

GMR KAMALANGA ENERGY LIMITED



**1X350 MW EXTENSION OF
3x350 MW KAMALANGA THERMAL POWER PROJECT
AT
DHENKANAL DISTRICT, ODISHA, INDIA**

EPC SCOPE BID DOCUMENT

DOCUMENT NO. 24A11-SPC-G-004

**TECHNICAL SPECIFICATIONS
FOR
INDUCED DRAUGHT COOLING TOWER**

**[FINAL]
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CONSULTANT



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SECTION-II

**TECHNICAL SPECIFICATION
FOR
INDUCED DRAUGHT COOLING TOWER**

PACKAGE-IV

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SECTION – II**INDUCED DRAUGHT COOLING TOWER****1.00.00 CODES & STANDARDS**

The design, manufacture testing and performance of the One(1) nos. induced draught 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:

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

BS: 4485: Specification for Water Cooling Towers

ANSI/ASME PTC-23: Performance Test Code for Atmospheric Water Cooling Equipment

Cooling Tower Institute of USA, ATC-140: "Isokinetic Drift Measurement test Code for Water Cooling Towers

Cooling Technology Institute of USA, STD-136: "Polyvinyl Chloride Materials used for Film Fill, Louvers and Drift Eliminators

Cooling Technology Institute of USA, STD-146: "Standard for Water Flow Measurement"

Cooling Technology Institute of USA, ESG-144: "CTI fastener material Guidelines"

Cooling Technology Institute of USA, ESG-153: "Recommended guidelines for Portland Cement Concrete for Mechanical draft Cooling Towers

AWWA C504: American Water Works Association standard for Rubber seated Butterfly valve

AWWA C207: American Water Works Association standard for Steel Pipe Flange for Waterworks service

BS: 3435: Measurement of Electrical Power and energy in acceptance testing

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 the relevant Indian Standards or else with the applicable American Standards.

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 shall prevail.

2.00.00 DESCRIPTION

The cooling tower for unit shall be of rectangular mechanical induced draft /counter-flow type.

Scope of the IDCT package contractor (hereinafter referred to in this section as "the contractor") shall on EPC (Engineering, Procurement and Construction) Mode including but not limited to Design, Engineering, Manufacture, Assembly, Testing at Manufacturer's works, supply & delivery, properly packed for transport F.O.R. site, of all equipment, system and accessories, steel structures including Civil, Structural, Architectural work, fire protection, air-conditioning and ventilation, complete and efficient erection, site testing, commissioning & putting into successful commercial operation of IDCT along with all required statutory approvals. Contractor/Bidder to complete all necessary extension and modification work required for the new IDCT and changes in existing arrangements.

For the proposal to be submitted, the Contractor/Bidder shall visit the site to ascertain actual scope of work.

Fire fighting for cooling tower #4 shall be provided by vendor as per existing unit.

The Contractor/Bidder shall take note that design engineering of the new IDCT envisaged in the specification is responsibility of the Contractor/Bidder himself. Such design engineering essentially includes system design and sizing of all equipment / components. In case of confusion and contradiction between subsections, if any there, the Contractor/Bidder is advised to seek clarifications from Owner during the pre-offer stage itself. Quantities indicated in the below mentioned clauses are broadly indicative and for the purpose of tendering only.

The cooling tower shall be designed to use clarified water to reject the steam cycle heat load from the steam surface condenser as well as the auxiliary Cooling Water System directly to the atmosphere. Cycle of concentration shall be 5 to 7 to optimize the use of inlet water. The hot water distribution pipes for counter flow type and the hot water basin for cross flow shall distribute the hot water over the PVC splash bars. The hot water cools by evaporation as it drains through the PVC fill into the cooling tower basin.

The induced draft cooling tower shall be divided into compartments referred to as cells. The mechanical draft cooling tower design shall allow individual cells to be shut down to suit operational requirements without affecting the performance of the adjacent cells. The mechanical draft cooling tower shall be erected over a water basin. Each cell shall have a fan stack located on the cooling tower roof to assist the hot air in escaping to the atmosphere. The cooling tower shall be of RCC construction. The cooling tower shall be designed for the ambient wet bulb temperature of 28.0°C. Minimum value of this recirculation correction factor shall be 0.5°C or as per relevant CTI standard.

The Scope of Works also exclude laying of CW & ACW Piping.

3.00.00 DESIGN CRITERIA

The cooling tower shall be complete with tower basin foundations and mechanical equipment as described below. The Induced Draught CT shall be back cell type, single inlet, with splash type fills, cross flow/counter flow tower (Hybrid tower shall not be accepted). PVC fill shall be supported from bottom on RCC piers raised from basin. Single fan shall be located on top of each cell. The cooling tower shall be designed to meet the duty conditions as specified strictly for range & approach with given WBT under most adverse conditions including allowance for recirculation.

The CT basin shall be so designed to have effective capacity (between min. water level & max. water level) to store at least ten (10) minutes of cooling tower flow at full load operation of the unit.

Basin is below FGL. Please refer drawing no:37-F4341S-S0304-01 for details

It should have proper arrangements for drains and sludge removal with approximate slope of minimum 1:200.

It shall consist of two compartments with proper stop log gates for isolation along with necessary baffling arrangement with cold water channel and pipes.

Number of operating cells in the cooling tower shall be as mentioned in the data sheet. Bidder shall provide spare cell(s) in the cooling tower to facilitate maintenance without affecting the tower performance. *Each unit shall be equipped with six sections of two rows (Independent of each other) induced draft cooling towers. The Induced Draught CT shall be two separate (standalone) cooling towers each comprising of 6 cells. Total no of cells 12 Nos (11 W + 1S) . Refer plot plan drawing for space and coordinate.*

The water distribution basin and piping system shall be so designed that when any one of the cells is out of operation for maintenance etc. the remaining cells shall be capable of handling the full quantity of water as specified.

The water distribution basin for counter flow tower and piping system for counter flow tower shall be so designed that when any one of the cells in each row for the proposed standalone cooling tower [other than standby cell(s)] is out of operation for maintenance etc. the remaining cells shall be capable of handling the full quantity of water as specified. The remaining cells should be capable of handling any surge in flow without splashing of water from hot water channel on to the drift eliminators. Sufficient freeboard maybe provided in hot water channel. Channel to be covered with perforated RCC covers to distribute overflowing water.

Thermal design of the cooling tower shall be such that the guaranteed performance is met without operating the spare cell(s). All cells of the tower shall be identical. Riser Bypass may be considered with a valve arrangement.

For counter flow tower, the area covered by the projected circle at 45 deg. angle from the fan cylinder opening on the drift eliminator plan area shall not be less than 80% of the drift eliminator plan area.

PVC virgin films, dimension of films can be shared by vendor during detailed engineering.

The layout of the cooling tower in the plant area and the wind rose are indicated in the plot plan drawing. The Bidder shall examine the proposed layout of the tower and accordingly determine the recirculation which must be taken into consideration for the purpose of design of the tower to ensure that the design parameters of the tower are maintained. Bidder may consider to apply a correction factor to the design wet bulb ambient temperature to accommodate the recirculation effect.

Sensible heat of evaporated water shall be taken into consideration in the thermal design of the cooling tower. The air flow requirement shall not be less than that worked out by the formula given below.

$$G \times H = L (T_1 - T_2) + E_v T_2$$

Where

L = Water flow rate in Kg/Hr

T₁ = Water inlet temperature to the tower in deg. C

T₂ = Water outlet temperature from the tower in deg. C

E_v = Evaporation loss in Kg/hr. To compute this factor, RH shall be taken as specified.

G = Air rate in Kg/hr.

H = Change in enthalpy of air in Kcal/Kg.

Calculations justifying the selected air flow and evaporation loss shall be enclosed with the bid. International / National standard table of properties of air shall be used; and a copy of the table clearly indicating the standard used shall be enclosed with the bid.

The bidder shall furnish in his bid the following:

- a.) Heat balance calculations and air requirements for cooling tower, Calculations justifying the selected air flow and evaporation loss.
- b.) Available tower characteristics (KaV/L – as a function of air & water rates, fill geometry, hot water temperature, air velocity etc.) based on field performance tests. The relationship shall be of general as per the equation below and shall include values of the constants “c” and “n”. The equation shall cover range of “L/G” values from at least 20% above to atleast 20% below design.

$$KaV/L = c(L/G)^n$$

The bidder shall also submit an equation and/or curve defining the demand requirement at design approach, range and wet bulb temperature. The design “L/G” value shall be identified.

- c.) Various pressure drops in the air circuit of the cooling tower to arrive at discharge pressure of fan.

- d.) Calculations for arriving at the design power consumption.
- e.) Calculations for pumping head
- f.) Tower Performance curves

The Bidder should establish and prove the validity and the basis of procedures and methods used in the calculations.

The tower orientation shall be such that it shall offer minimum restriction to air flow. To ensure uniform and stable distribution of entering air, the velocity pressure ratio [ratio of system pressure drop (i.e. from air inlet to the drift eliminator) to the velocity pressure at the inlet] shall not be less than 5. For counter flow towers, the velocity at air inlet shall be calculated based on the clear air entry area available in vertical plane at the inner face of cooling tower wall. For purpose of calculating the velocity pressure ratio, the air velocity shall be computed considering the total air flow entering the individual cell and the gross inlet area of the individual cell. This will be calculated independently for each cell and the value calculated for each cell shall not be less than 5. For towers provided with over-dimensioned cold water basin, the inlet air area shall be computed considering the water level in the cold water basin at normal water level. Design wind speed 50 m/s.

Since the plant life is 30 years, Vendor to select cell isolation motorized valves considering leak proof and long life. Design and material selection shall be considered accordingly by vendor.

Bore Log- 313 to 321 for proposed IDCT Location shall be considered (Geotech investigation report)

4.00.00 DRIVE EQUIPMENT

4.01.00 Gear Box

- a) The fans shall be motor driven through suitable heavy duty reduction gear suitable for installation in outdoor and humid environment. Flexible coupling shall be provided both at motor and reducer to minimise the effect of misalignment on account of any setting and/or warping. Flexible couplings should be pin & bush type. Ample clearance shall be provided between the horizontal drive shafts (if used), pillow block covers and fan blades, to avoid damage to blades by accidental contact under worst vibrating conditions. The support structure of the reduction gear shall be rigid.

The gear drive shall be of spiral, bevel or worm type and the reduction may be accomplished either in single stage or multi stages.

The gearing arrangement shall be dust, moisture and oil proof right angle pattern self-lubricated type, designed for continuous operation under extreme conditions of heat and humidity well proven in tropical atmosphere for cooling tower service.

The design rating of the gear box shall be arrived at after considering a service factor of minimum 3. While selecting the gear box design rating, the thermal deaerating effect at 50 deg. C shall also be considered. The detailed

gear box sizing calculations shall be furnished for Purchaser's approval. In no case, the design rating of the gear box shall be less than 125 % of the name plate KW rating of the selected drive motor. Also, the mechanical rating shall be checked so that minimum 25 % margin is available at Pull Out Torque of the motor.

The gear box design should be such that the temperature of oil shall be within the recommended limits of the manufacturer. The gear boxes shall utilise non-hygroscopic oil for lubrication so that its lubricating properties are not lost if contaminated with water vapor. Each gear box shall be provided with a base plate. The vibration measurement sensors shall be mounted on the gear box. Vibration signal from these sensors shall be hardwired to IDCT PLC.

It shall be possible to read the oil level from the same point outside the stack. Approved oil gauge and level indicator shall be provided so that the oil level can be checked regularly without affecting the operation of the fan. Thermometer pockets for measuring the oil temperature in the reduction gear unit shall also be provided with remote indication outside the fan stack. The lubrication system shall ensure oil to continuously flow to and from the gear case in which the gears will be completely immersed.

The pipework for oil level gauge/dipstick and thermometer shall be arranged in such a way that oil can be drained and refilled from outside the stack. This pipework shall have proper supports at frequent intervals and shall be insulated. Further, a breather connection shall also be provided in the gear box so that it prevents moisture from entering the gear box. The Breather arrangement and details of oil seals shall be to Owner's approval. The water will be distributed across the plan area of the fills such the average water flow variation will be within 5%.

- b) Bidder shall furnish the maximum temperature that the lube oil can withstand and shall guarantee the maximum value of lube oil temperature when the gear reducer is in operation.
- c) The gear cases, covers and pinion cases shall be of high quality, close grained cast iron epoxy enamel coated. Ring and pinion gears shall be of case hardened Nickel - Molybdenum steel with hubs securely keyed to stainless steel grade 316 shafts. All shaft bearings shall be heavy duty bearing. Piping MOC should be SS 316, rubber hoses should be avoided. The fan drive shaft shall be firmly held in place between two (2) heavy duty roller type bearings adequately spaced to prevent vibration and misalignment of fans owing to wear of the bearings. The thrust bearings shall be of the ball and roller type.
- d) A rigid reinforced cement concrete frame shall be supplied for the support and permanent alignment of motor drive, drive shafts and gear reducers. Angle and shaped plate retainers surround and guard the drive shaft. The frame assembly shall be with neoprene or equivalent moisture protective material.
- e) A vibration limit switch of approved make rated at 240V, 8 amps AC continuous for each cell shall be provided to sense any excessive horizontal

vibration of the cell or fan over the permissible limit at the fan level and open the motor circuit. Tripping action shall be positive. The switch shall be used in the control circuit to disconnect power supply from the fan motor when excessive vibration occurs.

The switch shall be single pole, single throw sealed mercury type with hydrogen quenched arc. The switch housing shall be furnished in hot dip galvanized cast iron with a bolted-on, gasketed cover plate; all materials painted with epoxy enamel. Reducing gear, drive motor and fan blades should be energy efficient as approved by owner.

4.02.00 Drive Shaft

The drive shaft shall be of tubular construction and shall be statically as well as dynamically balanced. The design of the shaft shall take into consideration a factor of safety of 2 (minimum) over the torque to be transmitted at design duty conditions. The fan shaft shall be designed in such a way that the first critical speed shall be at least 120% of the operating speed of the shaft. Shaft design requiring intermediate bearings are not acceptable. The beams at fan deck level should be designed based on dynamic analysis. The bearings shall be of proven design and shall be suitable for operation in the humid condition prevalent in the fan stack. The minimum life of bearing shall not be less than 40,000 working hours. The drive shaft design shall be such that the fan blades should not be damaged in case of shaft failure. MOC of shaft should be Carbon fibre.

4.03.00 Fans

- a) Induced draught fans (one for each cell) shall be of axial type/propeller type of suitable capacity with blades which can be adjusted so that pitch can be altered + / - 5 deg. from the normal setting. For adjusting the fan blades, graduated stop marks with suitable locking arrangements shall be provided on the hub so that all the blades can be set to the same angle accurately. The fan blades shall be easily removable. These shall be of aero-foil section and shall provide uniform air velocity from hub to tip with low noise and vibration. Stack shall be provided to eliminate air turbulence in the throat area. Blades, shanks and hubs shall be suitably insulated to prevent electrolytic corrosion. The exit velocity of vapours by fan stack shall be 5m/sec. MOC of blades will be E-Glass fibre epoxy resin.
- b) The number of blades shall preferably be not less than 6 and shall not exceed 8 and the blade tip velocity shall not exceed 65 m/sec. Each fan shall be driven by an electric motor suitable for operation at 415 Volts, A.C. Fans shall be of proven design and make and shall be subject to Purchaser's approval. No of blades should be even numbers
- c) For maintenance of drive equipment (Fan, motor, gear reducer, etc.) following handling arrangements shall be furnished as below:

Each cell of cooling tower shall be provided with a monorail. In addition, the cooling tower shall be provided with 3 Nos. manually operated chain pulley blocks along with travelling trolley, the capacity of which shall be such as to be able to lift the heaviest portion of the fan motor assembly, but in no case less than 2 MT. The function of the three (3) numbers of monorail hoists is as below:

- 1) One to be used to lift equipment from ground level to tower top and accordingly the lift shall be provided.
- 2) The balance two (2) monorail to be used for handling equipment for two (2) numbers of cells simultaneously during maintenance, the lift of which shall be selected accordingly.
- 3) The fan stack must be made of FRP structure.

