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 1X660 MW PANKI TPS Extn 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 PANKI TPS Extn – One (1) No. 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):**

	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) for each basin half, 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. 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.

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 CT in presence of employer / purchaser through **CTI approved/licensed testing agency**.
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	**One 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

	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 ± 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 not withstanding 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.405 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

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 = 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: $V = 0.85 \times C \times (i)^{0.54} \times (d/4)^{0.63}$.

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.

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:**

1.0	**GENERAL INFORMATION**		
	No. of Cooling Towers required	:	One (01) Nos.
	Location		Out door
	Duty		Continuous
	Type		NDCT with PVC Splash V-Bar type fills
	Finished ground level		EL (-) 0.50 M (RL+ 126.0 M)
	Basin Kerb level (Basin Sill Top level)		EL(+) 0.0 M (RL+ 126.5 M)
2.0	**DESIGN PERFORMANCE FOR EACH COOLING TOWER**		
2.1	Design Cooling water flow	:	90000 M^3/hr.
2.2	Design ambient wet bulb temp.	:	28.0 ^oC
2.3	Design inlet air wet bulb temperature.	:	28.0 ^oC
2.4	Approach w.r.t. design inlet air wet bulb temperature (viz. 28.0^oC)	:	5.0 ^oC
2.5	Cold water temperature	:	33 ^oC
2.6	Hot water inlet temperature	:	40.5 ^oC
2.7	Cooling Range	:	10.0 ^oC
2.8	Design ambient Relative Humidity	:	45%
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. Max Water Level • Frictional losses within bidders T.P. with 10% margin • Velocity head	:	Not to exceed 17.6 MWC from Max WL Or 17.8 MWC from FGL
2.10	Maximum permissible drift loss	:	Max. 0.002 %
2.11	Design pressure for hot water distribution	:	6.2 kg/cm^2(g)

2.12	system Maximum foundation Diameter (outermost edge of foundation)	:	NA
2.13	Minimum Basin Diameter	:	140 M
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 (-) 0.50 M (RL+ 126.0 M
4.2	Maximum water level	:	EL (-) 0.30 M (RL+ 126.20 M
4.3	Min. Water level	:	EL (-) 0.90 M (RL+125.60 M
4.4	Storage capacity between Normal and minimum water levels.	:	6 minutes (Between Max. & Min. Water Level) of Cooling tower design Flow
4.5	Invert level of CT Basin	:	EL (-) 1.40 M (RL+ 125.1 M) ---at basin centre EL (-)2.10 M (RL+ 124.40 M) ---at basin periphery
4.6	Invert level of CW Channel near CT level	:	EL (-)5.4 M (RL+ 121.10 M)
4.7	a) Depth of Sludge pit b) Submersible type sludge pumps	: :	Suitable for complete dewatering. To include sludge pump submergence & clearance depth below basin/ channel invert level 1 working + 1 standby (Min capacity of 100 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		3.75M from Min WL (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 through gates at Min. Water Level	:	1.2 M/Sec.
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 Two (2) Nos.: Diametrically opposite, for the full height of Tower.
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 RC platform of 1.5M clear width
6.0	**HOT WATER SUPPLY HEADER TERMINALS**	:	As per terminal point Annex-2 enclosed. CW piping in BHEL scope 3840mm X 20mm thick 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	:	Yes

	valves(motorised) on risers		
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
7.7	Isolation valves in sludge pit	:	Yes– Sluice gate / butterfly valve with complete head stock arrangement is required
7.8	Drain Piping from sludge pit to terminal point	:	Yes
7.9	Electric Hoist 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	:	Polyethylene or approved equal

8.8	Fills	:	PVC Splash V-bar type
8.9	Fill support col, beams & trusses	:	R.C.C
8.10	Louvers	:	R.C.C.
8.11	Drift eliminators	:	PVC
8.12	Fasteners/wetted parts	:	SS-316
8.13	Piping	:	**Above 150 Nb** : Carbon steel plates to IS 2062 `rolled and welded as per IS 3589 **Below and 150 Nb** : IS 1239 (Heavy Grade)
8.14	Hot Water Distribution Pipes (Inside CT)	:	HDG Steel / PVC
8.15	Hot water line valves		
	a) BF Valves	:	Body & disc: 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-304
8.20	Screen	:	SS -316
8.21	Guide for Screen	:	SS-304
8.22	Bolts, buts & other hardware	:	Stainless Steel

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 **Primer -** Application of two (2) coats (DFT of each shall be min 35 microns) of Epoxy primer. **Finish –** Two (2) coats (DFT of each shall be min 35 microns) of high build epoxy paint. Total DFT of min. 150 microns.

9.2	External surface – over ground piping	:	**Surface preparation :** Sand blast to SA 2.5 **Primer -** Application of two (2) coats (DFT of each shall be min 35 microns) of Epoxy primer. **Finish –** Two (2) coats (DFT of each shall be min 35 microns) of high build epoxy paint. Total DFT of min. 150 microns.
9.3	External surface – Buried piping	:	CW buried Piping shall be encased in 500 mm thick RCC.
	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	:	Refer Annexure-4

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

d) Mandatory spares – Annexure-4.

