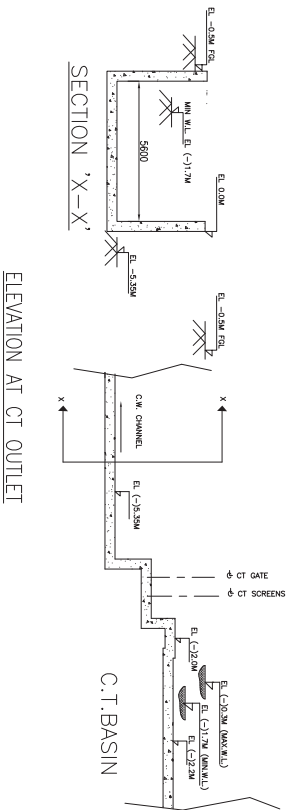
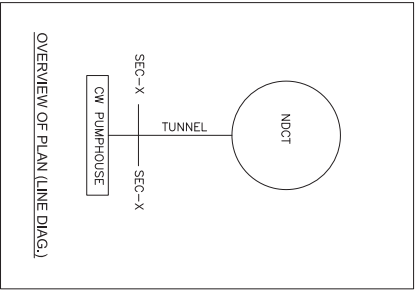
ANNEXURE-2



EXTRACT OF COOLING TOWER AREA AS PER TENDER PLOT PLAN
1 X 660 MW BHUSAWAL T.P.S. UNIT-6 TPP



ANNEXURE-1



CUSTOMER: MAHAGENCO
CONSULTANT: PROCON ENGINEERS
PROJECT: 1X660MW BHUSAWAL TPS
JOB NO.: 415
DRG TITLE: G.A DRG. OF CW PUMP HOUSE
REV NO.: 00
SHEET NO.: 4 OF 4
DATE: 02/01/18
(REV ENGRS)

 MAHARASHTRA STATE POWER GENERATION CO. LTD.	MAHARASHTRA STATE POWER GENERATION CO. LTD.	Volume: III-E1	
	BID SPECIFICATION NO.: DG/BSL U-6/2011/T-1	Section-2	
REV: R0	WATER TREATMENT SYSTEMS	Page 41 of 313	
<u>ANNEXURE- 3</u> <u>ANALYSIS OF RAW WATER</u>			
<u>SR. NO.</u>	<u>PARAMETERS</u>	<u>UNITS</u>	<u>VALUES</u>
1.0	pH		8.0 – 8.5
2.0	Temperature	°C	22 - 30
3.0	Conductivity	µS/cm	1300
4.0	Colour	Hazen Units	Not Available
5.0	Odour		Not Available
6.0	Taste		Not Available
7.0	TDS	ppm	870
8.0	P-Alkalinity as CaCO ₃	ppm	Nil
9.0	M-Alkalinity as CaCO ₃	ppm	400
10.0	T – Alkalinity as CaCO ₃	ppm	400
11.0	Organic Matter as KMnO ₄	ppm	50
12.0	Iron (as Fe)	ppm	1
13.0	Turbidity (NTU)	ppm	100 during Non – Monsoon Up to 10,000 during Monsoon
14.0	CATIONS		
	(a) Ca as CaCO ₃	ppm	295
	(b) Mg as CaCO ₃	ppm	77
	(c) Na as CaCO ₃	ppm	203

CONSULTANT : PROCON ENGINEERS

 MAHAGENCO Maharashtra State Power Generation Co. Ltd.	MAHARASHTRA STATE POWER GENERATION CO. LTD.		Volume: III-E1
	BID SPECIFICATION NO.: DG/BSL U-6/2011/T-1		Section-2
REV: R0	WATER TREATMENT SYSTEMS		Page 42 of 313
<u>SR. NO.</u>	<u>PARAMETERS</u>	<u>UNITS</u>	<u>VALUES</u>
	(d) K as CaCO ₃	ppm	10
	Total Cation	ppm	585
15.0	ANIONS		
	(a) HCO ₃ as CaCO ₃	ppm	400
	(b) Chlorides	ppm	149
	(c) SO ₄ as CaCO ₃	ppm	33
	(d) Fluoride as CaCO ₃	ppm	1
	(e) Nitrate as NO ₃	ppm	2
	Total Anion	ppm	585
16.0	Ammonia	ppm	Absent - Traces
17.0	Silica Colloidal (as SiO ₂)	ppm	< 1 (can be present in summer)
18.0	Silica Non - Colloidal (as SiO ₂)	ppm	36
19.0	Free Chlorine	ppm	Nil
20.0	Total Suspended Solids	ppm	Not Available
21.0	Carbonates as CaCO ₃	ppm	Not Available
22.0	Boron	ppm	Not Available
23.0	Oil & Grease	ppm	Not Available