In addition to the above, a hand trolley sized to carry 1.25 times the heaviest and largest single piece of equipment shall also be provided for the cooling tower to be used on the fan deck to transport equipment from each cell to and from the end of tower where the monorail hoist is located to lift equipment from ground level to tower top. Suitable number of platforms (no. to be decided during detailed engineering) for doing maintenance work in situ for gear reducer, fan and motor shall also be provided. Platforms and handrails should be of GI with FRP coating with sufficient load bearing capacity.

4.04.00 Fan Motor

Each electric motor shall be provided with a base plate and a base frame. Fan motor shall have atleast 15% margin over the actual power requirement of the gear box when the fan is working at rated duty point and at 50 deg. C ambient temperature. Motors should also conform to the enclosed Standard Specification for Induction Motors. All Motors shall be energy saving type like IE 3 or IE4 with remote monitoring of temperature and vibration.

4.05.00 Stop log Gates, Screens and Handling Facility

- a) For isolation of the cold water basin of the tower, grooves for adequately sized vertical lift steel stop log gates, shall be provided in the cold water outlet channel of the tower. The gate shall move freely inside the steel frame work embedded in the concrete walls of the open channel at cold water outlet. Approved flexible contact bottom sealing arrangement shall be provided for all gates.
The Stop log gates shall be designed in accordance with the provisions of IS: 5620, in general and in accordance with the specification. The Stop log assembly shall be made in identical interchangeable units. The gates shall be designed corresponding to the maximum water level and wave effect with full hydrostatic pressure with the downstream completely empty.
- b) Adequately sized vertical cleanable screens 10x10mm opening in 8 swg thick galvanized steel woven wire mesh construction in steel frame work shall be furnished on the upstream of the sliding gate. Similar to slide gate, the screen shall freely move inside the steel frame work embedded in the concrete walls of the open channel. The screen shall have approved flexible contact bottom sealing arrangement. Motorized Cleaning arrangement for the screen must be there *in CT Basin outlet*. In case of Overflow there must be a channel to back the flow to fore bay instead of going to trench directly.

One (1) manual chain pulley hoist complete with chain and hooks for lifting

of the screens to be provided. SS 304 may be considered as MOC. Suitable arrangement like Jib crane for lifting of components from FGL to the fan deck/top of deck shall be provided with access at the ground level for handling the equipment

- c) *Motorized Gantry arrangement of suitable capacity at Fan deck level with track for its movement shall be provided. Vendor must consider a Gantry crane per cooling tower for longitudinal & transverse and lifting movement along the cooling tower (all 6 cells) including approach to the maintenance bay. Crane capacity shall be considered 125% margin on heaviest weight to be lifted by crane.*

4.06.00 **Miscellaneous**

- a) Necessary stub connections for pitot tubes shall be provided in the hot water risers for measurement of flow using Pitot tube. Any special equipment tools and tackles required for the successful completion of the Performance & Guarantee Test shall be included by the bidder in his scope.
- b) One (1) - locally mounted industrial type, brass encased, mercury in glass, red mercury and black etched stem type thermometers shall be furnished, each located at each of the cell vertical steel hot water risers to measure hot water temperature along with remote indication in the cooling tower control panel.
- c) One (1) - 150 mm dia dial pressure gauges each having readings in meters head with black figures on white dial, weather proof construction, complete with 800 # ASA screwed isolating forged steel globe valves and pipe fittings as required shall be furnished, each located at each of the cell vertical steel hot water risers to measure the hot water pressure along with remote indication at cooling tower control panel.
- d) Locally mounted, excessive cell vibration relays of approved make for each cell shall be furnished to measure any excess horizontal vibration of the cell over permissible limit at the fan level as per para I.6.801 (e) with a remote indication in control panel.
- e) Any other instruments required for local mounting for proper operation of the IDCT shall be furnished to Engineer's approval. Control panel shall be located in the CW pump house control room, where all meters, protections, annunciations are provided.
- f) *Internal Road and Drain around the IDCT areas and its connection to the existing Road & drain network.*
- g) *Secondary approach to IDCT at both ends connecting to nearby internal road, similar to the existing arrangement.*
- h) *Fine grading and levelling of the area after completion work, to facilitate smooth evacuation of storm water to the drains.*

4.07.00 **Cold Water Arrangement:**

- i. Cold water from the basin shall flow by gravity to CW Pump House through an adequately sized outlet channel limiting the water velocity at the cooling tower outlet not to exceed one meter per sec at minimum water level.

Provision shall be made to completely drain the basin for which the basin floor shall be sloped towards the drain sump [2 x 2 m plan area and 2.5 m deep] in the IDCT. From the drain sump, water shall flow into an adequately sized external sludge sump, through a 300 mm NB CI pipe 12 mm thick provided with cast iron body gate valve of size 300 mm NB with extended spindle. The sludge drain water shall be disposed off up to ETP, the system to be provided as needed.

- ii. Drainage of cooling tower basin shall be carried out through 2x100% capacity portable sump pumps which shall be furnished with receptacles and hose pipes. Necessary supporting arrangement at external sludge sump for portable sump pumps for drainage of cold water basin shall also be provided by the bidder.
- iii. Basin outlet channels must be connected to forebay with a suitable isolation gate for isolating Unit#4 incoming water during maintenance or reverse flowing towards Unit#4 basin from forebay. As both Unit 3 and 4 CT basins will be connected to same fore bay, provision must be there to completely isolate one unit channel to the fore bay.
- iv. Basin wall is just above the FGL, vendor must consider FRP/Heavy duty GI handrails all across the basin. Similarly, FRP/ Heavy duty GI handrails with toe-guards must be provided above IDCT operating floor across the periphery FRP/ Heavy duty GI handrails can be provided for the cooling tower and staircase instead of galvanized steel

4.08.00 Inlet Louvers; Fill and Fill Supports :

- a. Louvres in air inlet is not required
- b. Fill shall be of splash/film type and easily installable. The PVC fill material of proven quality shall be provided promoting a high rate of heat transfer, allowing low resistance to air flow and maintain uniform water & air distribution throughout the fill volume. The make and its properties shall be subject to Employer's approval. Bidder shall furnish details of PVC/PP fill regarding fire retarding properties, ageing effect, vibration caused by water and wind effects. The fill material shall be highly resistant to deterioration and shall be fire retardant.
- c. PVC Fills must be ultraviolet ray stabilized fire retardant V type with virgin PVC materials, Black colored fills shall be provided.
Type test of PVC material: In addition to the routine tests specified elsewhere, ultra-violet exposure for 500 hours on the PVC material shall be carried out once as per ASTM-G155/ISO 4892/equivalent. Test Method 3 and Impact resistance test before and after UV exposure shall be conducted as per ASTM D-256. The above test shall be carried out by the Contractor at reputed third party laboratory.
- d. Fill supports shall be constructed of pre-cast or pre-stressed reinforced cement concrete, properly cured and finished. The structure shall preferably be supported on piers. All joints shall be neatly made with a rich mixture of 1:1 cement and sand (refer Civil Volume) after thoroughly cleaning all

surfaces and applying paint. A minimum ten (10) days cycle shall be adopted for casting of fill laths.

4.09.00 Inlet Water Distribution System:

General Requirements

The hot water distribution system of the tower should ensure uniform distribution to all operating cells and also to all areas in a cell. For cross flow type towers a minimum free board of 50 mm shall be provided with the stand- by cell not in service. Each cell shall be able to operate independently. Suitably sized motor remote operated valves for isolation of any cell for any maintenance or repair work and to regulate the flow of water to individual cells shall be provided. The water shall be discharged throughout the plan area of the packing. For counter flow towers sufficient head room shall also be provided between the water distribution system and packing for inspection and maintenance. Fill cone down spray/up spray water distribution system should be provided so that there is no interference between the nozzle exit and top of fill.

Specific requirements for cross flow towers:

The hot water distribution basin shall be provided with a suitable cover to avoid direct sun rays falling on the distribution trough/ basin to minimize algae growth and to prevent choking of distribution nozzles. The covers provided shall be easily openable for inspection and maintenance of the distribution system. In case of overflowing of Hot Channel there must be a provision to transfer the overflowing water to CT basin directly without falling on the fills.

Specific Requirements for counter flow towers:

All distribution pipe work shall be adequately supported. The pipe supports shall accommodate thermal movement while ensuring the pipe joints do not fail when subjected to pressure surges. The Bidder shall submit the details of the proposed method of supporting distribution system. The design calculations for sizing of the system shall be furnished by the Bidder for Employer's approval during detailed engineering stage.

4.10.00 Drift Eliminators:

The PVC drift eliminators should keep the drift loss to a maximum of 0.005% of total water in circulation. The drift eliminators shall be of profile type and gluing is not allowed. The air pressure drop across the eliminators shall be kept to a minimum by providing proper number of air flow direction changes across the eliminators.

Drift eliminators shall be furnished in adequately thick PVC UV stabilized white construction. The water collected in the eliminators shall be returned to the tower basin and shall not mix with the discharge air system.

4.11.00 Recovery Stack; Fan Deck; and Staircases

- a. Recovery stack shall be of proper shape to improve the fan performance. The height of the stack shall be sufficient to recover the velocity and discharge the humid to a sufficient high level to minimize recirculation.
- b. Fan deck shall act as an access platform for the mechanical equipment. Adequate access for roof deck, fan deck, distribution level, drift eliminators shall be provided along with access to water distribution level of each cell from tower roof deck. Walkways with platforms and suitable hand and knee rails and toe guards shall be provided inside tower. Shall be corrosion resistant material
- c. Handrails shall be provided all around the periphery of the cooling tower fan deck with vertical pipe posts spaced at not more than one meter. Wherever, cables are routed along the periphery of the fan deck, the channel supports provided for cable shall be suitably spaced.
- d. There are two different standalone cooling towers. Hence two RCC stair cases in each cooling tower on either side shall be considered. Total should be 4 nos stairs for two(2) nos standalone cooling towers

4.12.00 Handling facility for Stoplog Gate

For isolation of the cold water basin of the tower, groove for steel stop log gates shall be provided in the cold water outlet channel of each cell. Number of stop logs to be supplied by bidder shall be as mentioned in the civil specification.

To handle the stop log gate a monorail beam at sufficient height shall be provided across each cold water channel. A hand operated chain pulley block with travelling trolley of adequate capacity (as mentioned in civil specification) to handle the stop log gates shall be provided. The capacity of hoist however shall in no case be less than 125% the weight of the stop log gate.

4.13.00 Miscellaneous

Necessary stub connections for Pitot tube shall be provided in the hot water risers for measurement of flow using Pitot tube. Any special equipment, tools and tackles required for the successful completion of the performance and guarantee test shall be provided free of cost. Riser valves shall be at approachable height or with proper approach ladder and platform.

All pipes exposed to atmosphere shall have epoxy/FRP coating for corrosion protection. Hot channel volume to be designed in a way to avoid overflow even in transient condition like 3 CW pump operation. A permanent flow measurement to be given at CW inlet header to each block of cells. Side stream filter system of 3% capacity for circulating water to be provided.

CW side stream filtration system for each cooling tower for Unit#4 shall be provided by vendor. Also the Bidder to consider an additional side stream filtration system for each cooling tower for Unit#3

No	Component Description	Material
1	Hot water inlet pipe	Mild steel :IS 20262
2	Hot water distribution system	PVC/FRP
3	Cooling tower reservoir	R.C.C
4	Cooling tower shell structure	R.C.C

5	Drift eliminator	PVC & Additive
6	Louver	RCC
7	Filler	PVC and additive
8	Filler Bracket	RCC
9	Internal support structure	RCC
10	Water Distribution Channel	RCC
11	Water Stop	PVC and additive
12	Stairs	RCC
13	Various steel structure	Galvanised steel sheet
14	Nozzle water spray	PVC & PPE
15	Fan blades	FRP
16	Drive shaft	SS304

Water Analysis Report

Water analysis					
Sl no	Parameter	Unit	Clarified Water	Blow down water	Raw water
1	PH		7.65	8.23	7.91
2	Specific conductivity	Us/cm	263.19	1810.47	208
3	Turbidity	NTu	6.87	16.12	13.51
4	TDS	PPM	171.1	1184	79.22
5	Total Hardness	PPM	84	564	79
6	Calcium Hardness	PPM	56.79	372.42	
7	Magnesium Hardness	PPM	28	191.66	
8	Chloride	PPM	22	137.25	20.9
9	Sio2	PPM	11.96	77.26	11.91
10	Iron	PPM	0.08	0.2	
11	Sulphate	PPM			

4.14.00 Instrumentation

All instrumentation within the package shall be provided as per the standard and proven practice of Package Supplier. This shall include but not limited to the following

Each fan unit shall be fitted with a low oil level and high vibration cut out switches mounted on gear box to sense vibration in 2 directions (axial and radial). The switches shall have 2 NO + 2 NC contacts separately wired in a rain and vermin proof junction box. Contacts for the above switches shall be suitable for 5 Amp 240 V AC / 8 Amp 24 V DC rating. Any auxiliary relays required to achieve above requirements and shall be provided by the bidder which will be mounted inside the box.

All sensors shall be IP 65 rating. Junction box /protection box shall be IP 66 rating. Gear box vibration & temperature analogue signal shall be connected to DCS for monitoring & protection.

For each gear box, oil level gauge, thermometer pockets with thermometers shall be provided external to the fan stack for local indication. For each of the hot water

header, necessary temperature gauge shall be provided for local indication.

All Instrumentation & Control cables along with trays and accessories from the field instruments to field junction boxes and from junction box to DCS shall be provided by the Bidder.

Nonstandard measuring elements are prohibited, so are those instruments containing poisonous substances like mercury and those products having been declared as obsolete by relevant authorities. All the instruments will be in international legal SI unit of measurement however in field pressure gauges all the pressures unit will be displayed in KG/ Sq. CM.

The associated local temperature indicators and pressure gauges installed on the proper as well as the various indicating meters mounted on small-sized instrument panels shall all be primary instruments made of stainless steel with a bezel diameter of 150 mm and an accuracy not inferior to 1.5 class.

The Supplier must include in his Bids the measuring points layout, P&ID diagrams as well as detailed instruments and equipment list within his scope of supply.

Monitoring System can be separately indicated as local control and also remote (DCS) details for easily identification of each system

The Supplier must include in his Bids the measuring points layout, P&ID diagrams as well as detailed instruments and equipment list within his scope of supply.

