VOLUME – IA
Part I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED

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VOLUME - IA PART – I CHAPTER – I

1.1 PROJECT INFORMATION

INTRODUCTION

5 x 800 MW Yadadri Thermal power station is being set up by TELANGANA STATE GENERATION CORPORATION at a site in Veerlapalem village, Dameracherla Mandal, NALGONDA DISTRICT, TELANGANA STATE, India. The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on BHEL/Owner. All relevant site data /information as may be necessary shall have to be obtained /collected by the Bidder.

A. PROJECT INFORMATION

1.	Name of the Project	YADADRI Thermal Power Station
2.	Station Capacity	5X800 MW (Coal based)
3.	Owner	Telangana State Power Generation Corporation Limited (TSGENCO)
4.	Site Location	Site is located 7 km from the SH 2 Miryalaguda - Vadapalle Highway.
5.	Latitude	*16° 42'*20.40 N
6.	Longitude	79° 34'41.56 E
7.	Nearest Town	30 Km Miryalaguda
8.	Nearest Railway Station	6.5 Km Damercherla
9.	Nearest Airport	130 Kms (Vijayawada)
10.	Site Conditions	
11.	Ambient Temperature	
	Daily minimum (average)	10°C
	Daily maximum (average)	47°C

	Design Ambient Temperature	50°C
	Ambient temperature (performance)	38°C
12.	Relative Humidity for design / efficiency	48-84 %
13.	Annual rainfall, mm	600 mm
14.	Plant Elevation above MSL	85 m above MSL
15.	Mean Wind Speed	8 km/h
16.	Wind Pressure	As per the latest revision of IS 875/1987
17.	Seismic co-efficient	Zone-II as per IS- 1893 (Part-IV)

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1.2 SCOPE OF WORKS

The scope of work shall comprise but not limited to the following:
(All the works mentioned hereunder shall be carried out within the accepted rate unless otherwise specified.)

1.2.1 The scope of works all Civil (Balance works), architectural, Mechanical, Electrical, C&I, works of Natural Draught Cooling Towers, NDCT 1, NDCT 3 & NDCT 5 of 5X800 MW Yadadri Super Critical Thermal Power Project site including supply of materials for civil **(excluding Cement, Structural steel & Reinforcement steel for civil works)** Mechanical, Electrical & C&I works required, all labour, tools & plants.

1.2.2 BHEL shall provide cement & reinforcement steel for civil works and structural steel for structural works only for incorporation in the permanent works as free supply.

1.2.3 The subject tender consists of 3 packages – Package 1, 2 & 3 and the scope covered in each package is mentioned below.

Package 1: NDCT of Unit-1

Package 2: NDCT of Unit-3

Package 3: NDCT of unit-5

"Note: The NDCT contractor is required to own the owner approved thermal design and GA drawing such that the responsibility of cooling tower performance shall remain with the bidder in all manners. Any questions or clarifications regarding thermal design may be sought by the NDCT contractor to satisfy himself of its veracity. The tentative quantities for thermo- hydraulic components (Fills and distribution system) listed for S. nos. 24 and 25 of price bid as per BHEL's design indicated in Annexure-1 of section IA (page no. 61 of 454 of technical specification (book 1 of 2)) and the same is calculated based on the area inside the NDCT at respective levels shown in the GA drawing. If found necessary, "the NDCT contractor may suggest modifications to the thermos-hydraulic components (listed at S. Nos. 24 and 25 in the price bid) with technical reasoning/ analysis/ calculations to justify the measures to improve the thermal performance of the NDCT which will be guaranteed by the bidder" and such the responsibility of cooling tower performance shall remain with the bidder in all manners.

While suggesting justifiable reasons for changes as above the NDCT contractor shall abide by the **following** constraints. Also, the NDCT contractor shall guarantee the NDCT performance considering the constraints that are inviolable.

1) Civil design of NDCT shell, shell profile and shell dimensions at various heights
2) Foundation of NDCT
3) Air inlet height
4) Basin & internal structure column- beam grid dimensions and elevations
5) Water distribution ducts
6) Layout of CW hot water inlet header to cooling tower
7) Height and diameter of NDCT

Once the changes with justifiable reasons/ analyses / calculations provided by the NDCT contractor are accepted by BHEL/ consultant and duly incorporated, the NDCT contractor will vet the final thermal design & GA of NDCT and furnish the performance guarantee. The thermal **design** and GA vetted by the NDCT contractor shall be furnished to customer for approval. The NDCT contractor shall vet the thermal design as above within two weeks of award of contract, for further approval by BHEL/ customer.

The GA drawing already approved by owner may be required to be approved again depending on **changes** to the thermos-hydraulic components, if any and the NDCT contractor shall furnish the relevant modifications agreed to by BHEL/ customer to these items (only) keeping the other dimensions frozen for further approval from BHEL/ customer.

The complete design and engineering of NDCT shall remain in the scope of BHEL's consultant.

All mechanical/ electrical/ C&I drawings prepared by BHEL consultant will be reviewed by NDCT contractor before submission to customer for approval.

The NDCT contractor is required to estimate the "lump sum" cost of the thermo-hydraulic components. This lump sum rate towards the item no. 24 & 25 are firm and NDCT Contractor cannot claim any extra compensation in case of any increase or decrease of quantity against these two items.

No change in the quantities and cost of thermo- hydraulic components shall be allowed during execution due to any reason whatsoever from that quoted during tender stage.

NDCT Contractor who quotes as per BHEL thermal design, should submit the Guarantee Schedule in the Technical Specification with reference no. SPEC. NO.: PE-TS-417-165-N002, SECTION: III, REV.NO.0, SHEET 1 OF 1.

NDCT Contractor is allowed to Modify the thermo-hydraulic components as per Clause no. 1.01 of Section-I of Technical Specification & Clause 2.3 of Scope of works, Technical Conditions of Contract, only when the NDCT Contractor proposes for the improvement of the 'Guaranteed Cold water temperature'. If NDCT Contractor proposes to modify the Thermal Design, he should submit the Guarantee Schedule in the Technical Specification with reference no. SPEC. NO.: PE-TS-417-165-N002, SECTION: III, REV. NO. 01, SHEET 1 OF 1. Any calculation submitted by NDCT Contractor along with the offer supporting the reduction of cold water temperature will be treated as reference only. The NDCT Contractor shall submit the calculations to BHEL Engineering Department during detailed Engineering stage only for review and approval.

The calculations will be approved by Engineering department of BHEL during detailed Engineering and shall be binding on the NDCT Contractor.

In case, if BHEL is not satisfied with the calculation and NDCT Contractor has failed to support their calculation for the proposed guaranteed temperature, then the NDCT Contractor is bound to accept the BHEL's thermal calculations as per tender conditions.

If NDCT Contractor does not meet the Guaranteed Cold Water Temperature offered by the NDCT Contractor as per the SPEC. NO.: PE-TS-417-165-N002, SECTION: III, REV. NO. 00, SHEET 1 OF 1 (or) SPEC. NO.: PE-TS-417-165-N002, SECTION: III, REV. NO. 01, SHEET 1 OF 1, as applicable, then LD shall be levied as per Cl. No. 11 of Technical Specification.

It is not the intent to list all details herein, scope of supply listed in brief as follows:

I. MECHANICAL:

a. Incoming hot water piping, including vertical run, supported on cooling tower, motorized butterfly valves on hot water risers. Terminal point for hot water pipe shall be as per enclosed NDCT GA drawing. Welding at terminal point shall be in bidder's scope. Bidder shall also supply a pressure gauge & temperature gauge at the terminal point. Any reducer/ expander required at the terminal point shall also be in the bidder's scope.

b. Inlet louvers, tower fills & fill support, drift eliminators including all supporting structures fastening arrangements & accessories.

c. Screens along with guides embedded in concrete shall be provided at the outlet of cold water channel.

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

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

f. Knife-edge gate valve/ sluice valve in each de-sludge connection and also de-sludge piping up to the disposal point at local storm water drain channels.

g. Pipe spools to be embedded in sludge pit walls and terminated with flanged end at suitable distance from outer face of respective wall.

h. Water distribution system consisting of pipes, hangers & pipe supports & anchoring arrangement for all piping coming under the scope of supply.

i. Two (2) nos. (1+1) sludge pumps (submersible type) complete with electric motors, non-return valve, isolation valve, piping support, hangers etc. for cold-water basin drainage. The bidder shall terminate pump discharge pipe work at a distance of 100M from sludge pit.

j. Counter flange, bolts, nuts & gasket for all piping connections in the scope of bidders and also at terminals.

II. ELECTRICALS:

a. Complete electrical equipments as per specification/ details indicated in technical specification (Section – II B) shall be in bidder's scope.

b. The scope of power & control cables & special cables shall be as per Section II B (electrical).

c. Base plate, foundation plate, anchor bolts, sleeves, inserts in concrete work for electrical and mechanical equipment & accessories.

III. C & I

a. Removable type pitot tube at each hot water inlet- piping header to measure the flow (during performance guarantee test only). The pitot tube shall be left with customer after the completion of the test.

b. One number pressure gauge and one number temperature gauge at hot water pipe header at T.P.

c. One number psychrometer

d. Local control panel for sump/ sludge pumps (submersible type)

e. Level switches for sump/ tank level high/normal/low/very low interlocks

f. Actuator for motorized BFV at inlet of hot water pipes

IV. CIVIL:

a. Complete civil (balance) works includes excavation, shoring, dewatering, backfilling, concrete work including shuttering, sand filling, disposal of surplus soil outside plant boundary, formwork including automatic climb form (jump form), laser beam survey instruments, fabrication, galvanizing and erection of steel structures and inserts, finishing anchor bolts, RCC sump/ duct, laying and testing hot water pipe line, water proofing, providing PVC water stops and joint fillers, drainage and other ancillary items connected with cooling towers. All faces of concrete structures and steel

structures coming directly in contact with water shall be coated with corrosion resistant coating system as approved. The surfaces that would include are inner face of the hyperbolic shell, raker column faces, inner faces of cold water basin, fill support structures, hot water distribution ducts & channels, cold water channels, etc.

The scope of this work shall consist of, but not limited to, the construction of reinforced concrete double curvature hyperbolic shell, ring beams, foundations (including blasting/ piling (as applicable)), cold water basins with partition walls, hot water ducts, drain sumps, external drain chamber with associated piping work, cold water channel with sluice gate up to the terminal point as specified elsewhere, hoists and monorails, primary and secondary hot water distribution duct, fill support system including columns and beams, drift eliminators, testing of cold water basin for water tightness, external stairs. Sludge pit for each basin section, all other staircases/ ladders as required, doors and their frames, walkways, platforms, steel fitting, fixture, inserts including fabrication of, hand railing, providing protective measures in concrete and steel materials against effect of water and other chemicals on the completed structure, supply & application of painting at site, etc.

b. The civil construction of the cooling tower shall be in accordance with following technical specifications and the data specification sheets enclosed with this specification –

i. Earthwork in excavation and backfilling
ii. Cement concrete (plain & reinforced)
iii. Masonry and allied work
iv. Finish to masonry and concrete
v. Metal doors, windows, ventilators, louvers, etc.
vi. Roof water proofing, insulation and allied work (as applicable)
vii. Painting, white washing, polishing, etc. (as applicable)
viii. Sheet work in roof and siding (as applicable)

c. The technical specifications are of general nature. Only those portions of the specifications which relate to the various works required to be done as per technical requirements as specified in the tender document need to be considered.

d. The cooling tower shell, ring beams, diagonal columns at base supporting ring beams below shell, cold water basin, fill support frame work, hot water distribution duct, cold water channel, louver, etc. shall be cast in-situ RCC construction.

V. The following are also included in bidder's scope:

a. One set of special tools & tackles required for maintenance of equipment & accessories in the cooling towers.

b. Various drawings, datasheets, calculations, test reports/ certificates, operation & maintenance manuals including as built drawing etc. as specified & as necessary.

c. Supply of first fill of lubricants for all equipment under this package including second fill/ replenishments as necessary during & after commissioning till handing over of the plant.

d. Supply of commissioning spares as on when required basis.

e. Scope of services shall include but not limited to erection/ testing/ commissioning/ trial run/ performance testing & handing over of cooling towers. Transportation of equipment, material to site, local clearance, storage at site etc. & supply of all labour including supervision personnel, materials, erection tools & tackles etc. as necessary for expeditious execution of works etc. are also included in bidder's scope. It shall be the responsibility of the bidder to arrange all T & Ps required for execution of complete job including erection & civil works.

VI. Equipment & services to be provided by the purchaser:

a. Supply & erection of incoming hot water piping up to bidder's terminal point

b. Supply & erection of sludge discharge piping beyond the bidder's terminal point, as applicable

c. Cold water outlet channels for cooling tower beyond the bidder's terminal point.

d. For electrical, civil and C & I work refer section C2/ D2, C3 & C4 respectively enclosed herein.

Note: The above provided list is indicative only for the bidder's guideline. For further, detailed scope of work is mentioned in relevant clauses of technical specification. **Any other structure / foundation not mentioned above, but required for completion of the scope of work in total, deemed to have been included in the bidder scope under this contract.** Such work will be executed under this contract by bidder as per the direction of Engineer in charge. If any item of work not available in the rate schedule of this contract, the rate will be fixed in line with clause 2.15.7 of GCC.

Cement & Reinforcement steel for civil works, Structural steel for structural works shall be provided by BHEL free of cost for incorporating them to the permanent works only.

1.2.4 The works to be performed under this contract consist of providing all labour, supervision, material, scaffolding, construction equipment's, tools and plants, temporary works, supplies including POL (petroleum, oil, lubricants, etc.), transportation and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of work in all respects. Testing of all materials, concrete, earthwork other allied works, preparation of bar bending schedules on the basis of construction drawings, preparation of fabrication drawings etc. are included on the rates of items of work. Works shall only be carried out with approved structural fabrication drawings.

1.2.5 The area of work shall be cleared of all vegetation, rubbish and other objectionable Matter and materials removed shall be burnt or otherwise disposed of as directed by The Engineer-in-Charge. No separate payment for these operations shall be

made. The cost of all these operations shall be deemed to have been included in the unit rates rendered for the different items under bill of quantities.

1.2.6 All the works areas shall be adequately flood lighted to the satisfaction of the Engineer-in-Charge when the work is in progress during the night shifts.

1.2.7 The unit rates shall include all material equipment, fixtures, labour construction plant, temporary works and everything whether of permanent or temporary nature necessary for the completion of job in all respects.

1.2.8 The unit rates for various items shall include all the stipulations mentioned in technical specifications for the particular BOQ item and nothing extra over B.O.Q rates shall be payable.

1.2.9 Drawings showing enough details for the construction as per the specification shall be furnished to the contractor in a phased manner.

1.2.10 The bidder should fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, local conditions, soil strata and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may have not been specifically brought out in the specifications.

1.2.11 Land for labour colony shall be provided by BHEL approximately nearer to site. The contractor to construct labour colony/ hutment as per the technical specification No.PSSR-PMX-CVL LABCOL/02, Rev-01 enclosed along with this tender. The contractor shall provide adequate water arrangement for drinking/washing/bathing with required toilets, drainage system, and electrification etc. in labour colony. Suitable paved area to be provided in the labour colony.

1.2.12 Special arrangements to be made for tackling pandemic – Contractor shall make arrangements for stay of workers within their premises as far as possible and/ or adjacent building and for implementation of STANDARD OPERATING PROTOCOL (SOP) as per government order. The transportation of workers to work place shall be arranged by the contractor in dedicated transport by ensuring social distance. Any person violating the pandemic measures published vide government order time to time will be liable to be proceeded for legal action as per the government order. Following shall be observed in work place:

1.2.12.1 All work places shall have adequate arrangements for temperature screening and provide sanitizers at convenient places.

1.2.12.2 Work places shall have a gap of one hour between shifts and will stagger the lunch breaks of staff, to ensure social distancing.

1.2.12.3 Use of AROGYA SETU will be encouraged for all employees both private and public.

1.2.12.4 Contractor shall sanitize their work place between shifts.

1.2.12.5 Large meetings to be prohibited. Spitting shall be strictly prohibited. Wearing of face cover is compulsory.

1.2.12.6 Government order (state/ center) being issued time to time for protective measures of pandemic shall be complied with strictly until government (state/ center) declares end of pandemic.

1.2.12.7 **Standard operating procedure for social distancing for workplace and offices**

The following measures shall be implemented by contractor for their office and workplaces:

1. All areas in the work premises including the following shall be disinfected completely using user friendly disinfectant mediums:
    a. Entrance gate of work place, office, if any
    b. Cafeteria and canteens, if any
    c. Meeting room, conference halls/ open area available/ verandah/ entrance gate of site, bunkers, porta cabins, buildings, etc.
    d. Equipments and lifts
    e. Washroom, toilet, sink, water points, etc.
    f. Wall/ all other surfaces
2. For workers coming from outside, special transportation facility shall be arranged without any dependency on the public transport system. These vehicles should be allowed to work only with 30-40% passenger capacity.
3. All vehicles and machinery entering the premise should be disinfected by spray mandatorily.
4. Mandatory thermal scanning of everyone entering and exiting the work place to be done.
5. Medical insurance for the workers to be made mandatory.
6. Provision for hand wash & sanitizer preferably with touch free mechanism shall be made at all entry and exit points and common areas. Sufficient quantities of all the items should be available.

7. Work places shall have a gap of one hour between shifts and will stagger the lunch breaks of staff, to ensure social distancing.
8. Large gatherings or meetings of 10 or more people to discouraged. Seating at least 6 feet away from others on job sites and in gatherings, meetings and training sessions.
9. Not more than 2/4 persons (depending on size) will be allowed to travel in lifts or hoists.
10. Use of staircase for climbing should be encourages.
11. There should be strict ban of gutka, tobacco, etc. and spitting should be strictly prohibited.
12. There should be total ban on non-essential visitors at sites.
13. Hospitals/ clinics in the nearby areas, which are authorized to treat pandemic patients, should be identified and list should be available at work place all the times.

FOR FURTHER DETAILED SCOPE OF WORKS REFER RELEVANT CHAPTERS IN THIS BOOK.

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1.3 FACILITIES & CONSUMABLES IN THE SCOPE OF CONTRACTOR / BHEL

(SCOPE MATRIX)

Sl.No	Description 1.3.1 PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.1.0	**ESTABLISHMENT**			
1.3.1.1.1	FOR CONSTRUCTION PURPOSE:			
A	Open space for office	Yes		
B	Open space for storage	Yes		
C	Construction of bidder's office, canteen and storage building including supply of materials and other services		Yes	
D	Bidder's all office equipment's, office / store / canteen consumables		Yes	
E	Canteen facilities for the bidder's staff, supervisors and engineers etc.		Yes	
F	Firefighting equipment's like buckets, extinguishers etc.		Yes	
G	Fencing of storage area, office, canteen etc. of the bidder		Yes	
1.3.1.1.2	FOR LIVING PURPOSES OF THE BIDDER			
A	Open space		Yes	
B	Living accommodation		Yes	
1.**3.1.2.0**	**ELECTRICITY**			
1.3.1.2.1	Electricity For construction purposes			Free of charges as provided by TSGENCO
1.3.1.2.1.1	Single point source	Yes		
1.3.1.2.1.2	Further distribution for the work to be done which include supply of materials and execution		Yes	
1.3.1.2.2	Electricity for the office, stores, canteen etc of the bidder which include:		Yes	

Sl.No	Description 1.3.1 PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.2.2.1	Distribution from single point including supply of materials and service		Yes	
1.3.1.2.2.2	Supply, installation and connection of material of energy meter including operation and maintenance		Yes	
1.3.1.2.2.3	Duties and deposits including statutory clearances for the above		Yes	
1.3.1.2.2.4	Living facilities for office use including charges		Yes	
1.3.1.2.2.5	Demobilization of the facilities after completion of works		Yes	
1.3.1.2.3	Electricity for living accommodation of the bidder's staff, engineers, supervisors etc on the above lines.(in case BHEL provides this facility, the scope should be given without ambiguity)		Yes	
1.**3.1.3.0**	**WATER SUPPLY**			
1.3.1.3.1	For construction purposes:	**Yes**		Free of charges as provided by TSGENCO
1.3.1.3.1.1	Making the water available at single point	**Yes**		
1.3.1.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	
1.3.1.3.2	Water supply for bidder's office, stores, canteen etc.			
1.3.1.3.2.1	Making the water available at single point		Yes	
1.3.1.3.2.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	
1.**3.1.4.0**	**LIGHTING**			

Sl.No	Description **1.3.1 PART I**	Scope to be taken care by		Remarks
		BHEL	**Bidder**	
1.3.1.4.1	For construction work (supply of all the necessary materials) At office storage area At the preassembly area At the construction site / area		Yes	
1.3.1.4.2	For construction work (Execution of the lighting work / arrangements) At office storage area At the preassembly area At the construction site /area		Yes	
1.**3.1.5.0**	**COMMUNICATION FACILITIES for site operations of the bidder**	**-**		
1.3.1.5.1	Telephone, Fax, internet, intranet, email etc		Yes	

Sl.No	Description **1.3.2 PART II**	Scope to be taken care by		Remarks
		BHEL	**Bidder**	
	CONSTRUCTION FACILITIES			
1.**3.2.1.0**	**Engineering works for construction**			
1.3.2.1.1	Providing the construction drawings for all the equipment covered under this scope	Yes		
1.3.2.1.2	Drawings for construction methods		Yes	In consultation with BHEL
1.3.2.1.3	As-built drawings – wherever deviations observed and executed and also based on the decisions taken at site- example – routing of small bore pipes	Yes	Yes	”
1.3.2.1.4	Shipping lists etc for reference and planning the activities	Yes	Yes	”
1.3.2.1.5	Preparation of site construction schedules and other input requirements		Yes	In consultation

Sl.No	Description 1.3.2 PART II	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.2.1.6	Review of performance (Form-14) and revision of site construction schedules in order to achieve the end dates and other commitments		Yes	with BHEL, As per requirement of BHEL targets
1.3.2.1.7	Weekly construction schedules based on Sl No 1.3.2.1.5		Yes	
1.3.2.1.8	Daily construction / work plan based on Sl No 1.3. 2.1.7		Yes	For daily monitoring meeting at site
1.3.2.1.9	Periodic visit of the senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of the bidder should be done once in every two months.		Yes	
1.3.2.1.10	Preparation of preassembly bay		Yes	
1.3.2.1.11	Laying of racks for gantry crane if provided by BHEL or brought by the contractor / bidder himself			**Not applicable**

1.3.3 OPEN SPACE:

Availability of land within plant boundary is very limited and the contractor has to plan and use the existing land considering the use of land by other Civil /mechanical/ electrical contractors and the storage of plant machineries and materials. The existing land shall be shared by all erections agencies. Land will be allocated with certain time frame and to the extent available/ considered necessary, and will be reviewed by BHEL depending upon the area availability. Area within plant premises for fabrication, batching plant, office, storage area etc. for construction purpose shall be provided as per availability free of cost. The contractor will be responsible for handing back all lands, as handed over to him by BHEL.