CONSULTANT : PROCON ENGINEERS



TITLE :
STANDARD TECHNICAL SPECIFICATION
FOR
NATURAL DRAFT COOLING TOWERS

SPECIFICATION NO. PE-TS-999-165-N004

VOLUME : II B

SECTION : D **Part-A**

REV. NO. 0 **DATE :** 22.03.2003

SHEET 1 of 9

1.0 GENERAL:

1.1 This standard specification covers the design, manufacture and assembly, inspection and testing at the Vendor's and/or his sub-vendor's works, suitable painting and packing requirements for transportation, erection, commissioning and testing at site of all materials and equipments inclusive of complete electrical and civil works for the Natural Draft Cooling Tower complete with all accessories as specified hereinafter.

2.0 CODES AND STANDARD:

2.1 The design, manufacture, inspection and testing and performance of the Cooling Tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American Standards and Codes of practice. The latest editions of the following standards and publications shall be followed in particular.

- a) Cooling Tower Institution of USA, Bulletin ATP-105: Acceptance Test Code for Industrial Water Cooling tower.
- b) PTC-23: ASME Performance Test Code for Atmospheric Water Cooling equipment.
- c) For Electrical, Civil Codes/ Standards refer respective Specification.
- d) BS-4485 – Specification for Water Cooling Tower.

2.2 In case of any conflict between the above codes/ standards and this specification, the later shall prevail and in case any further conflict in the matter, the interpretation of the specification by the Engineer shall be final and binding.

3.0 DESIGN REQUIREMENTS:

3.1 The Cooling Tower shall be designed for continuous operation to cool not less than the design flow of water from specified inlet temperature to outlet temperature at a design ambient wet bulb temperature as indicated under Data Sheet-A enclosed to this specification.

3.2 All the components shall be capable of safe, proper and continuous operation at all cooling water flows up to and including those specified under Data Sheet-A and shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

3.3 The cooling tower shall be Natural Draft cross flow/ counter flow type as per enclosed Data Sheet-A.

3.4 The vendor under this specification shall assume full responsibility in proper design and operation of each and every component of the cooling tower as well as the cooling tower as a whole unit.



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- 3.5 The Cooling tower shall be suitable for handling the fluid as per Data Sheet-A and also for achieving the specified parameters in Data Sheet-A.
- 3.6 The Cooling tower shall be designed such that the drift losses and the evaporation losses are limited to the values as specified in Data Sheet-A.
- 3.7 The Cooling Tower structure shall be of adequate strength to withstand the wind load and the effect of earthquake on the structure. Design wind pressure and horizontal/vertical seismic coefficient shall be taken as mentioned in the specification for civil works enclosed to this specification.
- 4.0 **CONSTRUCTIONAL FEATURES:**
- 4.1 **Casing and Louver (If required):**
- 4.1.1 The Louvers shall be designed for air entry to the tower with low velocity for minimum pressure drop and less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards.
- 4.1.2 The louvers and casing shall be made of material as specified in the Data Sheet-A.
- 4.2 **Partitions:**
- 4.2.1 Partitions shall be provided so that one section can be taken out of service without affecting the operation of capacity of other section.
- 4.3 **Fill:**
- 4.3.1 Cooling tower fills type and material shall be as specified in Data Sheet-A.
- 4.3.2 Design and arrangement of the fills shall be so as to expose high air/ water surface with minimum air pressure drop.
- 4.4 **Fill Supports:**
- 4.4.1 Fills shall be supported at frequent intervals, which shall minimise sag. Possibility of dislodgement and damage to fill materials as a consequence of induced vibration in the fill.
- 4.5 **Drift Eliminations:**
- 4.5.1 Multipass drift eliminators with minimum two-pass zig zag path type shall be provided so as to limit the drift loss to that specified in Data Sheet-A.
- 4.5.2 The eliminator frame shall be of rugged construction and shall be firmly secured to the structural



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frame to arrest vibration. Suitable access to the eliminator frame work from the basin should be provided for any maintenance or physical replacement of eliminator blades etc., when the particular cell is taken out for maintenance.

