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 2X660MW UDANGUDI 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. 2 X 660 MW UDANGUDI – Two (2) nos. 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):**

	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.

	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 one no. CT in presence of employer / purchaser through **CTI approved/licensed testing agency**. The performance test of remaining one(1) no 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

	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 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.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

	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.

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	:	Two (02) Nos.
	Location		Out door
	Duty		Continuous
	Type		NDCT with PVC Splash fills
	Finished ground level		EL (-) 0.50 M (RL+ 3.3 M)
	Basin Kerb level (Basin Sill Top level)		EL(+) 0.0 M (RL+ 3.8 M)
2.0	**DESIGN PERFORMANCE FOR EACH COOLING TOWER**		
2.1	Design Cooling water flow	**:**	85500 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	:	33.0 ^oC
2.6	Hot water inlet temperature	:	43.0 ^oC
2.7	Cooling Range	:	7.5 ^oC
2.8	Design ambient Relative Humidity	:	75% (Bidder shall collect the actual data for a period of 20 years from the meteorological department pertaining to Thoothukudi location and design for plant accordingly. Design condition shall be subjected to owner's approval. Adverse condition of the above two shall be taken for the design condition without any commercial implication.)
2.9	Liquid Handled	:	Sea 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 16.0 MWC from FGL

2.10	Maximum permissible drift loss	:	Max. 0.005 %
2.11	Design pressure for hot water distribution system	:	5.5 kg/cm^2(g)
2.12	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+ 3.3 M)
4.2	Maximum water level	:	EL (-) 0.30 M (RL+ 3.5 M)
4.3	Min. Water level	:	EL (-) 1.15 M (RL+ 2.65 M)
4.4	Storage capacity between Normal and minimum water levels.	:	7 minutes (Normal Water Level shall be 200 mm below Maximum Water Level)
4.5	Invert level of CT Basin	:	EL (-) 1.45 M (RL+ 2.35 M) ---at basin centre
4.6	Invert level of CW Channel near CT level	:	EL (-)4.65 M (RL(-) 0.85 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 (Pump capacity: To evacuate the entire basin water in Twelve (12) hours)
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		3.5M 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 IA 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.: 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 3832mm X 16mm thick with 250 MM RCC encasement 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
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
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	:	Duplex SS (For Wetted parts) SS 316L (For others)
8.13	Piping	:	**Above 300 Nb** : Carbon steel plates to IS 2062 internally lined with CorroCoat or Poly Urea or Glass Flake Coating of 1500 Microns DFT, rolled and welded as per IS 3589 **Below and 300 Nb** : Duplex SS
8.14	Hot Water Distribution Pipes (Inside CT)	:	GRP
8.15	Hot water line valves		
	a) BF Valves	:	Body: CI IS 210 Gr 260 / IS 2062 with Rubber/Ebonite Lining Disc & Shaft: Duplex SS Seal : EPDM Internal Hardware : Duplex SS Test pressure & duration shall comply with AWWA C504
	b) Sludge pit isolation valves		
	Body	:	Duplex SS
	Spindle & Trim	:	Duplex SS
8.16	Sludge outlet pipe	:	Duplex SS
8.17	Submersible Pumps	:	Casing: Duplex SS Impeller: Duplex SS
8.18	Sluice gates with rubber seals in cold water outlet	:	SS 316L
8.19	Guide for stop log gates	:	SS 316L
8.20	Screen	:	SS 316L
8.21	Guide for Screen	:	SS 316L
8.22	Bolts, buts & other hardware	:	Duplex SS (For Wetted parts) SS 316L (For others)

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. 200 to 250 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. 200 to 250 microns.
9.3	External surface – Buried piping	:	CW buried Piping shall be encased in 250 mm thick RCC. For other Non-encased Buried pipe: External Corrosion Protection Tape of Coal Tar based material confirming to AWWA C203.
	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:

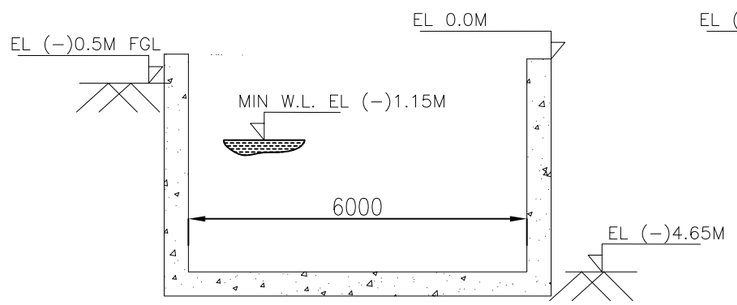
a) Sketch showing details CT and CW Channel Levels. Annexure-1.

b) Key Plan showing Terminal Points- Annexure-2.