CHAPTER 18: NATURAL DRAUGHT COOLING TOWER

18.0 Natural Draught Cooling Tower

18.01 Codes & Standards

18.01.00 The design, construction, manufacture, performance, testing and commissioning 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:

18.01.01 BS 4485 Water Cooling Tower (Part 1 thru' 4)

18.01.02 Cooling Tower Institute of USA, Bulletin ATC-105: "Acceptance Test Procedure for Water Cooling Tower."

18.01.03 PTC-23: ASME Performance Test Code for Atmospheric Water Cooling Equipment.

18.01.04 IS: 11504: Criteria for Structural Design of Reinforced Concrete Natural Draught Cooling Towers.

18.01.05 American Society of Testing Materials

18.02 The materials of various components such as PVC, plain and reinforced concrete, bars and steel wires for concrete reinforcement etc. shall be in accordance with relevant Indian Standards or else to applicable American Standards.

18.03 In case of any contradiction between the aforesaid Standards and stipulations as per this technical specification as specified hereinafter, the stipulations of this technical specification shall prevail.

Also, in case of any contradiction between this technical specification and stipulations of the enclosed "Data Specification Sheets", the stipulations of the Data Specification Sheets will prevail.

18.04 GENERAL PERFORMANCE REQUIREMENTS

18.04.01 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 and other design parameters as enumerated in the enclosed Natural Draught Cooling Tower Data Specification Sheets.

18.04.02 The cooling tower shall be designed for continuous operation throughout the year, unless specially stated otherwise in Data Specification Sheet. The guaranteed performance (cold water temperature) shall be achieved at all wind velocities as specified.

18.04.03 The cooling tower shall also give satisfactory performance while handling the specified water during monsoon months, with the range as indicated in Data Specification Sheet.

18.04.05 For arriving at the air properties such as enthalpy, density etc., no correction for altitude shall be considered. All properties shall be taken from the data provided on CTI or BS code corresponding to sea level.

18.04.06 Bidder shall also furnish the following in support of tower design and performance, along with the bid without which the offer is liable for rejection.

18.04.07 Heat balance calculations.

18.04.08 Justification for the outlet air temperature. This could be in the form of operating experience on existing towers or laboratory test on actual fill shape, material and configuration as offered. In the case of laboratory test, Bidder shall indicate correction / scaling factor applied to predict performance of full size tower under field conditions.

18.04.09 Calculations to show the adequacy of tower height to provide the required Draught.

18.04.10 Calculations for tower duty coefficient and performance coefficient.

18.04.11 Sketch showing fill arrangement which should clearly indicate the total depth, horizontal and vertical spacing.

18.04.12 Drift loss of the cooling tower expressed in % of rated capacity shall be limited to as close to zero as possible.

18.04.13 The Bidder shall assume full responsibility in proper design and operating of each and every component of the complete cooling tower as well as the cooling tower as a whole.

18.05 SYSTEM DESCRIPTION

18.05.01 The natural draught cooling tower will be located inside the plant boundary and will be used for cooling the hot circulating water returning from the condenser and various other heat exchangers. The circulation of water will be maintained by Circulating Water (CW) Pumps and Auxiliary Cooling Water (ACW) pumps located inside C.W. pump house.

18.05.02 The hot circulating water reaching the cooling tower will be raised to the top of the hot water distribution system of the tower. The hot water distribution pipes inside the Tower shall be fitted with spray nozzles to distribute the hot water evenly over the PVC fill located immediately below. The hot water cools by evaporation as it drains through the PVC fill into the cooling tower basin.

18.05.03 The cooled water will be collected in a circular basin located under the cooling tower. The basin shall have a central partition, such that any half of the basin can be cleaned/ repaired while the other half is in use.

18.05.04 Water from the cold water basins will flow through RCC channel to the sump of the C.W. pump house.

18.05.05 The supplier should preferably be in a position to take up maintenance/ overhauling work as and when desired by the Owner during whole life of operation of the plant, on service contract and/or piecemeal basis.

18.06 DUTY AND CAPACITY

18.06.01 Cooling tower shall be capable of cooling the total quantity of hot condensate circulating water and auxiliary cooling water, through the specified 'Range' at the design wet bulb temperature and other parameters as per Data sheet. This cooling shall be possible even with the maximum or calm wind conditions. The Cooling tower shall be designed for continuous operation throughout the year.

18.06.02 The basin wall curb level shall be minimum 500 mm above the finished grade floor. The grade level surrounding the cooling tower shall provide for effective storm water drainage away from the tower. Depth of basin from well top shall be suitable for 6 minute storage of rated capacity excluding free board of 300 mm and not less than minimum one (1) metre. Basin slope towards cooling sump shall be 1 in 120.

18.06.03 The bidder shall review the analysis of water in circulation. All materials and components furnished under this specification shall be suitable for continuous and reliable operation of the tower with the water in circulation. Special care must be taken to select and use materials and components, which will not corrode, leach or be subject to organic and inorganic deposits or destructive action leading to subsequent failure or erosion by water droplets or be source of electrolytic corrosion being set-up between components. Any materials or components, found inadequate for the service during the first 12 months, after commissioning will have to be replaced at site with suitable material of construction in all towers without any additional cost to the Owner at a time when unit is under shut down.

18.06.04 Re-cooled water from tower basin will be conveyed through a concrete channel to the circulating water sump for recirculation. Hot water will be delivered to the tower through distributing headers. Re-cooled water from tower shall be thoroughly mixed to ensure temperature equalization prior to entering the channel leading to the pumps.

18.07 SCOPE OF SUPPLY AND WORKS

The following Equipment shall be supplied under this specification.