4.6 Hot Water Distribution System:

4.6.1 Motorised/Manual valves (as indicated in Data sheet A) shall be provided in the hot water distribution piping such that each section can be isolated without affecting the operation of other section.

4.6.2 The pipes and valves in hot water distribution system shall be designed to take care of the possible thermal stresses due to temperature variation. This could be achieved by providing sliding supports for supporting all the pipes fabricated from carbon steel.

4.6.3 The hot water distribution piping and valves shall be designed for the design pressure as indicated in the Data Sheet-A.

4.7 Cold Water Basin:

4.7.1 The cooling tower basin shall be constructed in RCC (unless otherwise specified in Data Sheet-A). The capacity of the cooling tower basin shall be as indicated in Data Sheet-A.

4.7.2 The cold water basin shall be partitioned into two chambers or as specified in Data Sheet-A. The two sections of the Cooling Tower basin should be separate water tight compartments, which can be isolated one at a time for cleaning/maintenance purposes.

4.7.3 Sludge pits with isolating valves and spool pipe having flanged ends shall be provided for individual basin chamber for connection to drainage pipe.

4.7.4 For each basin chamber, there shall be a cold-water outlet channel. In the connection between basin chamber and cold water outlet channel there shall be a stationary coarse bar screen and gate in the absence of any specific preference under Data Sheet-A.

4.7.5 Each basin chamber shall have an overflow arrangement and scouring arrangement.

4.8 Submersible sludge Pumps:

4.8.1 The submersible type sludge pumps complete with electric motors, discharge side valves, piping, supports, hangers and clamps etc. shall be supplied at the option of the purchaser for each cooling tower for basin draining/ desludging. The quantity, design parameters and the materials of construction of the vertical sludge pumps shall be as per Data Sheet-A. Each pump shall be non-clog type, self water lubricated. The vertical sludge pumps shall be treated as an optional item and are to be offered if asked for in the Data Sheet-A enclosed to this specification.



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4.9.0 Screens & Gates in Cold Water outlet Chamber:

4.9.1 The screens shall be vertical stationary type; the opening size and the mesh aperture shall be as per Data Sheet-A. The guides for the screens to be embedded in the concrete shall be of material as per Data Sheet-A.

Lifting lugs or eye bolts shall be provided on top of the screen frame for ease of handling.

4.9.2 For handling screens, one set of monorail with supporting structure and chain pulley hoist complete with lifting chain and trolley for mounting the hoist shall be furnished. The chain pulley hoist shall be manually operated and shall conform to IS-3832 class-II.

4.9.3 The gates fixed in vertical sections in cold water outlet chamber shall be as per standard practice and quality, material and type shall be as given in Data Sheet-A.

4.9.4 The isolating valves on the scour lines within the sludge pits shall conform to class I of IS-780 and shall be of reputed make.

4.10 Hardware:

4.10.1 All nails and fastening bolts, nuts and washers etc used in the cooling tower which are coming in direct contact with water or humid air shall be made of stainless steel 304, all others nuts & bolts etc. shall be made of HDG steel.

4.11.0 Access:

4.11.1 Two R.C.C. staircases for approach to the hot water distribution level

4.11.2 Doors for entrance into Cooling Tower Distribution level shall be provided as specified in Data Sheet -A.

4.11.3 Two external ladders for approach to top of cooling tower from water distribution level.

4.11.4 Access/platforms for inspection and maintenance of hot water distribution system along with spray nozzles.

4.11.5 Suitable arrangement for supporting walkways inside the cooling tower shall be made and loading of such arrangement shall be independent of the fill material.