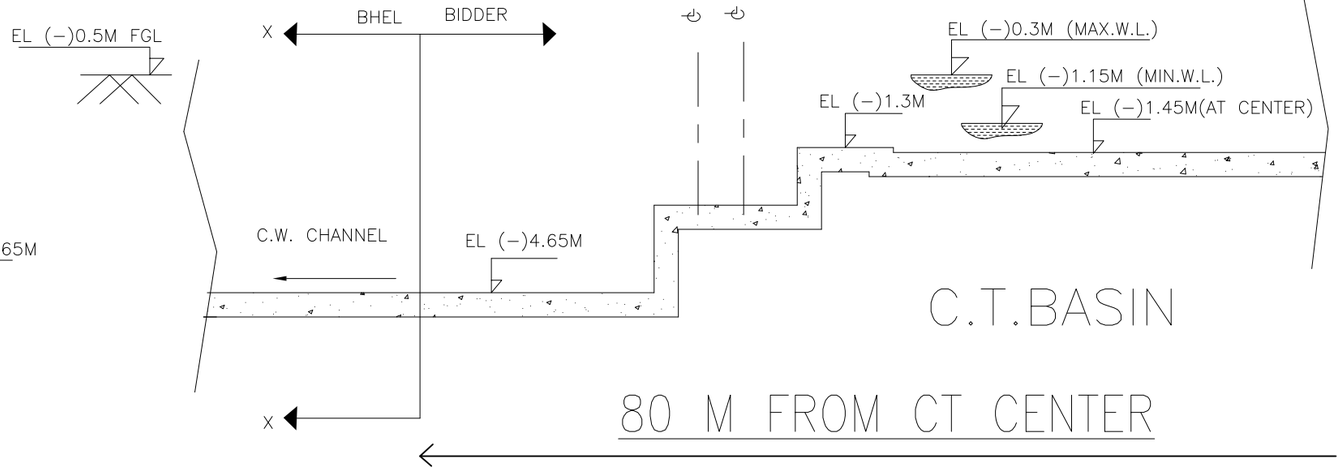
c) Cooling water Analysis – Annexure-3

d) Mandatory spares – Annexure-4.

ANNEXURE–1

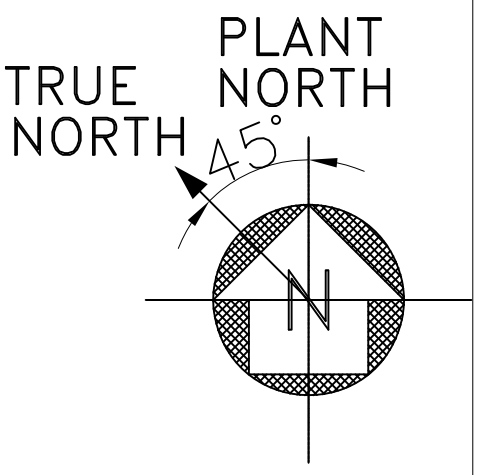


SECTION 'X–X'



ELEVATION AT CT OUTLET

ANNEXURE–2



CT # 1

65000

65000

BHEL CT VENDOR

132.500E

200.000S

280000

CW-18

CW-16

ACW UFM

BHEL CT VENDOR

65000

65000

CT # 2

Annexure-3

TYPICAL SEAWATER ANALYSIS

SAMPLE IDENTIFIED AS : SEA WATER

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,001,E-78+04,088/09.09.06
MARK	TOP LAYER
COLLECTED ON	09/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	7.98
2	Conductivity	ASTM D1125-99	53700µS/cm
3	Temperature	ASTM method	34°C
4	Turbidity	ASTM D1889-00	12.5 NTU
5	Salinity	ASTM method	35.5
6	Total Suspended Solids	ASTM D1888	6 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	400 mg/l
9	Magnesium as Mg	ASTM D511-98	1274 mg/l
10	Sodium as Na	ASTM D1428	12600 mg/l
11	Potassium as K	ASTM D1428	380 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	1.57 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.30 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.16 mg/l
21	Chloride as Cl	ASTM D512-99	21088 mg/l
22	Sulfate as SO4	ASTM D516-02	3189 mg/l
23	Nitrate as NO3	ASTM 3867-99	0.87 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.008 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	140 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL

27	Fluoride as F	ASTM D1179-99	1.4 mg/l
28	Boron as B	ASTM D3082-03	1.29 mg/l
29	Phosphate as PO4	ASTM D515-97	0.08 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.31 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.18 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.5 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	10 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	62 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	BDL (DL : 0.003 mg/l)
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,001,E-78+04,088/09.09.06
MARK	BOTTOM LAYER
COLLECTED ON	09/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	7.98
2	Conductivity	ASTM D1125-99	53700µmhos/cm
3	Temperature	ASTM method	34°C
4	Turbidity	ASTM D1889-00	14.8 NTU
5	Salinity	ASTM method	35.4
6	Total Suspended Solids	ASTM D1888	8 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	400 mg/l
9	Magnesium as Mg	ASTM D511-98	1270 mg/l
10	Sodium as Na	ASTM D1428	12500 mg/l
11	Potassium as K	ASTM D1428	376 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	1.76 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.33 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.17 mg/l
21	Chloride as Cl	ASTM D512-99	20987 mg/l
22	Sulfate as SO4	ASTM D516-02	3000 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.21 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.008 mg/l

25	Bicarbonate as HCO3	ASTM D1067-02	137 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.2 mg/l
28	Boron as B	ASTM D3082-03	1.36 mg/l
29	Phosphate as PO4	ASTM D515-97	0.08 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.40 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.20 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.4 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	9 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	53 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit
DL : Detection Limit.

COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+23.641,E-78+03,898/10.09.06
MARK	TOP LAYER
COLLECTED ON	10/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.1
2	Conductivity	ASTM D1125-99	53700µmhos/cm
3	Temperature	ASTM method	32°C
4	Turbidity	ASTM D1889-00	13.9 NTU
5	Salinity	ASTM method	35.5
6	Total Suspended Solids	ASTM D1888	11 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	400 mg/l
9	Magnesium as Mg	ASTM D511-98	1270 mg/l
10	Sodium as Na	ASTM D1428	12500 mg/l
11	Potassium as K	ASTM D1428	375 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	1.87 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.35 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.21 mg/l
21	Chloride as Cl	ASTM D512-99	20886 mg/l
22	Sulfate as SO4	ASTM D516-02	3113 mg/l
23	Nitrate as NO3	ASTM 3867-99	0.83 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.01 mg/l

25	Bicarbonate as HCO3	ASTM D1067-02	137 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.4 mg/l
28	Boron as B	ASTM D3082-03	1.29 mg/l
29	Phosphate as PO4	ASTM D515-97	0.15 mg/l
20	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.36 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.23 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.5 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	11 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	57 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit
DL : Detection Limit.

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+23.641,E-78+03,898/10.09.06
MARK	BOTTOM LAYER
COLLECTED ON	10/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.1
2	Conductivity	ASTM D1125-99	53700µmhos/cm
3	Temperature	ASTM method	34°C
4	Turbidity	ASTM D1889-00	12.8 NTU
5	Salinity	ASTM method	35.5
6	Total Suspended Solids	ASTM D1888	11 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	393 mg/l
9	Magnesium as Mg	ASTM D511-98	1260 mg/l
10	Sodium as Na	ASTM D1428	12500 mg/l
11	Potassium as K	ASTM D1428	378 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	1.90 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.49 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.25 mg/l
21	Chloride as Cl	ASTM D512-99	20987mg/l
22	Sulfate as SO4	ASTM D516-02	3019 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.35 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.01 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	135 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL

27	Fluoride as F	ASTM D1179-99	1.0 mg/l
28	Boron as B	ASTM D3082-03	1.19 mg/l
29	Phosphate as PO4	ASTM D515-97	0.15 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.37 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.21 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.6 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	7 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	45 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,396,E-78+04,025/11.09.06
MARK	TOP LAYER
COLLECTED ON	11/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.05
2	Conductivity	ASTM D1125-99	53700µmhos/cm
3	Temperature	ASTM method	32°C
4	Turbidity	ASTM D1889-00	13.4 NTU
5	Salinity	ASTM method	35.4
6	Total Suspended Solids	ASTM D1888	11 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	393 mg/l
9	Magnesium as Mg	ASTM D511-98	1260 mg/l
10	Sodium as Na	ASTM D1428	12500 mg/l
11	Potassium as K	ASTM D1428	378 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.11 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.38 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.17 mg/l
21	Chloride as Cl	ASTM D512-99	20886 mg/l
22	Sulfate as SO4	ASTM D516-02	3396 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.33 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.01 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	135 mg/l