18.07.01 General

- Thermal, mechanical and structural design of cooling tower including all appurtenant civil works.
- Drift eliminators
- Supply at site of all materials and equipment required for construction.
- Construction of cooling tower including all work and services connected herewith.
- Construction of cold water basin, cold water outlet channel/ duct and basin de-sludge arrangement.
- Hot water distribution piping/ducting along with spray nozzle system.

- Supply, shop testing of components and erection of all mechanical equipment, PVC fill, Spray nozzles, etc.

- Complete lightning protection system, aviation obstruction lighting system, earthing including the necessary power distribution arrangement as per technical specification for "Electrical Works, Vol. IV".

18.07.02 **Detailed Scope of Civil Works**

Refer to Chapter-13 of Volume-VI of this specification.

18.07.03 **Detailed scope of Mechanical works**

- Hot water distributions spray system of reliable & efficient design, along with its supporting arrangement.

- Hot water duct/pipe work along with supports and anchors.

- Gear operated with chain pulley arrangement isolation valves on hot water inlet piping before hot water distribution system to achieve basin maintenance.

- Painting both inside and outside surfaces of steel pipes with three coats of rust and corrosion resisting paint including thorough cleaning of the surfaces.

- Tower PVC fill, drift eliminators including all required supporting structure and accessories, etc. as necessary.

- Screens along with guides embedded in concrete at each of the cold water outlet channels from the cold water basin.

- Sluice gate with mechanical jack arrangement and guides in each of the cold water outlet channel connection from the cold water basin.

- Manually operated chain pulley blocks, together with the monorails and supporting frames for the handling of screen and gates.

- Cold water outlet duct/tunnel.

- 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.

- Tower Fill Hot water By-Pass Nozzle connections on Hot water duct/ piping for system lines flushing during commissioning.

- Instrument tapping provisions on hot water duct/piping and cold water duct/piping for carrying out flow and temperature measurement during PG test.

18.07.04 **Detailed Scope of Electrical Works**

Refer Volume IV - Electrical works.

18.07.05 Any additional equipment, material, services which are not specifically mentioned here, but are required to make the plant/systems in the scope of the Bidder complete in every respect in accordance with the technical specification and for safe operation and guaranteed performance, shall be deemed to be covered under the scope of this specification.

18.07.06 All accessories and hardwares.

18.07.07 One set of special tools and tackles.

18.07.08 All relevant drawings, data and O&M manuals.

18.07.09 The scope of this specification also includes erection, installation, site testing, commissioning, trial run, performance and guarantee tests, training of operating personnel, O&M of the plant till commencement of commercial operation and other erection services to ensure trouble free operation and commissioning of the Equipment/System.

18.08 DESIGN AND CONSTRUCTION

18.08.01 Hot Water Distribution System

18.08.01.01 The distribution system shall be designed for flexible and satisfactory operation at all reasonable loads.

18.08.01.02 The hot water distribution shall be suitable for handling an additional 20% flow over the design circulating water flow. The hot water distribution shall be done by two headers, each covering half of cooling tower area so that it can be operated at 50% capacity.

18.08.01.03 The hot water distribution piping and valves shall be designed for a working pressure as calculated by the Bidder.

18.08.01.04 The spray system can be either upward or downward maintaining water spray even with shutdown flows.

18.08.01.05 The sprayers shall be arranged in a uniform pattern with proper distance to produce 10% to 20% overlapping of the individual sprays. This arrangement shall provide extremely even water distribution with uniformly sized droplets entering the fill. The spray overlapping required avoiding dry pockets in the fill due to variations expected in water head availability in main hot water duct.

18.08.01.06 The spray nozzle shall be reliable and effective in breaking the hot water jet into a spray pattern of uniformly sized droplets. It should be proven and tested design to provide maintenance free service for minimum 3 years.

18.08.01.07 The fixing arrangement of spray nozzles to hot water distribution header shall be of flanged joint type. Screwed joint shall be avoided as they are likely to get loosened due to flow induced vibrations.

18.08.01.08 The distribution of water shall be in Ducts / troughs of approved material. The entire water distribution system shall be self-draining and non-clogging type.

18.08.01.09 The distribution troughs/pipes shall be independently supported from the

structures and shall be easily removable. Provision shall also be made for easy flushing or cleaning of all troughs / pipes.

18.08.01.10 The structural design of the water distribution system shall also consider the following loadings, combined as appropriate.

a) Self weight.

b) Hydraulic pressure during normal operations, including pressure surges.

c) Hydraulic pressures due to mal-operation of tower or supply pumps.

18.08.01.11 Seismic loading on the water distribution system shall also be considered.

18.08.01.12 The water distribution system shall be provided with adequate pressure surge relief facilities to prevent pressure loadings in excess of values used in the design. If such facilities are not provided, a further increase in loading shall be considered in the design. The pressure level to be considered shall not be less than 1.5 times the design pressure.

18.08.01.13 The design of water distribution system and its supports shall be capable of accommodating all thermal stresses and movements due to changes in inlet water temperature, outlet water temperature and ambient temperature.

18.08.01.14 If open basin system of distribution is provided, the basin shall be provided with removable type covers made of pre-cast concrete.

18.08.01.15 Splash boxes in cross flow tower shall be provided at the discharge of each distribution valve to minimize splashing and to facilitate even distribution of water.

18.08.01.16 The nozzles shall be spaced to give even distribution of water over the entire space occupied by top row of fills.