4.15.00

Electrical Part

- a. All power and control cable tray required for IDCT shall be FRP type.
- b. All electrical Motor shall be energy efficient type (IE4).
- c. Bidder to consider VFD as required for all motors.
- d. Bidder to consider the erection of connecting cable tray for power and control cable from existing nearby cable tray from main plant to proposed IDCT switchgear room and also for each motor & LCP wherever required.
- e. All HT, LT and control cable from main plant required for IDCT package shall be consider by bidder scope and only two number of HT 6.6kV feeders shall be provided by Owner.
- f. All required transformer with 2X100% capacity and switchgear (PCC, MCC) with spare feeders complying with the technical specification for each rating shall be considered for whole IDCT package.
- g. Illumination shall be consider as per IS standard.
- h. Earthing and lightning system shall be in scope of bidder and U#4 earthing shall be connected to existing nearby earthing grid.
- i. Bidder shall consider numerical relay for all feeders and digital meter for energy measurement system and complying communication protocol shall be available for remote monitoring and remote operation of all feeders.
- j. Bidder shall be responsible for all required regulatory approval like Approval from **CEA/State Electrical Inspectorate** etc.
- k. Bidder shall Complied with **IS /IEC standards** for all electrical equipment in IDCT package.

The package contractor shall provide the package Motor Control Center (MCC) or Power Distribution Boards (PDB) for small loads. Estimated power requirement and load lists should be submitted during bidding stage. All MCC shall be with double incomer and PDB shall be with single incomer. Engineering, supply, erection and commissioning of the complete power distribution system from the respective MCC/PDB incoming side (including cable routing from the feeder provided by the client) to the individual loads of the package shall be in the scope of the package contractor.

All scope related clauses mentioned in this package-specific document shall supersede other documents in case of any contradiction.

The contractor shall comply with the applicable sections of project technical specification [VOL-IIF1, IIF2, IIID] for all equipment provided and their protection, except for any special requirements of the application.

4.16.00 Control and Instrumentation Scope

The Instrumentation and Control System for IDCT shall be complete in all respects and adequate for safe, reliable and efficient operation of the plant under normal and worst service and environmental conditions. Instruments, systems and equipment and their installation shall conform to high standards of engineering design and workmanship in all respects.

C&I system for the IDCT of unit#4 shall be based on the existing Programmable Logic Controller (PLC) dedicated for units #3 and 4. Make of PLC is Allen Bradley.

Presently unit#3 IDCT control system is in operation. Necessary augmentation of the existing PLC shall be carried out by the bidder for safe and efficient operation of unit#4 IDCT.

Existing spare Inputs/outputs as well as additional input/output cards and other required hardware shall be used for complete operation and control of unit#4 IDCT. Operational logics for unit #4 IDCT shall be implemented in the existing PLC. New I/O cards shall be installed in the existing spare I/O slots of the system cabinet.

Operation of unit#4 IDCT shall be carried out from the control room of unit#3 using existing operator stations, Engineering stations, servers, printers etc. Control room for U#4 IDCT will be existing U#3 Common IDCT CCR.

Entire cabling (supply, laying and termination) including that from instruments to local panels / JBs/ RIOs etc and from there up to the PLC shall be in bidder's scope.

Cable from PLC to MCC/ SWGR and electrical actuator with integral starters, LPBS for drives, etc shall be in bidder's scope. Cables shall be provided as per Specification volume –IIE.

All control cable & cable tray for IDCT (design & supply) required for integration will be in bidder scope .

All field instruments required for IDCT system shall be in bidder scope with standard compliance and shall be calibrated at site. Detailed instrument specifications/datasheets shall be provided. All instruments and system shall be provided as per approved vendor list.

Scope of instruments include the following:

(a) Vibration probes with transmitters

(b) Low oil level switches

(c) RTD on gear box

(d) Instrument cables (along with associated cable trays & supports) from above field instruments upto junction box located on the cooling tower fan deck and from junction box to PLC.

(e) Motor Winding & bearing temperature

For detail specification of PLC and instrumentation system please refer specification Volume IIE.

4.17.00

The filler materials shall be arranged to allow for uniform collection of hot water and ease of maintenance/replacement. The filler materials shall be non-inflammable and designed with a high strength to resist deformation. The

Supplier shall make available the detailed technical specifications for packaging, of PVC fillers (stable UV), describing non-inflammability, ageing contributors thereof as well as vibration resulting from flowing of water and air. The performance and brands of the fillers used shall be subject to approval by the Owner.

The Supplier shall give priority to water-spraying type fillers. In cases where the Supplier furnishes thin-film fillers, a side-flow filtering design shall be provided in order to prevent clogging of the fillers

In case of water-spraying fillers, the spraying rods shall be horizontal and equipped with suitable supports to avoid damages or sagging. The cooling towers shall be sufficiently level such that the water can be distributed evenly through the spraying rods without resulting in water channels or in case of convection towers, the fillers are not allowed to migrate to the air inlet area.

Where modified PVC thin-film fillers are used, no regenerative material is allowed to add therein.

The fillers shall be of fire-retardant type with the fire-retardant oxygen index being, not less than 40.

The thickness of the base filler sheets shall not be less than 0.40-0.05 mm.

The fillers shall be bonded into blocks with a bonding % not less than 93%.

The compaction strength of filler blocks shall be no less than 300 kg/m².

The filler supports shall be made of FRP or non-metallic materials

The fillers shall be placed for ease of maintenance and replacement and shall be fixed by means other than sailing.

4.18.00 Accesses inside Cooling Tower

Within the cooling towers, the fan access platforms and access paths for the tower proper components shall be provided. The access platforms and paths shall be made of stainless steel or non-metallic materials.

The cooling towers shall be provided with quick-open type access doors which shall be ensured to be highly air-tight and readily removable. All the metal parts on the access doors shall be made of stainless steel. Maintenance Panels of Fiber Reinforced Plastic. The enclosure panels of the tower proper shall be made of fiber reinforced plastic sheets. The fiber reinforced plastic sheets shall have large-section trapezoid-shaped web structure and the jointing of the panels shall not be allowed to expose externally. The enclosure structure of fiber reinforced plastic shall be designed to withstand a wind load larger than 690 Pa

The various physical and chemical performance Indicators of the fiber reinforced plastic shall be consistent with or superior to the international standards. The color of the maintenance panels of fiber reinforced plastic is yet subject to determination.

Access platform inside cooling tower must be made of Steel / FRP with Heavy Duty GI Pipe handrails in both sides.

Partition Panels

The partition panels shall be made of fiber reinforced plastic.

The various physical and chemical performance indicators of the partition panels of fiber reinforced plastic shall be consistent with or superior to the international standard.

5.00.00 TESTS AT SITE

After Installation at site, the complete systems/equipment will be operated at site to show satisfactory performance as required by the applicable clauses of the specification. Further, all piping shall be hydraulically tested at site.

6.00.00 PERFORMANCE & GUARANTEE TEST AT SITE

6.01.00 Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

6.02.00 The cold water temperature as specified in technical data sheets shall be guaranteed for the design conditions of CW flow, range, ambient WBT specified in technical data sheet and design power consumption indicated by the bidder 6.02.01

The cooling towers shall be manufactured and tested in accordance with the international standards and the standards established by the manufacturer. The atmospheric cooling towers shall be designed such that they are able to operate in a balanced manner under the design load in order to eliminate excessive high noises.

- 6.02.02 The noises emitted from the cooling towers shall satisfy the relevant requirements.
- 6.02.03 If the cooling towers fail to satisfy the performance requirements attributable to the problems of design and manufacturing of the equipment, the Supplier shall work out the solutions free of charge.
- 6.02.04 The noise level measured at 1.0 m apart from the cooling towers shall not be higher than 85 dB.
- 6.03.00 **Quality Assurance**
- 6.03.01 The Supplier shall comply with all the technical requirements in this Technical Specifications.
- 6.03.02 The equipment provided by the Supplier shall be state-of-the-art, proven, reliable and brand-new, free from any defects and errors in design, material selection and process. The technical documents and drawings shall be correct and complete with clear charts and diagrams, sufficient to satisfy the requirements of installation, startup, shutdown, normal operation and maintenance.
- 6.03.03 The Supplier shall take effective measures to control the quality and service of the outsourced and purchased parts and ensure that they meet the Technical Specifications requirements.
- 6.03.04 The Purchaser has right to send representatives to the premise of the Supplier or at the manufacturing factories of outsourced and purchased parts to inspect manufacturing processes and quality of goods delivered under the Contract, check the elements, components and materials delivered for compliance with the Contract and standards, and attend the tests for some elements or the whole assembly conducted by the Supplier as specified in the Contract. For such purpose, the Supplier shall provide the Purchaser's representatives with technical documents, drawings, and the instruments, tools, office appliances necessary for tests and inspections.
- 6.03.05 Prior to manufacturing, the Supplier shall submit a manufacturing schedule identifying the items to be inspected and tested, so that the Purchaser can determine which items are subject to on-site inspection. The Purchaser shall confirm with the Supplier on the items subject to on-site inspections, and notify the Supplier of the same to facilitate the arrangement of the Supplier.
- 6.03.06 The pumps and associated motors shall have one year warranty period, during which the Supplier shall be responsible for maintenance and replacement at his own cost in case of any defects
- 6.04.00 **Cooling Tower :-**

The test circulating water flow shall be corrected for change in test fan power

consumption as compared to the design fan power consumption using the cube root formula. "Predicted cold water temperature" shall then be arrived at from the guaranteed cold water temperature by correcting the same for the test conditions of range, ambient conditions and corrected circulating water flow using the performance curves furnished by the contractor. In case the "Test cold water temperature is higher than the "Predicted cold water temperature", Employer reserves the right to reject/accept the tower after assessing the liquidated damages. The bidder shall submit the procedure, calculations and correction curves for approval by the owner in the tech evaluation stage.

In case required heat load is not available during the performance testing of the tower, individual cells may be tested and the average of tower capability of cell shall be considered as complete tower capability.

6.05.00 The testing agency proposed by the Contractor shall be approved by the Owner

Scope

Acceptance test procedure shall cover the determination of the thermal capability and verification of all the guarantee figures of the cooling tower supplied for the project.

Codes for Conduct of Tests

The following codes and standards shall be applicable for conducting the tests:

- a) Cooling Tower Institute of USA, Bulletin ATC-105: "Acceptance Test Code for Water Cooling tower."
- b) Code ATC-105 - Acceptance test code for water cooling towers (latest version)
- c) BS-4485 - Specification for water cooling towers
- d) BS-1042 - Methods for the measurement of fluid flow in pipes.
- e) BS-3435 - Measurement of electrical power and energy in acceptance testing.
- f) ASME 195 - Supplements on instruments and apparatus.
- g) DIN 1947 - VDI / ATC-105 -Acceptance Code of Cooling Tower (Latest).

7.00.00 SHOP TESTS

All the materials for the various components/parts of the equipment shall be tested for mechanical and chemical properties including hardness as per the requirements of relevant codes/CTI latest standards:

I. Gear Box

- a. Gear Box shafts and blanks shall be subjected to ultrasonic test and dye penetration test.

- b. Each gear box shall be tested / checked for overall assembly and Backlash of gears during assembly.
- c. No load run test for all gear boxes shall be carried out for 8 hrs to detect any abnormal noise, excessive vibrations and oil leakage. Temperature rise after 8 hrs. shall be checked.

II. Fan

- a. Fan blades shall be checked for proof strength and moment weight.
- b. Welds shall be 100% DP tested and 10% radiography on butt welds of hubs shall be carried out.
- c. Fan Assembly (fan shaft, hub and blades) shall be checked for overall assembly, static balancing as per ISO/1940 Gr. 6:3, blades track variations and blade tip clearances.
- d. Fan hub and fan shaft shall be dynamically balanced.
- e. Material test certificates for raw materials such as resin, glass roving, fiberglass mats and foam compound shall be submitted for each batch of raw material.

III. Stop-log Gates

- a. DPT on welds shall be carried out.
- b. Stop log gates shall be checked for dimensional conformity and smooth operation and leakage tightness at site.

IV. Galvanized Items

Galvanized items shall be checked for thickness of coating, weight of zinc coating, adhesion test, visual examination and Preece test (uniformity of coating) as per the requirement of relevant IS codes.

V. PVC Fills

Following properties of PVC fills shall be checked as per relevant codes: CTI convention STD-136

- Chemical and physical properties
- Density, tensile strength, hardness, elastic module
- Fire retardant properties
- Ageing effect
- Dimensions including thickness of fills
- Virgin PVC and ultra violet ray stabilization-500 hour exposure
- Resistance to deterioration

- Hot water stability
- Load test after gluing
- Impact resistance test before and after 500 hour of exposure to UV.
- Heat Distortion
- Flammability
- Density as per ASTM & DIN
- Vicat softening temperature as per IS: 6307/DIN 53460
- Static balance test on the hub and blades of fan
- Dynamic balance test on the driving connection of fan
- Mechanical running test on fan reduction gearbox of cooling tower, involving noise, vibration, temperature rise of bearing, oil seal leakage and etc.

VI. Drive Shaft

- a. Drive shaft tube shall be checked for internal defects by UT/Eddy Current test and all other tests as per relevant codes.
- b. Welds shall be subject to 100% Dye penetration test.
- c. Assembled drive shaft shall be dynamically balanced as per ISO-1940, Gr. 6.3.

The tests mentioned above shall be carried out on test specimens in laboratories approved by the Owner. The fills shall be checked for dimensions including the minimum thickness, length and wave height, and load test shall be conducted after bonding.

7.01.00 Implementation Test

- i) The Supplier will be responsible for implementation of these tests, which shall be conducted upon the completion and within one-year test run of cooling tower. The atmospheric conditions at which such tests are to be conducted shall be within the tolerance of design conditions as specified in this section, preferably May to September.
- ii) The supply of necessary instruments for performance guarantee test and associated calibrations shall be in the scope of the Supplier. Such instruments shall be calibrated by an approved independent agency in advance, but no earlier than six (6) months before the test. The calibration certificate shall remain valid throughout the tests.
- iii) Instrument lists, calibration certificates, measurement charts and data sheets provided by the Supplier shall be submitted to the Owner for approval. The basic instruments required for these tests involve the following as a minimum:
- iv) Two pressure gauges shall be provided in the water pipes. The hot water header of

cooling tower shall be equipped with pitots and necessary isolation valves and connection stubs to measure the flow of water. For the purpose of precision of measurement, pitot elements shall be used, equipped with devices capable of transverse movement. In addition, one anemometer shall be installed to measure the ambient wind velocity. One time meter for mechanical absorption shall be provided to measure the wet-bulb temperature.