1.3.4 ELECTRICITY**:**

1.3.4.1 Construction power will be provided to the contractor at one single point within the plant area by BHEL on free of cost basis as per provided by TSGENCO. The contractor to

Provide necessary meter for measuring the power consumption. The contractor shall make his own arrangement for further distribution with necessary isolator/LCB etc.

1.3.4.2 Necessary "Capacitor Banks" to improve the Power factor to a minimum of 0.9 shall be provided by the contractor at his cost. Penalty if any levied by customer on this account will be recovered from contractor's bills.

1.3.4.3 Any duty, deposit involved in getting the Electricity shall be borne by the bidder. As regards contractor's office shed also all such expenditure shall be borne by the contractor.

1.3.4.4 Provision for distribution of electrical power from the given single central common point to the required places with proper distribution boards, approved cables and cable laying including supply of all materials like cables, switch boards, pipes etc., observing the safety rules laid down by electrical authority of the State / BHEL / their customer with appropriate statutory requirements shall be the responsibility of the tenderer / contractor.

1.3.4.5 BHEL is not responsible for any loss or damage to the contractor's equipment as a result of variations in voltage / frequency or interruptions in power supply.

1.3.4.6 Contractor has to make their own arrangements for electricity requirement for labour colony at their cost.

1.3.4.7 As there are bound to be interruptions in regular power supply, power cut/ load shedding in any construction sites, contractor should make his own arrangement for alternative source of power supply through deployment of adequate number of DG sets at their cost during the power breakdown / failure to get urgent and important work to go on without interruptions. No separate payment shall be made for this contingency.

1.3.5 WATER:

1.3.5.1 Construction Water at single point will be provided by BHEL as provided by TSGENCO and further distribution is in the scope of bidder. The required pumps & accessories, pipes for drawing water from the given point and further distribution will be arranged by the contractor at their cost to go on without interruptions.

1.3.5.2 In case of non-availability of water, the contractor shall make his own arrangements of water suitable for construction purpose to have un-interrupted work. No separate payment shall be made for any contingency arrangement made by contractor, due to delay/ failure for providing water supply.

1.3.6 MATERIAL SUPPLY:

Supply / providing aggregate, river sand and all other materials required for the work are in the scope of the contractor. **BHEL shall provide cement & reinforcement steel for civil works, structural steel for fabrication works only for incorporation in the permanent work AS FREE SUPPLY.**

- Regarding supply of cement, the cement shall be provided normally in bulkers and shall be unloaded in the silos (2 Nos minimum 100MT each per 30 Cum batching plant and 3 nos minimum 100MT each per 60 Cum batching plant) to be installed by the bidder nearer to their batching plants. This is only minimum requirement and the No. of cement silos shall be increased based on the site requirement. On advance request of the bidder, the cement shall be supplied in Bags for other than RCC works like masonry, flooring works etc. Advance request for supply of cement in bags shall be minimum two months.
- The steel material will be issued from BHEL stores, within the plant premises. Collection and transporting to the place of work is in contractor's scope without any extra cost to BHEL. The steel will be issued to the agency in standard lengths. In some instances, for 8mm, 10mm &12mm dia. reinforcement steel will be supplied in coil form. No extra claims will be entertained against issue of Non-standard lengths of steel and de coiling of 8mm, 10mm &12mm dia. steel.
- Bidder to note that steel materials required for Embedment's, inserts, MS Grating, Galvanized Grating, GI Handrail, Stainless Steel Handrail, SS Sheets for Bunker liner, Stop Lock Gate, Stationery Screen, fasteners like MS/HT/HSFG bolts/nuts, lock nuts, washers and foundation bolts other than those supplied by BHEL, shall be supplied by the bidder. However, Bidder shall use the scrap materials available with BHEL or with the respective bidders, for their use in the permanent works as embedment/inserts etc. after necessary store issue formalities, if taken from BHEL and shall be accounted for monthly reconciliation, if it belongs to the bidder's scrap materials.
- If any matching sections of steel are not available with BHEL, contractor may arrange these sections on certification of BHEL and the landing cost of sections to site will be reimbursed based on the prevailing rate at SAIL at the time of procurement at the nearest SAIL outlet with the freight charges against supporting document.

1.3.6.1 Aggregates:

Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious materials. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to alkali silicate reaction in a laboratory approved by the engineer in-charge.

- Coarse aggregate

Aggregate of sizes ranging between 4.75mm and 150m will be termed as coarse aggregate. Only coarse aggregate from approved quarries and conforming to IS:383 will be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary.

The grading of coarse aggregates by sieve analysis shall be as per IS:383.

- Fine aggregate

  Aggregate smaller than 4.75mm and within the grading limits and other requirements set in IS:383 will be termed as fine aggregate or sand. Only fine aggregate from approved sources and conforming to the above IS specification will be allowed to be used on works.

  In certain cases there may be two types of sand, one very fine sand and the other very coarse. In such cases, the two types shall be combined to meet the requirements of a particular zone of IS:383. In most cases, the preferred zone is Zone-II. Bidder shall supply/ provide only river sand for this scope of work.

1.3.7 CONSUMABLE

All consumables, like gas, electrodes, chemicals, lubricants etc. required for the scope of work, shall be arranged by the contractor at his cost unless otherwise specifically mentioned in the contract. In the event of failure of contractor to bring necessary and sufficient consumables, BHEL may arrange for the same at the risk and cost of the contractor. The entire cost towards this along-with overhead shall be paid by the contractor or deducted from the contractor's bills.

1.3.8 LIGHTING FACILITY:

Adequate lighting facilities such as flood lamps, hand lamps and area lighting shall be arranged by the contractor at the site of construction, and contractor's material storage area etc. at his cost.

1.3.9 CONTRACTOR'S OBLIGATION ON COMPLETION:

On completion of work, all the temporary buildings, structures, pipe lines, cables etc. shall be dismantled and leveled and debris shall be removed as per instructions of BHEL by the contractor at his cost. In the event of his failure to do so, the expenditure towards clearance of the same will be recovered from the contractor. The decision of BHEL Engineer in this regard is final.

1.3.10 Blasting

Bidder should produce documentary evidence of valid blasting license for Telangana State (or) should produce documents for having tie-up with agency who is possessing valid blasting license for Telangana state within 30 days from issue of LOI.

For details on blasting refer enclosed bill of quantity (rate schedule) & volume-IA Part-II General technical specification.

1.3.11 DEWATERING

Contractor shall ensure at all times that his work area & approach/ access roads are free from accumulation of water, so that the materials are safe and the erection/ progress schedule are not affected. No separate claim in this regard shall be admitted by BHEL. No separate payments for dewatering of subsoil, surface water or catchments water, if required, at any time during execution of the work including monsoon period shall be considered by BHEL.

1.3.12 BID DRAWINGS

Plot plan drawing enclosed is only tentative & for information purpose and this may get revised during execution.

VOLUME-IA PART-I CHAPTER – IV

1.4 T&Ps TO BE DEPLOYED BY CONTRACTOR

1.4.1 All the tools and plants required for satisfactory completion of the work have to be arranged by the contractor.

1.4.2 The contractor is required to arrange the following suggestive minimum Major T&Ps and minimum other T&Ps for the satisfactory completion of the work.

FOR EACH PACKAGE

Sr No	**Description of Tools & Plants**	**Mobilizing time from the date of start of work**
	Major T&P	
B1	1 No. Poclain CK90 excavator	1 no. within 20 days, depending up on the requirement.
B2.1	1 no. automatic concrete batching plant with printing facility (60 Cum/Hr) – and DG backup. With minimum 2 Nos of silo (100MT each) per batching plant.	1 no to be commissioned Within 30 days,
B 2.2	1 no. automatic concrete batching plant with printing facility (30 Cum/Hr) – and DG backup. With minimum 2 Nos of silo (100MT each) per batching plant.	1 no to be commissioned Within 60 days,
B3	Suitable capacity tyre mounted crane – 1 no.	As per requirement at site
B4	Tower crane of suitable capacity for height of approx. 200m and bottom radius 75m along with operator and necessary spares – 1 no.	Within 30days from commencement of work at site
B4A	Scissor lift of suitable capacity for erection of fill structures.	As per requirement at site

Sr No	**Description of Tools & Plants**	**Mobilizing time from the date of start of work**
	Major T&P	
B5	Jump form for shell concreting along with all accessories e.g. required no. of jacks (including spare jacks), power packs, ropes, safety accessories, etc. all complete required for smooth operation of jump form – 1 set.	As per requirement at site
B6	Suitable passenger lift cabin for carrying (min 8 passengers) along with all accessories – 1no.	To be arranged at site before commencement of work of shell
B7	1 nos. Concrete Boom Placer of 36m boom length (as applicable) additional 1 concrete pump as stand by (60 cum/ hr min capacity & lift 90M)/.	Boom placer 1 No within 15 days/ Concrete pump as per requirement.
B8	5 no. transit mixer (5/6 M3 capacity) with standby 1 no.	3 no within 15 days. Balance as per site requirement.

Sr No	**Other T&Ps**	**Mobilizing time from the date of start of work**
B9	1 No. JCB	As per site requirement.
B10	2 nos. dumper (Min 15 cum each)	As per site requirement.
B11	1 nos. diesel Mixer machine of 0.5 cum capacity	As per requirement at site
B12	1 nos. self-priming dewatering pump 5 HP (diesel)	Within 20 days.

Sr No	**Other T&Ps**	**Mobilizing time from the date of start of work**
B13	2 nos. self-priming dewatering pump 10 HP (electric)	Within 10 days
B14	3 nos. curing pump – 1.5 /2 HP (pump for curing at heights)	1 no. within 20 days 2 nos within 45 days.
B15	3 nos. reinforcement bending machine	As per site requirement.
B16	1 no. Vibromax (earth compactor)	As per site requirement.
B17	2 nos. reinforcement cutting machine	As per site requirement.
B18	Welding rectifiers – 2nos for piping erection	As per requirement at site
B19	8 sets of raker column steel shuttering	As per requirement at site
B20	MS scaffolding pipe / ACROW SPAN	As per requirement at site
B21	Welding machine (submerged arc) – 2 nos	As per requirement at site
B22	1 nos. power driven earth rammer (Roller Type 1/2 T)	As per requirement at site
B23	Civil laboratory equipment's as per list in Sl 1.4.6 with temporary building one AC lab size 4.5mtrx6mtr and 1 non AC lab 4.5 mtrx4.5 mtr.	Within 30 days.
B24	Optical/laser plumb – 3 nos	Before start of shell concreting
B25	2 no total station with adequate arrangement for Surveyors.	1 no. Within 15 days. and balance progressively as per requirement

Sr No	**Other T&Ps**	**Mobilizing time from the date of start of work**
B26	2 no theodolite 1 second accuracy	1 no. within 15 days. and balance progressively as per requirement
B27	3 no's auto level & staff + 2 no's as required	2 nos. Within 15 days. And balance as per requirement.
B28	100 no's concrete cube moulds	50 nos within 30 days and balance progressively as per requirement
B29	Adequate no. of small trucks 2T/5T for shifting of reinforcement/cement/shuttering etc. within site	As per requirement at site
B30	1 nos. drinking water tank – 5000 lit.	As per requirement at site
B31	2 nos. mobile toilet blocks for labour use.	As per requirement at site
B32	1 nos. truck mounted 125 KVA DG set	As per requirement at site
B33	Construction power cable	As per requirement at site
B34	Construction water Pipeline	As per requirement at site
B35	1 nos ultra-sonography testing machine	As per requirement at site
B36	Concrete vibrator with adequate needle (Minimum 10 nos diesel/electric)	6Nos (at least 3nos. diesel driven) within 45 Days. Balance as per site requirement.
B37	Portable fire extinguishers as below: Soda acid – 10 sets. Dry chemical powder – 10 sets CO2 – 10 sets. Water & sand bucket (4 buckets in one	25% within 30 days and balance progressively within 90 days.

Sr No	**Other T&Ps**	**Mobilizing time from the date of start of work**
	stand) – 10 sets. Fire hose with nozzle (50 M length) – 5 sets.	
B38	1 no. compression testing machine (200 T cap)	1 Nos. within 30 days
B39	2 Nos. Multi stage high lift water pump (for curing) (lifting height 210 metres). One shall be working and other shall be stand by.	Before of start of NDCT shell
B40	Power winch -2.5 T – 1 nos. for Internal / External Finishing as applicable	As per requirement at site
B41	Walky Talky – 3 Nos	As per requirement at site

Note:

1. T&P shown in the above mentioned list and the mobilization schedule is tentative requirement considering parallel working. However, mobilization schedule modification as well as no. of T&Ps as mutually agreed at site for major T&Ps, have to be adhered to. Numbers/ time of requirement will be reviewed time to time at site and contractor will provide required T&P/ equipment's to ensure completion of entire work within schedule/target date of completion without any additional financial implication to BHEL. Vendor shall give advance intimation & certification regarding capacity etc. prior to dispatch of heavy equipment's. Also on completion of the respective activity, demobilization of T&P in total or in part can be done with the due approval of engineer in charge. Retaining of the T&P's during the contract period will be mutually agreed in line with construction requirement.
2. All T&P and all IMTEs, which are required for successful and timely execution of the work covered within the scope of this tender, shall be arranged and provided by the contractor at his own cost in working condition.

3.In the event of contractor failing to arrange the required tools, plants, machineries, equipment, material or non-availability of the same owing to breakdown, BHEL will make alternative arrangement at the risk and cost of the contractor.

Case 1: BHEL provides its own Capital T&P.

In case the BHEL provides any T&P which is owned by BHEL, hire charges (as per BHEL norms) will be recovered from the contractor as per the prevailing BHEL corporate hire charges. In case, the T&P is specifically listed in "T&Ps to be deployed by Contractor", "Hire charges applicable to outside agencies other than contractors working for BHEL" will apply. If not listed, "hire charges applicable to contractor working for BHEL" will apply. The hire charges of Capital tools & plants are exclusive of operating expenses e.g. operator, fuel & consumables and the same shall be arranged by the contractor at his cost.

Case 2: In all cases other than that specified in case 1 above, actual expenses incurred by BHEL along with applicable overheads will be back-charges to the contractor.

4. In the event of need of change of type of any of major T&Ps, approval shall be taken from BHEL Engineer in-charge prior to mobilization. The decision of Number of T&P required due to replacing the enlisted T&P as per above table, shall be taken after analyzing the production capacity and suitability of both the T&Ps.

5. Clause no. 1.6.1 of this specification may please be referred for date of start of work.

1.4.3 In addition to the above, any other tools and plants required for execution of the above work are in contractor's scope.

1.4.4 The Bidder shall establish laboratory arrangements or get the materials tested through approved national accredited laboratory and submit the reports for approval of BHEL/ Customer

1.4.5 The laboratory must have qualified technicians to carry out all tests and must be adequately equipped to ensure that all necessary testing work can carried out in compliance with the standards.

1.4.6 Field and laboratory testing procedures for materials follow Indian standard specifications with necessary equipment's like as given in table below:

CONCRETE TESTING EQUIPMENT

SL NO	NAME OF TEST	NAME OF EQUIPMENT	SIZE OF EQIPMENT	IS REF.
1	Initial & final setting time, Consistency of cement	Vicat Apparatus with desk pot	Standard	IS 5513

2	Shrinkage of cement, Auto Clave Test	Le Chatelier's appratus Auto Clave Equipment	Standard	IS 5514
3	Abrasion value test	Los Angles Abrasion testing machine	Standard	IS 2386
4	Aggregate Impact value test	Aggregate Impact value testing machine with blow counter	Standard	IS 9377
5	Aggregate crushing value test	Crushing value apparatus	Standard	IS 2386
6	Flakiness index	Thickness gauge for measuring flakiness index	Standard	IS 2386
7	Elongation Index	Elongation guage	Standard	IS 2386
8	Bulk density, voids and bulking apparatus	Measuring cylinders	3, 5,10 & 15 liters cylinders	
9	Workability of concrete	Slump cone	Standard, at least 04 no's	IS 456
10	Specific gravity of aggregates	Pycnometer	Standard, at least 02 no's	IS 383
11	Cement mortar cube vibrating	Motorised vibration machine for cement testing	Standard	IS 4031
12	Course aggregate Sieve analysis (Concrete & Road Works)	Sieve set	450mm dia GI Frames Size: 125 mm, 90 mm, 75 mm, 63 mm, 53 mm, 40 mm, 20 mm, 16 mm, 12.5 mm, 10 mm, 4.75 mm, Pan and cover	IS 383

13	Fine aggregate sieve analysis	Sieve set	200 mm dia Brass sieves; Size 4.75 mm, 2.36 mm, 1.18 mm 600 micron, 300 micron, 150 micron, 75 micron, 75 micron, Pan and cover	IS 383
14	Sieve Shaker	Motorized Sieve shaker	Mfg. Catalogue	
15	Silt content check	Sand silt content beaker	Standard	

1.4.7 Contractor shall have at all times experienced operators and technicians for routine and breakdown maintenance of the equipment. Any delay in rectification of defects will warrant BHEL rectifying the defect and charging the cost to the contractor.

1.4.8 The area and infrastructure development of the work area are to be carried out by the customer. However, in construction projects of this magnitude all the areas / approaches might not be ready. In such cases consolidation of ground and arrangement of sleepers / sand bag filling etc for safe operation / movement of equipment including cranes / trailers etc shall be the responsibility of the contractor at his cost. No compensation on this account shall be payable.

1.4.9 In case the contractor fails to provide any T&P which is in the scope of contractor and if BHEL provides such T&P available with BHEL, hire charges prevailing (as per BHEL norms) as on that day will be recovered from the contractor as per the prevailing BHEL Corporate Crane hire charges (may vary from time to time). Corresponding pages of Corporate Crane hire charges are enclosed in Part II of Technical Conditions of Contract (Volume-I Book-I). This may get revised further as per the BHEL corporate guidelines. However, prevailing rates as on date of execution may be applicable

1.4.10 Crane operators deployed by the contractor shall be tested by BHEL before they are allowed to operate the cranes.

1.4.11 In case, cement is issued through bulkers being supplied from manufacturer /stockiest, the same shall be emptied in cement silos of batching plant and necessary assistance shall be provided by contractor. Contractor to note that batching plant being established at site shall have cement silos of 100 MT capacities each as mentioned in clause 1.4.2.B- list of Tools & Plants to be deployed by the contractor.

VOLUME-IA PART-I CHAPTER – V

1.5 T&Ps provided by BHEL

1.5.1 BHEL will not provide any T & Ps for this scope of work

1.5.2 All the tools and plants required for execution of the above work are in contractor's scope.

1.5.3 In case if the contractor fails to provide T&P and other equipment's, BHEL will arrange for the same and the cost will be recovered from the contractor's bill with BHEL overheads, as applicable from time to time which may vary during contract period

VOLUME-IA PART-I CHAPTER – VI

1.6 TIME SCHEDULE

1.6.1 TIME SCHEDULE

1.6.1.1 The commencement of work at site shall be mutually agreed date between bidder and BHEL to start the work.

1.6.1.2 The entire works of the cooling towers including green belt area (as applicable) as detailed in the Tender Specification shall be completed as per below schedule against each package from the date of commencement of work for respective packages.

1.6.1.2.1 **Package-1**

1.6.1.2.1.1 Readiness of NDCT-1 for unit synchronization: 15 months

1.6.1.2.1.2 Final bill & contract closure: 22 months

1.6.1.2.2 **Package-2**

1.6.1.2.2.1 Readiness of NDCT-3 for unit synchronization: 17 months

1.6.1.2.2.2 Final bill & contract closure: 24 months

1.6.1.2.3 **Package**-3

1.6.1.2.3.1 Readiness of NDCT-5 for unit synchronization: 20 months

1.6.1.2.3.2 Final bill & contract closure: 25 months

1.6.1.3 During the total period of contract, the contractor has to carry out the activities in a phased manner as required by BHEL and the program of milestone events.

1.6.1.4 The contractor is required to refer Form 15 in Volume 1- BOOK 2 for all the instructions to be taken immediately after receipt of LOI.

1.6.2 MOBILISATION

The Contractor has to subsequently augment his resources in such a manner to achieve the COMPLETION SCHEDULES:

The above time allowed for completion of work including Sundays and Holidays is from the date of commencement of work. Detailed program to be prepared by the tenderer taking in to consideration of the COMPLETION SCHEDULES /site decision on drawings flow (latest) and submitted for BHEL's approval.

1.6.3 In order to meet above schedule in general, and any other intermediate targets set, to meet customer / project schedule requirements, contractor shall arrange & augment all necessary resources from time to time on the instructions of BHEL.

1.6.4 In case the project is to be advanced, the civil works in the scope of the contractor is to be advanced to meet the project requirement. No extra payment whatsoever shall be paid on this account.

1.6.5 SUBMISSION OF L3 SCHEDULE

The contractor shall submit and a detailed area/structure wise L3 schedule within 7 days in consultation with BHEL based on the tentative schedule provided as per the clause 1.6.7. The detailed L3 schedule shall be approved by BHEL and same shall be implemented. Bidder shall submit L3 schedule in MS Projects to meet the agreed project schedule covering various mile stone activities and their split up details such as construction, procurement of materials, fabrication & erection activities. This schedule shall also clearly indicate the interface facilities/ inputs to be shall commence from the date of completion of the whole of the work in each package, certified by the Engineer.

1.6.6 GUARANTEE PERIOD

The Guarantee period shall be as mentioned below:

As stipulated in General conditions of contract (clause no. 2.24 “PERFORMANCE GUARANTEE FOR WORKMANSHIP”)

or

18 calendar months from the date of completion of supplies

or

12 calendar months from the date of satisfactory commissioning of the package, whichever is later.

1.6.6.1 Seller/ contractor’s liability in respect of any complaints, defects and claims shall not be limited to supply and installation of replaced parts free of charge, or repair of defective parts to the extent that such replacements are attributable to or arise from faulty workmanship, material or design, in the manufacture, of the stores but at the option of purchaser, to the payment of the value, expenditure and damages as mentioned hereafter, provided defects on being discovered are brought to the notice of the seller/ contractor within a period of three (3) months from the date of expiry of the guarantee period as per the specification.

1.6.7 CIVIL WORKS SCHEDULE FOR NDCT-3 & NDCT-5, at 5X800MW YADADRI POWER PROJECT

The schedule for civil works is as given below.