4.11.6 Whether specifically mentioned in the data sheet or not, steel components and fittings used in walkways, handrails and access doors shall be hot dip galvanised after fabrication.

5.0 INSPECTION AND TESTING:

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5.1	The inspection/ testing of cooling tower and its various components shall be as per the approved Quality Plans.		
5.2	Hydrostatic test for the hot water distribution piping shall be conducted at site after complete erection. The test pressure and duration shall be as per Data Sheet-A.		
6.0	TEST AT SITE:		
6.1	The Cooling Tower as a whole shall be tested at site to check and ascertain that the performance meets the requirements of the specification. It is the responsibility of the vendor to conduct the performance test of the cooling tower and prove the specified parameters to the satisfaction of the purchaser. The test shall be witnessed by the purchaser/ customer's representative or both, for which 15 days clear notice will be given to purchaser by the vendor.		
6.2	The performance test of the cooling tower shall be carried out in accordance with cooling tower Institute Bulletin No. ATP 105 Acceptance test for Industrial Cooling Tower. The details of the proposed test procedure shall be submitted by the vendor sufficiently in advance of the commencement of test for the review and approval of the purchaser.		
6.3	Necessary correction curves required for correcting the test results for any difference in test and guaranteed design condition shall be furnished by the supplier for approval along with the proposed test procedure.		
6.4	All testing and calibrating instruments required for the site performance test shall be arranged by the cooling tower supplier without any extra cost. All instruments used by the supplier shall be duly calibrated from a recognised Institution and the same is to be arranged by the supplier.		
7.0	PERFORMACNE GUARANGTEE, TOLERANCE & PENALTIES:		
7.1	Each equipment shall be guaranteed to meet the performance requirement as specified.		
7.2	The tests shall be conducted at the manufacturer's works/ site in accordance with this specification and rectification of all defects shall be satisfactory done without charging any extra amount to purchaser.		
7.3	The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within a time period decided by purchaser. No extra amount shall be charged to purchaser for such rectification. After rectification, retesting will be done by purchaser/ customer's representative without any extra cost to purchaser till satisfactory performance is achieved.		
7.4	The vendor shall submit performance curves for the cooling tower showing variation in performance from the design duty point with change in approach to wet bulb temperature,		



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cooling range, water loading of the tower.

7.5 The vendor shall guarantee the performance of the whole cooling tower plant to meet the specifications when tested in accordance with cooling tower institute acceptance test code ATP-105, performance curves as per ATP-105 shall be furnished by the vendor.

7.6 If any defects are observed, the bidder shall rectify the same without extra cost to the purchaser. Even after rectification if the guaranteed performance is not achieved, then for every increase of 0.5 degree C or part thereof in the cold water temperature over design conditions, a sum as specified in data Sheet-A shall be paid by vendor to the purchaser for shortfall of guarantee, for the cooling tower.

7.6.1 In case the cold water temperature exceeds the acceptable limits of purchaser, the whole plant will be rejected and the vendor shall refund the entire money paid to him together with any penalty levied otherwise.

8.0 SPECIAL CLEANING PROTECTION & PAINTING:

8.1 All equipment shall be neatly finished. All exposed metal/ concrete/ wooden surface shall be smooth and free from burrs/ projections.

The metal surfaces to be painted should be accessible, suitable for priming and affording maximum protection throughout the life of the plant. The surface preparation shall be done either mechanically or chemically by one or more of the methods as given in IS-1477 (Part-I) and shall include the following:

- a) Removal of oil, grease, dirt and swarf etc., as per Section 6.1 of IS-1477 (Part-I).
- b) Removal of rust and scale etc., as per Section 6.2 of IS-1477 (Part-I).
- c) Sand blasting/ shot blasting as per Section 6.2.4 of IS-1477 (Part-I) or wire brushing and picking as specified in Data Sheet-A.

8.2 INSIDE SURFACE OF PIPING & VALVES IN HOT WATER RISERS:

8.2.1 The inside surfaces of the piping and the valves which are in contact with water and which are not made of stainless steel or other corrosion resistant materials shall be painted with coal tar based epoxy paint of approved make and quality over a coat of Zinc Chromate Primer. The thickness of cured coating shall be as specified in Data Sheet-A.