26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	0.8 mg/l
28	Boron as B	ASTM D3082-03	1.38 mg/l
29	Phosphate as PO4	ASTM D515-97	0.10 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.39 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.25 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.2 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	8 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	41 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,396,E-78+04,025/11.09.06
MARK	BOTTOM LAYER
COLLECTED ON	11/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.05
2	Conductivity	ASTM D1125-99	53300 µmhos/cm
3	Temperature	ASTM method	34°C
4	Turbidity	ASTM D1889-00	13.6 NTU
5	Salinity	ASTM method	35.2
6	Total Suspended Solids	ASTM D1888	4 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	385 mg/l
9	Magnesium as Mg	ASTM D511-98	1265 mg/l
10	Sodium as Na	ASTM D1428	12000 mg/l
11	Potassium as K	ASTM D1428	376 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.25 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.29 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.14 mg/l
21	Chloride as Cl	ASTM D512-99	20683 mg/l
22	Sulfate as SO4	ASTM D516-02	2747 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.43 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.04 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	128 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.4 mg/l

28	Boron as B	ASTM D3082-03	1.22 mg/l
29	Phosphate as PO4	ASTM D515-97	0.12 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.34 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.20 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.5 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	11 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	57 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,503,E-78+04,543/12.09.06
MARK	TOP LAYER
COLLECTED ON	12/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.05
2	Conductivity	ASTM D1125-99	53600 µmhos/cm
3	Temperature	ASTM method	32°C
4	Turbidity	ASTM D1889-00	13.6 NTU
5	Salinity	ASTM method	35.4
6	Total Suspended Solids	ASTM D1888	6 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	401 mg/l
9	Magnesium as Mg	ASTM D511-98	1265 mg/l
10	Sodium as Na	ASTM D1428	12400 mg/l
11	Potassium as K	ASTM D1428	378 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.13 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.28 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.15 mg/l
21	Chloride as Cl	ASTM D512-99	20784 mg/l
22	Sulfate as SO4	ASTM D516-02	2855 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.62 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.03 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	130 mg/l

26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.2 mg/l
28	Boron as B	ASTM D3082-03	1.24 mg/l
29	Phosphate as PO4	ASTM D515-97	0.11 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.33 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.20 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.6 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	8 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	41 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,503,E-78+04,543/12.09.06
MARK	BOTTOM LAYER
COLLECTED ON	12/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	7.98
2	Conductivity	ASTM D1125-99	53200 µmhos/cm
3	Temperature	ASTM method	32°C
4	Turbidity	ASTM D1889-00	13.4 NTU
5	Salinity	ASTM method	35.1
6	Total Suspended Solids	ASTM D1888	5 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	377 mg/l
9	Magnesium as Mg	ASTM D511-98	1274 mg/l
10	Sodium as Na	ASTM D1428	12000 mg/l
11	Potassium as K	ASTM D1428	375 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.37 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.27 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.14 mg/l
21	Chloride as Cl	ASTM D512-99	20480 mg/l
22	Sulfate as SO4	ASTM D516-02	2729 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.49 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.03 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	128 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL

27	Fluoride as F	ASTM D1179-99	1.0 mg/l
28	Boron as B	ASTM D3082-03	1.24 mg/l
29	Phosphate as PO4	ASTM D515-97	0.16 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.34 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.19 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.2 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	8 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	41 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+23,977,E-78+04,380/12.09.06
MARK	TOP LAYER
COLLECTED ON	12/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.08
2	Conductivity	ASTM D1125-99	53300 µmhos/cm
3	Temperature	ASTM method	32°C
4	Turbidity	ASTM D1889-00	12.5 NTU
5	Salinity	ASTM method	35.2
6	Total Suspended Solids	ASTM D1888	6 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	385 mg/l
9	Magnesium as Mg	ASTM D511-98	1265 mg/l
10	Sodium as Na	ASTM D1428	12000 mg/l
11	Potassium as K	ASTM D1428	376 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.17 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.26 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.13 mg/l
21	Chloride as Cl	ASTM D512-99	20582 mg/l
22	Sulfate as SO4	ASTM D516-02	2747 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.39 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.04 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	128 mg/l