PACKAGE 1 – NDCT 1

Sl. No	Area of work	Completion from the date of commencement of civil work
1	Initial site mobilization	Within 15 days
2	Tower crane erection	Progressively by 2nd Month
3	Basin floor	Progressively by 3rd month
4	Basin wall & pedestals	Progressively by 4th month
5	Completion of Raker column	Progressively by 5th month
6	Grillage structure	Progressively by 9th month
7	Completion of precast beams	Progressively by 9th month
8	RCC for Cold water channel	Progressively by 12th month
9	RCC hot water duct	Progressively by 12th month
10	RCC shell	Progressively up to 13th month
11	Completion of fills	Progressively by 14th month
12	Completion of hot water inlet pipes	Progressively by 14th month
13	All electrical works, staircase, internal painting, cage ladder erection	Progressively by 15th month
14	Readiness for unit sync (readiness of half basin)	Progressively by 15th month
15	Readiness of complete cooling tower including inspection, testing	Progressively by 20th months
16	Entire finishing and handing over, final bill & reconciliation	Progressively by 22nd month
17	PG test	As per BHEL readiness and instruction

PACKAGE 2 – NDCT 3

Sl. No	Area of work	Completion from the date of commencement of civil work
1	Initial site mobilization	Within 1 Month
2	Tower crane erection	Progressively by 2nd Month

Sl. No	Area of work	Completion from the date of commencement of civil work
3	Basin floor	Progressively by 3rd month
4	Basin wall & pedestals	Progressively by 4th month
5	Completion of Raker column	Progressively by 5th month
6	Grillage structure	Progressively by 10th month
7	Completion of precast beams	Progressively by 10th month
8	RCC for Cold water channel	Progressively by 13th month
9	RCC hot water duct	Progressively by 13th month
10	RCC shell	Progressively upto 14th month
11	Completion of fills	Progressively by 15th month
12	Completion of hot water inlet pipes	Progressively by 15th month
13	All electrical works, staircase, internal painting, cage ladder erection	Progressively by 16th month
14	Readiness for unit sync (readiness of half basin)	Progressively by 17th month
15	Readiness of complete cooling tower including inspection, testing	Progressively by 22nd months
16	Entire finishing and handing over, final bill & reconciliation	Progressively by 24th month
17	PG test	As per BHEL readiness and instruction

PACKAGE 3 – NDCT 5

Sl. No	Area of work	Completion from the date of commencement of civil work
1	Initial site mobilization	Within 1 Month
2	Tower crane erection	Progressively by 2nd Month
3	Basin floor	Progressively by 3rd month
4	Basin wall & pedestals	Progressively by 4th month
5	Completion of Raker column	Progressively by 5th month
6	Grillage structure	Progressively by 10th month
7	Completion of precast beams	Progressively by 10th month
8	RCC for Cold water channel	Progressively by 14th month
9	RCC hot water duct	Progressively by 14th month
10	RCC shell	Progressively up to 15th month
11	Completion of fills	Progressively by 17th month

Sl. No	Area of work	Completion from the date of commencement of civil work
12	Completion of hot water inlet pipes	Progressively by 16th month
13	All electrical works, staircase, internal painting, cage ladder erection	Progressively by 18th month
14	Readiness for unit sync (readiness of half basin)	Progressively by 20nd month
15	Readiness of complete cooling tower including inspection, testing	Progressively by 24th months
16	Entire finishing and handing over, final bill & reconciliation	Progressively by 25th month
17	PG test	As per BHEL readiness and instruction

1.6.8 Intermediate Milestones for Penalty is as follows.

S No	Description	Completion month from the contractual date of start of the work	Intermediate Milestone
Package-1 - NDCT 1 of Unit 1			
1	Completion of Raker column	5th Month	M1
2	Completion of RCC shell	13th month	M2
Package-2 - NDCT 3 of Unit 3			
1	Completion of Raker column	5th Month	M1
2	Completion of RCC shell	14th month	M2
Package-3 - NDCT 5 of Unit 5			
1	Completion of Raker column	5th Month	M1
2	Completion of RCC shell	15th month	M2

1.6.8.1 M1 and M2 shall be intermediate milestones for this work. Incase delay in achieving M1 milestone the penalty shall be levied on the bidder. Incase delay in achieving each M1 milestone is solely attributable to the contractor, 0.5% per week of executable contract value limited to Maximum 2% of executable contract value will be withheld. Incase delay in achieving each M2 milestone is solely attributable to the contractor, 0.5% per week of executable contract value** limited to Maximum 3.0% of executable contract value will be withheld.

1.6.8.2 Amount already withheld, if any, against slippage of M1 milestone, shall be released only if there is no delay attributable to contractor in achievement of M2 milestone.

1.6.8.3 Amount required to be withheld on account of slippage of identified intermediate milestone shall be withheld out of respective milestone payment and balance amount shall be withheld at 10% of RA bill amount from subsequent RA bills.

1.6.8.4 Final Deduction towards LD (if applicable) on account of delay attributable to contractor shall be based on final delay analysis on completion/ closure of contract as per GCC. Withheld amount, if any due to slippage of intermediate milestones shall be adjusted against LD or released as the case may be.

1.6.8.5 In case of termination of contract due to any reason attributable to contractor before completion of work, the amount already withheld against slippage of intermediate milestones shall not be released and be converted into recovery.

1.6.8.6 **Note:** **Executable contract value - value of work for which inputs/ fronts were made available to contractor and were scheduled for execution till the date of achievement of that milestone.

1.6.9 RECORDS TO BE MAINTAINED AT SITE:

1.6.9.1 Record of Quantity of FREE/Chargeable items issued by BHEL must be maintained during contract execution. Also reconciliation statement to be prepared at regular intervals.

1.6.9.2 The under mentioned Records/ Log-books/ Registers applicable to be maintained.

1.6.9.2.1 Hindrance Register.

1.6.9.2.2 Site Order Book.

1.6.9.2.3 Test Check of measurements.

1.6.9.2.4 Cement Supply and Consumption Daily Register

1.6.9.2.5 Records of Test reports of Field tests.

1.6.9.2.6 Records of manufacture's test certificates.

1.6.9.2.7 Records of disposal of scraps generated during and after the work completion.

1.6.10 The above schedule is tentative. In case the project is to be advanced, the civil works in the scope of the contractor is to be advanced to meet the project requirement. No extra payment whatsoever shall be paid on this account.

The above completion schedule against each structure/ building is for entire completion and handing over the structure/ Building to BHEL. The foundations, pedestals, floors, etc, required for the mechanical equipment erection/ structural

erection shall be handed over to BHEL progressively within the scheduled period given in the above table, as per the BHEL site requirement.

1.6.11 The above time allowed for completion of work including Sundays and Holidays is from the date of commencement of work. Detailed program to be prepared by the bidder taking in to consideration of the COMPLETION SCHEDULES / site decision on drawings flow (latest) and submitted for BHEL's approval.

1.6.12 In order to meet the above schedule in general, and any other intermediate targets set, to meet customer/ project schedule requirements, Contractor shall arrange & augment all necessary resources from time to time on the instructions of BHEL Engineer.

1.6.13 The bidder must submit a detail schedule (area wise) for completion of work to meet civil work schedule given in CLAUSE 1.6.7 within 15 days from the date of issue of LOI.

1.6.14 The major activities as mentioned below against the work schedule given in clause No.1.6.7 are to be indicated in detailed schedule which will be prepared by the bidder:

VOLUME-IA PART-I CHAPTER – VII

1.7 TERMS OF PAYMENT

1.7.1 Secured Advance

Not applicable

1.7.2 Advance for Mobilization

1.7.2.1 Interest bearing advance for mobilization, limited to 5% of the contract value will be paid against submission of bank guarantee of at least 110% of the advance valid for the contract period, which will be recovered from the first running bill onwards. The advance for mobilization shall be paid as under,

1.7.2.2 2% of contract value after receipt of initial security deposit and additional security deposit as applicable (if any), consortium SD as per relevant clauses in the GCC/TCC along with unqualified acceptance of detailed letter of intent.

1.7.2.3 1.5% of the contract value on completion of site mobilization of machinery & T&Ps (per NDCT) as given below and on certification by site in-charge for compliance (subjected to compliance of clause no. 1.7.2.2):

PACKAGE-1

1. JCB – 1nos
2. Poclain CK90 excavator – 1nos
3. Batching plant – 30 cum/hr capacity – 1 no. with 2 nos silo (100MT each)

PACKAGE-2

1. JCB – 1nos
2. Poclain CK90 excavator – 1nos
3. Batching plant – 30 cum/hr capacity – 1 no. with 2 nos silo (100MT each)

PACKAGE-3

1. JCB – 1nos
2. Poclain CK90 excavator – 1nos
3. Batching plant – 30 cum/hr capacity – 1 no. with 2 nos silo (100MT each)

1.7.2.4 1.5% of contract value on completion of site mobilization of machinery and T&Ps as given below in addition to the above, and on certification by site in-charge for compliance:

PACKAGE-1

1. Transit mixer – 2 nos
2. Concrete pump - 1 no.

PACKAGE-2

1. Transit mixer – 2 nos
2. Concrete pump - 1 no.

PACKAGE-3

1. Transit mixer – 2 nos
2. Concrete pump - 1 no.

1.7.3 Interim Payment

1.7.3.1 Interim bills in the form of monthly running bills prepared by the contractor in soft as well as Hard copies shall be based on the quantities executed and measured.

1.7.3.2 90% item rate shall be released after completion of works certification by Engineer in charge.

1.7.3.3 5% of the item rate shall be released after submission of the quality check formats as per the quality plan for the quantum of work billed and duly certified by engineer.

1.7.3.4 Further, 5% can only be released after successful completion of commissioning and handing over of cooling tower.

1.7.3.5 All admissible deductions shall be made from the above 90% value

1.7.4 Retention amount shall be as per GCC.

1.7.5 BHEL Site Engineer, at discretion, may operate the part rate of the items in line with GCC clause no. 2.23.1 (v). Payment for supply portion (subjected to approval of Engineer In-Charge) shall be made only after receipt of material at site.

1.7.6 Royalty/seigniorage charges

Royalty/**seigniorage** charges for excavation inside plant premises as applicable as per Govt of Telangana shall be reimbursable to the bidder by BHEL for the quantum of earth work done on submission of necessary proof of payments as required by M/s TSGENCO for reimbursement.

1.7.7 METHOD OF MEASUREMENT

Mode of measurement shall be as per relevant clauses of the relevant IS 1200 in conjunction of IS code 3385 shall be adopted. In case the same is also not available, the standard procedure adopted in CPWD shall be adopted. In case the same is also not available in CPWD, the measurement of the work done will be based on the mutual agreement between BHEL and contractor. In all the above cases, the interpretation of BHEL will be final and binding to the contractor. Measurement guidelines as a ready reference is also available in the technical specification.

1.7.8 NO CLAIM WHAT SO EVER MAY BE, WILL BE ENTERTAINED UNDER THIS CONTRACT, AFTER DULY SIGNING THE FINAL BILL ALONG WITH MEASURMENT BOOKS AND ACCEPTED BY BHEL.

VOLUME-IA PART-I CHAPTER - VIII

TAXES AND OTHER DUTIES

1.8.1 Goods and service Tax (GST) & Cess

1.8.1.1 The successful bidder shall furnish proof of GST registration with GSTN Portal in the State in which the Project is being executed, covering the services under this contract. Registration should also bear endorsement for the premises from where the billing shall be done by the successful bidder on BHEL for this project/ work.

1.8.1.2 Contractor's price/rates shall be exclusive of GST & Cess (if applicable) (herein after termed as GST). Contractor shall submit to BHEL the GST compliant tax invoice/debit note/revised tax invoice on the basis of which BHEL will claim the input tax credit in its return. Since this is a works contract, the applicable rate shall be @ 18% GST, as applicable presently

1.8.1.3 Bidder shall note that the GST Tax Invoice complying with GST Invoice Rules wherein the 'Bill To' details will as below:

BHEL GSTN - 36AAACB4146P1ZG
NAME - BHARAT HEAVY ELECTRICALS LIMITED
ADDRESS - Yadadri Thermal Power Station, 5X800 MW (Coal based), Veerlapalem village, Dameracherla Mandal, Nalgonda District, Telangana State.

1.8.1.4 GST charged in the tax invoice/debit note/revised tax invoice by the contractor shall be released separately to the contractor only after contractor files the outward supply details in GSTR-1 on GSTN portal and input tax credit of such invoice is matched with corresponding details of outward supply of the contractor and has paid the GST at the time of filing the monthly return.

1.8.1.5 In case BHEL has to incur any liability (like interest / penalty etc.) due to denial/reversal / delay of input tax credit in respect of the invoice submitted by the contractor, for the reasons attributable to the contractor, the same shall be recovered from the contractor.

1.8.1.6 Further, in case BHEL is deprived of the Input tax credit due to any reason attributable to contractor, the same shall not be paid or Recovered if already paid to the contractor.

1.8.1.7 Tax invoice/debit Note/revised tax invoice shall contain all such particulars as prescribed in GST law and comply to the timelines for issue of the same. Invoices shall be submitted on time to the concerned BHEL Engineer In Charge.

1.8.1.8 TDS under GST (if/ as & when applicable) shall be deducted at prevailing rates on gross invoice value from the running bills.

1.8.1.9 E-way bills / Transit passes / Road Permits, if required for materials / T&P etc., bought into the project site is to be arranged by the Contractor only.

1.8.1.10 BHEL shall not reimburse any amounts towards any interest / penalty etc., incurred by contractor. Any additional claim at a later date due to issues such as wrong rates / wrong classification by contractor shall not be paid by BHEL.

1.8.2 All taxes and duty other than GST & Cess

The contractor shall pay all (except the specific exclusion viz GST & Cess) taxes, fees, license charges, deposits, duties, tools, royalty, commissions, Stamp Duties, or other charges / levies, which may be levied on the input goods & services consumed and output goods & services delivered in course of his operations in executing the contract and the same shall not be reimbursed by BHEL. In case BHEL is forced to pay any of such taxes, BHEL shall have the right to recover the same from his bills or otherwise as deemed fit.

1.8.3 Statutory Variations

Statutory variations are applicable under the GST Acts, against production of proof. The changes implemented by the Central / State Government during the tenure of the contract viz. increase / decrease in the rate of taxes, applicability, etc. and its impact on upward revision / downward revision are to be suitably paid/ adjusted from the date of respective variation. The bidder shall give the benefit of downward revision in favour of BHEL. No other variations shall be allowed during the tenure of the contract.

1.8.4 New Taxes/Levies

In case Government imposes any new levy / tax after submission of bid during the tenure of the contract, BHEL shall reimburse the same at actual on submission of documentary proof of payment subject to the satisfaction of BHEL that such new levy / tax is applicable to this contract.

1.8.5 Direct Tax

BHEL shall not be liable towards Income Tax of whatever nature including variations thereof arising out of this contract as well as tax liability of the bidder and their personnel. Deduction of tax at source at the prevailing rates shall be effected by BHEL before release of payment as a statutory obligation, unless exemption certificate is produced by the bidder. TDS certificate will be issued by BHEL as per the provisions of Income Tax Act.

VOLUME-IA PART-I CHAPTER -IX

1.9.0 BILL OF QUANTITY

As mentioned in the Volume II, Price Bid

1.9.1 Bidders shall quote 'Total Amount' in the format enclosed as a separate Excel File in BHEL NIC e-Procurement portal for the subject tender and upload the same under 'Packet details - > Tender covers -> Finance '(Cover Type Description – Price Bid)'' and same shall be taken into account for evaluation and awarding and hence, shall be complete in all respect for the full scope of work defined in specification and in accordance with terms & conditions of the tender. Any other entry elsewhere in the price bid shall be treated as Null and Void. Quoting of rates in any other form/formats will not be entertained

1.9.2 The above mentioned "Total amount" is for the entire Bill of Quantity (BOQ) given in Part-C of the Price bid.

1.9.3 BHEL has the pre-fixed the weightages for the amount of individual items of Bill of Quantity with respect to the "Total amount" in Part-C.

1.9.4 Based on the pre-fixed weightages, the amount for the individual items of the Bill of Quantity shall be arrived at. This amount shall be rounded off to the nearest rupee.

1.9.5 Based on the quantities of individual item and the amount arrived in SI NO. 1.9.4 above, unit rate of individual items shall be derived. This unit rate shall be rounded off to four decimal places.

1.9.6 Bidder to note that this is an item rate contract. Payment shall be made for the actual quantities of work executed at the unit rate arrived at as per SI NO. 1.9.5 above.

1.9.7 The quantities given in the contract are tentative and may change to any extent (both in plus side and minus side). The derived item rates (as mentioned above) for individual items shall remain firm irrespective of any variations in the individual quantities. No compensation becomes payable in case the variation of the final executed contract value is within the limit of Minus (-) 15% of awarded contract value.

1.9.8 Quantity provided in the BOQ for Package-1 is for NDCT-1 (Natural draught cooling tower - 1 of Unit 1), Quantity provided in the BOQ for Package-2 is for NDCT-3 (Natural draught cooling tower - 3 of Unit 3) and Quantity provided in the BOQ for Package-3 is for NDCT-5 (Natural draught cooling tower - 5 of Unit 5).

1.9.9 The bidder should quote price only for Package-1 only. The Price for package-2 and package-3 shall be derived from final award value of Package-1. (as explained in Mode of award)

VOLUME-IA PART-I CHAPTER -X

1.10.0 GENERAL

The scope of the work will comprise of but not limited to the following:

(All the works mentioned hereunder shall be carried out within the accepted rate unless otherwise specified.)

1.10.1 Bidders are requested to furnish the following at PSSR-HQ

i) Security Deposit.

ii) Unqualified Acceptance for Detailed LOI / Work Order.

iii) Rs.100/- Stamp Paper for preparation of Contract Agreement.

1.10.2 Bidders are requested to furnish the proof of documents for the following at the respective PSSR- Site

i) PF Regn No.

ii) Labour License No.

iii) Workmen Insurance Policy No.

1.10.3 **In addition to the clause 2.8 of General Conditions of Contract (Volume-1C of Book-II) the contractor shall comply with the following.**

1.10.4 **BOCW Act & BOCW Welfare Cess Act**

1.10.4.1.1 The Contractor should Register their Establishment under BOCW Act 1996 read with rules 1998 by submitting Form I (Application for Registration of Establishment) and Form IV (Notice of Commencement / Completion of Building Other Construction Work) to the respective Labour Authorities i.e.,

a) Assistant Labour Commissioner (Central) in respect of the project premises which is under the purview of Central Govt.-NTPC, NTPL etc.

b) Appropriate State authorities in respect of the project premises which is under the purview of State Govt.

1.10.4.1.2 The Contractor should comply with the provisions of BOCW Welfare Cess Act 1996 in respect of the work awarded to them by BHEL.

1.10.4.1.3 The contractor should ensure compliance regarding Registration of Building Workers as Beneficiaries, Hours of work, welfare measures and other conditions of service with particular reference to Safety and Health measures like Safety Officers,

safety committee, issue of Personal protective equipments, canteen, rest room, drinking water, Toilets, ambulance, first aid centre etc.

1.10.4.1.4 The contractor irrespective of their nature of work and manpower (Civil, Mechanical, Electrical works etc) should register their establishment under BOCW Act 1996 and comply with BOCW Welfare Cess Act 1996.

1.10.4.1.5 Contractor shall make remittance of the BOCW cess as per the Act in consultation with BHEL as per the rates in force (presently 1%) BHEL shall reimburse the same upon production of documentary evidence. However, BHEL shall not reimburse the Fee paid towards the registration of establishment, fees paid towards registration of Beneficiaries and Contributions of Beneficiaries remitted.

1.10.4.1.6 Non-compliance to provisions of the BOCW Act and BOCW Welfare Cess Act is not acceptable. In case of any non-compliance, BHEL reserves the right to withhold any sum it deems fit. Only upon total compliance to the BOCW Act and also discharge of total payment of Cess under the BOCW Cess Act by the Contractor, BHEL shall consider refund of the amounts.

1.10.5 **PROVIDENT FUND**

1.10.5.1.1 The contractor is required to extend the benefit of Provident Fund to the labour employed by you in connection with this contract as per the Employees Provident Fund and Miscellaneous Provisions Act 1952. For due implementation of the same, you are hereby required to get yourself registered with the Provident Fund authorities for the purpose of reconciliation of PF dues and furnish to us the code number allotted to you by the Provident Fund authorities within one month from the date of issue of the letter of intent. In case you are exempted from such remittance an attested copy of authority for such exemption is to be furnished. Please note that in the event of your failure to comply with the provisions of said Act, if recoveries therefore are enforced from payments due to us by the customer or paid to statutory authorities by us, such amount will be recovered from payments due to you.

1.10.5.1.2 The final bill amount would be released only on production of clearance certificate from PF / ESI and labour authorities as applicable.

1.10.6 **OTHER STATUTORY REQUIREMENTS**

1.10.6.1.1 The Contractor shall submit a copy of Labour License obtained from the Licensing Officer (Form VI) u/r25 read with u/s 12 of Contract Labour (R&A) Act 1970 & rules and Valid WC Insurance copy or ESI Code (if applicable) and PF code no. along with the first running bill.

1.10.6.1.2 The contactor shall submit monthly running bills along with the copies of monthly wages (of the preceding month) u/r78(1)(a)(1) of Contract Labour Rules, copies of monthly return of PF contribution with remittance Challans under Employees Provident Fund Act 1952 and copy of renewed WC Insurance policy or copies of

monthly return of ESI contribution with Challans under ESI Act 1948 (if applicable) in respect of the workmen engaged by them.

1.10.6.1.3 The Contractor should ensure compliance of Sec 21 of Contract Labour (R&A) Act 1970 regarding responsibility for payment of Wages. In case of "Non-compliance of Sec 21 or non-payment of wages" to the workmen before the expiry of wage period by the contractor, BHEL will reserve its right to pay the workmen under the orders of Appropriate authority at the risk and cost of the Contractor.

1.10.6.1.4 The Contractor shall submit copies of Final Settlement statement of disbursal of retrenchment benefits on retrenchment of each workmen under I D Act 1948, copies of Form 6-A (Annual Return of PF Contribution) along with copies of PF Contribution Card of each member under PF Act and copies of monthly return on ESI Contribution – Form 6 under ESI Act 1948 (if applicable) to BHEL along with the Final Bill.

1.10.6.1.5 In case of any dispute pending before the appropriate authority under ID Act 1948, WC Act 1923 or ESI Act 1948 and PF Act 1952, BHEL reserve the right to hold such amounts from the final bills of the Contractor which will be released on submission of proof of settlement of issues from the appropriate authority under the act.

1.10.6.1.6 In case of any dispute prolonged / pending before the authority for the reasons not attributable to the contractor, BHEL reserves the right to release the final bill of the contractor on submission of Indemnity bond by the contractor indemnifying BHEL against any claims that may arise at a later date without prejudice to the rights of BHEL.