8.3 Outside Surface of Piping (Buried):

8.3.1 Surface treatment as specified in Data Sheet-A.



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8.3.2 Coating/ wrapping/ concrete lining as specified in Data Sheet-A.

8.4 **Outside Surface or Piping (Exposed):**

8.4.1 Surface treatment as specified in Data Sheet-A.

8.4.2 One coat of red oxide primer.

8.4.3 Synthetic enamel paint of approved shade, make and quality. The thickness of cured coating shall be as specified in Data Sheet-A.

8.5 All steel parts used for cooling tower construction shall be hot dip galvanised as per IS-4736 after shop fabrication. The external surfaces of the flow regulating valves access platform, access door and also the hoisting derrick subjected to hot water fumes shall also be thoroughly cleaned and treated and shall be coated with rust preventing paints.

8.6 All parts shall be properly boxed, crated or otherwise protected for transportation. Exposed metal finished surfaces shall be thoroughly greased before transportation.

8.7 The external and internal surfaces of the tower shall also be painted.

9.0 **DRAWING AND DATA AFTER AWARD OF CONTRACT:**

The vendor shall furnish drawings and other technical documents as given in Data Sheet-C, enclosed with the specification.

10.0 **SPECIAL TOOLS & TACKLES:**

Special tools & tackles, if any, shall be included in scope of supply by the vendor. A list giving description of such tools & tackles shall be furnished by vendor.



TITLE :

**DATA SHEET – C
FOR
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DATA / DOCUMENTS TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

1. 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, end wall derrick etc. and the limits of scope of supply of electrical works.
2. General Arrangement drawing of Cooling Tower basin indicating overflow and desludging arrangement.
3. General Arrangement and Sectional Assembly drawings pertaining to the following components of the Cooling Tower.
 - a) Tower fill with supporting arrangement.
 - b) Drift eliminator installation and details.
 - c) Complete hot water distribution system including flow regulating valves, distribution basin/ pipes and nozzles etc.
4. Arrangement drawing of the cold water outlet chambers and sludge pits incorporating also the arrangement of screens, gates, valves and piping terminal details.
5. Cooling tower performance curves showing wet bulb temperature V/s. cold water temperature for design cooling range, 90% cooling range and 110% cooling range at 90% ,100% and 110% of design flow.
6. Detailed GA and sectional assembly drawing of BF valves in hot water risers indicating materials of construction of various components.
7. General Arrangement and cross-sectional assembly drawings of sludge pumps and motor drives along with their performance curves.
8. Electrical drawings and data.
 - i) Cable Schedule
 - ii) Cable tray and trench layout.
 - iii) Drawing on illumination system of cooling tower structure including wiring diagram showing conductor and conduct sizes and design calculation.
 - iv) Drawing on Aviation Obstruction Lighting System.
 - v) Drawing on grounding system inclusive of lighting protection system.



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DATA SHEET – C
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vi) Drawing of lighting sub-distribution board & junction boxes.

10. Drawings, data and calculation on civil works :

- i) Design calculations for strength and suitability showing justification for size of members chosen for all structural components of cooling towers inclusive of prestressed concrete fill where applicable. All civil and structural design calculations shall be furnished by the supplier for approval of the purchaser.
- ii) Load drawings setting out clearly and concisely the various loads taken into consideration for design.
- iii) Civil drawings for cold water basin, sludge sumps, connecting channels, partitions, louvers, end walls, longitudinal beams, hot water distribution basin, its covering, staircase, platforms, cable trenches, etc. all complete.
- iv) Bar bending details for all reinforced concrete structures.
- v) Insert details, anchor bolt details.
- vi) Final painting schedule.
- vii) Other drawings & data as necessary.

11. Test procedure along with details of tests to be conducted for the offered cooling tower.

12. Quality Plan along with complete details of the testing and inspection requirements of mechanical and electrical items of the cooling tower in BHEL format.

13. Operation and Maintenance Manuals

14. Field Quality Plan for site activities – viz. Civil works & Erection.

15. Cooling tower performance test procedure.