26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.4 mg/l
28	Boron as B	ASTM D3082-03	1.36 mg/l
29	Phosphate as PO4	ASTM D515-97	0.16 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.32 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.19 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.5 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	10 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	62 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+23,977,E-78+04,380/12.09.06
MARK	BOTTOM LAYER
COLLECTED ON	12/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.05
2	Conductivity	ASTM D1125-99	53100 µmhos/cm
3	Temperature	ASTM method	34°C
4	Turbidity	ASTM D1889-00	13.2 NTU
5	Salinity	ASTM method	35
6	Total Suspended Solids	ASTM D1888	5 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	409 mg/l
9	Magnesium as Mg	ASTM D511-98	1265 mg/l
10	Sodium as Na	ASTM D1428	12000 mg/l
11	Potassium as K	ASTM D1428	375 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.11 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.27 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.15 mg/l
21	Chloride as Cl	ASTM D512-99	20480 mg/l
22	Sulfate as SO4	ASTM D516-02	2729 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.56 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.03 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	140 mg/l

26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.2 mg/l
28	Boron as B	ASTM D3082-03	1.21 mg/l
29	Phosphate as PO4	ASTM D515-97	0.12 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.32 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.20 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.5 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	9 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	53 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

Annexure-4

2x660 MW UDANGUDI TPS STAGE-I

MANDATORY SPARES FOR ELECTRICAL

(* One set corresponds to actual quantity of components and devices as installed for the equipment at Site)

Sl.No	Description	Unit	Quantity
1	**Illumination system**		
a)	Each type and rating of HRC fuse	Nos.	10
b)	Each type and rating of MCBs	Nos.	10
c)	Each type and rating of lamp	Nos.	10 % of total population or 1-No which is higher
d)	Each type and rating of ballast	Nos.	10 % of total population or 1-No which is higher
e)	Each type and rating of starter	Nos.	10 % of total population or 1-No which is higher
f)	Each type and rating of igniter	Nos.	10 % of total population or 1-No which is higher
g)	Each type and rating of capacitor	Nos.	10 % of total population or 1-No which is higher
h)	Each type and rating of receptacles	Nos.	10 % of total population or 1-No which is higher
i)	Lighting Switches	Nos.	10 % of total population or 1-No which is higher
j)	Junction Boxes(each type)	Nos.	10
k)	Photo voltaic sensor	Nos.	10 % of total population or 1-No which is higher
l)	Electronic circuit for the above	Nos.	10 % of total population or 1-No which is higher
2	**LT Motors of each type and rating**		
a)	Driving end bearing	Set*	1
b)	Non driving end bearing	Set*	1
c)	Terminal block for motors up to 30 Kw each rating	Nos.	10
d)	Terminal block for motors above 30 Kw each rating	Nos.	5
e)	Motors of each type & rating	Nos.	10% of installed quantity or 1 –no whichev is higher
3	**DC Motors of each type and rating**		
a)	Driving end bearing	Set*	1
b)	Non driving end bearing	Set*	1
c)	Carbon brushes of each type	Set*	10
d)	Brush assemblies of each type	Set*	2
e)	Terminal blocks of each type	Set*	2
f)	Motor of each type & rating	Nos.	10% of installed qty or 1-no Which ever is higher

2x660 MW UDANGUDI TPS STAGE-I - EPC		
MANDATORY SPARES FOR CONTROL & INSTRUMENTATION		
SI. NO.	**PARTICULARS**	**QUANTITY**
1	RTD's of each type and length(with head assembly, terminal block & nipple)	10% or 2 nos. of each type and length, whichever is more
2	Thermocouples of each type like K-type, R-type, metal etc. (with head assembly, terminal block & nipple)	10% or 2 nos. of each type and length which ever is more
3	Local Indicators like temperature gauges, pressure gauges, differential pressure gauges, flow gauges, flow meters etc.,	10% or 2 no. of each make, model and type whichever is more and for each plant (to be divided to various ranges in proportion to main of all make, model, type population)
4	Process Actuated Switch Devices Includes all types of Pressure, differential pressure, flow, temperature, differential temperature, level switch Devices	5% or 1 no. of each type and model whichever is more
5	**POWER SUPPLY SYSTEM – 24 VDC (To be provided for each system)**	
	Silicon controlled thyristors, diodes, power transistors	100%(1 Lot)
	Capacitors	1 set
	Filter regulators	20% of each model or 2 nos. whichever is more.
6	**INSTRUMENTATION CABLE, INTERNAL WIRING & ELECTRICAL FIELD**	
	Pre fabricated cable of each type.	10% of installed quantity
	Pre fabricated cable connector of each type	10% or 1 no. of each type and model, whichever is more.
	Other cables	5% of each type, pair and size of actual installed quantity
7	**Electrical actuator, complete assembly, of each rating**	**2 Nos.**
Note: Mandatory Spares mentioned here are inline with spares list received from PG vide email dated 23.03.2018. Quantity mentioned is considered for 2 Units		