1.10.7 **DEPLOYMENT OF SKILLED / SEMI-SKILLED TRADESMEN**

The following clause is applicable in case the contract value / contract price is Rs.Five crores and above.

The contractor shall, at all stages of work deploy skilled / semi-skilled tradesmen who are qualified and possess certificate in particular trade from CPWD Training Institute / Industrial Training .Institute / National Institute of Construction Management and Research (NICMAR), National Academy of Construction, CIDC or any similar reputed and recognized Institute managed / certified by State / Central Government. The number of such qualified tradesmen shall not be less than 20% of total skilled / semi-skilled workers required in each trade at any stage of work. The contractor shall submit number of man days required in respect of each trade, its scheduling and the list of qualified tradesmen along with requisite certificate from recognized Institute to Engineer-in-Charge for approval. Notwithstanding such approval, if the tradesmen are found to have inadequate skill to execute the work of respective trade, the contractor shall substitute such tradesmen within two days of written notice from Engineer-in-Charge. Failure on the part of contractor to obtain approval of Engineer-in-Charge or failure to deploy qualified tradesmen will attract a compensation to be paid by contractor at the rate of Rs. 100 per such tradesman

per day. Decision of Engineer-in-Charge as to whether particular tradesman possesses requisite skill and amount of compensation in case of default shall be final and binding.

1.10.8 **GENERAL**

1.10.8.1 Contractor shall execute the work as per sequence and procedure prescribed by BHEL at site. The applicable erection manuals which are available with BHEL site office are to be referred for compliance and guidance before taking up the work. Any rework on this failure to comply with will be to account of contractor only. BHEL engineer, depending upon the availability of materials, fronts etc., will decide the sequence of erection and methodology. No claims for extra payment from the contractor will be entertained on the grounds of deviation from the method of erection adopted in erection of similar jobs in other projects or for any reason whatsoever.

1.10.8.2 Contractor has to work in close co-ordination with other erection agencies at site. BHEL engineer will co-ordinate area clearance. In a project of such magnitude, it is possible that the area clearance may be less / more at a particular given time. Activities and erection program have to be planned in such a way that the milestones are achieved as per schedule / plans. Contractor shall arrange & augment the resources accordingly.

1.10.8.3 The contractor is strictly prohibited from using BHEL's regular components like angles, channels, beams, plates, pipe / tubes, and handrails etc. for any temporary supporting or scaffolding works or as bed for pre-assembly works. Contractor shall arrange himself all such materials. In case of such misuse of BHEL materials, a sum as determined by BHEL engineer will be recovered from the contractor's bill. The decision of BHEL engineer is final and binding on the contractor.

1.10.8.4 All the works such as cleaning, leveling, aligning, trial assembly, dismantling of certain components for checking and cleaning, surface preparation, fabrication of sheets, tubes and pipes as per general engineering practice and as per BHEL Engineer's instructions at site, cutting, weld depositing, grinding, straightening, chamfering, filing, chipping, drilling, reaming, scrapping, lapping, fitting-up etc., as may be applicable in such erection works and are necessary to complete the work satisfactorily, shall be carried out by the contractor as part of the work within the quoted rate. Major machining work, which is only to be carried out in workshops, will be arranged by BHEL.

1.10.8.5 The work covered under this specification is of highly sophisticated nature, requiring the best quality workmanship, engineering and construction management. The contractor should ensure successful and timely operation of equipment installed. The contractor must have adequate quantity of tools, construction aids, equipments etc.,

in his possession. He must also have on his rolls adequate trained, qualified and experienced supervisory staff and skilled personnel.

1.10.8.6 The contractor will be responsible for the safe custody and proper accounting of all materials in connection with the work. If the contractor has drawn materials in excess of design requirements, recoveries will be effected for such excess drawls at the rate prescribed by manufacturing units.

1.10.8.7 No member of the already erected structure, platform, pipes, grills, other component and auxiliaries should be cut without specific approval of BHEL engineer.

1.10.8.8 No temporary supports shall be welded on the pressure parts of piping. Welding of temporary supports, cleats, etc. on the boiler columns shall be avoided. In case of absolute necessity contractor shall take prior approval from BHEL Engineer. Further, any cutting or alternation of member of the structure of platform or other equipment shall not be done without specific prior approval of BHEL Engineer.

1.10.8.9 Contractors shall ensure that all their Staff / Employees are exposed to periodical training programme conducted by qualified agencies / personnel on ISO 9001 – 2015 Standards.

1.10.8.10 Contractor has to clear the front, expeditiously and promptly as instructed by BHEL Engineer for other agencies, like piping, Turbine, Generator erection, Cabling, instrumentation, insulation etc., to commence their work from / on the equipments coming under this scope. Sometimes, more than one agencies may have to work in same location. Sometimes it may be required to re-schedule the activities to enable other agencies to commence / continue the work so as to keep the overall project schedule.

1.10.8.11 The terminal points decided by BHEL are final and binding on the contractor for deciding the scope of work and effecting the payment for the work done up to the terminals.

1.10.8.12 For the purpose of planning, contractor shall furnish the estimated requirement of power (month wise) for execution of work in terms of maximum KW demand.

1.10.8.13 If applicable, all boiler, piping layout drawings received from BHEL for pipeline erection to be submitted to Boiler Inspector for approval. After approval of the above drawing, Erection of pipe line to be started. Inspection fee and registration fee as mentioned in Chapter VIII of Special Conditions of contract (Volume-IB in Volume-I Book-II) shall be paid by BHEL.

1.10.8.14 Contractor should obtain the formal statutory clearance from Chief Inspector of Boilers to carry out erection & Welding of piping under IBR purview. Arrangement for the visit of Boiler inspector for field inspection, hydraulic test etc., is in the scope of contractor, and necessary drawing / details only will be given by BHEL.

1.10.8.15 Contractor shall arrange the necessary clearance from statutory authorities like IBR, Electrical Inspectorate, Explosive, etc. including the load test on Hoists/Handling as required for installation of the plant and equipment and render all assistance, service required in this regard.

1.10.8.16 All the necessary certificates and licenses required to carry out this scope of work are to be arranged by the contractor then and there at no extra cost.

1.10.8.17 Contractor shall submit a copy of license to undertake construction / repair of Boilers & Piping issued by Boiler inspectorate before commencement of Pressure Parts / Piping Erection.

1.10.8.18 Crane operators deployed by the contractor shall be tested by BHEL before he is allowed to operate the cranes.

1.10.8.19 The contractor must obtain the signature and permission of the security personnel of the customer for bringing any of their materials inside the site premises. Without the Entry Gate Pass these materials will not be allowed to be taken outside.

1.10.8.20 Upon completion of daily work, the contractor shall remove from the vicinity of work all scrap packing materials, rubbish, unused and other materials and deposit them in places to be specified by BHEL Engineer.

1.10.8.21 During the course of erection, if the progress is found unsatisfactory, or if the target dates fixed from time to time for every milestone are to be advanced, or in the opinion of BHEL, if it is found that the skilled workmen like fitters, operators, technicians employed are not sufficient, BHEL will induct required additional workmen to improve the progress and recover all charges incurred on this account including all expenses together with BHEL overheads from contractor's bills.

1.10.8.22 On completion of work, all the temporary buildings, structures, pipe lines, cables etc. shall be dismantled and leveled and debris shall be removed as per instructions of BHEL by the contractor at his cost. In the event of his failure to do so, the expenditure towards clearance of the same will be recovered from the contractor. The decision of BHEL Engineer in this regard is final.

1.10.9 **UTILITY POINTS**

1.10.9.1 Number of utility points (Service / plant air, service / plant water, service / washing steam, inert gas (N2) etc., shall be indicated in the P & I diagram. Contractor to locate the utility points as advised by site engineer and shall route the piping to these points as per site conditions, and shall submit as built layout with 'BILL OF MATERIAL' to BHEL for approval

1.10.9.2 The utility points shall be located at convenient point to handle and to be terminated with brass / bronze valve with suitable connection for hose pipe

1.10.10 **DOCUMENTATION**

1.10.10.1 The following information shall be furnished by the bidder within two weeks of award of contract for purchaser's approval:

a) Bar chart covering planned activities at site
b) Detailed organization chart
c) Details of T&P available with contractors with documents proofs.

1.10.10.2 The following information shall be furnished by the bidder after testing and inspection: Test certificates of various tests conducted at site. All inspection and test certificates shall be signed by BHEL representative also.

1.10.11 **RECORDS TO BE MAINTAINED AT SITE:**

1.10.11.1 Record of Quantity of FREE/Chargeable items issued by BHEL must be maintained during contract execution. Also reconciliation statement to be prepared at regular intervals.

1.10.11.2 The under mentioned Records/ Log-books/ Registers applicable to be maintained.

a. Hindrance Register.
b. Site Order Book.
c. Test Check of measurements.
d. Supply and Consumption Daily Register of Cement and Steel
e. Records of Test reports of Field tests.
f. Records of manufacture's test certificates.
g. Records of disposal of scraps generated during and after the work completion.

VOLUME-IA PART – I CHAPTER - XI

1.11.0 PROGRESS OF WORK

The scope of the work will comprise of following but not limited to the following:

1.11.1 Refer forms F -14 to F-18 of volume I D of volume -I book-II. Plan and review will be done as per the formats.

1.11.2 Contractor is required to draw mutually agreed monthly construction programs in consultation with BHEL well in advance monthly as per the Form-14. Contractor shall ensure achievement of agreed program and shall also timely arrange additional resources considered necessary at no extra cost to BHEL. Progress review meetings will be held at site during which actual progress during the week vis-a-vis scheduled program shall be discussed for actions to be taken for achieving targets. Contractor shall also present the program for subsequent week. The contractor shall constantly update / revise his work program to meet the overall requirement. All quality problems shall also be discussed during above review meetings. Necessary preventive and corrective action shall be discussed and decided upon in such review meetings and shall be implemented by the contractor in time bound manner so as to eliminate the cause of nonconformities.

1.11.3 The contractor shall submit daily, weekly and monthly progress reports, manpower reports, materials report, consumables (gases / electrodes / ferules / lugs) report, T&Ps availability report and other reports as per Performa considered necessary by the Site Engineer as per the BHEL formats.

1.11.4 The contractor shall submit weekly / fortnightly / monthly statement report regarding consumption of all consumables for cost analysis purposes.

1.11.5 The monthly report ending on 24th of every month shall be submitted as a booklet and shall contain the following details: -

a) Colour Progress photographs to accompany the report should be submitted.

b) Construction progress in terms of quantity, CUM, etc., completed as relevant to the respective work areas against planned.

c) Site Organization chart of engineers & supervisors as on 24th of the month with further mobilization plan

d) Category- wise man hours engaged during the previous month under the categories like fitters, electricians, welders, riggers, khalasis, grinder-men, gas-cutters, crane operators, store keepers, lab technicians, helpers, security etc. Data will be spilt up under the work area.

e) Consumables report giving consumption of all types of gases and electrodes during the previous month.

f) Availability report of cranes/T&Ps

g) Safety implementation report in the format

h) Pending material and any other inputs required from BHEL for activities planned during the subsequent month.

1.11.6 The manpower reports shall clearly indicate the manpower deployed, category wise specifying also the activities in which they are engaged.

1.11.7 During the course of construction, if the progress is found unsatisfactory, or if the target dates fixed from time to time for every milestone are to be advanced, or in the opinion of BHEL, if it is found that the skilled workmen like fitters, operators, technicians etc employed are not sufficient BHEL will induct required additional workmen to improve the progress and recover all charges incurred on this account including all expenses together with BHEL overheads from contractor's bills.

1.11.8 It is the responsibility of the contractor to provide all relevant information on a regular basis regarding construction progress, labour availability, equipment deployment, testing, etc.

1.11.9 The progress reports shall indicate the progress achieved against plan, indicating reasons for delays, if any. The report shall also give remedial actions which the contractor intends to make good the slippage or lost time so that further works can proceed as per the original plan the slippages do not accumulate and affect the overall programme.

1.11.10 The contractor to reflect actual progress achieved during the month and will be submitted to BHEL, so that slippages can be observed and necessary action taken in order to ensure that the situation does not get out of control will update the construction schedule forming part of this contract each month.

VOLUME-IA PART- I CHAPTER-XII

1.12.0 MATERIAL HANDLING

The scope of the work will comprise of but not limited to the following:

(All the works mentioned hereunder shall be carried out within the accepted rate unless otherwise specified.)

1.12.1 Open land as available shall be provided by BHEL on free of cost basis. Contractor shall maintain one centralized fenced store cum bar bending yard. Hard surfacing of this yard and all round drain shall be carried out by the contractor at his own cost within the quoted rate. Batching plant area, shall be provided nearer plant premises and contractor shall make use of the area for installation and operation of the Batching Plant at his own cost. The bidder shall make complete arrangement of necessary security personnel, to safeguard all such materials in his custody. Materials issued will be used only for construction of permanent work. The contractor shall take care of material issued by BHEL and shall protect the same from theft, damage and weathering.

1.12.2 The system for receipt, storage & issue of materials shall be available with vendors for easy traceability.

1.12.3 Periodic audit of system of purchasing, storing and issue, etc. will have to be carried out by the vendors. BHEL will also audit the same.

1.12.4 The contractor shall construct waterproof cement store (capacity 400MT) for initial period for storing and stacking of cement, CGI/ asbestos roofing (slope) with brick masonry wall, PCC flooring. Materials required for the same shall be provided by contractor at his own cost. Cement has to be kept over wooden raised platform. Stacking of cement is to be done as per IS codes with proper illumination and locking arrangements.

1.12.5 The contractor shall in no case be entitled for any compensation or damages on account of any delay in supply or non-supply thereof for all or any such material.

1.12.6 Clotting of cement and excessive rusting of steel must be avoided. In case, due to any cause attributable to the contractor, rusting of steel for BHEL issued steel occur rendering the same unusable, then such quantity of cement and steel shall be recovered from the interim payment at the penal rate specified in the tender.

1.12.7 The contractor shall maintain proper store account for all the BHEL issued materials and shall give three copies of once in two months computerized reconciliation statement of such account to the BHEL.

1.12.8 All TMT shall be stacked over sleeper's diameter wise.

1.12.9 All structural steel (issued for insert/ embedment) shall be stacked plate size wise and thickness wise beams, channels and angles shall be stacked separately on sleepers.

1.12.10 Materials shall not under any circumstances taken out of the project site unless otherwise permitted by BHEL.

VOLUME-IA PART –I CHAPTER -XIII

1.13 ACCOUNTING OF MATERIALS ISSUE

The scope of the work will comprise of but not limited to the following:

(All the works mentioned hereunder shall be carried out within the accepted rate unless otherwise specified.)

The material issued to the contractor by BHEL will be accounted as follows:

1.13.1 ISSUE OF CEMENT

1.13.1.1 Cement as received from the manufacturer/ stockiest will be issued free of cost to the contractor. The cement shall be provided normally in bulkers and shall be unloaded in the silos (Adequate numbers of cement silo of cumulative capacity of 200MT per 30CUM batching plant or as required for batching plant mobilized other than the capacity mentioned) to be installed by the bidder nearer to their batching plants. Cement unloading arrangements to silo and required manpower support shall be provided by the successful bidder at his own cost.

1.13.1.2 On advance request of the bidder, the cement shall be supplied in 50kg tamper proof sealed Bags for other than RCC works like masonry, flooring works etc. The theoretical weight of each bag of cement for issued purposes will be considered as 50 kg, the contractor shall be accountable for the cement issued to him on this notional weight only. No claim whatsoever will be entertained because of difference between theoretical and actual weight of the bags of cement. The empty cement bags duly accounted for against issue shall be in the custody of the contractor and the same shall be disposed by the contractor as per statutory regulation prevailing in the project.

1.13.1.3 The contractor shall submit to the engineer, a statement indicating estimated quantity of cement required during a quarter, at least two months in advance of the quarter. In addition, the contractor shall also furnish the estimated requirement of cement during a month by the third week of the previous month indicating his requirement.

1.13.1.4 Bidder is responsible for unloading the cement as soon as the arrival of cement, either in silo, if received in bulker or in the weather proof cement storage sheds, if received bags. Bagged cement shall be stored in a weatherproof sheds having dense impervious bituminous or concrete floors which shall be kept swept clean at all times. The storage arrangements shall be fully completed and approved by the owner before any cement is delivered to site. The construction of cement storage sheds as per the requirement of BHEL, unloading of cement bags, stacking properly in the storage sheds, removal of the sheds after the completion of the work is in the scope of bidder

1.13.1.5 Bidder is responsible for sampling and testing of cement as per Indian Standard/Specification/approved quality plan in the testing laboratory established by the bidder.

1.13.1.6 Bidder is responsible for carrying out design mix as per IS 456/10262 Latest revision and specification, using the cement provided by BHEL and submit the design mix proportions for the approval of BHEL/TSGENCO. The design/trial mix shall be carried out time to time on change of brand/type of cement supplied by BHEL and suitable adjustments on the quantity of ingredients (sand, aggregates, admixture) of the concrete to get the required workability and durability, shall be the responsibility of the bidder without any extra cost to BHEL.

1.13.1.7 Following shall be limit for the maximum quantity of BHEL issue materials that would be with the contractor at any point of time when work is in progress (excluding what has already been incorporated in the works).

SLNO	ISSUE OF MATERIALS	MAX. QTY IN CONTRACTOR'S STORE
1.	Cement	Requirement of one month

1.13.2 **RETURN OF CEMENT**

Sealed cement bags remaining unused and in perfectly good condition at the time of completion or termination of the contract shall be returned promptly, (within 15 days from assessment) if BHEL/ Engineer is satisfied of the physical condition of the cement. Return of such cement to the project stores/ place as identified within the project area by Engineer/ BHEL will not be entitled to handling and incidental charges. Surplus sealed and good conditioned cement bags will be taken back on weighment basis.

1.13.3 **CEMENT CONSUMPTION AND WASTAGE**

1.13.4 The theoreticaL consumption of cement shall be based on the following.

i. For design mix concrete as per approved design mix.

ii. For nominal mix concrete work, as per minimum cement as specified or as approved by Engineer-in-charge.

For item of works, where volume mix is permitted in writing by the BHEL, for masonry works, plaster other miscellaneous items, the cement consumption shall be governed by the "Statement of Cement Consumption" attached to the Delhi schedule of Rates of CPWD-DSR- LATEST REVISION unless otherwise specified in the specifications

or the drawing of contract or mutually agreed by Engineer-in-charge and contractor.

Actual consumption = Issue – Surplus/ unused quantity of cement returned in good condition by contractor to store. (No sweep cement will be taken back by BHEL).

1.13.5 **CEMENT WASTAGE**

Allowable wastage: One and half percent (+1.5%) of theoretical consumption of cement unless specified otherwise in the technical specification.

For any material issued by BHEL to the contractor free of cost, and which is not accounted by the contractor to BHEL, then recovery for such material shall be effected at penal rates.

Sl No	**Cement consumption**	**Basis of issue & penal recovery**
C-1	Theoretical consumption (without considering any wastage or loss).	Free
C-2	Actual consumption being Limited to one and half percent (+1.5%) of aforesaid theoretical consumption towards allowable wastage.	Free
C-3	Actual consumption beyond one and half percent (+1.5%) of above (C-1).	Penal rate

1.13.6 **ISSUE OF STEEL**

1.13.6.1 The steel shall be issued to the contractor on the following basis:

(a) Structural Steel : Weighment basis (Unit – MT)

(b) Reinforcement Steel : Weighment basis (Unit – MT) and Earthing rod (MS round).

1.13.6.2 All the steel (structural, reinforcement, earthing MS rod,) issued by the BHEL shall be properly accounted for. The total quantity of steel required for the work will be calculated from the approved Bar Bending schedule, fabrication drawings, approved laps, chairs and lugs. The measurement for payment as well as for accounting shall be based on the sectional weights as indicated in the following IS specifications. No rolling tolerances shall be accepted in any case for issue, return, reconciliation & payment purpose.

IS: 808- latest revision Beams, Channels and Angles

IS: 1730- latest revision Plates, Sheets and Strips/Flats

IS: 1732- latest revision Rounds including deformed high yield strength bars.

1.13.6.3 In case any such sectional weights are not available in the above documents, the manufacturer recommendation shall be binding.

1.13.6.4 The steel issued to the contractor shall be mainly in standard length and sections as received from the supplier. However, the contractor shall be bound to accept the steel in length as available in the project stores no claims for extra payment because of issue of non-standard length will be entertained.

1.13.6.5 The contractor shall satisfy himself of the quality and quantity of the materials at the time of taking delivery from BHEL stores. No claims whatsoever will be entertained by BHEL because of quality or quantity after the materials are taken by the contractor from BHEL stores.

1.13.6.6 The contractor shall submit to the engineer, a statement indicating estimated quantity of steel required during a quarter, at least two months in advance of the quarter. In addition, the contractor shall also furnish the estimated requirement of steel during a month by the third week of the previous month indicating his requirement.

1.13.6.7 Following shall be limit for the maximum quantity of BHEL issue materials that would be with the contractor at any point of time when work is in progress (excluding what has already been incorporated in the works).

SL. NO.	ISSUE OF MATERIALS	MAX. QTY IN CONTRACTOR'S STORE.
1.	Reinforcement Steel & Earthing rod MS round.	Requirement of one month
2.	Structural Steel	Requirement of one month

1.13.6.8 Bidders to ensure that no lamination materials are taken over by them from BHEL.

1.13.6.9 Fabrication wastage, if any due to above, shall not be compensated by BHEL.

1.13.6.10 Bidder to note that steel materials required for MS Grating, Galvanised Grating, GI Handrail, Stainless Steel Handrail, Stainless steel for SS Flue can, fasteners like MS/HT/HSFG bolts/nuts, lock nuts, washers and foundation bolts, embedded items other than those supplied by BHEL, etc shall be supplied by the bidder. However, Bidder shall use the scrap materials for their use in the permanent works as embedment/inserts etc. after necessary store issue formalities and shall be accounted for monthly reconciliation.

1.13.7 **RETURN OF MATERIALS**

1.13.7.1 All surplus steel and all wastage materials will be taken back on weighment basis.

1.13.7.2 Surplus, unused and untampered steel shall be sorted section-wise and returned separately for a place directed by BHEL/Engineer within the project area. Return of such materials will not be entitled to any handling and incidental charges.

1.13.7.3 All wastage / scrap (including melting scrap, wastage, un usable scrap) shall be promptly returned to the stores and a receipt obtained for material accounting purposes. Return of such material will not be entitled to any transportation and incidental charge.

1.13.8 **SCRAP & SERVICEABLE MATERAILS:**

1.13.8.1 All Structural steel of length above 2 M except M.S. Plate shall be considered as serviceable materials provided the materials is in good and acceptable condition. Structural steel in length less than 2 M shall be treated as scrap.