- v) The performance tests shall be based on the ambient wet-bulb temperature. The performance curves of cooling tower shall be provided to determine its performance. Such curves shall show the variation of performance with the changes of ambient wet-bulb temperature and the cooling range, relative humidity, wind velocity, water load of cooling tower. Performance curves for the cases with 90%, 100% and 110% of design water flow shall be provided. Each case shall include three (3) or more cooling range curves and at least four (4) relative humidity curves to show the impacts of wet-bulb temperature and relative humidity as well as the cooling range of water temperature at outlet. The range curves shall be plotted based on a fixed step increase of 0.5 °C, adequate to cover 20% of the design range. The relative humidity curves shall be shown with an increase at a certain interval, capable of covering expected conditions, including 5%, 20%, 40%, 60% and 100% of relative humidity. The design conditions shall be illustrated according to the set design water flow. The dry-bulb temperature corresponding to wet-bulb temperature shall be included in each fixed relative humidity chart. All the performance curves shall be based on the ambient wet-bulb temperature.
- vi) The guaranteed performance of equipment shall be verified after the assessment of performance test by the Supplier. In case that the test results deviate from the guaranteed value, the Supplier shall correct the same according to relevant requirements to ensure compliance with the guaranteed values. The Supplier shall be responsible for all the modification costs, including costs for labor and material as well as additional test expenditures. During the term of the Contract, only one retest is allowed.
- vii) Considering the inaccuracy arising from design and instruments, the maximum temperature tolerance in cooling water shall be 0.3°C. Other tolerances are not allowed.
- viii) The Supplier shall conduct tests under or close to the design conditions as far as practicable. The unit shall operate under the condition of 350MW during the test, with variation not exceeding the following:
 - a) Wet-bulb temperature 5°C
 - b) Dry-bulb temperature 10 °C (relative humidity shall not fall to 40%)
 - c) Range 20%
 - d) Circulating water flow 10%
- ix) At the stage of design, water distribution of all the operating chambers and/or

components of cooling tower shall be demonstrated.

- x) The ambient wind velocity shall be measured according to Clause 1.6.4 in this test procedure without exceeding the following values:
 - a) Max. wind velocity 50 m/s
 - b) One-minute cycle 100 m/s

The test shall last no less than one hour after a stable condition is achieved. In case that the heat stagnation is longer than 5 minutes, the test duration shall be at least one hour plus such stagnation time.

8.00.00 CONTROL & OPERATION PHILOSOPHY

8.01.00 This control write-up/ operation philosophy details the control/ operation requirements of the cooling tower fans as a general guideline only and the Contractor shall furnish his proposed philosophy during detailed engineering for owner's review and approval.
Cooling tower fan motors will be controlled from Main Control Room from DCS as well as from local control panel at CW pump building..

8.02.00 Modes of operation:

The fans can be started in SOLO mode or in GROUP mode. The selection for individual and Group operation shall be made from DCS. Further, any of the fan can be put either in STANDBY mode or in NOT IN STANDBY mode.

(i) Group Mode

START in Group Mode:

On receipt of the GROUP START command from DCS, all pre-selected fans (except for the fans selected as "STANDBY") would start sequentially one after another after pre-defined time gap between start of the fans.

STOP in Group Mode:

On receipt of the GROUP STOP command from DCS, all the running fans will be tripped simultaneously. GROUP STOP command will have priority over and already existing GROUP START command.

(ii) SOLO Mode:

In the DCS, for each individual fan, a separate START/STOP button will be provided. The START button will be enabled only when the SOLO mode is selected. Fans can be started in SOLO mode immediately by pressing the START button. The fan can be stopped either by pressing the STOP push-button (of the corresponding fan) or GROUP STOP button.

8.03.00 Interlock & Protection

Following are the Start-up permissive for the fans:

- a. MCC healthy
- b. Oil level NOT VERY LOW
- c. Emergency PB not pressed
- d. Gearbox oil temperature NOT HIGH

Following are the protections for Fan tripping:

- a. Oil level VERY LOW
- b. Emergency PB pressed
- c. Vibration VERY HIGH
- d. Motor overload and any electrical protection action
- e. Gear box temperature VERY HIGH

Fans will continue to run unless the standard electrical protection switches or a vibration limit switch or any other protective instruments/devices provided with each fan motor drive arrangement prohibits its operation.

When such a trip signal is received, the particular fan motor gets tripped. The other fan motors, however, continue to run. The fault is manually attended and corrective measures are taken to remove the fault after which the motor can be re-started.

Control System shall issue OPEN/CLOSE command for Electrical breaker operation and monitor status. Necessary interlocks finalized during detailed engineering shall be implemented.

The close status of butterfly valves and the ON/OFF/TRIP status of fans shall be indicated in in the Motor Control Centre (MCC), Main Control Room as well as in local control room.

Operator shall be alerted through audio visual indication during the condition when the fan of any cell is ON and the corresponding cell isolation valve is closed or vice-versa.

Bidder shall furnish detailed control write-up indicating permissive, trip and interlock conditions for each drive/ equipment including group start/stop steps for a group of drives/equipment.

8.04.00 Modification of Set-Points Etc.

In OWS, there should be a provision to modify the ALARM and TRIP set point for the vibration monitoring system as well as for the sequence times under proper password protection and available only to the system maintenance engineer/administrator. The operators can, however, view the settings. Auto start/stop of cooling tower fans as per cold water temp set point shall be given.

Annunciation also must be there when cooling water temp reaches its max/min points.

8.05.00 Cleaning & painting

All parts shall be cleaned and sundries and all foreign matters. The equipment shall be drained, dried sealed with secures cover.

The equipment shall be painted with two coating of primer and three coating of finish before delivery. The supplier shall provide complete descriptions about corrosion resistance, including cleaning and coating process and characteristics of paint used.

9.00.00 Package and Shipping Requirements

9.01.01 The package of equipment shall comply with the provisions of relevant international standards, and measures against rain, moisture, rust and vibration shall be taken to avoid damage to components such as bearings arising from vibration and collision during transportation.

9.01.02 The equipment shall be fully discharged of water and dried before delivery, and in case that removal of plug or drain valve etc. becomes necessary for water discharge, the Supplier shall ensure that they are reassembled before delivery.

9.01.03 Protection measures shall be taken for all openings, flanges and joints to prevent corrosion, damage and ingress of foreign matters during transportation and storage. The inlet/outlet and pipe orifices of pump shall be sealed with cover plates.

9.01.04 The threaded holes to be connected on site or weld holes of tube nozzles shall be protected with threads or other methods.

9.01.05 Coverings, metal tapes or fasteners shall not be welded onto the equipment.

9.01.06 Support and fixing shall be considered for equipment contained in the packing box, and all the loose parts shall be loaded into separate small boxes that are to be put into the box.

9.01.07 Each packing unit shall be provided with associated packing list that is enclosed in a sealed package (moisture resistant) and positioned at an obvious location in the unit. The components and parts contained in each packing unit must be with distinct marks and labels that indicate part number, serial number, description and quantity etc. and shall be consistent with the packing list.

9.01.08 Measures against moisture and rust shall be taken for the equipment and accessories to ensure that no rust and damage will occur within 12 months. Generally inspection shall be carried out after 12 months and anti-rust treatment shall be performed again.

9.01.09 The packing shall be in accordance with relevant provisions for transportation, and

shall avoid slide, collision and wear of internal parts during transportation and handling so as to prevent damage to these parts.

- 9.01.10 The equipment packing shall be marked with the following signs:
Transportation marks: "Keep away from moisture", "Protect against vibration", "Stack in this direction", "Center of gravity" and "Secure the sling here" etc.
Shipping marks: Delivery number, Index number, Port of departure, Port of destination, Volume (L×W×H), Net weight, Nomenclature of equipment, Gross weight, Consignee, Consignor.
The required class of storage and custody.
- 9.01.11 The equipment shall be completely dried before shipment with all the openings and flange connections adequately protected to prevent it from damage, corrosion and ingress of any foreign materials.
- 9.01.12 The Supplier shall provide package standards and schematics along with the Bids. The Supplier shall ensure that the package can meet the requirements of six-month outdoor storage on site.
- 9.01.13 Equipment Marking
- 9.01.14 The nameplates of equipment shall be made of metal sheets that are erosion resistant.
- 9.01.15 The nameplates shall be erected at places where they are easily visible.
- 9.01.16 The following items shall be marked on the nameplates which are abrasion resistant, including but not limited to:
- Place of origin
 - Manufacturer
 - Type of equipment
 - Equipment name
 - Code for manufacture date
 - Inspection code at delivery
 - Major technical parameters
 - KKS codes of equipment

10.00.00 Technical Data (to be completed by the Supplier)

No.	Item	Unit	Data
1	Type or model		
2	Dry-bulb temperature	°C	36
3	Wet-bulb temperature	°C	28
4	Barometric pressure	hPa	1013
5	Relative humidity	%	60

No.	Item	Unit	Data
6	Feed water temperature	°C	41.5
7	Outlet water temperature	°C	32.5
8	Performance parameters		
(1)	Cooling water requirement	(m ³ /h)	4600
(2)	Air-water ratio		
(3)	Water drenching density	m ³ /(m ² .h)	
(4)	Wind velocity of water drenching section	m/s	
(5)	Total resistance of tower	Pa	
9	Fan		
(1)	Type		
(2)	Diameter	mm	
(3)	Speed	r/min	
(4)	Power	KW	
(5)	Air flow	(m ³ /h)	
(6)	Full pressure	Pa	
10	Associated motor		
(1)	Type		
(2)	Manufacturer		
(3)	Degree of protection	IP55	
(4)	Insulation level		
(5)	Power	kW	
(6)	Speed	r/min	
(7)	Voltage		
(8)	Weight		
11	Outline dimension (L×W×H) at location of ±0.00	mm	
12	Dead weight of tower	kg	
13	Operation weight	kg	
14	Water inlet pressure	Pa	
15	Water inlet pipe diameter	mm	
16	Relative elevation of water inlet pipe	mm	
17	Required head of water inlet pipe	m	
18	Quantity of lifting device and lifting sling	Pieces	
19	Service life of tower	Yr	
20	Service life of wear parts	Yr	
21	Quality warranty period	Month	

ATTACHMENT A**Technical Specifications for Motor, Cable and Control Cabinet****A.1 Motor**

A.1.1 All AC motors shall be of squirrel-cage type, suitable for direct on-line start-up, design of which shall meet the requirement of continuous operation. The motors shall be such designed that they shall satisfy the requirements of continuous operation and not be subject to overheat even when the ambient temperature is 50°C. When the system voltage at 93% of the rated voltage, the driven equipment shall be able to operate at 103% of the rated speed with the estimated heaviest load. The motors shall be capable of delivering rated output when the frequency is of rated value and deviation between the actual power supply voltage and rated voltage does not exceed 10% or when the voltage is of rated value and deviation between actual power supply frequency and rated frequency is within range from -5% to +3%. The motors shall be capable of delivering rated output in case of combined voltage and frequency variation of 10%. A 15% margin shall be considered over the load point and the motor may reach the rated nameplate power at 50 °C; or the input power of driven equipment is required to have at least a 10% margin, the motor may reach the rated nameplate power. (Unless otherwise specified in Driven Equipment Technical Specifications or General Electric Technical Specifications, the higher among the two shall be selected.)

A.1.2 All DC motors are of shunt-excited type with rated voltage of 220 V, able to operate continuously under any permitted voltage in 220 VDC system under actual working conditions. DC motor shall be completed with a starter (when it is required to start with step mode, so as to reduce the start-current). The start current of DC motor shall not exceed 2.5 times the full load current. The motor shall be started under 70% of the rated voltage. The insulation class shall be F and the temperature-rise limit shall be B. The protection class of the housing shall be IP-54.

A.1.3 Lifting motor can be of 3-phase slip-ring type, and shall comply with the requirement of IS 3177. Lifting motor will adopt S4 duty system, with a continuous load rate of 40%.

A.1.4 The motor shall be designed to start on-line under the rated voltage. The start current shall not exceed 6 times the full load current of all the ancillary equipment; but the boiler feed water pump is an exception, where the start current shall be limited to 4.5 times and the IS tolerance provisions are to be met.

The motor shall be able to withstand the stress applied on it if it is started under 110% rated voltage.

If the motor is started under 80% rated voltage with full load on the terminal side, it may reach the full speed.

Motor shall be capable of three equally spread starts per hour, two starts in succession,

with motor initially at rated load operating temperature, but this is not a frequent requirement.

Reverse rotation shall be considered in the design of pump motors and the motor design shall be able to bear the stress generated during start under 125% rated speed of reverse direction.

The design of the motor shall be able to bear any torque and/or electrical stress of high current that may be generated from normal service life and performance characteristics without leading to and deterioration.

Under hot state and 110% rated voltage, the withstand locking time shall be at least 2.5 s longer than the start time of the motor (if the motor start time is in 20 s); if the motor start time is over 20 s, the withstand time shall be 5 s longer than the motor start time.

The hot state withstand curve shall have at least 10% margin above the motor full load current, in order to allow the relay to perform protection setting using the rated output of the motor.

A.1.5 All the insulation windings shall be made of copper.

6.6kV motor and 220V DC motor are provided with class-F insulation, with windings temperature rise within the limit for class-B; all 415V AC motors shall be at least provided with class-B insulation.

All motors shall be capable of twice successive hot start provided that their initial temperature is equal to normal operating temperature.

The motor shall be able to continuously operate under 75% rated voltage of motor terminal for 5 minutes without generating harmful heat.

A.1.6 All windings insulation shall be made from non-water absorbing, non-oil blemishing and flame-proof material. The insulation system for 6600 V AC motors shall withstand the negative or positive 0.3 / 3.0 microsecond wave (2.7 pu rated peak line to earth operating voltage) switching surges originating from non-effectively earthed power system. All 6600 V AC motors shall have BIL of 31 kV (Peak) 1.2 / 50 microsecond wave and shall withstand a power frequency voltage of 14.2 kV (rms) for one minute.

A.1.7 When starting up under the lowest permitted start-voltage, acceleration torque under any rotary speed shall at least be 10% of the motor's rated full-load torque.

A.1.8 All the motors shall be designed in such a manner that in case of extreme variation of voltage and frequency, the maximum impulse current and rotor-locking as well as the maximum torque resulted therefrom will not endanger the motor and the driven equipment.

A.1.9 Maximum torque of the motors under rated voltage shall not be less than 205% of its full-load torque, and that of the crane motors shall not be less than 275% of the full-load

torque. The motor shall suit the switch-over of busbar in 6.6kV/415V system, which will not do any harm to its service life. The contractor shall provide the research report on the stability of the system at the time when voltage is lost transiently.

- A.1.10 Within the whole scope of work specified in the specifications (with the worst working condition considered), the motor's maximum continuous rating shall at least be 115% of the maximum load required by the driven equipment.
- A.1.11 Space heaters shall be provided for all 6.6 kV high-voltage motors, outdoor 415 V motors with a rated power at or above 30 kW, the windings are thus kept dry during the outage and single-phase 240V, 50 Hz AC power supply shall be applicable for the space heaters, which is subject to the Purchaser's confirmation.
- A.1.12 The manufacturer should insure that shaft current will not cause any damage to the bearing.
- A.1.13 For motors furnished with cooler, dial thermometer shall be provided, with adjustable alarming contact for indicating primary air temperature at inlet and outlet of the motor.
- A.1.14 Noise level of all motors shall meet the stipulation specified in IEC/IS 12065, with double amplitude of vibration within the limit specified in IEC/IS 12075. The motor shall also be able to withstand the vibration generated by the driven equipment.
- A.1.15 Unless otherwise specified, the degree of all motor shields shall meet the requirement of IP-55. Outdoor or semi-outdoor mounted motors shall be of weather proof structure.

For indoor arranged large power circulating water pumps without direct exposure to coal dust, their shields shall meet the stipulations specified in IP-54.

For hazardous areas, shields that may provide enhanced safety shall be used according to the permitted requirements.

The motors shall be of natural ventilation type, or totally enclosed fan cooling type (TEFC) or closed air circuit air-cooling type (CACA). Motors with large capacity may be cooled through closed air loop water.