18.08.01.17 The nozzles and splash plates shall be made of High Density Polyethylene or approved equal.

18.08.01.18 The pipes & valves etc. used shall be designed and arranged to take care of the possible thermal stress due to temperature variation. The pipes & fittings shall have extra heavy thickness.

18.08.01.19 Ready accessibility to the different parts like isolation valves etc. shall be provided and as required necessary platform/walkway and ladder shall be provided for this purpose.

18.08.02 **Louver and Casing**

18.08.02.01 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.

18.08.02.02 The louvers and casing may be made of concrete. Concrete casing wall shall be supported from the basin through reinforced concrete. Hinged access door with platforms shall be provided for entry into the tower at suitable locations.

18.08.03 **Fill**

18.08.03.01 Cooling tower fill shall be made PVC, V-bar type of approved make.

18.08.03.02 Minimum weight of fill should be 100 Kg/sqm.

18.08.03.03 The Bidder shall enclose with his proposal a write-up on the method of replacement of damaged/deteriorated fills during the life of cooling tower. Also Bidder's experience with pre-stressed concrete fills shall be clearly furnished in proposal. Bidder shall also indicate whether these are to be manufactured at shop or at site.

18.08.03.04 The PVC fill if offered shall be durable and fire retardant quality. The Bidder shall furnish details of PVC fill along with his offer indicating fire retardant properties, ageing effect, vibration caused by water and wind effects. Frequency of replacement of PVC fills and the method of such replacement shall also be mentioned with above details. The PVC fills shall be of proven quality and the make and its properties shall be subject to Purchaser's approval. The Bidder shall furnish with his proposal, a sample of the fill material to be used for the specified cooling tower.

18.08.03.05 Design and facing of the fills shall be such as to expose high air/water surface with minimum air pressure drop. Air velocity through the fills shall be uniform.

18.08.04 **Fill Supports**

18.08.04.01 Splash bar type fills shall be supported on the grids at frequent intervals, preferably not exceeding 450 mm, to minimize sag, possibility of dislodgement, and damage to fill materials as a consequence of induced vibration in the fill.

18.08.04.02 For film type filling, the sheet like fills consisting of multiple vertical surfaces shall be tied with filling support bars by stainless steel or nylon wires. Suitable spacers shall be used to maintain verticality of the sheets.

18.08.04.03 The fill and the support system shall be sufficiently strong to withstand the water loading when the flow path is 30% chocked.

18.08.05 **Drift Eliminators**

18.08.05.01 Zig-Zag path type Multi pass Drift eliminators (minimum two pass) shall be provided so as to limit the drift loss to that specified earlier or as in the Data Specification Sheet.

18.08.05.02 In case the tower is provided with pre-stressed concrete or PVC fill, drift eliminators may be made up of PVC.

18.08.05.03 The eliminator frame shall be of rugged construction and shall be firmly secured to arrest vibration.

18.08.06.00 **Access**

18.08.06.01 Staircases shall be provided external to the cooling tower along with stairways, landings, walkways, handrails and access doors. Minimum 2 Nos.

staircase 1000 mm wide and minimum landing width of 1000 mm at locations as necessary to give safe and convenient access to the top and the interior parts of the tower.

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

18.08.06.03 Whether specifically mentioned in the Data Specification Sheet or not, steel components and fittings used in walkways, handrails shall be hot dip galvanized after fabrication.

18.08.07 **Cooling Tower Basin & Outlet Sumps**

18.08.07.01 The hot water distribution basin and cold water outlet channel of the cooling towers shall be designed by considering a minimum of 10% margin over the design cooling tower flow.

18.08.07.02 Cooling tower basin, shall be supplied/constructed along with all civil parts, base plates, anchor bolts, nuts, and other accessories, pipe sleeves, inserts, etc. and as required to complete the work in all respects.

18.08.07.03 The work shall include excavation/back-filling as necessary, all concrete/steel work, cold water outlet sump & sludge pit for each basin, water-proofing and all other works.

18.08.07.04 The basin shall be partitioned into two individual chambers such that one section can be taken out for maintenance /de-sludging while the other section is in operation.

18.08.07.05 Sludge pit with isolating valves, and spool pipe shall be provided for individual basin chambers for connection to drainage pipe.

18.08.07.06 For each basin chamber, there shall be a cold water outlet sump. In the connection between basin chamber and cold water sump there shall be screen and sluice gate/Butterfly valve.

18.08.07.07 Each basin chamber shall have overflow arrangement at sludge pit end.

18.08.07.08 Basin slope towards cooling sump shall be 1 in 120.

18.08.08 **Screens & Isolating Devices in Cold Water Outlet Sumps, Valves and Pipes in Sludge Pits and Accessories**

18.08.08.01 Screens shall be out of 8 gauge 25 mm clear opening SS wire netting welded to frame of structural steel section/flats. Framework shall be hot dip galvanized and provided with primer and bituminous painting. Two numbers of screens shall be supplied per tower. Lifting lugs or eye bolts shall be provided on top of the screen frame for ease of handling.

18.08.08.02 For handling screens, one set of monorail with supporting structure and chain pulley hoist complete with lifting chain and push type trolley for mounting the hoist shall be furnished, if asked for in the Data Specification Sheets. The chain pulley hoist shall be manually operated and shall conform to IS: 3832, Class-2.

18.08.08.03 Sluice gates or Butterfly valves in cold water outlet sumps shall be provided as mentioned in Data Specification Sheet. Sluice gates shall be as per appropriate class of IS: 3042. Butterfly valves shall conform to AWWA C-504 (latest revision).