1.13.8.2 Plates having both sides greater than 1 Metre OR if any side is less than 1 M but greater than 0.5 M and the total area is equal or greater than 2 Sq. Metre shall be considered as serviceable.

1.13.8.3 All pipes measuring 2 M and above in length shall be treated as serviceable materials provided they are in good and acceptable condition. Pipe in less than 2 M length shall be treated as scrap.

1.13.8.4 All TMT measuring 3 M and above in length shall be treated as serviceable materials provided they are in good and acceptable condition. TMT in less than 3 M length shall be treated as scrap.

1.13.9 **STEEL CONSUMPTION AND WASTAGE**

1.13.9.1 **REINFORCEMENT AND EARTHING ROD MS ROUND STEEL CONSUMPTION AND WASTAGE.**

a) CONSUMPTION.

The theoretical consumption of various sections and/or diameter of reinforcement and earthing rod steel shall be based on approved construction drawing and bar bending schedule. Weight shall be calculated considering the sectional weights as per Indian standards. No extra cost shall be payable to the contractor for any deviation in weights for the different procedures adopted for issue and calculation of the theoretical consumption including rolling tolerances.

Actual consumption = Issue – Surplus.

Surplus = Un-tampered & unused quantity of steel and

Serviceable materials as stipulated under clause "Scrap and Serviceable Materials (Refer Clause 1.13.8 above)" returned by the contractor to BHEL store along with relevant documents.

Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE

ALLOWABLE WASTAGE: - (+3%) of the theoretical consumption shall be considered as allowable wastage. Invisible wastage (max limit to 0.5%), if any, shall be considered to be included in the specified 3 % allowable wastage.

S.No	CONSUMPTION OF REINFORCEMENT STEEL & EARTHING ROD, MS ROUND	BASIS OF ISSUE
R-1	Theoretical consumption (without considering any wastage, scrap or loss) as per spec. & drg.	Free
R-2	Wastage limited to plus three percent (+3%) of the aforesaid theoretical consumption (R-1) towards allowable wastage including invisible wastages (invisible wastages limited to 0.5% of theoretical consumptions)	Free
R-3	Wastage beyond three Percent (3%) of the aforesaid theoretical consumption (R-1)	Penal Rate

1.13.9.2 **STRUCTURAL STEEL, (ROLLED SECTION, PLATES ETC.) CONSUMPTION & WASTAGE.**

A) CONSUMPTION: -

The theoretical consumption of various sections shall be based on approved drawings. Weights shall be calculated considering the sectional weights as per Indian standard. No extra shall payable to the contractor for any deviation in weights for the two different procedures adopted for issue and calculation of the theoretical consumption including rolling tolerances.

Actual consumption = Issue – Surplus.

Surplus = Un tampered & unused quantity of steel and

Serviceable materials as stipulated under clause "Scrap and Serviceable Materials (Refer Clause 1.13.8 above)" returned by the contractor to BHEL store along with relevant documents.

Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE

Allowable wastage: - 4% (FOUR percent) of the theoretical consumption shall be considered. Wastage shall be considered as cut pieces and scrap material, measured as per actual weightment basis. Invisible wastage (max limit to 0.5%), if any, shall be considered to be included in the specified 4 % allowable wastage.

S.No	CONSUMPTION OF STRUCTURAL STEEL (ROLLED SECTION, PLATES)	BASIS OF ISSUE
S-1	Theoretical consumption (without considering any wastage, scrap or loss) as per spec. & drg.	Free
S-2	Wastage limited to plus Four percent (+4%) of the aforesaid theoretical consumption (S-1) towards allowable wastage including invisible wastages (invisible wastages limited to 0.5% of theoretical consumptions)	Free
S-3	Wastage beyond four Percent (4%) of the aforesaid theoretical consumption (S-1)	Penal Rate

1.13.10 **RECONCILIATION OF MATERIALS**

The contractor shall submit a reconciliation statement of steel issued to him with each RA Bill.

At the time of submission of bills, the contractor shall properly account for the material issued to him as specified herein to the satisfaction of BHEL certifying that the balance material are available with contractor's custody at site.

At the time of submission of bills by the contractor, if it is noticed by BHEL that the wastage is high and calls recovery at the penal rate, then, BHEL will proceed for recovery for the excess wastage as per penal recovery rates as specified.

The reference drawings for actual material consumption to be used for the purpose of reconciliation shall be drawings prepared by the BHEL and drawings approved by BHEL for fabrication works and such other drawings approved by BHEL. This shall also include the bar bending schedule prepared by the contractor and approve by BHEL.

1.13.11 RECOVERY OF MATERIAL

If wastage exceeds the specified limit, the recovery of excess wastage shall be made from monthly R/A Bill at the Penal Rate.

1.13.12 PENAL RATE OF MATERIALS

A	**REINFORCEMENT STEEL HCRM** Cold rolled steel, high strength, deformed bar or mild steel round bars including earthing rod MS round	**Rs. 64,785/- per MT** + GST and/or other taxes & duties
B	**STRUCTURAL STEEL – Long Products** Rolled steel Beams, channels, and angles, etc. in sizes and lengths as available.	**Rs. 69,347/- per MT** + GST and/or other taxes & duties
C	**STRUCTURAL STEEL – Flat Products** MS plates, MS flats, MS pipes, Chequered Plates, etc. in sizes and lengths as available	**Rs. 81,428/- per MT** + GST and/or other taxes & duties
D	**CEMENT OPC 53 GRADE**	**Rs. 3,725/- per MT** + GST and/or other taxes & duties

VOLUME-IA PART – II CHAPTER 1

CORRECTIONS / REVISIONS IN SPECIAL CONDITIONS OF CONTRACT, GENERAL CONDITIONS OF CONTRACT AND FORMS & PROCEDURES

Sl No: 1

Clause 4.1.11 of SCC is deleted.

Sl No: 2:

OCCUPATIONAL HEALTH, SAFETY & ENVIRONMENT MANAGEMENT/ QUALITY ASSURANCE PROGRAMME

The following clauses in Occupational Health, Safety & Environment Management / Quality Assurance Programme published in Chapter-IX of Special Conditions of Contract (Volume I Book-II) is revised as under.

Chapter IX Clause 9.1 is modified as below:

Contractor will comply with HSE (Health, Safety & Environment) requirements of BHEL as per the "HSE Plan for Site Operations by Subcontractor" (Document No. HSEP: 14 Rev01) enclosed.

Chapter IX Clause 9.1.1 to 9.1.25 stands deleted.

Chapter IX Clause 9.2 to 9.62 stands deleted.

Sl No: 3:

Clause No. 10.5 on RA Bill Payments, in Special Conditions of Contract (SCC), Volume-IB, Book-II, is revised as under:

The payment for running bills will normally be released within 30 days of submission of running bill complete in all respects with all documents. It is the responsibility of the contractor to make his own arrangements for making timely payments towards labour wages, statutory payments, outstanding dues etc., and other dues in the meanwhile.

Sl No: 4

The following clause is added under clause 1.10 Security Deposit in General Conditions of Contract (Volume I Book II): "1.10.8 Bidder agrees to submit Security Deposit required for execution of the contract within the time period mentioned. In case of delay in submission of Security Deposit, enhanced Security Deposit which would include interest (Base rate of SBI +6%) for the delayed period, shall be submitted by the bidder. Further, if Security Deposit is not

submitted till such time the first bill becomes due, the amount of Security Deposit due shall be recovered as per terms defined in NIT/contract, from the bills along with due interest."

Sl No: 5: Void

Sl No: 6

Existing format on Monthly Performance Evaluation of Contractor, as available in Form No F-14 of Volume ID Forms and procedure stands Deleted. Form No.- F-14 (Rev 01) is enclosed.

Sl No: 7

Existing format on Monthly Performance Evaluation of Contractor, as available in Form No F-15 of Volume ID Forms and procedure stands Deleted. Form No.- F-15 (Rev 03) is enclosed.

Sl No: 8

Existing format for Integrity Pact, as available in Volume ID Forms and procedure stands Deleted. Revised Format is enclosed in NIT.

Sl No: 9

Existing format for BANK GUARANTEE FOR SECURITY DEPOSIT, as available in Form No. F-11 (Rev 00) of Volume ID Forms and procedures stands deleted. Refer Proforma of Bank Guarantee (in lieu of Security Deposit)-Form WAM 22 provided in Part-II of Volume-IA Technical Conditions of Contract.

Sl No: 10

Procedure 2.3 that forms the part of Forms and Procedures is published in Volume IA Part II of this booklet (Volume-I Book-I).

VOLUME-IA PART – II CHAPTER 2 to 12

In the next 820 pages as below:

CHAPTER	Details	No. of sheets
CHAPTER 2	Technical Specification NDCT (Book 1 of 2)	455
CHAPTER 3	Technical Specification NDCT (Book 2 of 2)	217
CHAPTER 4	HSE Plan For Site Operations By Subcontractor	82
CHAPTER 5	Form 15 Rev 03	08
CHAPTER 6	Form 14 Rev 01	06
CHAPTER 7	Proforma Of Bank Guarantee (In Lieu Of Security Deposit)-Form WAM 22	03
CHAPTER 8	Procedure For Conduct Of Conciliation Proceedings	11
CHAPTER 9	T&P Hire charges	10
CHAPTER 10	No Deviation Certificate	01
CHAPTER 11	Technical Specification of Labour Colony	10
CHAPTER 12	Drawings	17

5X800MW TSGENCO YADADRI TPS (UNIT 1 TO 5)

TECHNICAL SPECIFICATION
FOR
NATAURAL DRAFT COOLING TOWERS
(TOTAL 2 BOOKS)

BOOK 1 OF 2

Specification No. : PE-TS-417-165-N002

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

COOLING TOWER TECHNICAL SPECIFICATION COMPRISE 2 BOOKS:

CONTENTS

SECTION TITLE

BOOK – 1 of 2 – Mechanical Specifications

I Specific Technical Requirements

IA Specific Technical Requirements (Mechanical)
IB Specific Technical Requirements (Elec.)
IC Specific Technical Requirements (C&I)

II Standard Technical Specifications

IIA Standard Technical Specifications (Mechanical)
IIB Standard Technical Specifications (Elec.)
IIC Standard Technical Specifications (C&I.)

III Documents to be submitted by Bidder

IIIA Guarantee Schedule (To be submitted along with the Bid by all Bidders)
IIIB Compliance Certificate (To be submitted along with the Bid by all Bidders)

BOOK – 2 of 2 – Civil Specification

Part-I
Part-II

SECTION I - SPECIFIC TECHNICAL SPECIFICATIONS

YADADRI THERMAL POWER STATION

PROJECT INFORMATION

1	Name of the Project	YADADRI Thermal Power Station
2	Station Capacity	5X800 MW (Coal based)
3	Owner	Telangana State Power Generation Corporation Limited (**TSGENCO**)
4	Site Location	Site is located 7 km from the NH5.
5	Latitude	*16° 42'*20.40 N
6	Longitude	79° 34'41.56 E
7	Nearest Town	30 Km Miryalaguda
8	Nearest Railway Station	6.5 Km Damercherla
9	Nearest Airport	130 Kms (Vijayawada)
10	**Site Conditions**	
	Ambient Temperature	
	Daily minimum (average)	10°C
	Daily maximum (average)	47°C
	Design Ambient Temperature	50°C
	Ambient temperature (performance)	38°C
	Relative Humidity for design / efficiency	48-84 %
	Annual rainfall, mm	600 mm
	Plant Elevation above MSL	85 m above MSL
	Mean Wind Speed	8 km/h
	Wind Pressure	As per the latest revision of IS 875/1987
	Seismic co-efficient	Zone-II as per IS- 1893 (Part-IV)

1.00	**INTENT OF SPECIFICATION:**
1.01	This specification is intended to cover the vetting of thermal design undertaken by BHEL Consultant, manufacture, assembly, inspection and testing at manufacturer's and/or his sub-contractors works, proper packing, delivery at site, transportation, unloading/handling at site, storage at site, site fabrication, site painting, erection including all civil works/ testing/ commissioning at site and performance testing of Natural draft type cooling tower for 5X800MW YADADRI TPS UNIT-1 to 5 including complete Electrical, C&I and Civil Works as specified and as necessary. This specifications is for Five (5) nos. Natural Draft Counter flow Cooling Towers for 5 x 800 MW YADADRI TPS Units-1 to 5 BHEL intends to get this NDCTs package executed by qualified contractors on an item rate basis. BHEL has done the thermal sizing of the NDCTs through its design Consultant and the same is approved by the owner. The owner approved thermal design is enclosed at Section IA along with the General Arrangement Drawing. The NDCT contractor is required to own the owner approved thermal design and GA drawing such that the responsibility of cooling tower performance shall remain with the bidder in all manners. Any questions or clarifications regarding thermal design may be sought by the NDCT contractor to satisfy himself of its veracity. The tentative quantities for thermo-hydraulic components (Fills and distribution system) listed for S.Nos. 24 and 25 of BOQ as per BHEL's Design are indicated in Annexure-1 of section IA and the same is calculated based on the area inside the NDCT at respective levels shown in the GA drawing. If found necessary ''the NDCT contractor may suggest modifications to the thermo-hydraulic components (listed at S. Nos. 24 and 25 in the BOQ) with technical reasoning/analysis/calculations to justify the measures to improve the thermal performance of the NDCT which will be guaranteed by the bidder''. And as such the responsibility of cooling tower performance shall remain with the bidder in all manners. While suggesting justifiable reasons for changes as above the NDCT contractor shall abide by the following constraints. Also, the NDCT contractor shall guarantee the NDCT performance considering these constraints that are inviolable. 1) Civil Design of NDCT Shell, Shell Profile and Shell dimensions at various heights 2) Foundation of NDCT 3) Air Inlet Height 4) Basin & Internal Structure Column-Beam Grid Dimensions and Elevations 5) Water Distribution Ducts 6) Layout of CW Hot water inlet header to Cooling Tower 7) Height and Diameter of NDCT. Once the changes with justifiable reasons/analyses/calculations provided by the NDCT Contractor are accepted by BHEL/Consultant and duly incorporated, the NDCT contractor will vet the final thermal design & GA of NDCT and furnish the Performance guarantee. The thermal design and GA vetted by the NDCT contractor shall be furnished to Customer for approval. The NDCT contractor shall vet the thermal design as above (for the option applicable) within two weeks of award of contract, for further approval by BHEL/customer. The GA drawing already approved by owner may be required to be approved again depending on changes to the thermo-hydraulic components, if any and therefore the NDCT contractor shall furnish the relevant modifications agreed to by BHEL/Consultant to these items (only) keeping the other dimensions frozen for further approval from BHEL/Customer. The complete design and engineering of NDCT shall remain in the scope of BHEL's Consultant. All Mechanical/Electrical/C&I drawings prepared by BHEL Consultant will be reviewed by the NDCT contractor before submission to customer for approval.

As the quantities for thermo-hydraulic components (listed at S.Nos. 24~~.1 to 24.7~~ and 25~~.1 to 25.5~~ in the BOQ) are going to be estimated by the NDCT contractor based on his modified arrangement, no variation in quantities of these items will be permitted during execution.

~~The NDCT contractor is required to estimate the "lump sum" cost of the thermo-hydraulic components based on his modified arrangement, if any and indicate the same separately (and not against the relevant BOQ items given by BHEL at S.Nos. 24.1 to 24.6 and 25.1 to 25.5 in the BOQ). This lump sum cost shall be added to the cost of other BOQ items quoted by the NDCT contractor on item-rate basis to arrive at the total cost of evaluation.~~

No change in the quantities and cost of thermo-hydraulic components shall be allowed during execution due to any reason whatsoever from that quoted during tender stage.

SECTION - I

SPECIFIC TECHNICAL REQUIREMENTS

SUB-SECTION IA - Specific Technical Requirements (Mech.)
SUB-SECTION IB - Specific Technical Requirements (Electrical)
SUB-SECTION IC - Specific Technical Requirements (C & I)
SUB-SECTION ID – Datasheet-A

SUB-SECTION – IA

SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)

1.00.00	**DELETED.**
2.00.00	**SCOPE OF EQUIPMENTS & WORKS UNDER THIS SPECIFICATION:**
2.01.01	**Scope (Mechanical):**
	a) Incoming hot water piping, including vertical run, supported on cooling tower, Motorized Butterfly valves on hot water risers. Terminal point for hot water pipe shall be as per enclosed NDCT GA Drg. Welding at terminal point shall be in bidder's scope. Bidder shall also supply a Pressure Gauge & Temperature Gauge at the terminal point. Any reducer/ expander required at the terminal point shall also be in the bidder's scope. b) List of steel which are free supplied by BTG shall be as per Section-VI , Volume-II. c) Inlet louvers, tower fills & fill supports, drifts eliminators, including all supporting structures, fastening arrangements & accessories. d) Screens, along with guides embedded in concrete shall be provided at the outlet of cold water channel. e) Sluice gate with mechanical jack arrangement and guides in each of the cold water outlet channel connection from the cold water basin. f) Manually operated chain pulley blocks, together with the monorails and supporting frames for the handling of screen and gates. g) Knife-edge gate valve/sluice valve in each de-sludge connection and also De-sludge piping up to the disposal point at local storm water drain channels. h) Pipe spools to be embedded in sludge pit walls and terminated with flanged end at suitable distance from outer face of respective wall. i) Water Distribution system consisting of troughs/ Pipes. Hangers & pipe supports & anchoring arrangement for all piping coming under the scope of supply. j) Two (2) Nos. (1+1) sludge pumps (submersible type) complete with electric motors, non-return valve, isolation valve, piping supports, hangers etc. for cold-water basin drainage. The bidder shall terminate pump discharge pipe work into Discharge Header of CW Blowdown pump at a distance of approx. 250 M from sludge pit. k) Counter flanges, bolts, nuts & gaskets for all piping connections in the scope of bidders and also at terminals.
2.01.02	**Scope (Electrical):**
	a) Complete electrical equipment as per specification/ details indicated in Section IIA shall be in bidders' scope. b) The scope of power & control cables & special cables shall be as per section IIA (electrical). c) Base plate, foundation plates, anchor bolts, sleeves, inserts in concrete work for electrical and mechanical equipment & accessories.
2.01.03	**Scope (C & I):**
	a) Removable type Pitot Tube at each hot water inlet- piping header to measure the flow (during performance Guarantee test only). The Pitot Tube shall be left with customer after the completion of the test . b) One no. Pressure Gauge and One no. Temp Gauge at Hot Water pipe header at T.P.

	c) One no. of Anemometer for measurement of wind velocity. d) One no. of Psychrometer. e) Local Control Panel for Sump/Sludge Pumps (Submersible type). f) Level switches for sump/tank level high/normal/low/very low interlocks. g) Actuator for Motorised BFV at inlet of hot water pipes.
2.01.04	**Scope (Civil):**
	a) Complete civil works as detailed in Book 2 of 2 (Civil Specification) including excavation, shoring, dewatering, backfilling, concrete work including shuttering, sand filling, disposal of surplus soil outside plant boundary, formwork including automatic climb form, laser beam survey instruments, fabrication, galvanizing and erection of steel structures and inserts, finishing anchor bolts, RCC sump/duct, laying and testing of hot water pipe line, water proofing, providing PVC water stops and joint fillers, drainage and other ancillary items connected with cooling towers. All faces of concrete structures and steel structures coming directly in contact with water shall be coated with corrosion resistant coating system as approved. The surfaces that would include are inner face of hyperbolic shell, raker column faces, inner faces of cold water basin, fill support structures, hot water distribution ducts & channels, cold water channel etc. The scope of this work shall consist of , but not limited to, the construction of reinforced concrete double curvature hyperbolic shell, ring beams, foundations (including Piling, if required), cold water basins with partition walls, hot water ducts, drain sumps, external drain chamber with associated pipe work, cold water channels with sluice gate up to the terminal point as specified elsewhere, hoists and monorails, primary and secondary hot water distribution troughs, fill support system including columns and beams, drift eliminators, testing of cold water basin for water tightness, external stairs, sludge pit for each basin section, all other staircases/ladders as required, doors and their frames, walkways, platforms, steel fitting, fixture, inserts, including fabrication, hand railing, providing protective measures in concrete and steel materials against effect of water and other chemicals on the completed structure etc. b) Supply & application of painting at site including lettering on the outer wall of the cooling tower as per customer requirement.
2.01.05	The following are also included in bidder's scope: a) One set of special tools & tackles required for maintenance of equipment & accessories in the cooling towers. b) Various drawings, datasheets, calculations, test reports/ certificates, operation & maintenance manuals including "As built drawings" etc. as specified & as necessary. c) Supply of first fill of lubricants for all equipments under this package including second fill/ replenishments as necessary during & after commissioning till handing over of the plant. d) Supply of commissioning spares on as required basis. e) Scope of services shall include but not limited to erection/ testing/ commissioning/ trial run/ performance testing & handing over of cooling towers. Transportation of equipments, material to site, local clearance, storage at site etc. & supply of all labor including supervision personnel, materials, erection tools & tackles etc. as necessary for expeditious execution of works etc. are also included in bidder's scope. It shall be the responsibility of the bidder to arrange all T & P required for the execution of complete job including erection & civil works.
3.00.00	**Equipment & Services to be provided by Purchaser:**
	a. Supply and erection of incoming hot water piping up to bidder's terminal point.