- A.1.16 All 6.6KV motor shall be provided with six(6) winding temperature detectors, two(2) per phase. In addition, all 6.6 kV motors shall be equipped with twin RTD and dial thermometer to monitor the bearing temperature. Independent terminals for grounding wire shall be furnished at both sides of the motor body.
- A.1.17 The startup motor of steam turbine (if applicable) is specially designed as per the technical specifications of the manufacturer, however, any deviation from the previously mentioned specifications shall be provided in the offer, and submitted to the Owner for approval.
- A.1.18 As per the Owner's standards and regulations, motors with rated power $\leq 200\text{kW}$ shall be connected in 415V system; while motors with rated power above 200kW shall be

connected with 6.6kV system. Motors with rated power < 0.2kW shall be of 240V single phase AC motors, which shall meet the requirements of IS: 996. All HV motors shall be able to be started up on-line directly via any type of circuit breaker specified.

A.1.19 For 6.6KV motor, the terminal box shall be Phase Segregated type .Independent junction box shall be provided for space heater and resistance thermometer. Protective degree of cable box/junction box of all motors shall be IP54 and IP55 respectively for indoor and outdoor motors.

A.1.20 The following standards and specifications shall be adhered to:

Three-phase induction motor	–	IS 325, IEC 34
Single phase AC motor	–	IS 996, IEC 34
Lifting motor	–	IS 3177, IEC 34
DC motor	–	IS 4722

A.1.21 Permitted temperature rise is as shown below:

Air-cooled motor: 70°C, use resistance-method to measure both insulation class B and F.

Water-cooled motor: Temperature rise of 6.6KV motors shall be limited to Class B .

A.1.22 Startup time of motor is as shown below:

- i) As for the motors with 20s startup time, when starting under minimum permitted voltage, the withstand time of locked-rotor when receiving the maximum voltage limit under hot status shall at least be greater than the startup time by 2.5s.
- ii) As for the motors with 20s-40s (inclusive) startup time, when starting under minimum permitted voltage, the withstand time of locked-rotor when receiving the maximum voltage limit under hot status shall at least be greater than the startup time by 5s.
- iii) As for the motors with startup time greater than 45s, when starting under minimum permitted voltage, the withstand time of locked-rotor when receiving the maximum voltage limit under hot status shall at least be greater than the startup time by 10%.
- iv) If the above requirements cannot be satisfied, then, the main shaft of the motor shall be installed with a rotary speed switch.

A.1.23 All motors shall be able to be started up on-line directly via any type of circuit breaker.

A.1.24 Emergency stop button shall be furnished aside all motors as per relative Indian regulations.

A.1.25 All motors shall be designed in such a manner that in case of extreme variation of voltage

and frequency, the maximum impulse current and rotor-locking as well as the maximum torque resulted therefrom will not endanger the motor and the driven equipment.

- A.1.26 In order to realize differential protection, neutral line current transformer of PS degree shall be provided for each phase on motors with rated power $\geq 1000\text{kW}$, in which independent neutral terminal junction boxes shall be used respectively. Differential CT and junction box shall be supplied by the motor manufacturer, who shall be responsible for the leading out of the neutral and the connection of differential CT. If connecting through cables, the applicable cables shall satisfy the requirements stated in Attachment A.2 and the wiring terminal for cables shall be shrinkage terminal. Differential CT junction box can be arranged at the opposite side of the terminal box for the main wire of the motor.
- A.1.27 The motor shall withstand for 1 sec due to sudden application of 150% rated voltage during bus transfer due to phase difference between the incoming voltage and the motor residual voltage.
- A.1.28 All motors shall be able to restore normal running in the following cases: system failure results in power loss of 0.2s (time for failure removal), then, suddenly the voltage is restored up to 60% of rated voltage, and kept at this value for 3 minutes, then, again the voltage is suddenly restored up to 80% of rated voltage, the motor, beginning from this value, shall be able to be accelerated and totally recovered to normal operation under the heaviest-load operating condition (fan and/or damper is open, pump outlet valve is open, rotary speed controller is at position of max. rotary speed and etc.).
- A.1.29 Motor shall be able to be started under full voltage; it is also suitable to be started at 110% rated voltage without being over-heated.
- A.1.30 Even if under the condition that there is a -20% difference between power source voltage and rated voltage, the motor shall also be able to fulfill a complete start cycle of driven equipment without any damage.
- A.1.31 Delete.
- A.1.32 Conductor of stator windings is made of copper.
- A.1.33 Rated power and rotary speed of each type of DC motor shall adapt to the characteristic of driven load. The motor shall be able to drive its driven equipment to operate continuously; and the temperature of its iron core and windings will not exceed the temperature limit specified in appropriate standards; even if the power source voltage deviates from the rated voltage by +15/-20%, the motor will still be satisfied.
- A.1.34 Generally, the rotary speed can be reversed through phase reversal, except for some motors, rotary direction of which will be indicated clearly by marked arrow. When DC power source is connected to terminals identified by letters of R, Y and B, the motor will be running in normal direction. Motors of same type shall be 100% interchangeable, easy to be interchanged without the need to be machined or installed specially or adjusted in

connection. All components of motors of same type shall be interchangeable also.

- A.1.35 Motor is allowed to be over-speeded (exceeding rated rotary speed by 20%) for 2 minutes.
- A.1.36 If sleeve bearings are not installed for the motors, anti-wear bearings shall be installed. Vertical shaft motors shall be provided with thrust bearings and pilot bearings. The bearings shall be provided with sealing parts to prevent leakage of lube oil and ingress of foreign substances such as dirt and water into the internal space of the bearings. The sleeve bearing shall be separated shaft sleeve with an oil ring, permanently aligned and operating in a sealed manner. The bearings lubricated with grease are to be pre lubricated, which are also provided with forced lubricating and draining devices so as to prevent excessive lubrication. Oil-immersion bearings shall be furnished with integrated self-cooling oil storage tank, oil ring detection point, oil level observation glass and oil level gauge showing stationary and rotary conditions, as well as oil filling and draining plugs. The Supplier shall insulate the bearings according to the requirements to prevent the generation of shaft current and damage to the bearing caused thereby.
- A.1.37 Oiling lubrication through oil nozzle is not feasible for small power motor, for lubrication of which the ball bearings may be furnished with sealing-type lubrication chamber without oil nozzle. With such kind of lubrication, the motor shall be able to run continuously for 20,000 working hours or three years (subject to the earlier date in the above two time periods) without maintenance.
- A.1.38 Because switching over of power supply needs a certain time and the motor terminal may have some residual voltage, therefore, the windings shall be such designed that the windings can withstand the electro-dynamic effect at the time when the motor is connecting to a new power supply.
- A.1.39 Six winding terminals will be led out, connecting method of which will not be specified. The junction box shall be installed at the left-hand side (facing the non-driving end); the junction box shall be such designed that it will be fully protected under any operating condition.

The motor junction box shall be of removable type, and the layout thereof shall be in compliance with the Indian Standards, namely, it shall be arranged on the motor base/sole plate. Unless otherwise specifically permitted, the junction box shall be capable of rotating for 360°, and 90° for each rotation.

The junction box shall be of the separated type and be provided with flexible end cover and connecting parts, and the protective degree of which shall be the same as the motor.

Enough space shall be provided inside the junction box for wiring/connecting aluminum armored cables. The wiring terminals shall be column shaped or lead type, and the structure thereof shall be adequately insulated from its framework. The wiring terminal is required to be clearly identified through phase identification to match the rotary direction

indicated at the NDE of the motor. The motor junction box shall be provided with suitable cable end and double-compression brass gland matching the cables used. The gland plate of single-core cables shall be non-magnetic.

The junction box shall be capable of withstanding the largest fault current running through the system for 0.25 second.

The junction box of 6.6 kV motors shall be phase-isolated. The neutral shall be led out from an independent junction box, which is provided with short connecting strip for star connection.

- A.1.40 For motor with power <2kW, wire connection with soft cable connected to independent junction box is permitted.
- A.1.41 Junction box for measurement circuit (if applicable) will be kept independent from the power source wiring box.
- A.1.42 For copper or copper alloy rotor cage, design problem in terms of expansion of short-circuit coil and conductor bar shall be paid with special attention. Application of cast aluminum rotor cage may also be considered.
- A.1.43 Two grounding terminals shall be provided for all motors.
- A.1.44 Mildew prevention measures, heat insulation and special treatment of metal shall be conducted on all the motors so as to prevent the propagation of mildew, invasion of insects and corrosion.

All the fittings and hardware shall be of anti-corrosion type.

- A.1.45 When 1.5 m from the motor, the noise level measured may not exceed 85db.

The peak amplitude of vibration shall be within the limits specified in India Standards.

All the HV motors shall be provided with vibration pads equipped with vibration detecting device.

All HT motors shall be provided with vibration pads for mounting vibration 6.6 kV motors shall be designed to withstand the maximum double amplitude vibrations upto 1500 rpm shall be 25 microns and 15 microns upto 3000 rpm.

- A.1.46 The framework of each motor shall be provided with two independent ground plates, and be furnished with screw holes, GI bolts and gaskets.

Grounding connections shall match the grounding conductor and meet the following instructions:

Motor with power >90 kW: copper flexible conductor of suitable dimension;

Motor with power of 30 kW to 90 kW: copper flexible conductor of suitable dimension;

Motor with power of 5 kW to 30 kW: copper flexible conductor of suitable dimension;

Motor with power <5 kW: copper flexible conductor of suitable dimension

The cable junction box shall be provided with independent ground plate.

- A.1.47 The motors shall be provided with drain plug to drain out the water from condensation and all the pockets on the motor housing.

If the weight of motor is 25 kg or more, ring type bolts or other suitable lifting means are required.

The motor shall be such designed that after the installation of the motor and the driven equipment, the drilled holes are easily accessible through the motor foot, or the aligning pins may be easily installed with mounting flange.

The motors including fans shall be coated with anti-corrosive paint according to the stipulations specified in IS-5.

High heat and ambient conditions shall be taken into account when selecting the paint.

- A.1.48 Standard routine tests shall be conducted on each motor according to the requirements stated in IS upon the completion of work. Additionally, the special tests specified in the technical specifications of driven equipment shall be conducted (if any).

The following type tests shall be conducted on typical 6600V sample motors of various types and powers:

- Measurement of stator resistance (and rotor resistance on slip ring motors).
- No load running of motor and reading of voltage, current, power input and speed.
- Locked rotor reading of voltage, current, power input and values of torque of motor.
- Full load reading of voltage, current, power input and slip.
- Temperature rise test.
- For 6600V AC motors, in addition to all the tests specified above, polarisation index test shall be carried out as a routine test on each motor (the minimum value of polarisation index for all motors shall be 2 when determined according to IS : 7816).

Di-electric tests to establish the insulation withstand level of motors shall be performed on a sample coil (identical to those to be used in the motor quoted for) for each type of motor. These tested sample coils shall not be used in the motors to be supplied.

- A.1.49 Drawings, data and manuals of the motors shall be supplied according to the following brief instructions:

Upon signing of the Contract:

List of motors;

Motor data sheet in compliance with the format of the data sheet in the Tender Documents.

Brief and wiring drawings of forced lube oil system (if any);

Type test report;

General arrangement drawings;

Foundation level and load;

Detailed information of cable terminal box;

Space requirement of motor dismantling and installation;

Thermal resistance curves for cold and hot state;

Start and speed torque under 80% and 100% voltage conditions;

Complete motor data;

Installation and maintenance manuals;

Test reports.

A.2 Cable (used inside the complete set of equipment)

A.2.1 The flowing type of cable shall be used inside the complete set of equipment:

a) 6.6 kV system power cable for

Medium voltage level, heavy-duty cross-linking power cable with rated core temperature of 90 °C shall be used in non-effectively grounded MV system. The cable shall have multi-strand twisted aluminum core, conductor/semi-conductor squeezed shield, squeezed cross-linked polyethylene insulation, squeezed insulation layer, semi-conductor type plus non-magnetic metal belt shield layer and squeezed PVC inner sheathing of type ST-2, galvanized steel belt/steel wire armor (for two-core and multi-core cable) or non-magnetic hard-pull aluminum wire armor (for single-core cable), squeezed PVC outer protective layer type of ST-2, FRLS. The structure and test shall comply with Indian standard IS 7089, part II.

b) LV power cable

1100/650 V heavy-duty HR cross-linked polyethylene power cable with rated core temperature of 90 °C and multi-strand twisted aluminum core, squeezed HR PVC external sheathing (type C), squeezed cross-linked polyethylene inner insulation, galvanized steel belt/steel wire armor (for two-core and multi-core cable) or non-magnetic hard-pull aluminum wire armor (for single-core cable), squeezed PVC outer protective layer type of ST-2, FRLS. The structure and test shall comply with Indian standard IS 1554, part I.

c) LV control cable

Except the rated temperature of cable core shall be 70 °C and that multi-strand twisted high-conductivity copper conductor shall be used, the other requirements are the same as that for LV power cable. Generally, the minimum size of control

cables shall be 2.5 mm sq. except signal and communication cables.

A.2.2 All cables shall be tested as per BIS/IEC standards.

A.2.3 Power cable shall be selected based on standard design so that the stock and spare parts can be minimized. Control cable shall be provided with backup core for future use. One backup core is required for the cable with less than four cores, two backup cores for the cable with five to twelve cores, and four backup cores for the cable with more than twelve cores.

A.2.4 AC and DC conductors shall not be arranged in one cable; cables for power circuit, control and interlocking circuit, instrument and measuring circuit shall be separate. A unique cable number shall be provided for each piece of cable at both ends, turning points and penetration of floor/wall.

A.2.5 All cable shall be continuous in length; in-line joint is disallowed except it is permitted by the Owner. Control and instrument cable can be marshaled in an appropriate box before being laid for reducing the numbers of cable. This is because that point-to-point cable-laying is uneconomic.

A.2.6 Generally, cable will be laid in hot-galvanized fabricated cable tray, either in trench or overhead.

A.2.7 All cables shall be installed in order, complying with the practice of excellent engineering. Double-compression cable gland shall be used for terminals of HV, LV cables and control cable at the equipment. For single core cable, aluminum cable gland shall be used.

A.2.8 After installation is finished, HV test shall be conducted on all power cables, and insulation resistance shall be recorded.

In order to reduce the losses caused by fire disaster or similar sudden event, fireproof separation shall be provided for main circuit, emergency security circuit and different tripping circuits.

A.3 Basic Requirements on Control Box

A.3.1 If the equipment has no interlocking relationship with other equipment and no centralized control requirement is raised, the manufacturer may supply the associate control box, which is subject to the Purchaser's confirmation. The control, interlocking and protection etc. of equipment shall be completed by the Supplier and only the 415/240V AC power supply will be made available by the Purchaser. The Supplier shall submit detailed information regarding the control box within 5 days after the Technical Specifications coming into effect. If the equipment has interlocking relationship with other equipment or centralized control requirement is raised, the manufacturer shall not supply the associated control box.

The associate control boxes supplied shall meet the following requirements:

- a) The control box must comply with the technical requirements stipulated in the applicable national and ministerial standards;
- b) The parts to be grounded within the control box shall be reliably connected to a grounding terminal and two grounding terminals capable of connecting conductors of 16mm² at least shall be reserved on the enclosure for the Owner's use;
- c) The protection degree of control boxes shall be: indoor IP54, outdoor IP55.