All mild steel parts shall be galvanized or painted with epoxy enamel primer & paint. The sluice gate may be rectangular or circular as per preference of the Bidder.

The sluice gates/Butterfly valves shall be complete with head-stock for manual operation. The head-stock shall have pillar, base plate and hand wheel made up of cast iron. The head-stock shall have rising/non-rising spindle with position indicator.

18.08.08.04 The flow area through each gate/valve and screen shall be such as to maintain a 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.

18.08.08.05 The isolating valves in sludge pits shall conform to appropriate class of IS: 780. Each valve shall be complete with pedestal type manual operator, with rising/non-rising spindle and valve position indicator.

18.08.08.06 The pipe spools, to be embedded in sludge pit for piping connection, shall be C.I. pipe as per IS: 1536, Class-LA, unless otherwise mentioned elsewhere.

18.08.09.00 **Hardware**

All nails and fastening bolts, nuts & washers used in the cooling tower stainless steel, if not specified in the Data Specification Sheet.

18.09 CIVIL AND ALLIED WORKS

Refer to Chapter-13 of Volume-VI of this specification.

18.10 CIVIL DESIGN BASIS

Refer to Chapter-13 of Volume-VI of this specification.

18.11 ELECTRICAL ITEMS

Refer Volume- IV: Electrical Works.

18.12 TESTING AND INSPECTION

18.12.01 Test at Manufacture's work

18.12.01.01 The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and shall be in compliance with requirements of applicable codes and standards.

18.12.01.02 The particulars of the proposed tests and the procedures for the tests shall be submitted to the Purchaser/Consultant for approval before conducting the tests.

18.12.01.03 Inspection shall be conducted by the manufacturer to establish and maintain quality of workmanship, to ensure mechanical accuracy of components, compliance with drawings, identity & acceptability of all material, part and equipment. Where specified, all such inspections shall be conducted in presence of Purchaser's representatives.

18.12.01.04 The Bidder shall submit to the Purchaser/Consultant at the initiation of the contract, the detailed bar chart showing the manufacturing program and indicating the period when Purchaser or his authorized inspecting agency are required at the shop for inspection and/or testing. Also, the manufacturer shall intimate the Purchaser 3 to 4 weeks in advance of such tests. The Purchaser/Consultant shall be given full access to all tests and inspection.

18.12.01.05 All materials used for cooling tower construction shall be of tested quality. Materials shall be tested as per the relevant standards or codes and test certificates shall be made available to the Purchaser/Consultant.

18.12.01.06 Where stage inspection is specified, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication by Purchaser's inspector who shall stamp the material. In case mill test certificates for the material are not available, the supplier shall carry out physical and chemical tests at his own cost from a testing agency, approved by the Purchaser, as per the requirements of specified material standard. The samples for physical and chemical testing shall be drawn up in presence of Purchaser's inspector who shall also witness the testing.

18.12.01.07 Hydrostatic testing for hot water distribution piping shall be at a pressure of 200% of design pressure after fabrication at shop.

18.12.01.08 Butterfly valves shall be tested as per the stipulations of AWWA C- 504, latest edition.

18.12.02 **Tests at Site**

18.12.02.01 After completion of construction, erection and commissioning of the cooling tower, performance test of the cooling tower shall be carried out as specified in Data Specification Sheet in accordance with Cooling Tower Institute Bulletin No. ATC-105 "Acceptance Test Procedure for Water Cooling Tower" or ASME (USA) performance test code PTC: 23 or other equivalent mutually agreed method. The details of the proposed test procedure shall be submitted by the supplier sufficiently in advance of the commencement of test for the review and approval of the Purchaser.

18.12.02.02 Necessary correction curves required for correcting the test results for any difference between test and guaranteed design conditions shall be furnished by the supplier for approval along with the proposed test procedure.

18.12.02.03 All testing and calibrating instruments required for site performance tests shall be arranged by the cooling tower supplier without any extra cost.

18.13 PERFORMANCE GUARANTEES

18.13.01 Each equipment shall be guaranteed to meet the performance requirements as

specified. If during the performance testing of the tower, the actual cooling water temperature obtained is higher than the guaranteed cooling water temperature (obtained from the performance curve) corresponding to the flow, wet bulb temperature, relative humidity and cooling range prevailing during the test, the contractor shall satisfactorily rectify all defects within scheduled time period.

18.13.02 After the tests conducted at the Manufacturer's works in accordance with this specification, rectification of any defect observed shall be satisfactorily done without charging any extra cost to the Owner.

18.13.03 The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within scheduled time period. No extra cost shall be charged to the Owner for such rectification. After rectification, retesting will be done by Bidder without any extra cost to Owner till satisfactory performance is achieved.

18.13.04 The bidder shall guarantee that the cooling towers offered shall meet the ratings and performance requirements stipulated in this specification. The bidder shall also furnish a declaration for certain guaranteed parameters like "Fulfillment of cold water temperature" which shall attract levees of liquidated damages for shortfall in performance. In case the contractor does not fulfill the guaranteed parameters, purchaser may undertake to rectify the system/equipment and expenditure incurred along with any other incidentals shall be recovered from the contractor.

18.14 DRAWINGS/DOCUMENTS, DATA & INFORMATION TO BE FURNISHED BY THE BIDDER ALONG WITH THE TECHNICAL OFFER

18.14.01 The Bidder shall furnish along with his proposal following specific drawings/documents/data as asked for in this section.