	b. Supply & erection of sludge discharge piping beyond the bidder's terminal point, if applicable. c. Cold-water outlet channels for cooling tower beyond the bidder's terminal point. d. For Electrical, C&I and Civil works, refer Sections IB/IIB, IC/IIC and Book 2 of 2 respectively enclosed herein.
4.00.00	The cooling tower shall comply with standard technical specifications of cooling towers enclosed in section -'II'. In the event of any conflict between Section -'II' & section 'I', the section 'I' shall prevail. In case of any contradiction in different clauses/parts of Section-I or any other clause of specification, the most stringent requirement shall prevail.
5.00.00	DELETED
6.00.00	DELETED
7.00.00	DELETED
8.00.00	**PERFORMANCE TESTING AT SITE**
8.01.00	**Scope:**
	To ascertain the fulfillment of guarantees after completion of erection and commissioning of the cooling tower, contractor shall carry out performance test for all five(5) nos. of NDCT in presence of employer / purchaser at site.
8.02.00	**Codes:**
	The following codes and standards shall be applicable for conducting test unless otherwise modified or supplemented by the enclosed procedure and mutually agreed to between Owner, BHEL and bidder. a) Code ATC-105: Acceptance test code for water cooling towers. (latest Version). b) BS-4485: Specification for Water Cooling Tower. c) BS-1042: Methods for the measurement of fluid flow in pipes. d) BS-3435: Measurement of electrical power and energy in acceptance testing. e) ASME 19.5: Supplements on instruments and apparatus.
8.03.00	**Conductance of tests:**
	Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by the bidder for the design conditions of CW flow, range, ambient WBT as specified
8.03.01	The bidder shall submit cooling tower performance test procedure as per ATC 105 for approval & conduct the test as per the approved procedure, in the event of order.
8.03.02	The bidder shall be given permission to inspect the Cooling Tower in advance and ready it for the test.
8.03.03	**Cooling Tower performance shall be tested jointly by Contractor in presence of BHEL and Owner. All the representatives shall jointly record data of test**. a) The responsibility for conducting the test will be with the bidder. b) **All test instruments required for the PG test will be provided by contractor and meets the stipulations of the CTI ATC 105.** c) Calibration of instruments to be used in the test shall be carried out by an approved independent agency. Calibration of instruments should be carried out previous to, but not more than six months before the test. The calibration certificate of the instruments should be valid for the period of test. d) List of instruments to be arranged by the bidder along with the calibration certificates of the instruments to be used and psychometric charts and tables should be submitted to owner for

	approval.
8.03.04	PG test shall be carried out by the bidder after completion of the cooling tower and at a time when the atmospheric conditions are within limits of deviation from the design conditions as specified in this section preferably in the period from May to September.
8.03.05	Performance test shall be carried out based on ambient WBT. The performance curves of the towers showing variation in performance with change in ambient wet bulb temperature, cooling range, relative humidity water loading of the tower etc, required to ascertain the performance of the tower shall be furnished to the successful bidder. Performance curves applicable to 90%, 100% and 110% of the design water flow rate shall be furnished to the successful bidder.
8.03.06	The guaranteed performance of the equipments shall be demonstrated by the bidder after evaluating the P.G. test should the result of the test deviate from the guaranteed values the bidder shall be given an opportunity to modify/rectify/replace the fills and other materials associated with the performance of tower as required to enable it to meet the guarantees. In such cases the PG test shall be repeated within one month from the date on which the equipment is ready for retest and cost of modification, including labour, materials and cost of additional testing shall be borne by the Bidder. The chance for repeat testing will be given only twice during the contract period. All the modifications carried out by the bidder in the Cooling Tower to meet the contractual requirements shall be carried out free of cost to the Owner in other towers (if applicable for the package).
8.03.07	In case the test cold water temperature as determined from the PG test is higher than the predicated value (based on the performance curves). Purchaser reserves the right to accept all the towers after assessing the LD/ Penalty for performance as specified in cl no- 11.00.00.
9.00.00	The makes of all the equipments under this specification shall be subject to purchaser's approval in the event of order.
10.00.00	It is mandatory for the bidder's to furnish along with the bid the deviations if any, whether major or minor in the '**Schedule of Deviations**' only. In the absence of the deviations listed in the '**Schedule of Deviations**', the offer shall be deemed to be in full conformity with the specification not withstanding anything else stated elsewhere in the offer, data sheets etc. **The hidden deviations or stated/ implied deviations in the offer shall not be acceptable and binding on the purchaser**.
11.00.00	**PERFORMANCE GUARANTEES AND LIQUIDATED DAMAGES**
	a) Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by bidder for the design conditions of CW flow, range, ambient WBT as specified. In case the test cold-water temperature as determined from the PG test is higher than the predicted value, Owner reserves the right to reject/replace the fills and other materials associated with the performance of the tower. In the event of its acceptance by purchaser, Penalty of 5% of the Cost of NDCT package value shall be deducted. b) The successful bidder shall demonstrate the above guarantees during performance testing at site. The purchaser is, however, not bound to accept the equipment and reserves the right to out rightly reject it if the actual values exceed beyond the plant design limits.
12.00.00	**INSPECTION AND TESTING:**
	Purchaser/ Customer or their authorized representatives shall have the right to inspect at any stage of manufacture & construction, all materials, components & workmanship & testing of material. The bidder shall provide all facilities for inspection & testing without any extra cost to the purchaser/ Consultant.

12.01.00	The contractor/ manufacturer shall conduct the following minimum specific tests to ensure that the equipment shall conform to the requirements of this section and in full compliance with the requirements spelt out in applicable codes and standards.
12.02.00	Material identification and testing of regulating valve assemblies, screen assemblies, all supporting structural assemblies, fills, all nuts and bolts, sluice valves, nozzles and all other applicable components constituting each cooling tower.
12.03.00	Hydrostatic testing of hot water distribution piping regulating valves and all other pressure parts at a pressure and duration as spelt out in this specification.
12.04.00	Visual, dimensional checking of all components of each cooling tower.
12.05.00	Material testing of all components, hydrostatic testing of all pressure parts at a pressure and duration in compliance with this specification, static and dynamic balancing tests of all rotating components such as pump shaft, line shaft, impeller etc. and complete performance testing as minimum for each sludge pump in each cooling tower.
12.06.00	Tests for hoists, chain pulley blocks and all other lifting tackle shall be carried out as per relevant Indian/ equivalent international standards.
12.07.00	Any other tests deemed necessary for safe, reliable and satisfactory operation of the equipment.
13.00.00	**QUALITY PLAN:**
13.01.00	The inspection & testing of the cooling towers & its various components shall be as per quality plans approved by the purchaser/ Customer. Bidder shall submit the quality plans based on the guidelines given in specification & quality plans enclosed herein. The customer hold points of BHEL/ Customer/Customer nominated agency shall be marked in the QP at the contract stage, in the event of order & inspection/ testing shall be carried out as per same apart from various test certificates/ inspection records etc. Following standard QP are enclosed for bidder's guidance: • Cooling tower • Pipes, fittings & pipe work • BF Valves • Chain Pulley Blocks • Gate/ Globe Valves • Submersible Pumps
13.02.00	The quality plans for various electrical, C&I and Civil works are enclosed in respective sections for bidder's compliance.
13.03.00	For equipments not covered above, bidder shall submit QP's for same on the basis of similar guidelines & submit for approval in the event of order.
14.00.00	**Tests at Site:**
14.01.00	After completion of erection and commissioning of the cooling tower, supplier in accordance with cooling tower Institute Bulletin No ATC-105 "Acceptance Test Procedure for Industrial Cooling Tower" shall carry out performance tests of each cooling tower.
14.02.00	Necessary correction curves shall be furnished by the Purchaser to include in Test procedure for correcting the test results for any difference between test and guarantee design conditions.
14.03.00	All mounting and calibrating instruments required for site performance tests shall be arranged by the cooling tower supplier without any extra cost.

15.00.00	**DRAWINGS, CURVES AND INFORMATION REQUIRED: DELETED**
16.00.00	**Successful bidder in the event of award of contract shall furnish the drawings/ documents for all temporary structures, all erection methodologies, bought items or self-manufactured and/or fabricated items.**

1.0	**GENERAL INFORMATION**		
	No. of Cooling Towers required	:	Five (05) Nos.
	Location		Out door
	Duty		Continuous
	Type		Natural draught Counter flow with PVC Splash Bar type
	Finished ground level		EL (-) 1.5 M (RL+ 80.0 M FOR UNIT- 1 &2) EL (+) 1.5 M (RL+ 83.0 M FOR UNIT- 3,4&5)
	Basin Kerb level (Basin Sill Top level)		EL(-) .1 M (RL+ 81.4 M FOR UNIT- 1 &2) EL(+) 2.9 M (RL+84.4M FOR UNIT 3,4&5)
2.0	**DESIGN PERFORMANCE FOR EACH COOLING TOWER**		
2.1	Design Cooling water flow	**:**	90000 M^3/hr.
2.2	Design ambient wet bulb temp.	:	28.0 ^oC
2.3	Design inlet air wet bulb temperature.	:	28.0 ^oC
2.4	Approach w.r.t. design inlet air wet bulb temperature (viz. 28.0^oC)	:	5.0 ^oC
2.5	Cold water temperature	:	33 ^oC
2.6	Hot water inlet temperature	:	42.5 ^oC
2.7	Cooling Range	:	9.5 ^oC
2.8	Design ambient Relative Humidity	:	45%
2.9	Liquid Handled	:	Clarified Water (refer details of cooling water analysis at Annexure-3)
	a) Total CW Pumping head permissible viz. static head plus frictional losses as below: • Static head w.r.t. Max Water Level • Frictional losses within bidders T.P. with 10% margin • Velocity head	:	Not to exceed 16.3 MWC from Max WL Or 17.4 MWC from FGL
2.10	Maximum permissible drift loss	**:**	Max. 0.002 %
2.11	Design pressure for hot water distributionsystem	**:**	6.2 kg/cm^2(g)

2.12	Maximum foundation Diameter (outermost edge of foundation)	:	NA
2.13	Minimum Basin Diameter	:	140 M
2.14	Maximum Cooling tower flow capacity to be considered for design of hot water distribution and cold water channel	:	Min 120% of design CW flow.
3.0	**SPECIAL FEATURES**		
3.1	Basin type		Sectionalized (two compartment) by partition wall. Each basin chamber shall have overflow arrangement and sludge pit end with necessary dewatering arrangement.
3.2	Whether fills are removable	:	Yes
3.3	Fills supporting by nailing acceptable	:	No
4.0	**Cold Water Basin Details**		
4.1	Finished ground level	:	EL (-) 1.5 M (RL+ 80.0 M FOR UNIT- 1 &2) EL (+) 1.5 M (RL+ 83.0 M FOR UNIT- 3,4&5)
4.2	Maximum water level	:	EL (-) 0.4 M (RL+ 81.1 M FOR UNIT- 1 &2) EL (+)2.6 M (RL+ 84.1 M FOR UNIT- 3,4&5)
4.3	Min. Water level	:	EL (-) 1.0 M (RL+80.5 M FOR UNIT- 1 &2) EL (+) 2.0 M (RL+ 83.5M FOR UNIT- 3,4&5)
4.4	Storage capacity between Normal and minimum water levels.	:	6 minutes (Between Max. & Min. Water Level) of Cooling tower design Flow.
4.5	Invert level of CT Basin	:	EL (-)1.5 M (RL+ 80.0 M FOR UNIT- 1 &2) ---at basin centre EL (-)2.08 M (RL+ 79.42 M FOR UNIT- 1 &2) ---at basin periphery EL (+)1.5 M (RL+ 83.0 M FOR UNIT- 3,4&5) ---at basin centre EL (+)0.92 M (RL+ 82.35 M FOR UNIT- 3,4&5) ---at basin periphery
4.6	Invert level of CW Channel near CT level	:	EL (-)1.5 M (RL+ 80.0 M FOR UNIT- 1 &2) EL (+) 1.5 M (RL+ 83.0 M FOR UNIT- 3,4&5)
4.7	a) Depth of Sludge pit b) Submersible type sludge pumps	: :	Suitable for complete dewatering. To include sludge pump submergence & clearance depth below basin/ channel invert level 1 working + 1 standby (Min capacity of 200 cub M / hr)
4.8	Number of sludge pits	:	Sludge pit with isolating valves, and spool pipe shall be provided for individual basin chambers for connection to drainage pipe.
4.9	Number of cold water outlet channels	:	One for each compartment of CW basin. Cold water outlet shall be designed for flow velocity through

			them within 1.2 M/sec during the rated flow from cooling tower, with the minimum water level in the cold water basin. At T.P Bidder to match same as per T.P. Drawing.
4.10	Depth of CW channel		4.4 M from FGL
4.11	Number of screens and gates in common outlet channel	:	One for each compartment of CW basin
4.12	Maximum allowable effective velocity through Cold water channel at Min. Water Level	:	1.2 M/Sec.
4.13	Maximum allowable effective velocity through gates at Min. Water Level	:	1.2 M/Sec.
4.14	Max. allowable effective velocity through screens at Min. Water Level	:	1.2 M/Sec.
4.15	Length of outlet channel including expansion joint in bidder's scope	:	As per terminal point details in Section C1 and details as shown in the enclosed Annexure-2.
5.0	**COOLING TOWER ACCESS DETAILS**		
5.1	Required number of stair cases from ground level up to hot water inlet for convenient access to top & interiors of Cooling tower	:	Two (2) Nos.
5.2	Number of cage ladders from ground floor to cooling tower top.	:	Minimum Four (4) Nos.: Two from reinforced concrete stairs to platform at the top of the tower and other two shall be from ground level itself.
5.3	Internal walkway of platform with hand rails	:	Walkways and platforms shall be provided inside the tower at distribution pipe level. These walkways and platforms shall provide safe and clear access to all sprayers and all distribution pipes. Clear width of walkways shall be 1.5M.
5.4	External walkway platform	:	1.2 M width around the circumference at top and at each aviation lamp levels
5.5	Platform for access of BFV	:	To be Provided by Bidder
6.0	**HOT WATER SUPPLY HEADER TERMINALS**	:	As per terminal point Annex-2 enclosed. CW piping in BHEL scope 3840mm X 20mm thk. shall be terminated with centre line of pipe elevation as shown in sketch. Further Piping from T.P. with isolating Motorized B.F. Valves in each riser shall be in bidder's scope.
7.0	**SCOPE OF SUPPLY :**		
7.1	Cooling tower basin outlet channels/ sump	:	Yes

	and sludge pits		
7.2	Hot water piping to distribution Duct	:	Yes
7.3	Hot water header isolation valves(motorised) on risers	:	Yes
7.4	Flanges/counter flanges for all flanged connections with bolts, nuts & gaskets etc.	:	Yes
7.5	Screen & guide for each cold water outlet sump/ channel	:	Yes
7.6	Stop Log gate with guides and sealing device for each cold water outlet sump/ channel.	:	Yes – Sluice gate / butterfly valve with complete head stock arrangement is required
7.7	Isolation valves in sludge pit	:	Yes
7.8	Drain Piping from sludge pit to terminal point	:	Yes
7.9	Pulley block for lifting each screen and stop log gate in cold water outlet sump/ channel	:	Yes
7.10	All necessary supports, hangers	:	Yes
7.11	Base plates, foundation plates, anchor bolts, sleeves, inserts, bolts, nuts for all equipment supplied	:	Yes
7.12	Drift Eliminator	:	Yes
7.13	**Electrical**		
	As per electrical plant specification	:	Yes
7.14	All related Civil works included	:	Yes
8.0	**MATERIAL OF CONSTRUCTION**		
8.1	Cold water basin, outlet channel/ sump & sludge pit.	:	R.C.C.
8.2	Shell/Casing & Superstructure	:	R.C.C
8.3	Basin partition wall	:	R.C.C
8.4	Internal walk way	:	R.C.C.
	External walkway platform		R.C.C
8.5	Staircase/Ladders	:	R.C.C./ HDG Steel

	Hand rail		Hot dip galvanized steel
8.6	Supporting structures	:	R.C.C.
	Hot water distribution basin	:	R.C.C
8.7	Hot water distribution nozzles	:	High Density Polyethylene or polypropylene or approved equal
8.8	Fills	:	PVC Splash V-bar type of approved make
8.9	Fill support col, beams & trusses	:	R.C.C
8.10	Louvers	:	R.C.C.
8.11	Drift eliminators	:	PVC UV Stabilised
8.12	Fasteners/wetted parts	:	SS-316
8.13	Piping	:	**Above 150 Nb** : Carbon steel plates to IS 2062 internally lined with anticorrosive coal tar epoxy paint of min. 200 Microns DFT, rolled and welded as per IS 3589 **Below and 150 Nb** : IS 1239 (Heavy Grade)
8.14	Hot Water Distribution Pipes (Inside CT)	:	HDG Steel / PVC
8.15	Hot water line valves		
	a) BF Valves	:	Body: CI as per IS-210, FG-260 Shaft: SS304 as per ASTM A-479 Test pressure & duration shall comply with AWWA C504
	b) Sludge pit isolation valves		
	Body	:	CI as per IS-210, FG-260
	Spindle & Trim	:	SS
8.16	Sludge outlet pipe	:	CI IS-1536, LA
8.17	Submersible Pumps	:	Casing: CI as per IS-210, FG-260 Impeller: Stainless Steel
8.18	Sluice gates with rubber seals in cold water outlet channel	:	As per appropriate class of IS: 3042, all mild steel parts to be galvanised.
8.19	Guide for stop log gates	:	SS 316L
8.20	Screen	:	SS -316
8.21	Guide for Screen	:	SS- 316 L
8.22	Bolts, buts & other hardware	:	SS-316 (for wetted) and MS for other

Note:

(a) Carbon /Mild steel parts or structures used in Cooling Tower or its vicinity shall be Heavily Galvanised.

(b) Material of construction for items not specified shall be subject to purchaser's approval during detailed engineering stage, in the event of order.

9.0	Pipe work Painting / Protection of Pipes:		
9.1	Internal surface		Surface preparation : Shot blasting or Grit Blasting. Internal Paint: Application of one (1) coats of each coat 40 to 50 microns) Epoxy resin based red oxide primer followed by adequate no. of coats of coal tar epoxy paint to achieve total DFT of min. 200 microns.
9.2	External surface – over ground piping	:	Surface preparation : Shot blasting or Grit Blasting. External Paint: Application of one (1) coat of (DFT of each coat 40 to 50 microns) Red lead primer followed by adequate no. of coats of synthetic enamel paint to achieve total DFT of min. 200 microns.
9.3	External surface – Burried piping	:	Surface preparation: Shot blasting or Grit Blasting . **External Paint**: (a) As per IS 10221: i) All Primer / coating / wrapping materials and method of application shall confirm to IS:10221 except asphalt/Bitumen material. Materials (Primer / coating / wrapping) as per AWWA-C-203 are also acceptable. ii) Protective coating shall consist of coal tar primer, coal tar enamel coating, glass fiber, tissue inner wrap followed by glass fiber or coal tar impregnated kraft outer wrap or finish coat. iii) Number of coats & wraps, min. thickness for each layer of application shall be as per IS-10221. Number of coats & wraps shall be decided based on soil resistivity as indicated in IS-10221. iv) Total thickness of completed coating & wrapping shall not be less than 4.0 mm. (b) Alternatively, the anti-corrosive protection for buried pipes can consist of anti-corrosive protection coal tar tapes. Material and application of tapes shall conform to IS 15337 or equivalent. These tapes shall be applied hot over the cold coal tar primer in steps of 2mm thickness so as to cover the spiral edges of the first tape by the application of second tape. The total thickness of finished protective coating shall be 4.0 mm minimum.
	INSPECTION AND TESTING		
10.0	Quality Surveillance by	:	Manufacturer, purchaser and customer
10.1	Material testing and identification	:	Required
10.2	Stage inspection to be witnessed by Purchaser and customer	:	Yes
10.3	Hydrostatic test for piping & valves required	:	Yes

10.4	Hydrostatic test to be witnessed by Purchaser and customer	:	Yes
10.5	Field performance test of individual items and the cooling tower as a whole required	:	Yes
10.6	Field performance test to be done by	:	By Bidder
10.7	All tests on the Butterfly valves at manufacturer's works to be witnessed by Purchaser	:	Yes
10.8	All testing instruments by supplier	:	Yes
10.9	Commissioning at site by	:	Bidder
10.10	Mandatory spares	:	Refer Annexure-5

Attachments:

Attachments:

a) Owner approved Thermal & Hydraulic Design Calculations of Natural Draught Cooling Tower (Annexure-1)
b) Owner approved General Arrangement Drawing of Natural Draught Cooling Towers (Sheets 1 to 6) (Annexure-2)
c) Owner approved Design Basis Report for NDCTs (Annexure - 3)
d) Cooling Water Analysis (Annexure - 4)
e) Mandatory Spares (Annexure - 5)

The following are the additional Technical Specifications for NDCTs. In the event of any contradictions or conflict between these specifications and the Sections IA, IB and IC, the stringent of the two shall prevail.

SECTION-A: SCOPE OF WORK

1.0 This specification covers the general requirements of construction and erection features and performance testing and commissioning of Natural Draft hyperbolic cooling towers (NDCTs).

2.0 It is not the intent to completely specify all aspects and details of the structure / works involved. However, the work shall conform in all respects to high standards of engineering and international construction and erection practices. Contractor's workmanship shall be such that the NDCTs are able to perform in continuous commercial operation without problems to the Owner. The Owner shall have the power to reject any work or materials, which in his judgment are not acceptable or not in full accordance with codes and/or international practices.

2.1 Time is of essence in this contract and hence, the NDCT contractor is required to mobilize all plant and machinery, engineers, supervisors and labour in adequate numbers to ensure that the construction work of all the five NDCTs is taken up, progresses and finished simultaneously as per Customer's schedule.

Apart from the above mobilization requirement the NDCT Contractor may consider time saving methods like painting of the shell and laying of Electrical items like GI conductors, cables, etc. lift by lift while constructing the shell. All such innovative measures to speed up construct work is required to be undertaken by the NDCT contractor.

3.0 The Contractor shall furnish all that is necessary and as required and/or demanded by the Owner even if such information is explicitly not sought herein. The scope of work includes, but is not limited to the following.

a) Construction of NDCTs including excavation, foundation, back filling, sand bedding, laying PCC, concreting, reinforcement, etc., providing electrically operated winches, jump formwork systems, separate lifts for movement of materials, passenger lifts to facilitate movement of staff and inspecting officers and proper communication system during construction period. BHEL will not bear any liability for any extra work, which might not have been perceived by the bidder but functionally required. The cost of such work will be entirely borne by the bidder.
b) Reinforced concrete basin including basin drainage, stop log gates & screens including guide frames and gravity conduits / channel up to the terminal point.
c) Material handling systems at CW channel, Sludge Pit, etc. wherever required.
d) Disposal of surplus excavated earth as directed by the Engineer.
e) Supply of all materials required at site for successful operation of NDCTs.
f) Hot water distribution piping system within the terminal points including Risers, Motorized Butterfly Valves, Internal Distribution Pipes, nozzles, fittings and supports.
g) Fill and its supporting frame works.
h) External RCC Staircases, RCC Platforms and Steel/FRP Doors, internal RCC Walkways and external Cage Ladders.
i) Hot dip galvanized MS handrails, fittings, fixtures, inserts etc., wherever required
j) Complete Earthing & Lightning protection and Aviation Warning systems.

k) De-sludging arrangements with knife-edge gate valves and Sludge Pumps, complete with electric motors, NRVs, isolation valves, piping, etc.

l) Water proof painting, Bitumastic or approved equivalent painting for all internal and external surfaces of basin, diagonal columns, fill supporting structure and inside surface of shell, and cement paint for external surface of shell as specified.

m) Supply and erection of hoist and monorails as necessary.

n) All necessary steel work, hardware etc.

o) Aviation Obstruction Lighting System complete with twin AOLs fixtures, brackets, hardware, JBs, Cables, Photo Cells, Lighting and Control Panels, etc.

p) Earthing & Lightning Protection System complete with GI coronal bands, GI down comers, fixtures, brackets, hardware, earth electrodes and risers and earth pits

q) Pitot tubes, Psychrometers, Temperature and Pressure gauges, Anemometers, Level Switches, etc required for performance monitoring and operation of cooling towers.

r) Trial commissioning and testing, including supply of all testing instruments and mounting the same. Also all isolating valves required on the flow measuring stubs shall be supplied by the Contractor during testing.