A.3.2 The power control box supplied together with the motor shall be in compliance with the national standard GB7251-87/IEC439 *Low-voltage Switchgear* and relevant IEC standard, and the protection class of the control box shall be indicated as per GB4942.2-85/IEC60034 *Protection Class of Low-voltage Electrical Enclosure*, which shall not be lower than that of main equipment. The control and relay protection design of electrical equipment shall be in accordance with relevant national and industrial standards currently in force and the relevant standard implemented shall be listed in the manual.

Certified quality products shall be used while obsolete products shall be excluded. The type of power control box supplied together with the motor shall be coordinated with the distribution cabinets of other equipment in the power plant and the Design Institute will provide the requirement on type when signing the *Technical Specifications*.

A.3.3 The type of power control box supplied together with the motor shall be coordinated with the distribution cabinets of other equipment in the power plant and the power circuit shall be completed with conventional AC contactor and protective relay, and shall be provided with overcurrent, three-phase imbalance and phase failure protections as well as manual reset. Main switch shall be provided inside the control box with each power consumer equipped with a separate power switch, main low-voltage power components such as switch, AC contactor and thermal relay shall be quoted separately based on the price of the product series from ABB, Schneider and Siemens, which will be selected and determined by the Purchaser finally. High-quality LED indicator shall be used, the button and select switch and transfer switch shall be of ADA20 series and the terminal block shall be Weidmuller product not inferior to UK6N. Constant temperature control with computer detection shall be employed for temperature control. The Supplier shall provide the configuration scheme, which will be confirmed by the Purchaser upon signing of the *Technical Specifications*. All associate local control boxes and power boxes supplied by the Supplier must be made of the steel plate with the minimum thickness of 2 mm.

A.3.4 Four-pole switches shall be selected for all LV incoming line switches, feeder switches, circuit breakers/disconnecting switches, and three-pole circuit breakers may be used only for motor feeders.

A.3.5 The nominal and rated voltages of all electrical components (including relay and indicator) inside the control boxes shall match with the voltage parameters provided for this project: AC 415 V/240 V, 50 HZ and DC 220 V, and other power supplies required shall be provided by the Supplier.



APPENDIX 1

Scope of Supply

1.0 General Requirements

- 1.1 This section specifies the scope of supply for the equipment under the Contract. The equipment provided by the Supplier shall be brand-new, state-of-the-art, proven, complete and reliable and the technical and economic indicators of the same shall comply with
- 1.2 The Supplier shall provide a detailed list of supply covering in turn such items as model, quantity, place of origin, manufacturer, etc. The Supplier shall also provide those parts that are necessary for operation and installation of the complete equipment during execution of the Contract, even though they are not included in this appendix or included but in insufficient quantity, and no change of contract price is anticipated for this. The supply requirements in the Technical Specifications shall also be considered as a supplement for this scope of supply. In case that any items are found missed during the installation, commissioning and operation, the Supplier shall supply the said items at his own expenses.
- 1.3 The Supplier shall supply all the special tools and consumables required for installation and maintenance as well as a detailed list of supply.
- 1.4 A list of spare parts shall be provided.
- 1.5 A list of purchased parts for the supplied equipment shall be provided.
- 1.6 *Safety provisions like vibration & temperature alarm/tripping should be provided for CT fan gear box by vendor*

2.0 Scope of Supply

2.1 Scope of Equipment

The Supplier will supply all the equipment and components required for the circulating water cooling tower of the Purchaser above $\pm 0.000\text{m}$ elevation excluding the civil part, and ensure that all these supplies are state-of-the-art.

FRP kinetic energy recovery body

Complete supply of fans, motors, reducers and transmission shaft

Drift eliminators and their supports

Water distribution system (including water distribution pipes, sprays and fittings)

Spray fills and their supports

Cooling tower fan safety supervisory system

Maintenance walkways and platforms inside cooling tower

FRP guard plates, partition plates and their supports

Lifting equipment

Guiding device

Standard parts, fasteners and accessories

Battery of limit: the inlet water pipe of the cooling tower has the first flange located 500mm outside the tower column axis as the battery of limit, and the electrical battery of limit lies at the motor junction box.

Electrical scope of engineering and supply shall be as mentioned under clause 4.15.

The Supplier shall provide a detailed list of supply in the form given below, covering such contents as description, model, specification, technical parameter, quantity, place of origin, and manufacturer, etc. The Supplier shall also provide those parts that are necessary for installation and operation of the complete equipment, even though they are not included in these Technical Specifications and/or in insufficient quantity.

List of Contract Equipment

No.	Description	Specifications	Unit	Qty.	Manufacturer's Name	Place of Origin	Remark

2.2 Spare Parts

The Supplier shall provide the Purchaser with all the required spare parts at low prices on long term basis, and the fabrication drawings for spare parts and vulnerable parts shall also be provided.

The spare parts shall be supplied separately in terms of the spare parts to be supplied together with the equipment and spare parts to be used for the warranty period of three years. The spare parts for the warranty period shall be quoted separately and shall not be included in the total price.

2.2.1 Spare parts to be supplied together with equipment (including but not limited to the following)

No.	Description	Specifications	Unit	Qty.	Place of Origin	Manufacturer	Remark

2.2.2 Spare Parts for 3 years' Operation and Maintenance of Power Plant

No.	Description	Specifications	Unit	Qty.	Remark

2.3 Special Tools

No.	Description	Specification	Unit	Qty.	Use	Remark

2.4 List of Imported Parts

No.	Description	Specifications	Unit	Qty.	Manufacturer	Remark

3.0 Terminal Point

Cooling Tower Inlet and Cooling Tower Outlet :

Please refer drawing no. 1. **37-F4341S-S0302-2-02-A** 2. **37-F4341S-S0303-02-A** &
3. **37-F4341S-S0304-01-0** as cloud marked.

Electrical: Scope shall be engineering, procurement, supply, erection and commissioning of all equipment and fittings from the 6.6kV outgoing feeder terminals to the individual loads of the package.

Hot water piping : Riser with butterfly valve above 1.0 m from FGL.

Cold water Piping : As per existing unit cooling tower drawing with terminal points as marked in cloud

Civil work : Civil design and construction as per existing cooling tower drawing by vendor.

C&I Works: Entire cabling (supply, laying and termination), Cable tray (supply & support) including that from instruments to local panels / JB's / RIOs etc and from there up to the PLC shall be in vendor's scope

APPENDIX 2

Technical Documents and Submission Schedule

Basic Requirements for Document Submission

- 3.00.00** The Supplier shall provide the following documents when bidding:
- Product achievements
 - Equipment outline drawing
 - Foundation load drawing
 - Technical equipment specifications
 - List of supply (the accessory material, specification and quantity are to be separately given)
 - The Supplier shall provide the performance characteristic curve following the changes of design parameters as follows:
 - 1) Relative humidity: 15%, 25%, 50%, 60%, 70%, 80%, 90%, 100%
 - 2) Design flow: 90% to 110%
 - 3) Cooling range: 90% to 110%
 - 4) Rated local environment wet ball temperature: 15°C to 30°C. In a step 1°C.

The Supplier shall as required by applicable codes identify the “guarantee range”.

1. System hydraulic design;
2. Progress of installation works;
3. Detailed drawings, diagrams and instructions for the system and function of structure and mechanical part.
4. The Supplier shall prepare design reports for all the principles in determining dimensions.
5. Cooling tower thermal and resistance performance calculation process and results;
6. A set of cooling tower schematic drawing (plan and section drawing), general layout and civil load drawing that are in line with these technical requirements.
7. Peer cooling tower performance test report issued by authorities;
8. Physical, chemical, aging and performance test reports issued by authorities for critical parts of cooling tower, such as drift eliminator, water distribution pipe, fills, FRP profiles;
9. Demonstrated applications and comments by users of cooling towers in this structure in power plants;

Documents/Drawings and Delivery Schedule

Category of Documents/Drawings	Copies of Paper Files	Quantity of Electronic Documents	Language	Delivery Schedule	Remark
3.1 Quality and Safety					
(1) Project Quality Manual	2	1	English	Within two (2) months after signing of contract.	
(2) Project Management and Work Procedure	2	1	English	Within three (3) months after award of contract.	
(3) Process Specifications	When necessary.	When necessary.	English	When requested by the Owner.	
(4) Quality Assurance Records	When necessary.	When necessary.	English	When requested by the Owner.	
(5) Inspection and Test Program	2	1	English	Within three (3) months after award of contract.	
(6) Quality Plan	2	1	English	Three (3) months before the planned test date	
(7) Safety and Health Procedure or System	2	1	English	Within two (2) months after the contract becomes effective.	
3.2 Progress Control					
(1) Delivery Schedule of Design Documents	1	1	English	Within one (1) month after signing of contract	
(2) Manufacturing Schedule Report	2	1	English	Before the 30 th day of each calendar month after	

Category of Documents/Drawings	Copies of Paper Files	Quantity of Electronic Documents	Language	Delivery Schedule	Remark
				the contract becoming effective	
3.3 Material Supply					
(1) Manufacturing and Delivery Schedule	1	1	English	To be provided in the bidding document.	
(2) Delivery Forecasting	1	1	English		
(3) Case/Package Lists	8	1	English		
(4) Packing List and Quality Certificate	8	1	English		
3.4 Documents/drawings to be submitted to Owner/Indian Government for review and approval			English		
3.5 Documents/drawings used for installation, commissioning, test-run, unit performance test and operation and maintenance					
(1) Calculation Sheets (data table)			English	As per the requirements of Design Document Delivery Schedule.	
(2) Instruction Manual on Usage of Equipment			English	As per the requirements of Design Document Delivery Schedule.	
(3) Design and Manufacturing Drawings			English	As per the requirements of Design	

Category of Documents/Drawings	Copies of Paper Files	Quantity of Electronic Documents	Language	Delivery Schedule	Remark
				Document Delivery Schedule.	
(4) End of Manufacturing Report (E.O.M.R)			English	Within fourteen (14) days after completion of inspection or test	
3.6 Documents/Drawings in relation with project design					
(1) Documents submitted together with the bidding documents			English		
(2) Data necessary for detailed design			English		
3.7 Data necessary for manufacturing surveillance					
3.8 Data necessary for training					
3.9 Standards and Technical Specifications					
(1) Lists of Standards and Technical Specification	1	1	English	Within one (1) month after signing of contract	

APPENDIX 3

Submission of Documents/Drawings

- 4.1 Submission of documents/drawings not to be reviewed and approved by the Owner/Indian Government.

The Supplier will provide a total of 20 hard copies and 1 soft copy to the Owner and the Purchaser for the purpose of this project.

- 4.2 Submission of documents/drawings to the Owner/Indian Government for review and approval.

Submission of documents/drawings for review

The Supplier shall submit to the Purchaser six hard copies documents/drawings as well as one soft copy necessary for review and approval.

Submission of documents/drawings approved by the Owner/Indian Government

The Supplier shall resubmit to the Purchaser fifteen hard copies of approved documents/drawings and one soft copy after review and approval by the Owner/Indian Government.

Drawings/documents not approved by the Owner/Indian Government

Drawings/documents to be modified and revised according to the review comments of the Owner/Indian Government

In case the documents/drawings submitted to the Owner/Indian Government are not approved by the Owner, the Supplier shall submit them again for approval in accordance with requirements in this appendix after making modification and revision according to the review comments of the Owner/Indian Government.

Drawings/documents not to be modified and revised according to the review comments of the Owner/Indian Government

In case the Supplier would not agree with the Owner/Indian Government on review comments of the documents/drawings and consider it is unnecessary to make revision and modification, the Supplier shall explain to the Owner/Indian Government its justifications and obtain the agreement of the Owner/Indian Government. Otherwise, the Supplier shall modify and revise the documents/drawings as per the requirements of this procedure.

Submission after revision and modification of approved drawings/documents by the Owner/Indian Government

For drawings/documents already approved by the Owner/Indian Government, in case they are necessary to be modified and revised according to the Owner's requirement or actual conditions at Site, the Supplier shall cause it to be modified in time and submit the modified

documents/drawings as per the provision of this procedure.

4.3 Submission of As-built Documents/Drawings

The Supplier shall submit to the Purchaser and the Owner six hard copies of as-built documents/drawings and one soft copy. The Supplier shall recover the drawings and data not subjected to modification after distribution as far as possible and supplement the shortage.

5.0 Delivery Requirement of Documents/Drawings

5.1.1 Document Transmittal Sheet

Document transmittal sheet must be used for transfer of documents. The Purchaser will provide relevant procedure to the Supplier after the Contract becoming effective which will specify such aspects as the content, format, communication identifier, authorized signatory, sequence number series, written language requirement for document transmittal sheets.

5.1.2 Delivery Procedure of Documents/Drawings

The Supplier shall transfer documents/drawings to the Purchaser as required by the Purchaser. The Purchaser will provide to the Supplier relevant procedures which specify the details after the Contract becomes effective.

6.0 The Purchaser will provide the list of drawings/documents to be submitted to the Owner for review or approval and the Supplier shall submit such drawings/documents based on the said list.

APPENDIX 4

Supervision, Inspection and Performance Acceptance Test

1 General

This Section applies to the quality assurance, shop inspection, surveillance and performance acceptance test of the equipment to be provided by the Supplier during the implementation of the Contract, so as to ensure that the equipment to be provided by the Supplier meets the requirements

2.0 QA Requirements

2.1 Quality Assurance Program

The Supplier shall develop a QA program to control the activities conducted for accomplishing the job within scope of Contract so as to ensure that the equipment and service within the scope of Contract shall comply with the technical specification or requirement. The supplier shall submit the program for confirmation and approval by the Purchaser.

The following contents shall be included in QA program supplied by Supplier:

- a) Organizational structure for managing and implementing the QA program.
- b) Qualification certificate data of Key personnel
- c) Appropriately qualified and experienced personnel required by each job.
- d) QA procedures to be followed in the process of design and technical research and development
- e) Method, procedure and plan to compile, collate and evaluate of information selected from different original data and incorporate them into the suggested design proposal.
- f) Documentation control systems
- g) Procedure for procurement of materials, components and assemblies and selection of Subcontractors' services including analysis of suppliers, check of source, inspection of arrived raw materials and inspection of purchased materials.
- h) Methods for protection, storage, inventory management and release of materials.
- i) Shop manufacturing control including process control and manufacturing and assembling control.
- j) Control and corrective action for non-conformity and concerned system.
- k) Inspection and testing procedures related to manufacture of equipment components.

- l) Calibration inspection control of measuring and testing equipment's.
- m) Quality supervision and self-monitoring system for QA system.
- n) Identification and evaluation system for inspection status.
- o) Authorization system for delivering finished products to the Purchaser.
- p) Final inspection and acceptance of completed parts of equipments.
- q) Recording and processing of design change and indicating them in related drawings.
- r) Custody of record
- s) Provide the quality inspection plan for equipment manufacture which shall specifies the specific quality control procedures used for controlling quality characteristic related to each work.
- g) Submittance of FQP- Cooling tower covering all disciplines of erection (Civil, Mechanical, Electrical and C&I with equipment details furnished) shall be submitted to GKEL for review and acceptance

The QA system shall include compilation and compliance with written quality inspection plan. After approved by the engineer from the Supplier, this QA system shall be part of the Contract. Any changes to this QA system are not allowed without prior written permission by the engineer from the Supplier.

The Supplier shall provide the following information related to each Subcontractor:

- a) Items to be subcontracted.
- b) Subcontractor's QA system.
- c) How to approve, supervise and inspect Subcontractor's quality inspection plan/quality procedure during Contract period.
- d) Quality inspection plan for each subcontracted item.