18.14.01.01 General arrangement drawing for cooling tower, incorporating all relevant dimensions, material of construction of different parts, limits of scope of supply of piping, limits of civil works included, basin details indicating overflow and de-sludging arrangement, arrangement of staircase, ladders, platforms, lightning protection system, Aviation obstruction lightning system of cooling tower etc.

18.14.01.02 Predicted performance curves, showing wet bulb Vs. cold water temperatures for design cooling range, 85% cooling range and 115% cooling range. Such curves shall be furnished for 85%, 100%, 115% flow. In case more than one operating point is specified, all above details/curves are to be furnished corresponding to all additional operating points also.

18.14.01.03 Cooling Tower Manufacturer's detailed literature including drawing and diagram for :

a) Tower fills with supporting arrangement.

b) Drift eliminator.

c) Complete distribution system including regulating type water distribution valves, distribution basin/pipes, orifices/ nozzles, etc.

18.14.01.04 Electrical power distribution scheme.

18.14.01.05 A detailed experience list about supply of similar plant by the Bidder/ Manufacturer and his collaborator.

18.14.01.06 A comprehensive write-up or Brochure on the details of manufacturing and testing facilities in the shop of Manufacturer.

18.14.01.07 All other relevant data and drawings as asked for in the specification and as required.

18.14.01.08 A sample of the fill material to be used for the specified cooling tower.

18.14.01.09 Bidder's proposal covering chemical treatment of cooling water to minimize biological fouling, scaling and corrosion as well as for containing concentration factor.

18.15 **DRAWINGS/DOCUMENT, DATA, AND MANUAL TO BE FURNISHED AFTER AWARD OF CONTRACT**

18.15.01 Final version of all drawings/data/information asked for in clause 18.14 above.

18.15.02 The following drawings shall be submitted within a reasonable time after placement of order :

18.15.02.01 General arrangement of the cooling tower, indicating all principal dimensions, extent of platforms, walkways, handrails, stairs, doors, illumination, arrangement of cooling tower structure and limits of supply and erection of piping, electrical and civil works.

18.15.02.02 Arrangement drawing of the cold water sumps and sludge pits for the cooling tower, incorporating also arrangements of screens, sluice gates, butterfly valves, gate valves, piping, and monorail chain pulley block installation, etc.

18.15.02.03 Performance curves as described in Clause 18.14.01.02.

18.15.02.04 Following drawings on mechanical equipment, their drives and accessories:

i) Fabrication and piping erection drawing.

ii) Outline and sectional drawings of valves of each category indicating also material of construction.

iii) Drawing on fill, drift eliminator and its support systems and fastening arrangement complete with data on material of construction.

iv) Drawing on splash boxes, nozzles in hot water basin, with data on material of construction.

v) Drawings on screens & gates with material of construction.

18.15.02.05 Electrical Drawings and Data as specified in Volume- IV: Electrical Works.

18.15.02.06 Detail technical particulars of equipment and materials under the scope of this specification.

18.15.02.07 **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 the cooling tower inclusive of pre-stressed concrete fill where applicable.

ii) Load drawings setting out clearly and concisely the various loads taken into consideration for design.

iii) Civil drawings for cold water basin, 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.

18.15.03 The Documents to be submitted before dispatch of Equipment for approval

18.15.03.01 Material Test Certificate for mechanical equipment.

18.15.03.02 Certificates on treatment done on timber components.

18.15.03.03 Test certificates on each electrical equipment, cables and accessories.

18.15.03.04 **Instruction Manuals**

i) The Instruction Manuals shall present the following basic categories of information in practical, complete and comprehensive manner prepared for use by operating and/or maintenance personnel :

- Instruction for initial installation of mechanical and electrical equipment.
- Instructions for operation, control, monitoring and protection.
- Instruction for maintenance, overhaul and replacement of parts etc.
- Recommended inspection points & periods of inspection.
- Lubrication Chart.
- Ordering information for all replaceable parts, etc.
- Write-up, leaflet/catalogue etc. covering equipment features.

ii) The information shall be organized in a logical and orderly sequence. A general description of the equipment including significant technical characteristics is required to familiarize operating and maintenance personnel with the equipment.

iii) Necessary drawings and/or other illustrations shall be included or copies of appropriate certified drawings shall be bound in the manual. Test, adjustment and calibration information, as appropriate, shall be included and shall be identified to the specific equipment. Safety and other warning notices and installation, maintenance and operating cautions shall be emphasized.

iv) A parts list shall be included showing part nomenclature, manufacturer's part number and/or other information necessary for accurate identification and ordering of replacement parts.

v) Instruction and part list shall be legible and prepared on good quality paper.

vi) The Instruction Manual shall be securely bound in durable folder.

vii) If a standard manual is furnished covering more than the specific equipment purchased, the applicable model (or other identification) number, part number and other information for the specific equipment purchased shall be clearly identified.

viii) The Instruction Manual shall include list of all special tools and tackle furnished with complete drawing and instruction for use of such tools and tackle.