4.0 TERMINAL POINTS

a. Hot water pipe (as shown in the GA drawing)

b. Cold water channel (as shown in the GA drawing)

c. Earthing & Lightning protection System

2 nos. of pig tails of tower circumferential earth mat for connection with plant earth grid. However earth mat interconnection between the cooling towers is in CT contractor's scope.

d. Lighting, power receptacles & Aviation Obstruction Lighting System

ACDB input terminal and Aviation control panel's input terminal. Input terminals shall be suitable for Owner's 3 core cables.

e. Instrument cables (at instrument junction box)

f. Cables for drain pumps (input terminals of starter panel)

Note: Jointing at terminal points is in CT contractor's scope. If any of the terminal point is not ready, then the contractor shall leave the TP with all necessary jointing accessories such as PVC water stopper in channel etc., for connection by others.

5.0 SPECIFIC COMPLIANCE

It is necessary for the bidder to comply with the following documents/drawings enclosed with this specification:

a. Thermal & Hydraulic Design Calculations
b. General Arrangement of Natural Draught Cooling Towers (Sheets 1 to 6)
c. Design Basis Report

SECTION-B: MECHANICAL WORKS

1.0 GENERAL

The scope of Mechanical works and testing requirements are covered in this section. The specification gives a broad outline of the scope of work and services to be provided by the contractor and it is not the intent of this specification to cover all the granular details of the package. It shall be the responsibility of the contractor to provide all the necessary materials, works and services required to complete the project in all respects, even if the same are not explicitly mentioned in this specification.

All the detailed fabrication drawings shall be prepared by the contractor and got approved by the Engineer-in-Charge. All the latest revisions of relevant Indian and International standards are applicable in this contract.

1.1 MEASUREMENT & PAYMENT

For payment of work done under this section, the actual quantity erected in the NDCT as measured and approved by the Engineer-in-Charge shall be considered for payment. The quantities lost towards wastage, etc., shall be to the contractor's account and no bills toward wastages, etc. shall be entertained.

2.0 FILL

Fills are of PVC Splash type. Fills should be supported in SS 316 L grids with PP Clips in such a manner that movement in both horizontal & vertical directions are arrested. Additional SS/PP tie wire should also be used to ensure that the fills do not fall off position due to failure of clipping arrangement.

The fills should not sag with all the working, scaling and temperature loads envisaged, including the induced vibrations.

The fill shape, size and configuration shown in the GA drawing enclosed with this specification must be followed without deviation. No changes in these aspects will be permitted.

3.0 HOT WATER DISTRIBUTION SYSTEM

Hot water should flow into the RCC Primary Ducts through MS Riser pipes that enter the NDCTs through the air inlet as shown in the enclosed GA drawing. It is preferred that the water discharges into the duct from the bottom.

A RCC Secondary Duct shall receive hot water from the Primary Duct for distribution into specific segments as per design.

The lateral distribution pipes embedded in the Primary and Secondary Ducts are fitted with down-spray type nozzles, which spray water uniformly over the fill. Spray pattern over the fill should be

circular or square, but solid in either case to ensure equal and uniform distribution of water over the fill without resulting in dry spots at all plant loads.

The complete water distribution system should be rigidly secured to the supporting structure as shown in the drawings.

3.1 PRIMARY DUCT

Primary duct is designed as a RCC channel with cast in-situ slab on top (i.e. closed on top). Each primary duct has 2 Nos. of 1000 mm (W) x 1000 mm (B) x 1000 mm (D) min. open surge shafts cum manholes with rungs to access duct bottom. Each primary duct also has a 100 NB drain plug with dummy nut.

The primary duct also acts as a walk way across the tower. Hence, handrails are provided on both sides along the duct.

3.2 SECONDARY DUCT

A Secondary duct is required to distribute hot water over small segments of the circular area which cannot be catered to by the Primary duct. This duct too is designed as a RCC channel but with a cast-in-situ slab on top.

The secondary duct too acts as a walk way. Hence, handrails are provided on both sides along the duct.

3.3 LATERAL PIPES

Lateral pipes are of PVC or other material as shown in the drawings. The pipes should be with Spigot ends so that couplers for jointing are avoided to the extent possible. Reducers, End Plugs, etc. needed for the operation of the distribution system and as shown in the drawings shall be provided by the contractor. All the accessories shall be of the same rating as of the pipe (Class 3 to IS: 4985).

Lateral pipes shall have pre-fabricated holes at desired intervals (as shown in the drawing) for fixing of nozzles. No drilling will be permitted in pipes after these are installed/embedded in HW ducts.

Maximum diametrical tolerance of (+) 1 mm is allowed for the holes. And alignment of holes shall be within + 10 mm tolerance limit. Hence, it is suggested that the contractor make a suitable jig arrangement at ground level to achieve this requirement.

Nozzles should be fixed to the lateral pipes by bolting and tying with Polypropylene (PP) straps as shown in the drawings. In case of additional fastening with PP straps, the straps shall be capable of taking a minimum load of 30 Kg. Necessary accessories for fastening shall be of same material as of the strap. Bolts shall be of SS-304 material.

After installation, the system shall be rigid and leak proof. Care must be taken by the contractor while Lateral pipes are embedded in the side walls of the primary and secondary ducts to ensure that no leakage or failure occurs during commercial long-term operation.

Pipe joints shall be rendered leak proof by proper application of gluing compound and riveting as shown in the drawings.

Alignment of lateral pipes shall be within the tolerance limits specified above for the pre-fabricated holes. All the nozzles shall be aligned to the direction of gravity. The levels of the pipes and nozzles shall be maintained to result in uniform distribution.

3.4 NOZZLES

The nozzles shall be of down-spray type in PP construction. The spray pattern shall be either circular or square with a minimum diameter of 900 mm.

The contractor shall offer a nozzle that achieves the spray pattern and diameter specified at a static head shown in thermal design calculations. The final choice of the nozzle shall be subject to acceptance by the Engineer-in-Charge.

The tolerance on nozzle opening size for discharge shall be limited to ±1% of that shown in the drawings. Contractor shall demonstrate the performance at 80%, 100% and 120% water loads at nozzle vendor premises using a properly designed test rig. The contractor shall submit testing facility details along with test procedure for review and acceptance before under taking the performance test and procurement or supply of nozzles.

Owner reserves the right to witness the nozzle testing at vendor works. Contractor shall submit the nozzle performance curves to the Owner for review and final acceptance of the proposed nozzle type to achieve the performance envisaged in designs and drawings.

In case of any deficiency is found in nozzle performance at a later stage, the Contractor shall provide additional nozzles or nozzles of a better type without any additional cost to the Owner to meet the design requirements.

In case nozzles comprise of two or more parts, assembly of the same shall be either by threaded connection or SS 304 bolting. The Contractor shall submit a sketch/drawing of the nozzle and its fixing arrangement, including two sample pieces along with his offer.

3.5 HOT WATER PIPING

The MS hot water riser piping shall be connected to the Owner's hot water header pipe at the Terminal Point as shown in the drawing. The end connection shall be of welded type. If the terminal points of owner's header pipes are not ready, all the open ends of the pipes shall be covered with polythene sheets to prevent corrosion.

Steel pipes shall be made either by ERW/SAW methods. Steel pipes shall conform to IS: 1239 (Medium grade) and IS: 3589 (Fe 410 grade) as the case may be. Steel plates for pipes shall conform to IS: 2062. For pipe sizes up to 300 NB, seamless long radius elbows shall be used unless otherwise specified. For pipe sizes above 300 NB, mitre bends shall be used.

The Contractor shall provide the necessary civil & structural works, if required for all the independent foundations, thrust blocks, etc supporting the hot water pipe.

3.5.1 Butterfly Valves

Butterfly Valves shall be electrically operated Double flanged type meeting the requirements of AWWA C – 504 or BS: 5155. Necessary cabling for actuators and limit switches, etc shall be provided by the Contractor up to a common Junction Box located near the Staircase.

POD (Proof of Design) Test	: AWWA C – 504
Operating Fluid	: Water at 45 to 50 deg. C
Design Pressure	: 5.0 Kg./Sq.cm
Max. Differential Pressure	: 5.0 Kg./Sq.cm.
Head loss coefficient	: Max. 0.25
Body	: Cast Iron to IS: 210 Grade FG 260 'OR' Fabricated steel confirms to IS:2062/IS:2002
Shaft	: Stainless Steel to AISI 410
Bearing type	: Self-lubricated type
Disc seat	: Nitrile Rubber
Body Seat	: SS 316
Internal Hardware	: SS 304
External Hardware	: High Tensile Steel
Fasteners	: SS 304
Gland Packing	: Teflon
Gaskets, Rings, etc.	: Nitrile Rubber
Accessories	: 2 Nos. of 2NO + 2NC Limit Switches 'OPEN' & 'CLOSE'.

All the butterfly valves shall be complete with graduated position indicator, arrow indicating the flow direction, actuators, limit switches, etc. The valves shall be suitable for erection in any position (Horizontal / Vertical, etc.). The operating mechanism shall be mounted directly on or supported from valve body.

All the butterfly valves shall be provided with hand wheel. Butterfly valves of size 350 NB and above shall be provided with reduction gear units. Valves shall close in clockwise direction. The hand controls shall be dimensioned to guarantee an easy manoeuvre under most severe conditions. The hand controls shall be provided with locking systems to avoid the disk assuming a not desired position during operation. The pulling force required on the hand wheel-rim shall not exceed 30 Kg. when operating the valve under full flow and operating pressure, in case of failure of actuator. The reduction units shall be watertight, complete with lubrication and position indicator.

3.5.1.1 Flanges

For valves designed as per AWWA C-504, flanges shall conform to ANSI B16.1 Class 150 for CI valves and AWWA C-207 Class D for fabricated steel valves. The counter flanges shall conform to AWWA C-207 Class D.

For valves designed as per BS: 5155 the flanges shall be as per BS: 4504. All the flanges shall be of slip-on and flat-face type. Flanges shall be fabricated from steel plates conforming to IS: 2062.

3.5.2 Ball Valves:

Ball valves are envisaged mainly for flow measurement ports. These valves shall conform to IS: 9890 and are of threaded type.

Pattern and Construction : Full bore in single piece

Nominal size : 150 NB

Design pressure : 6 kg/sq.cm

Material of construction : Carbon Steel Valves to IS: 9890

3.5.3 Sluice Gate (if applicable)

The sluice gate shall be of circular opening conforming to IS: 3042 Class – 1, with rising spindle. The materials of construction of the gates shall be as follows:

Frame and Door : CI Grade 20 of IS: 210 with an inside coating of Epoxy coal tar.

Face, seat rings, trim and Spindle Nut : SS 316

Spindles, bolts and nuts : Hot dip double galvanized MS

Each sluice gate shall be furnished complete with extension spindle through extra-strong pipe of required length connected to the floor-stand through stem coupling. The floor-stand shall be provided on concrete floor of the drain box. Each gate shall be furnished with bell-bottom base and

shall 815 mm high, provided with an indicator and open/close positions clearly marked on the stand. The floor-stand shall be furnished with 450 mm diameter hand wheel and wheel-stem coupling to suit the sluice extension pipe.

3.5.4 Miscellaneous

Each hot water header shall have 3 Nos. of 150 NB, 200 mm long MSHDG stubs with threaded or flanged ends (depending on valve ends) for measurement of water flow with Pitot tube. Each stub shall be fitted with 150 NB Ball Valve for isolation purpose. All necessary bolts, washers, nuts shall be of MSHDG.

Each hot water header shall have one number stub for pressure gauge with isolation valve and one thermowel for temperature measurement.

3.6 CONSTRUCTION FEATURES OF M.S. PIPING:

3.6.1 End Preparation, Cutting, etc.

For steel pipes, end preparation for butt-welding shall be done by machining/flame cutting. Socket weld preparation shall be saw/machine cut. All the welding electrodes and other requirements for welding, including any special material, shall be arranged by the contractor.

For tees, laterals, mitre bends and other irregular details, template shall be used for accurate cutting.

3.6.2 General Instructions for Piping Construction

While erecting the field run pipes, the contractor shall check the accessibility of valves, instrument tapping points and maintain minimum head room requirement and other necessary clearances from the adjoining work areas. Irrespective of whether mentioned in the drawings or not, all pipelines shall be given proper slope towards the drain point.

3.6.3 Welding:

a. Before welding the ends shall be cleaned by wire-brushing, filing or grinding.
b. Welding of piping shall be done by certified welders. Welders' qualification shall be as required by ASME Section-IX. Welding at any joint should be completed in one go.
c. Welding under this specification shall be done by a process approved by the Engineer-in-Charge.
d. Automatic or semi-automatic welding shall be done only with the specific approval of the Engineer-in-Charge.
e. As far as possible welding shall be carried out in flat position. In case that is not possible, welding shall be done in a position as close as to the flat position as possible.
f. Downward technique is not allowed in the welding of pipes in horizontal position, unless permitted by the Engineer-in-Charge.

g. Combination of welding processes or usage of electrode of different classes or 'makes' in a particular joint shall be done after the welding procedure has been duly qualified and approved by the Engineer-in-Charge.

h. Welding carried out in ambient temperature of 50°C or below shall be heat-treated.

3.6.4 Alignment & Spacing

a. The pipes joined by welding shall be aligned correctly within the existing tolerance on diameters, wall thickness & out of roundness, which shall be preserved during welding. All flange facings shall be true and perpendicular to the axis of the pipe with bolt holes being off centre, unless different orientations are shown in drawing to match some equipment connections.

b. Components to be welded shall be aligned and spaced.

c. Root opening shall be 1 mm to 2 mm for wall thickness of 2.4 mm or under and for all thicknesses in oxy-acetylene welding. For 2.4 mm and above, root opening shall be 2 mm to 3 mm.

d. Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form a part of final welding these shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints.

e. Electrode size for tack welding shall be selected depending upon the root opening.

f. Tack welding should be equally spaced as follows:

For 65 NB pipe and smaller	: 2 tacks
For 80 NB to 300 NB pipe	: 4 tacks
For 350 NB & larger pipes	: 6 tacks

3.6.5 Welding Technique

a. Root pass shall be made with respective electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.

b. Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxy-acetylene welding is recommended.

c. The route pass of butt-joints shall be so as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.

d. Each pass shall be cleared to be made free of slag before the next pass is deposited.

e. In case of deviation from the welding process and electrodes as specified, the contractor shall seek the approval of Engineer-in-Charge before implementing the change.

f. On completion of each run, craters, weld irregularities, slag, etc. shall be removed by grinding or chipping.

g. During the process of welding, all movements, shocks, vibrations or stresses shall be carefully avoided in order to prevent weld cracks.

h. Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG (3.25 mm). At least two passes shall be made on socket weld.

4.0 BASIN

Basin is divided into two equal parts by a diametrical partition wall. Each NDCT basin compartment shall be provided with a cold water outlet and a drain sump at the opposite ends. A peripheral drain shall be provided with a minimum floor slope of 1:400 towards the drain sump for easy cleaning of the basin. The basin floor itself, in turn will be provided with a slope of 1:120 towards the peripheral drain.

Sludge will be removed using portable pumps, which shall be supplied by the contractor. The Contractor shall make all provisions such as platforms with handrails, discharge piping up to terminal point, etc. for smooth operation of these pumps. Rungs shall be provided up to the bottom of sump in each compartment for maintenance of valves and pumps.

5.0 COLD WATER CHANNEL

Cold water outlet near cooling tower is partitioned into two parts. Each part of cold water outlet shall have Screens and Stop Log Gates as shown in the drawings. Guide frames of Screens and Gates shall be interchangeable.

To obtain proper alignment of the guide channels, a bigger slot will be left in the concrete and after fixing the channels in position the grouting of these channels will be done by secondary grout/concrete so that fixtures do not get disturbed.

Monorails with push trolleys, chain pulley blocks and hooks shall be provided for handling of gates and screens,. The structural arrangement required for the monorails shall also be provided by the contractor as per the approved drawings.

A walkway with handrails shall be provided across the outlet for easy operation of gates and screens. Both the compartments of cold water outlet shall be combined into a gravity channel at the end of the partition wall as shown in the drawings. The combined cold water outlet shall be covered with RCC cast-in-situ slab up to terminal point. Termination of cold water outlet shall be done with PVC water stopper.

5.1 SCREEN

Mesh	: SS 316 L
Mesh Size	: 25 mm x 25 mm to IS: 2405, Part 1
Supporting Frame	: SS 316L slide parts.
Guide Frame (Embedded in Concrete)	: SS 316 L sealing surface
Trash Tray	: SS316
Fasteners	: SS 316

Screens shall freely move inside the structural framework embedded in the concrete walls of the open channel. Screens provided in the outlet channel shall have a trash tray incorporated on the upstream side of the bottom edge of the screen to catch any debris falling down the screen during removal.

5.2 STOP LOG GATE

Standard	: IS: 5620
Guide frame (Embedded in Concrete)	: SS 316 L sealing surface
Gate (including supporting frame)	: IS 2062 Gr. A
Skin plates of gate	: Min. 8thk designed as per IS 5620
Slide Seal	: EPDM Musical note confirms to IS: 11855
Bottom Seal Plate	: SS 316 L
Painting	: Specified elsewhere
Fasteners	: SS 316

Slide gate constructed in hot double-dip galvanized structural steel sections shall be furnished as per the drawings to be given during execution. The gate shall move freely inside a structural framework embedded in the concrete walls of the open channel. The gates shall have a continuous bearing under compression all around the opening ensuring no leakage.

6.0 ACCESS

6.1 STAIR CASE

All stair cases shall be 'Dog Legged'. The minimum clear width of the stairways and platforms shall be 1000 mm. Minimum clear headroom of 2.5 m shall be maintained over platforms and walkways.

6.2 ACCESS DOORS

The doors shall be of single leaf – double skin type and of 2.1 m (H) x 1.2 m (W) size fabricated from 1.25 mm thick MSHDG steel construction. Painting shall be carried out as specified elsewhere. Alternatively, the Contractor may offer these doors in FRP material as well.

6.3 CAGE LADDER

The cage ladder shall conform to IS: 3696. The ladders shall be min. 600 mm wide and made of hot double dip galvanized 75 mm x 6 mm thick flats with 20 mm diameter rungs at 300 mm centres with

stays at every 1.75 m connected to the wall. The ladder shall be provided with a hot double dip galvanized MS cage consisting of 50 mm x 6 mm straps at 800 mm centres with min. five (5) Nos. 50 mm x 6 mm vertical cage flats throughout the complete length of the ladders. Intermediate landing platforms with handrails, as required and/or as shown in the drawings shall be provided.

6.4 WALKWAYS

Walkways shall be min. 1000 mm wide and shall have min. 2.1 m headroom, unless otherwise specified. All walkways shall have safety handrail of min. 1.2 m height on both sides.
6.5 RUNGS

MSHDG rungs of 25 mm diameter shall be embedded in RCC walls wherever required. Each rung shall be 450 mm wide x 150 mm above wall face unless otherwise specified.

7.0 MATERIAL HANDLING FACILITIES

7.1 AT TOP OF SHELL

During maintenance of the tower, to lift the materials like lighting poles, aviation lights, welding machine etc., from ground to the top of the tower, material handling provision to be made at the top of the tower. MSHDG plates of size 300 x 300 x 20 mm shall be embedded in the wall, flush with the outside concrete surface at 1 m C/C on the shell circumference at the top most platform level. Each plate shall have four tapped holes with nuts welded to the back of each hole (for having extra-long thread engagement) for fixing bolts later. The drilled and tapped holes and nuts shall be suitable for 20 mm diameter bolts. Care shall be taken to prevent entry of concrete into the nut and tapped holes. This arrangement is to support a swivelling lifting arm to hoist a load of 1000 kg.

7.1.1 PORTABLE ROTATING TYPE LIFTING ARM

Lifting arms including swivelling brackets, pins, etc. complete shall be provided along with 250 mm diameter CS pulleys. It shall be possible to easily erect/dismantle this arrangement as and when required. All structural steel sections, brackets and inserts such as bolts, nuts, plates, etc., shall be of MS hot dip galvanized.

7.2 FOR SCREEN AND SLIDE GATE IN COLD WATER CHANNEL

Monorail beam at sufficient height shall be provided. A hand operated chain pulley block with traveling trolley of capacity not less than 125% weight of slide gate shall be provided. All other accessories for this system shall also be designed for the same load. Monorails shall be extended outside the cold water channel to lift/lower the equipment from/to the ground level.

Life	: Not less than 20 years
All CI parts	: Grade FG260 of IS: 210
Chain pulley blocks	: IS: 3832, Class 2 duty
Hand operating chain	: IS: 2429 grade 30 pitched & polished

Load Chain : IS: 3109 grade 40

Hook : IS: 7847

MOC of hook : High tensile steel and heat treated as per Clause 7.1 (b) of IS: 3815

Wire ropes/slings : IS: 2266

8.0 HARDWARE

All the hardware immersed in water or in direct contact with water/water spray shall be of SS 304, unless otherwise specified. The hardware not in contact with water or moisture shall be of MSHDG, unless otherwise specified.

10.0 TESTS:

The contractor shall submit detailed QAPs for approval. Typical QAPs are given elsewhere in this document.

10.1 FILL

10.1.1 Material Test

For plastic fills and drift eliminators impact tests shall be done as per ASTM-D-256 and flammability tests as per ASTM-D-635. Density and Vicat softening tests shall also be done. The contractor shall submit test certificates from approved third party laboratories for approval by the owner. All tests on Fills & Drift Eliminators shall conform to CTI STD-136.

10.1.1.1 UV Test for Plastic fills

UV test shall be done as per ISO-4892. Impact test shall be done before and after UV test. Test certificate from approved third party laboratories shall be submitted for approval by the owner.

10.1.2 Dimensional Test & Load Test on Fill

Dimensional accuracy and material thickness will be checked randomly at site. Load Test shall be done on a mock fill assembly. Both the tests will be done in presence of Engineer-in-Charge.

10.2 BUTTERFLY VALVES

Butterfly valves shall meet the proof of Design test and Disc strength test confirm to AWWA-C-504. Seat leak test shall be done in both directions. In case of fabricated valves, UV test on plates 20 mm or above thickness for body, disc and shaft shall be done. Radiography test on 100% butt welds and 10% DPT on fillet welds shall be done in presence of Engineer-in-Charge.

10.3 GATE/BALL VALVES

Material test, DPT for 100% butt welds and 10% fillet welds, assembly fit up and hydraulic test shall be done and certificates of same to be submitted for approval.

10.4 SLIDE/STOP LOG GATE

Material and DPT for 100% butt welds and 10% fillet welds shall be done and certificates of the same shall be submitted for approval. Assembly fit up, Dimensional accuracy and Leak tight test shall be done at site.