The Supplier shall provide valid documents to demonstrate to the satisfaction of the engineers from the Purchaser that the provisions of the approved and accepted QA system are well implemented by the Supplier, and the said QA system shall involve the lower tier QA system supervised by the Supplier.

The Supplier shall supervise the lower tier QA system, the related documents reflecting scope of supervision and implemented supervision shall be kept as valid objective evidences. If requested by the engineers from the Supplier, all the documents related to any inspection shall be submitted to them as separate supplementary document or as a document package.

2.2 General Requirements for QA

All materials, components, equipment and systems involved in these Technical Specifications shall be designed, purchased, manufactured, installed, commissioned and tested at every stage in accordance with the requirements of a complete QA system. Shop inspection and test including shop performance test and on-site test for all equipment and systems shall be in accordance with relevant laws and standards and the requirements of these Technical Specifications.

The Supplier shall supply a detailed and complete list of checks and tests so that he or his Subcontractor may check and test the equipment's and systems under this contract in shop and on site.

The quality plan for design and technology research and development shall include separate verification, confirmation and evaluation procedures in aspects of suitability for purpose, feasibility, safety and conformity with standard and maintenance requirement and cost effectiveness respectively.

The Supplier shall independently compile detailed quality inspection plan for equipment manufacture and submit the same to the Purchaser for approval.

The manufacturing quality inspection plan for all components and equipment's made by the Supplier shall specify the related laws/standards to be followed by the quality control department carrying out each kind of tests/inspections and related quality practice and procedure.

The Supplier shall also submit the copies of reference document/equipment standard/acceptance specification/test and inspection method and procedure mentioned in the quality inspection plan altogether. These quality inspection plans and reference document/standard shall be approved by the Purchaser firstly before commencement of manufacturing work. These approved documents shall form part of the Contract. In these approved quality inspection plans, the Purchaser/ his authorized representatives shall mark the field witness point (W-point) and hold for inspection point (H-point). H-point refers to a certain point equipment manufacture, which requires approved documentary evidences from tests/inspections completed with presence of Purchaser or his authorized representatives, otherwise, no further manufacturing of equipment's is permitted.

All changes to these Technical Specifications, approved quality inspection plans and applicable standards shall be documented and submitted to the Purchaser/ his authorized representatives for approval and processing.

Regarding all welding activities, the Supplier shall submit a complete welding schedule to Purchaser's engineer for approval. This welding schedule shall be submitted together with all supporting documents such as welding procedure, heat treatment procedure and NDT procedure.

Any equipment and material shall not be released from manufacturer's shop before final acceptance thereof. Before delivery, the Purchaser's engineer/his authorized representatives must make a final inspection on equipments and materials including the

verifications of all test/inspection records signed by the Purchaser's engineer/ his authorized representatives previously, the delivery of equipments and materials must be signed and approved by the Purchaser's engineer/his authorized representatives.

The Purchaser or QA/quality inspection team represented by him shall issue a delivery permit for equipments and materials following an acceptable final inspection, this permit will allow the Supplier to deliver equipments and materials and claim for payment.

Furthermore, during all stages of shipment, it is required that the Supplier shall guarantee the packages of goods are suitable for marine transport, unloading at port of entry, inland transport, on-site storage till installation.

All materials used or delivered shall be attached with valid and approved material certificates and test and inspection reports. These certificates and reports shall specify page numbers or other acceptable marks. The materials need to be certificated shall bear associated stamps and description thereof.

All castings and forgings shall be attached with quality certificate obtained through test, which shall include detailed data such as chemical analysis, heat treatment record and result of mechanical performance test.

All the welding and brazing work shall be carried out according to prepared and approved procedures based on ASME Section IX I/BS-4870 or other equivalent standards as may be accepted by the Purchaser.

Based on ASME Section IX or BS-4870 or other equivalent standards accepted by the Purchaser, all the brazing workers or welders employed in the Supplier/subcontractor's factories in any phase of performance of the Contract shall be qualified welders.

In addition, welding of the pressurized parts and high pressure pipes shall be in compliance with requirements of IBR (Indian Boiler Regulations).

All the NDTs shall be carried out according to the approved standards. Personnel to carry out NDT shall be qualified personnel in compliance with SNT-TC-IA (American Society for Non-destructive Testing) standards or the standards approved by the Purchaser. Results of NDT shall be properly recorded and submitted to the Purchaser for approval.

All the subcontractors recommended for equipment's, materials and services by the Supplier as well as their QA plans shall be approved by the Purchaser.

The subcontractor's QA plans shall be discussed and finally determined by the Purchaser/ his authorized representatives, which shall be an integral part of the purchase orders between the Supplier and the sub-suppliers.

The technical specifications and for all the purchased items and purchase order list established by the Supplier shall be submitted to the Purchaser for approval.

The Purchaser reserves the rights to carry out quality supervision on the Supplier's quality system and procedures or his subcontractor's quality management and control activities. The Supplier shall provide the Purchaser with all the necessary help to implement the said supervisions.

Quality supervision/approval of test and inspection results shall not prejudice the

Purchaser's right to reject the equipment which fails to reach the required performances upon completion of installation, and in no event shall limit the Supplier's responsibilities and obligations to achieve satisfactory performances of the equipments in accordance with the requirements in the Specifications.

Quality requirements on the main equipments shall also be applicable for spare parts and replacements.

Repair/rectification procedures adopted to bring any of the work activities into compliance with requirements shall be approved by the Purchaser's engineer.

2.3 QA Documents

The Supplier is required to submit four hard copies and one copy of following QA documents within 2 weeks from delivery of the equipment:

- a) Shop test reports of the parts and materials as specified in the Technical Specifications;
- b) Inspection methods, schemes and procedures for verification of satisfactory execution of inspection and test points in the quality inspection plans which are attached with verified quality inspection plans and executed inspection points therein as well as general description of verification thereof;
- c) NDT results/reports including descriptions and reports on radiographic inspection;
- d) Shop test results/reports of the tests carried out according to the applicable statutes and standards as defined in Technical Specifications;
- e) Welder certification list, which lists the qualification assessment procedures and weld identities for the welders;
- f) Schematic drawings and diagrams of the traceable methods indicating positions on the equipment where radiography is to be carried out;
- g) Stress relief annealing operation time-temperature schematic drawing;
- h) Inspection and test reports of hold points agreed between both parties which are formally signed by the QA personnel of the Purchaser and the Supplier. The followings shall also be recorded during inspection:
 - i) Some major repair work involved to enable the work to be acceptable.
 - ii) The repair work shall constitute the part of the quality of accepted products.
 - iii) Compliance certificates demonstrating compliance with the requirements in the finally agreed Technical Specifications.

3.0 Shop Inspection Requirements

- 3.1 Shop inspection is an important item for quality control. The Supplier shall inspect and test strictly the manufacture links in the shop. The Supplier shall provide the Contract Equipment with quality certificates, inspection records and test reports, which shall be part of the quality certificates upon delivery.
- 3.2 The Inspection shall cover the whole process including receipt of raw material and element, component manufacturing, assembly, inspection and delivery test.
- 3.3 The test results shall meet the requirements as specified in Attachment 1. The Supplier shall take measures to remedy the unconformity, if any, to meet the requirements and submit a nonconforming report to the Purchaser. The Supplier shall notify in time the Purchaser of any critical quality problem, if any.
- 3.4 The Purchaser's Engineer and his formally authorized representative and/or external inspection institutes on behalf of the Purchaser may at any time check or inspect during manufacturing of the equipment. If part of the equipment manufacturing work is to be carried out in workshops or shops other than that of the Supplier, the Purchaser's engineer and authorized representative shall have the right to check or inspect such part as if the checks or inspections are carried out in the Supplier's own workshops or factories.
- 3.5 The Supplier shall give written notice to the Purchaser's Engineer/authorized representative within 21 days prior to material/equipment inspection. Cost incurred during inspection other than travel and accommodation cost shall be borne by the Supplier. The Purchaser's engineer / authorized representative shall participate in witness of the inspection within 15 days unless such witness has been confirmed to be canceled. In the event that such period is expired, the Supplier may inspect the equipment in absence of the inspection personnel, to whom 8 copies of the verified test reports shall be submitted.
- 3.6 The Purchaser's Engineer/authorized representative shall give written comments to the Supplier of his comments on rejection of the drawing, equipment and process in accordance with the Contract within 15 days from witness of inspection. The Supplier must carefully treat with the said defects or find solutions thereto, or demonstrate that it is unnecessary to rectify such defects according to the specifications in this Contract and state such demonstration to the Purchaser's engineer / authorized representative in written form.
- 3.7 The Purchaser's engineer/authorized representative shall issue a certificate within 15 days upon completion of shop test by the Supplier or his subcontractor, which shall otherwise be issued within 15 days on receipt of the Supplier's test certificates by the Purchaser's Engineer/authorized representative provided that such test is not witnessed by the Purchaser's personnel. Failure of issuance of such certificate by the Purchaser's engineer/authorized representative shall not impede the Supplier from proceeding with the work. Should further tests are not in compliance with the requirements in the Contract upon installation of the equipments by the Supplier, the foregoing completion of the shop test and issuance of the certificate shall not hold the Purchaser from rejecting these equipment.
- 3.8 Unless otherwise specified, the Supplier shall undertake cost of the labors, materials,

electric power, oil, water, devices and instruments incurred by any tests under the Contract in shop/workshop of either the Supplier or his subcontractors so as to facilitate the Supplier and the Purchaser to conduct such equipment tests.

- 3.9 For successful planning of the test in advance, in addition to issuance of inspection notice under Clause 3.5, the Supplier shall provide quarterly inspection schedule stating H-points of the Purchaser and inspection plans for the final inspection and the updated quarterly inspection schedule shall cover the inspections for three consecutive months, which shall be submitted prior to the fifth day of each calendar month.

4.0 Equipment Surveillance Requirements

Work activities as specified in surveillance agreement shall be performed during equipment surveillance process under the Contract such as contract management, quality control, progress control, investment control as well as organization and coordination, etc.

The Supplier shall provide the Purchaser with purchase plans (or contract) for castings and forgings 6 months prior to commencement of equipment machining and list and purchase plans for purchased and outsourced pieces (or contract) 2 months prior to commencement of equipment machining.

- 4.1 The Purchaser will engage experienced surveillance/technical supervision company and his Engineer to carry out surveillance of Contract Equipment manufactured by the Supplier.
- 4.2 The raw materials for important parts can only be fed after being confirmed (record witness) by the surveillance representative.
- 4.3 Witness documents shall be submitted to the Purchaser's surveillance representative within seven days from witness.
- 4.4 The Supplier shall provide production plan prior to feeding of the equipment materials and submit the updated production and quarterly inspection & test plans in written form to surveillance representative and the Purchaser (see Article 3.9).
- 4.5 The Purchaser's surveillance representative shall have the access to the technical information related to equipment surveillance (including relevant standards, design basis, calculation sheet, technical requirements and qualification certificates of welder, NDT personnel as well as physical and chemical examination personnel), with whom the Supplier shall actively cooperate and provide copies of relevant information without additional costs.
- 4.6 The Supplier shall not replace the important parts and special parts of the Contract Equipment without the Purchaser's approval.
- 4.7 The Purchaser's surveillance representative shall have right to inspect the equipment manufacture quality at workshop at any time.
- 4.8 The Supplier shall provide the Purchaser's surveillance representative with dedicated office as well as communication and living conveniences.

- 4.9 Once discovered, any major quality problem and manufacture defects during manufacturing of the equipment shall be notified to the Purchaser and his surveillance representative on a timely basis without concealment.

4.10 Basis of Surveillance

As per the relevant provisions of the Contract and the EPC Contract with the Owner.

4.11 Modes of Surveillance

Modes of surveillance include shop test, document witness, site witness and hold for inspection, naming I, R, W and H point.

I-point: re-inspection, random inspection, tests and NDT for metal welding carried out by the Purchaser's surveillance representative in the shop of the Supplier, which shall all be carried out on basis of satisfactory self-inspection by the Supplier.

R-point: items for which inspection or test records or reports shall be provided by the Supplier, i.e. record witness. The witness documents shall be reviewed by the Purchaser's Manufacturing Surveillance representative.

W point: inspection or test items that requiring participation of the Purchaser's surveillance representative, i.e. site witness items. The Supplier shall provide inspection methods or test programs and inspection records or test reports thereof prior to and on completion of inspection or tests, i.e., site witness.

H-point: hold for inspection. All the work must be hold for inspection or test participated by the Purchaser/his authorized surveillance representative for witness purpose (the Purchaser shall be responsible for delay occurred as a result of failure of timely presence on site by the Purchaser). The Supplier shall provide inspection methods or test programs and inspection records or test reports thereof prior to and on completion of inspection or tests

The Purchaser will respectively give the Supplier 21 and 10 days prior written notice of the H and W points prior to surveillance and inspection of the equipments and 10 days prior written notice of the R and I point prior to check or inspection.

Upon notification for quality witness, the Purchaser shall in time send his representatives for site witness. If the Purchaser's representative fails to be present on time, W-point will turn automatically to R-point; however for H-point, the Supplier shall not proceed with next procedure unless the point is agreed by the Purchaser in writing to be turned to R-point. In the latter case, the Supplier shall consult with the Supplier to change the witness date and if the Purchaser fails to appear again, the H-point will turn automatically to R-point.

The Supplier and the Purchaser's surveillance representative shall sign a witness form after each item of surveillance, which shall be made in three (3) copies and two (2) copies shall be hold by the Surveillance Representative. Modes of surveillance shall be document and site witness as well as hold for inspection. Upon completion of each item of surveillance, the Supplier and the Purchaser's surveillance representative shall jointly sign on the quality control and quality inspection plans and a record thereof shall be established

in form of attached table (in English), which shall not relieve the Supplier of his liabilities after being signed and sealed.

The Purchaser's surveillance representative may witness or abort to witness all the witness points/hold points tests. In the latter case, all the tests conducted shall be deemed as being witnessed.

4.12 Items of Surveillance

Items of surveillance shall include, but not be limited to the major items listed in the table below. This table shall be detailed prior to commencement of surveillance and during signing of surveillance agreement or approval of the Supplier's quality inspection plans.

Equipment Surveillance Item List

No.	Name of Spare Parts and Processes	Items of Surveillance	Modes of Surveillance		
			H	W	R Qty.
1					
2					
3					
4					
5					
6					
Note: H—hold for inspection, W—field witness, R—Record witness, Quantity—quantity of inspected specimens					

5.0 Performance Acceptance Test

5.1 The Performance Acceptance Test is to verify if the performance of the Contract Equipment satisfies the performance requirements.

5.2 Location of the performance acceptance test shall generally be at the site of the Purchaser.

5.3 Time of performance test: as specified in Commercial Part.

5.4 The performance acceptance test shall be presided over by the Purchaser, with Supplier being involved. The test program shall be prepared by the Supplier and finalized through consultation with the Purchaser. If the test is to be performed at the site, the Supplier shall provide cooperation in accordance with the contract; if the test is to be performed in the shop, the Supplier shall provide necessary material and labor for the test.

5.5 Standards and Methods for Performance Acceptance Test

Performance tests shall be in accordance with relevant ASME and Indian IBR standards, etc.

5.6 The Supplier shall provide measuring points as well as technical and personnel coordination necessary for the performance acceptance tests.