ANNEXURE-A

DATASHEET FOR NATURAL DRAFT COOLING TOWER

1.0 General Information

Type of Cooling Tower	:	Natural Draft, Hyperbolic
No. of Cooling Towers Required	:	One
Location	:	Outdoor
Duty	:	Continuous

2.0 Design Working Conditions

Hot water inlet temperature	:	43.0°C
Design Ambient wet bulb temperature (WBT)	:	28°C
Design Ambient temp. for electrical equipment	:	50°C
Design Ambient Relative Humidity (RH)	:	65%
Whether inlet air wet bulb temperature to be corrected considering re-circulation as per CTI bulletin PFM-116	:	Yes
Design CT inlet wet bulb temperature	:	By Bidder
Basin Holding Capacity	:	6 mins of design CT capacity
Design Wind speed	:	As per site data

3.0 Performance Requirement

Rated Cooling Water flow	:	By Bidder
Cooling range	:	10.0°C
Approach to ambient wet bulb temperature	:	5.0°C
Maximum permissible drift loss	:	0.002%

Design pressure for hot water distribution system	:	By Bidder
Operating range to be established by cooling tower characteristics curves and performance curves	:	As per Clause no. 18.14.01.02

4.0 Special Features

Type of Tower design. (Bidder to justify his offer)	:	Counter-flow / Cross-flow
Type of fill	:	PVC Splash (V-bar type of approved make)
Whether fills are removable type	:	Yes

5.0 Material of Construction

Cold water basin, outlet channel/sump & sludge pit	:	R.C.C.
Casing & superstructure	:	R.C.C.
Basin diagonal partition, if any	:	R.C.C.
Staircase	:	R.C.C./HDG Steel
Hot water distribution piping		
• Inside Tower	:	HDG Steel/PVC
• Outside Tower	:	MS pipes with PVC/FRP Wrap on outside.
Hot water distribution nozzles Equal	:	Polypropylene/Approved
Fills	:	PVC with minimum spacing of 20 mm
Fill Support	:	R.C.C./HDG Steel
Louvers	:	R.C.C.
Drift eliminator	:	PVC
Hot water piping	:	IS: 3589
Butterfly valve for hot water distribution system/cold water outlet channel	:	
• Body	:	CI as per IS-210, FG-260

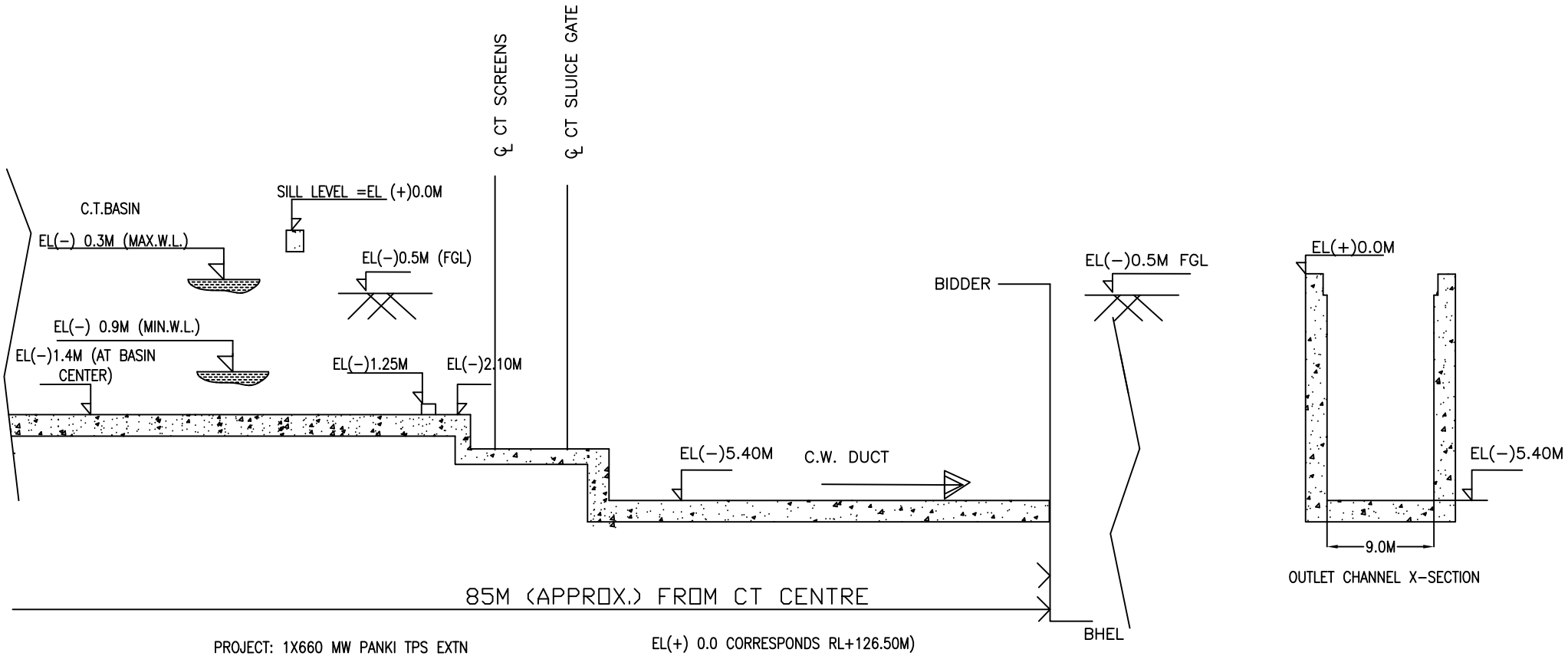
• Disc	:	- do -
• Shaft and spindle	:	SS304 as per ASTM A-479
• Shaft bearing	:	Leaded bronze, self lubricated (BS-1400, LB-2)
• Seat ring	:	ASTM A-479, Type 304
• Gland packing	:	Impregnated Teflon
• Seal	:	Nitrile Rubber, Shore Hardness 50-60 Deg.
• Bolts & Nuts (in contact with water)	:	Stainless Steel Sludge pit isolation valves:
• Body	:	CI IS-210, FG-260
• Spindle & Trim	:	Stainless Steel.
• Sludge outlet pipe	:	CI IS-1536, LA
• Screen	:	Anodised Aluminium
• Guide for screen	:	CI IS-210, FG-260
• Bolts, nuts & other hardware	:	Stainless Steel