5.7 Cost for Performance Acceptance Test

The expenses related to test coordination etc. of the Supplier have been included in the total Contract Price, and other expenses shall be borne by the Purchaser if the test is to be carried out at the site and shall be included in the total Contract Price if to be carried out at the Supplier's shop.

5.8 Result Confirmation of Performance Acceptance Test

The Purchaser shall undertake to prepare the performance test report with the participation of the Supplier, which shall be countersigned by both parties for confirmation. Any contradiction regarding the test result shall be settled by mutual negotiation, upon failure of which the matter shall be reported to the superior for coordination.

If either party fails to designate personnel to participate in the test after receiving the notification from the other party, he shall be deemed to have accepted the test results and shall sign and stamp thereon.

6.0 Attached tables

Attached Table 1 - Requirements for Document and Information to be Submitted for QA, Surveillance and Inspection.

Category of Documents/Drawings	Copies of Paper Files	Quantity of Electronic Documents	Language	Delivery Schedule	Remark
1 Quality Assurance					
(1) Project Quality Program/Manual	2	1	English	Draft to be submitted for approval before signing of contract.	
(2) Project Management and Work Procedure	2	1	English	Draft to be submitted for approval before signing of contract.	
(3) Process Specifications	When necessary	When necessary.	English	When requested by the Owner.	
(4) Work Instructions	When necessary	When necessary.	English	When requested by the Owner.	
(5) Quality Assurance Records	When necessary	When necessary.	English	When requested by the Owner.	
(6) List of Relevant Specifications and Standards Adopted	2	1	English	Submit together with QA program/manual	
(7) Relevant	When	When	English	When	

Category of Documents/Drawings	Copies of Paper Files	Quantity of Electronic Documents	Language	Delivery Schedule	Remark
Specifications and Standards Adopted	necessary	necessary.		requested by the Purchaser	
2 Surveillance and Inspection					
(1) Quality Plan	2	1	English	Within two (2) months after signing of contract.	
(2) Quality Inspection and Test Plan	2	1	English	Within two (2) months after signing of contract.	
(3) Quality Inspection and Tests Quarterly Rolling Plan	1	1	English	The first revision shall be submitted upon signing of the Contract and the rests shall be submitted prior to the fifth day of each month	
(4) Documents with Respect to Quality of the Delivered Shipments	4	4	English.	To be submitted within 2 weeks upon delivery of the equipments and materials	
(5) End of Manufacturing Report (E.O.M.R)	6	1	English.	To be submitted within 30 days upon completion of inspection or tests and delivery of all the equipment and materials	The Purchaser will, within two months after award of contract, provide to the Supplier the procedure of "preparation and submission of EOMR"

Attached Table 2 - Quality Plan

Quality Plan									
Manufacturing Quality Plan									
Name of the manufacturer: Plan for item: Stage: Material/Receiving/In process									
Inspection MQP No.:									
Revision Number:Date:									
Serial No.	Characteristic/Item	Category	Type/Method of Check	Extent of Check	Reference Document	Acceptance Norm	Format of Record	Witnessed by	Remark
A	B	C	D	E	F	G	H	I	J

Attached Table 3 - Quality Inspection and Test Plan

Manufacturing Inspection & Test Plan

Part Name:

Equipment:

No.	I&T Item	Applicable Standards	I&T Point			Remark
			Manufacturer	DCPL	OWNER	

APPENDIX 5

Technical Services and Design Liaison

1.0 Supplier's On-site Technical Service

- 1.1 The site service personnel of the Supplier are designated to ensure that the equipment supplied may be safely and normally put into service. The Supplier shall assign qualified service personnel to the site, and shall provide associated site technical service plan indicating man-month details in his tender. If the man-months listed in the following schedule cannot satisfy the need of the Project, the Supplier shall increase the man-months and the costs thus incurred shall be borne by the Supplier.

Site Service Schedule (format)

No.	Service Description	Planned Man-days	Personnel		Remark
			Title	No. of Personnel	
Total					

- 1.2 The Supplier's site service personnel shall meet the following qualification requirements:
- 1.2.1 They shall observe laws and regulations, site policies and procedures, as well as safety regulation of power industry;
- 1.2.2 They shall have strong sense of responsibility and enterprise, and report to work on time;
- 1.2.3 They shall know the engineering and construction of the Contract Equipment, and have site experience in same or similar units and the ability to instruct the site work correctly;
- 1.2.4 They shall be healthy and adapt to the working condition on site with fluent oral English ability.

The Supplier shall provide the Purchaser with a list of introduction of the service personnel (and the format thereof). The Supplier shall replace the unqualified service personnel.

Introduction of the Service Personnel

Name		Gender		Age		Education	
Discipline		School of Graduation		Title		Title	
Personal Information	Brief introduction to working experience						
	2. Work experiences on the same or similar project site						

- 1.3 Duties of the Supplier's Site Service Personnel

- 1.3.1 The duties of the Supplier's site service personnel mainly include delivery expedition, unpacking inspection of goods, and solutions to quality problems, instruction of installation and commissioning, participation in trial operation and performance acceptance test.
- 1.3.2 The Supplier's site service personnel shall make technical presentations to the Purchaser, and explain and demonstrate the ongoing procedures and methods before installation and commissioning. The Supplier's service personnel shall confirm the installation status and sign a certificate for key processes (see the following table), and otherwise the Purchaser is not allowed to proceed with the next process. The Supplier shall take full responsibility for the problem due to the incorrect instruction of the Supplier's service personnel in the process confirmed and signed by the Supplier.

Key working procedures to be provided by the Supplier for installation and commissioning (format)

No.	Name of Process	Description of Process	Remark

- 1.3.3 The Supplier's site service personnel shall have the full right to handle all the technical and commercial issues occurred at the site. The Supplier's site service personnel shall solve the quality problem, if any, within the duration as specified by the Purchaser. If the Supplier entrusts the Purchaser to handle the problem, the Supplier's site service personnel shall issue a letter of attorney to the Supplier and take the corresponding economic responsibility.
- 1.3.4 The Supplier shall take the full responsibility for all the acts of its site service personnel.
- 1.3.5 The replacement of the Supplier's site service personnel shall be subjected to consultation with the Purchaser in advance.

1.4 Purchaser's Obligations

The Purchaser shall provide cooperation with the Supplier's site service personnel and provide assistance in daily necessities, transportation and communications.

2.0 Training

- 2.1 The Supplier shall be responsible to provide training required for normal installation and operation of the Contract Equipment. The training topics shall be consistent with the Project progress.
- 2.2 The Supplier shall give training program and contents (including format) in his Bids.
- 2.3 The time, place, number of trainees, etc shall be determined by the Purchaser and the Supplier through consultation.

The Supplier shall provide facilities, place and documents and others required for training, as well as convenience in accommodation and transportation.

No.	Content of Training	Scheduled Man-months	Constitution of Instructors		Venue	Remark
			Title	No. of Personnel		
1						
2						
3						
4						
5						

3.0 Design Liaison

The Supplier shall head for the venues specified by the Purchaser in time and for coordination if so required without additional cost.

APPENDIX 6

List of Spare Parts for 3 Years' Operation and Maintenance of Power Plant

"Spare Parts for 3 year's Operation and Maintenance of Power Plant" means the spare parts for operation and maintenance of the Power Plant for three years jointly selected by the Purchaser and the Supplier after take-over. The Owner and the Purchaser will select the said spare parts from the list below, for which separate order will be placed by the Purchaser.

Mandatory spare parts mean the spare parts to be provided at the request of the Owner for three years of operation and maintenance of the Power Plant;

Recommended spare parts means the spare parts recommended by the Supplier based on his experience in design, manufacturing, operation and maintenance of Contract Equipment to be used for three years of operation and maintenance of the Power Plant and the said recommended spare parts list shall be complete in respect of variety and quantity, no matter whether it is included in the above item.

No.	Description	Specifications	Unit	Qty.	Weight (Ton)	Manufacturer	Remark
a)	Mandatory spare parts						
b)	Recommended spare parts						

Appendix-7

Cooling tower performance guarantee (PG) test shall be in line with CTI , ATC 105 : "Acceptance Test Code for Water Cooling Tower" for the following parameters:

Sl. No	Parameters	Data	Unit
1	Cooling Water Flow Rate	507826 (CELL 11W+1S)	(m ³ /h)
2	Cooling Tower Inlet Temperature (HWT)	41.5	°C
3	Cooling Tower Outlet Temperature (CWT)	32.5 (Guarantee)	°C
4	Design Ambient Wet Bulb Temperature	28	°C
5	Design Inlet Wet Bulb Temperature	28.5	°C
6	Fan Power Consumption	Bidder to fill up	BKW
7	Sound Level @ 1 m	85	dBA
8	Tower Pump Head above basin Curve	Existing unit # 3	m

Performance Guarantee attracting liquidated damages:

SI No.	Description	Parameter for Performance Guarantee	Rate of liquidated damages	Applicability of bid evaluation / LD
1	Cooling Tower Cold Water Temperature (CWT)	a) The acceptance limit without LD is permissible for the guaranteed value of cold water temperature (CWT) 32.5 °C b) If the cold water temperature exceeds the guaranteed value 32.5 °C, LD shall be levied for increase in cold water temperature upto 0.5 °C per 0.1 °C. increase of the cold water temperature (CWT) at design condition. Limited Value : Increase of cold water temperature more than 0.5 °C (i, e more than 33 °C) from the guaranteed value of 33 °C, IDCT shall be rejected.	For every 0.1°C of increase of the cold water temperature (CWT) at design condition from the guaranteed value	Only LD

APPENDIX - 8

Demonstration parameters for cooling tower :

Sl. No	Demonstration parameters for cooling tower.	Data	Unit	All design cells in Operation (N-1)	One design cell out of Operation (N-2)
1	Cooling Range	9 (41.5 – 32.5)	°C		
2	Cooling Approach	4.5 (32.5 to 28)	°C		
3	Cooling Tower Efficiency	Vendor to fill up	%		
4	Heat Load	Vendor to fill up	KW		
5	Water loss a) Evaporation loss, b) Drift loss c) Blowdown loss	Vendor to fill up	%		
6	COC	5			
7	Liquid-to-Gas Ratio (L/G)	Vendor to fill up			

Note : N (Total no of cells) = 12

ANNEXURE-A

DATA SHEET FOR INDUCED DRAUGHT COOLING TOWER

1.00 DESIGN PARAMETERS

1.01	Quantity of Water to be cooled	:	By Bidder
1.02	Number of towers	:	Two (2)
1.02.1	Number of cells per tower:		
	(a) Operating	:	Two individual towers consisting 6 cells in each row, (Total 2 towers, 12 cells, FRP fan stack)
	(b) Standby	:	11W+1S
	(c) Total	:	2N+2; arranged as (N+1) in each row of the back-to back construction
1.03	Duty of each tower	:	To cool plant circulating water and auxiliary Cooling Water
1.04	Period of operation	:	Continuous duty, all round the year
1.05	Hot water temperature (°C)	:	Bidder to indicate
1.06	Cold water temperature (°C)	:	32.5 (guaranteed)
1.07	Cooling range (°C)	:	Temperature rise across condenser plus 1 deg. C.
1.08	Recirculation allowance (°C)	:	0.5
1.09	a) Design ambient wet bulb temp. (°C)	:	28 (for details, refer Met Data)
	b) Design inlet wet bulb temp. (°C)	:	28.5
1.10	Approach (°C)	:	4.5
1.11	Static pumping head from basin curb	:	Bidder to indicate
1.12	Friction loss in cooling tower piping	:	Bidder to indicate
1.13	Range	:	9
1.14	Water flow of one group cooling Tower	:	50783 m ³ /h(Final cooling tower capacity and cell capacity will be informed after receive of condenser cooling water total flow for unit #4 from Successful Turbine Supplier)

1.15	Water flow of one cooling unit	:	4616.64 m ³ /h
1.16	Design dry bulb temp	:	36°C
2.00	BASIN (to be designed on uncrack basis)		
2.01	Type	:	Single
2.02	Material of construction	:	R.C.C. M-30 (dense preferably air entrained) having a mix rich with a low water to cement ratio
2.03	Effective storage Capacity (between Min. & Max. water level)	:	10 minutes of cooling tower flow at full load operation of the unit
2.04	Drain box size	:	2000 x 2000 mm for satisfactory cleaning of tower
2.04.01	Number of drain boxes	:	Two (2)
2.05	Cold water discharge pipe	:	Required effective cross-sectional area for 1.0 metres/sec. water velocity
2.05.01	Material of construction	:	R.C.C. M-30 (dense preferably air entrained) having a mix rich with a low water to cement ratio
2.06	Stop log gate on cold water channel	:	As required
2.07	Cleanable screen	:	As required
2.07.01	Screen	:	10mmx10mmx8 SWG galvanised steel wire mesh in steel channel frame epoxy painted
3.00	MATERIALS OF CONSTRUCTION		
3.01	Louvers	:	RCC
3.02	Structure and basin	:	R.C.C. M-30 (dense preferably air entrained) having a mix rich with a low water to cement ratio
3.03	Splash Fill	:	Durable PVC
3.031	Fill support	:	R.C.C. M-30 (dense preferably air entrained) having a mix rich with a low water to cement ratio
3.04	Drift eliminators	:	Durable PVC
3.04.01	Drift eliminator support from bottom	:	R.C.C. M-30 (dense preferably air entrained) having a mix rich with a low water to cement ratio

3.05	a)	Fan blades	:	Fibre Glass Reinforced Polyester (hollow cast)
	b)	Drive shaft and coupling	:	.Carbon Fibre
	c)	Base frame	:	Epoxy painted galvanized steel
	d)	Hardware	:	Silicone bronze (wet); stainless steel 316 (dry)
	e)	Anchor bolts	:	Stainless steel 304
3.06		Stack (fan)	:	FRP
3.07		Nozzles (low pressure non clogging type)	:	Polypropylene
3.08		Distribution pipes	:	Unplasticized Polyvinyl Chloride (UPVC)
3.09		Fan deck	:	RCC
3.10		Hot water Header	:	MS to IS: 2062
3.11		Hot water Distribution Pipes	:	PVC (IS 4985 Class 3)/FRP/HDPE (IS 4984 PN6, grade PE 80)/or RCC/ pre-cast open trough
3.12		Fan Hub	:	Heavily Galvanized M.S.
3.13		Stop Log gates		
	a.	Guides/ Anchors	:	CS IS 2062 Gr B
	b.	Gate leaf & lifting beam	:	CS IS 2062 Gr B
	c.	Rubber seals	:	As per Appendix-B of IS: 4622
	d.	Lifting Beam	:	CS IS 2062 Gr B
3.14		Nozzles/splash cups	:	PVC/Polypropylene/Gun metal as per IS: 318 Gr VI
3.15		Hand railing	:	Hand railing at all locations shall be provided with heavy duty GI pipes of suitable size and safety standard.
3.16		Protective Coating to the Concrete surface	:	All concrete surfaces in contact with water shall be applied with Waterproofing bituminous coat. Other surfaces shall be applied with suitable IPN based coating.
3.17		Cable Tray	:	All Cable tray (power& control) material shall be of FRP type.

- Note:**
1. The splash bars shall be tied into corrosion free material to grids supported on concrete frames.
 2. Any other work/equipment whether specified or not but needed to complete the cooling tower shall be deemed included in the contractor's scope of work.