6.0 Inspection And Testing

Quality surveillance by	:	Manufacturer/Purchaser
Material testing and identification	:	Required
Stage inspection to be witnessed by Purchaser	:	Yes
Hydrostatic test for piping & valves required	:	Yes
Hydrostatic test to be witnessed by Purchaser	:	Yes
Field performance test of individual items and the cooling tower as a whole required	:	Yes
Field performance test to be done by Contractor	:	Manufacturer/EPC
All tests on the Butterfly valves at manufacturer's works to be witnessed by Purchaser	:	Yes
All testing instruments by supplier	:	Yes
Commissioning at site by	:	Manufacturer/EPC

Contractor

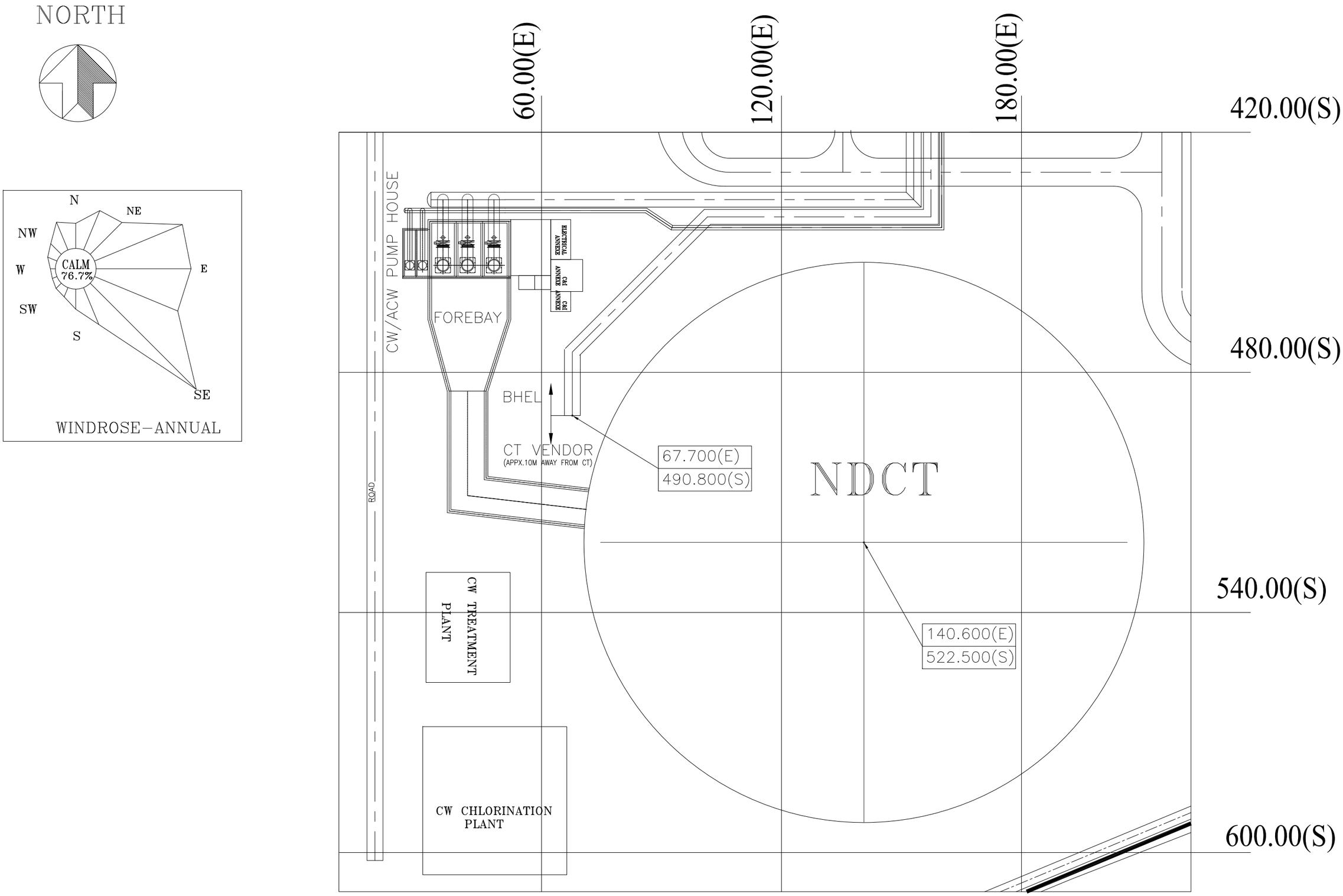
ANNEXURE – (I)



PROJECT: 1X660 MW PANKI TPS EXTN
COOLING TOWER SPECIFICATIONS

EL(+) 0.0 CORRESPONDS RL+126.50M)

COOLING TOWER COLD WATER OUTLET
WITH CT BASIN WATER LEVELS



EXTRACT OF COOLING TOWER AREA AS PER TENDER PLOT PLAN

1X660MW PANKI TPP