10.5 CHAIN PULLEY BLOCKS

Test certificates of material and DTP shall be submitted for approval. Full load test and 25% overload test shall be carried out with all motions and safety features at site.

10.6 HOT WATER PIPES

Certificates of material and welder qualification shall be submitted for approval. Assembly fit up, dimensional accuracy, DPT and NDT (if required) shall be done at site.

10.7 SCREENS

Certificates of material and DPT shall be submitted for approval. Assembly fit-up test and dimensional accuracy shall be done at site.

11.0 VENDORS LIST

S. No	DESCRIPTION	VENDORS
1.	Testing Agency for Fills & D/E	Shriram Labs, New Delhi / CIPET, CHENNAI
2.	Butterfly Valves	AUDCO / FOURESS / KEYSTONE / IL / INTER VALVE/ KIRLOSKAR / DYNAMIC
3.	Structural Steel	SAIL / TATA / JINDAL / VIZAG STEEL
4.	PVC Pipes	SUPREME / FINOLEX / PRINCE
5.	Push Trolley, Chain Pulley Block, Hook & Chain	WMI / INDEF
6.	Red Oxide Zinc Chromate Primer	'APCOMIN' OF ASIAN PAINTS / BISON UNIVERSAL OF BRITISH

		PAINTS / '3100' OF JANSON & NICHOLSON / SYNTHETIC ZINC CHROMATE OF SHALIMAR PAINTS
7.	Epoxy Primer	HINDUSTAN CIBA GEIGY / Dr. BECK & Co / CHEM.E.LEEK
8.	Epoxy Paint	HINDUSTAN CIBA GEIGY / Dr. BECK & Co / CHEM.E.LEEK
9.	Aviation Obstruction Lights	BINOY / INSTAPOWER / AVAIDS
10.	PVC Fills & D/Es	CONTRACTOR'S OWN MAKE / MM AQUA
11.	SS Weld / FRP Mesh	CONTRACTOR'S OWN MAKE / WIRE NETTING INDUSTRIES / JEETMUL JAICHANDLAL / NBC Weld Mesh
12.	Nozzles	CONTRACTOR'S OWN MAKE / VULQUA

This vendor list is tentative and shall be subject to CUSTOMER approval during detailed engineering.

SECTION-C: ELECTRICAL & INSTRUMENTATION

1.0 AVIATION OBSTRUCTION LIGHTING SYSTEM (AOLS)

The aviation obstruction lights shall meet the recommendations of ICAO and all the requirement of Director General of Civil Aviation, India and FAA guidelines in general.

Aviation lights shall be fixed on the top of NDCTs. Type of fixtures shall be as listed below.

Tower height	Type of Light	Description
<= 150m	Type B, Medium Intensity	Red flashing light with directional intensity of 2000cd ± 25%. Flash frequency shall be in the range of 20 to 60 per minute
> 150m	Type A, High Intensity	White flashing light with directional intensity of 200000cd ± 25%. Flash frequency shall be in the range of 40 to 60 per minute

The number of fixtures shall be as given under.

Top diameter	No. of fixtures
<=20 ft	3
20 ft < >= 100ft	4
100 ft < >= 200ft	6
> 200 ft	8

All flashing lights shall flash simultaneously. Low and Medium intensity lights, if applicable should be operated only in night times. High intensity lights should be operated in day time with full intensity (2,00,000 Cd), during twilight times with 20,000 Cd and in night times operates with 2,000Cd intensity. Installation and setting angles for high intensity lights shall conform to table no.6.2 of ICAO / FAA guidelines.

1.1 AVIATION OBSTRUCTION LIGHTS (AOL)

Each AOL fixture shall have 100% standby light i.e. twin type. In case of failure of any operating light, the standby should be activated automatically with auto changeover facility giving hooter feedback. AOL shall be LED type conforming to IP-65 grade protection class. High intensity lights shall have

intensity step changers. The control panel for the AOLs shall be mounted near the main distribution board under the staircase.

1.2 Photoelectric light detectors shall be furnished and installed near NDCTs to monitor the north sky. The detector shall cause the control unit to energize the aviation lighting system with the north sky illuminance. The lighting system may be energized during short periods of decreasing illumination due to abrupt periods of shadow during daylight hours, but shall not be de-energized as the result of short periods of increasing illumination levels due to lighting flashes or stray light sources when overall illumination level is such that the system is operating.

1.3 Temporary warning lights shall be installed during construction and these shall be located above the top most point of the obstruction and shall be shifted as construction progresses. These lights need to be installed only after the level of obstruction is greater than 50 m above ground. Temporary warning lights shall be of four fixtures each with not less than 10 candelas of red light. Power for operation of the temporary lights shall be obtained from the construction power system. Electrical circuits and cables for these lights shall be furnished, installed and maintained by the Contractor during the construction / erection period. These lights shall be operated right from sunset to sunrise.

1.4 The contractor shall provide hand railing around the beacon platforms, if applicable for attending to any maintenance work.

1.5 The AOLs shall be adequately secured to the handrails / parapet wall of the top platform against wind forces.

1.6 All cables shall be supplied and fixed as per relevant IS codes, clamped at intervals of 1000 mm by the side of the ladder. The cables shall be PVC insulated and PVC sheathed / armoured copper conductor of 650/1100V grade heavy duty conforming to IS: 1554 Part – I (latest revision). The cable shall be subject to Owner's approval.

1.7 The contractor shall install weatherproof terminal boxes with cable glands on top of the NDCTs at a location close to the AOLs. Suitable pull boxes shall be provided at convenient locations.

1.8 There will be two incomers – one main and the other stand-by. Automatic changeover facility with manual option shall be provided in case of failure of main incomer. Standby incomer will be disconnected once the main incomer is restored with suitable delay. A 0-30 second delay timer should be provided to prevent change over taking place for very short-term failure. A16 ampere or higher rating circuit for AOLs shall be provided. The aviation warning lights shall be controlled by photoelectric cell facing north sky through contractor. Auto manual operation selector switch shall be provided for 'ON' and 'OFF' operations. A wall mounted, sheet steel enclosed type Distribution Board (DB) shall be supplied and installed at the ground level for below the staircase. It shall have arrangement to receive Owner's PVC cable (size to be intimated later) and shall have an isolating switch and separate switch fuse circuits for feeding the aviation lights. The DB shall be outdoor type dust and vermin proof and shall have a sheet steel thickness of not less than 2 mm and shall have a proper gasket with removable gland plates at top and bottom. The DB shall also house the automatic switching arrangement described above. The board shall be dead front type; all equipment shall be mounted on auxiliary door. The DB shall be provided with two separate and distinct Grounding terminals. The cables and cabling between distribution board, flashing control unit and AOL fixtures shall be in Contractor's scope.

1.9 Lighting fixtures, conduits, junction boxes, etc., shall be properly earthed using GI wire of 14 SWG. Earth wire will run along the entire length of the cable between the fixtures and DB where it will be connected to the earth.

1.10 Contractor's scope includes supply, installation, commissioning and maintenance of the complete AOL system and its cabling until the NDCTs are taken over by the Owner. The scope shall also include the associated civil works.

1.11 AOL system shall be test operated by the Contractor for not less than 12 months from the date of trial commissioning. Equipment and work that fails during the test period shall be repaired or replaced at the option of the Engineer-in-Charge. Upon any failure in this system during the test period, a new test period of 12 months will be required after repair or replacement of the equipment that has failed.

1.12 POWER RECEPTACLES

32A TPNE industrial type switch-socket outlet(s) shall be provided on the top peripheral platform and on landing platforms, if applicable as specified elsewhere.

2.0 EARTHING AND LIGHTNING PROTECTION

The Contractor's scope of supply for lightning protection includes complete system required as per IS: 2309 from air termination rods to earth mat and electrodes, whether specifically mentioned herein or not.

Grounding system shall confirm to IS: 3043. Each air terminator shall be connected to individual earth-pits through individual down conductors and earth conductors. Apart from the above, a coronal band and an earth mat shall be provided for each NDCT. Depending on the number of earth pits, four shall have test links and two shall have pigtails for connecting to main plant earth grid. All structures and equipment (even the one which are not supplied by the contractor but are in the cooling tower area) shall be connected by minimum two parallel conductors to nearest down/earth conductors.

2.1 Material of Construction

Material of conductors used above Ground level shall be of GI with zinc deposition of minimum 610 gm/m^2. All buried conductors are of MS round bars of min. 40 mm diameter.

a.	Air terminator	: 2 m long, 20 dia. Copper rod with pointed tip
b.	Coronal Band	: 75 x 10 thk GI flat
c.	Down Conductor	: 75 x 10 thk GI flat
d.	Earth Conductor	: 40 dia MS rod
e.	Earth Mat	: 40 dia MS rod
f.	Earth Electrode	: 3 m long, 40 dia MS rod
g.	Grounding for Columns & Structures	: 50 x 6 thk. GI flat
h.	Handrails & Steel structures	: 40 x 3 thk. GI flat

i. Grounding for Distribution boards & Control Panels, etc. : 40 x 3 thk. GI flat

j. & Grounding for Power outlets Lighting Fixtures : 14 SWG GI wire

2.2 AIR TERMINATOR

Tip of air terminator shall be pointed and at least 1.2 m above top of cooling tower. Air terminator shall be clamped with heavy-duty GI clamps at a minimum of 3 points to the structure. Air terminators shall be connected to down conductor and coronal band by use of pressure type fittings.

2.3 CORONAL BAND

Cooling tower shall have a coronal band connecting all air terminators provided at the top of the cooling tower. It shall be clamped to structure at 1000 C/C intervals all around.

2.4 DOWN CONDUCTOR

Down conductors shall be connected to Air terminators via the Coronal band at the top of the cooling tower and to the earth conductor at 300 mm above FGL through a test point at 1.2 m above grade. These conductors shall be continuous as far as possible. Intermediate breaks if any, shall be welded to form continuous circuit from top to bottom. Lapping of down conductor by bolting is not acceptable. These conductors shall be embedded in the outer surface of the concrete shell and diagonal columns with a minimum cover of 50 mm. These shall come out of the shell at the top of the cooling tower and at the ring beam level.

Ladders shall be electrically connected to the down conductors at top, middle and bottom by bolted connections.

2.4. TEST LINK

Test link shall be of 50 x 6 thk GI flat with electroplated bolts, nuts and washers. Test link shall be installed in a GI box fixed on the outside surface of the raker column.

2.5 EARTH CONDUCTOR

Earth Conductor shall be connected to down conductor, earth mat and earth pit by welding. Earth conductor shall be taken through approx. 1.3 m long, 100 NB AC pipe filled with PCC (1:3:6).

2.6 EARTH MAT

Cooling tower shall have a circular earth mat of diameter at least 12 m more than the cooling tower sill diameter and laid at 1000 mm below the ground. All the joints shall be of welded type.

2.7 EARTH PIT

Earth Pit shall be constructed as per IS: 3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600 mm. Earth Pits shall be treated with salt and charcoal, in case average resistance of soil is more than 20 ohm-meters.

2.8 CLAMPS & ANCHORS:

All connections, clamps, anchors, etc. of the lightning protection system shall be made of GI fittings. All joints, unless otherwise specified shall be clamped or bolted (min. 2 Nos. of bolts) to form high pressure contact for a connection of adequate current carrying capacity and mechanical strength.

2.9 VERTICAL AND HORIZONTAL REINFORCING BARS

All vertical reinforcing bars at the top and the bottom portion of the cooling tower shall be electrically connected to the nearest horizontal reinforcing bar and these bars shall in turn be connected to the down conductors. At locations where vertical reinforcing bar is spliced, each of the spliced bar shall be electrically connected to at least one horizontal reinforcing bar which in turn shall be electrically connected to the down conductor. These electrical connections shall be made by winding tightly with not less than five (5) wrapped turns of 14 SWG GI wire.

2.10 TEMPORARY LIGHTNING PROTECTION

Temporary arrangement for lightning protection during construction shall be maintained by connecting the reinforcement bars to two Grounding conductors of minimum size 50 x 6 thk. Temporary protection shall be provided even after the completion of the tower till such time that the permanent air termination rods and various conductors, etc. are installed.

3.0 INSTRUMENTATION
3.1 PRIMARY INSTRUMENTS

a. Thermowel

Thermowel shall be of one piece solid bore type in SS 316 and of step-less tapered design as per ASME PTC 19.3.

b. Temperature Gauge

Range	: 0^o C – 50^o C (linear 270^o arc in metric units)
Accuracy	: + 1% of span
Dial size	: 150 mm
Sensing element	: Mercury in steel with SS Bulb and Capillary
Body material	: Die-cast aluminium
Protection	: IP55
Zero / Span adjustment	: Required
Accessories	: SS Thermowel

TELANGANA STATE POWER GENERATION CORPORATION LIMITED [TSGENCO]

YADADRI THERMAL POWER STATION
[5 x 800 MW]

NALGONDA, TELANGANA, INDIA

SPECIFICATION NO. PE-TS-417-600-C004

TECHNICAL SPECIFICATION FOR NATURAL DRAFT COOLING TOWER

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

VOLUME: VII-D

TECHNICAL SPECIFICATION
FOR
NATURAL DRAFT COOLING TOWER (NDCT)

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VOLUME: VII-D

TECHNICAL SPECIFICATION FOR NATURAL DRAFT COOLING TOWER

1.00.0 INTENT OF SPECIFICATION

1.01.0 This specification is intended to cover supply and installation of Five (5) nos. of Natural Draft Cooling Tower (NDCT) as detailed hereinafter for 5 x 800 MW Yadadri Super Thermal Power Station for Telangana State Power Generation Corporation Ltd. (TSGENCO) at Nalgonda, Andhra Pradesh.

1.02.0 The scope shall include design, engineering, construction of natural draft reinforced concrete hyperbolic cooling tower including all manufacture, assembly/ pre-assembly, tests at manufacturer's works, shop painting, seaworthy packing, complete with all accessories, auxiliaries as specified hereinafter and as required for safe and trouble free continuous commercial operation.

1.03.0 The scope of this specification also includes but not limited to erection/installation, supervision, including unloading, storage and handling at site, site testing, commissioning, trial run, performance and guarantee tests, training of operating personnel, O&M of the plant till commencement of commercial operation and other erection services to ensure trouble free operation and commissioning of the plant

1.04.0 It is not intended to specify completely herein, all details of design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation up to the vendor's guarantee in a manner acceptable to the purchaser, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work of material which in his judgment is not in full accordance therewith.

1.05.0 The provisions of this technical specification are general in nature and cover broad aspects. Technical specification outlines the minimum requirements. However, it would be absolute responsibility of the bidder to collect, interpret, analyze all necessary information / data for the successful design and construction of the cooling tower. Structural safety and successful operation of the tower shall be the total responsibility of the bidder notwithstanding the approval of the owner.

2.00.00 **CODES AND STANDARDS**

2.01.0 The design, construction, manufacture, performance, testing and commissioning of the cooling tower as specified hereinafter shall comply with the requirements of all applicable latest Indian /British/American Standards and Codes of Practice. The latest editions of the following standards and publications shall be followed in particular:

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

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

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

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

2.01.5 American Society of Testing Materials

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

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

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

3.00.0 **GENERAL PERFORMANCE REQUIREMENTS**

3.01.0 The cooling tower shall be designed for continuous operation to cool not less than the design flow of water from specified inlet temperature to outlet temperature at a design ambient wet bulb temperature and other design parameters as enumerated in the enclosed Natural Draught Cooling Tower Data Specification Sheets.

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

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

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

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

3.05.1 Heat balance calculations.

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

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

3.05.4 Calculations for tower duty coefficient and performance coefficient.

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

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

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

4.00.0 **SYSTEM DESCRIPTION**

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

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

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

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

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

5.00.0 **DUTY AND CAPACITY**

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

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

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

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

6.00.0 **SCOPE OF SUPPLY AND WORKS**

The following Equipment shall be supplied under this specification.

6.01.0 **General**

- Thermal, mechanical and structural design of cooling tower including all appurtenant civil works.
- Drift eliminators
- Supply at site of all materials and equipment required for construction.
- Construction of cooling tower including all work and services connected herewith.
- Construction of cold water basin, cold water outlet channel/ duct and basin de-sludge arrangement.
- Hot water distribution piping/ducting along with spray nozzle system.
- Supply, shop testing of components and erection of all mechanical equipment, PVC fill, Spray nozzles, etc.
- Complete lightning protection system, aviation obstruction lighting system, earthing including the necessary power distribution arrangement as per technical specification for "Electrical Equipment and Accessories, Vol.V-A & Vol.V-B".

6.02.1 **Detailed Scope of Civil Works**

- Excavation and back filling for columns foundation and substructure below cold water basin level.
- R.C. foundation raft & Cold water Basin, R.C. Shell, R.C. support framework for fill support.
- Hot water distribution duct.

  Painting of concrete surfaces shall be as per Cl. 9.09.00 of volume - VII D.
- Providing and installation of access doors in the shell of cooling tower including the necessary fittings and appliances on Tower Shell. The access doors shall be of heavy duty MS doors dully painted with 3 coats of epoxy paints.

- Main access RC staircase outside the tower up to Hot water Duct top, internal RC walkways and platforms all with necessary galvanized MS pipe handrails.
- Cold water channel outlet into gravity tunnel.
- De-sludging arrangement for each compartment of cold water basin.
- Provision of permanent acc ess ladd er up to top of tower manufactured in galvanized mild steel with adequate back-guards and landing platforms. The ladder s hall c omply wi th a ll applicab le regulations.
- Provision of peripheral drainage around cooling tower as per Cl. 9.11.00 of volume - VII D
- Necessary site clearing and grading all round the tower in accordance with specifications and drawings.
- Water fill test of c old water basi n, cold water outl et channel and tunnel.
- Hydro test of Hot water Duct.
- Supply and erection of all base plates, foundation p lates, anchor bolts, slee ves, nuts , fasteners, e mbedded p arts and any other likewise mat erial required for all electrical and mechanical equipment and accessories to complete the work.
- Rock anchors will not be considered for foundations in any case.
- Preparation and supply of all working drawings required for the work:
- Piling, excavation, dewatering, sh oring and s huttering, bac kfilling around underground structures and dispo sal of s urplus s oil outsi de the plant boundary / to the designated dump yard.

Any other works not menti oned herein, but suffici ently imp lied an d are necessary for completion and proper functioning of the cooling tower.

6.03.1 **Detailed scope of Mechanical works**

- Hot water dis tributions spray system of reliable & effic ient desi gn, along with its supporting arrangement.
- Hot water duct/pipe work along with supports and anchors.

- Gear operated with chain pulley arrangement isolation valves on hot water inlet piping before hot water distribution system to achieve basin maintenance.
- Painting both inside and outside surfaces of steel pipes with three coats of rust and corrosion resisting paint including thorough cleaning of the surfaces.
- Tower PVC fill, drift eliminators including all required supporting structure and accessories, etc. as necessary.
- Screens along with guides embedded in concrete at each of the cold water outlet channels from the cold water basin.
- Sluice gate with mechanical jack arrangement and guides in each of the cold water outlet channel connection from the cold water basin.
- Manually operated chain pulley blocks, together with the monorails and supporting frames for the handling of screen and gates.
- Cold water outlet duct/tunnel.
- Knife-edge gate valve/sluice valve in each de-sludge connection and also De-sludge piping up to the disposal point at local storm water drain channels.
- Tower Fill Hot water By-Pass Nozzle connections on Hot water duct/ piping for system lines flushing during commissioning.
- Instrument tapping provisions on hot water duct/piping and cold water duct/piping for carrying out flow and temperature measurement during PG test.

6.04.1 **Detailed Scope of Electrical Works**

Refer Volume V-B, Section-XV, Technical Specification for Chimney and Natural Draft Cooling Tower- Electrical works.

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

6.06.0 All accessories and hardwares.

6.07.0 One set of special tools and tackles.

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

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

7.00.0 **DESIGN AND CONSTRUCTION**

7.01.0 **Hot Water Distribution System**

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

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

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

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

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

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

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

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

7.01.9 The distribution troughs/pipes shall be independently supported from the structures and shall be easily removable. Provision shall also be made for easy flushing or cleaning of all troughs / pipes.

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

a) Self-weight.

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

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

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

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

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

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

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

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

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

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

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

7.02.0 **Louver and Casing**

7.02.1 Louvers shall be de signed for air entry to the tower with low velocity for minimum pres sure drop and less chance of reci rculation of moist ai r. To eliminate splash out, louvers shall slope to shed water inwards.

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

7.03.0 **Fill**

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

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

7.03.3 The Bidde r s hall en close with his proposal a write-up o n the meth od of replacement of damaged/deteriorated fills during the life of cooling tower. Also Bidder's experience with pre-stressed concrete fills shall be cl early furnished in proposal. Bidder shall also indicate whether these are to be manufactured at shop or at site.

7.03.4 The PVC fi ll if offered shal l be durabl e and fire retardant qu ality. The Bidder shall furn ish detai ls of PVC f ill a long with h is offer i ndicating fire reta rdant properties, ageing effe ct, vibration c aused b y water an d wi nd eff ects. Frequency of rep lacement of PV C fills and the method of such rep lacement shall also b e mentioned with abo ve details. T he PVC fills sha ll be of proven quality and the ma ke and its properties sh all be subject to Purchaser's approval. T he B idder shall furnish wi th his proposal, a sample of the fill material to be used for the specified cooling tower.

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

7.04.0 **Fill Supports**

7.04.1 Splash b ar type f ills shall be supported on t he grid s at f requent i ntervals, preferably not e xceeding 450 mm, to minimize sag, pos sibility of dislodgement, and damage to f ill materials as a consequence of induced vibration in the fill.

7.04.2 For fi lm type filli ng, the sheet like f ills consisting of multiple vertical surfaces shall be tied with filling support bars by stainless steel or nylon wires. Suitable spacers shall be used to maintain verticality of the sheets.

7.04.3 The fill and the support system shall be sufficiently strong to withstand the

water loading when the flow path is 30% chocked.

7.05.0 **Drift Eliminators**

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

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

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

7.06.0 **Access**

7.06.1 Staircases shall be provided external to the cooling tower along with stairways, landings, walkways, handrails and access doors. Minimum 2 Nos. staircase 1000 mm wide and minimum landing width of 1000 mm at locations as necessary to give safe and convenient access to the top and the interior parts of the tower.

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

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

7.07.0 **Cooling Tower Basin & Outlet Sumps**

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

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

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

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

7.07.5 Sludge pit with isolating valves, and spool pipe shall be provided for individual

basin chambers for connection to drainage pipe.

7.07.6 For each basi n chamber, there shall be a cold water out let su mp. In the connection between bas in c hamber and c old water s ump there sha ll be screen and sluice gate/Butterfly valve.

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

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

7.08.0 **Screens & Isolating Devices in Cold Water O utlet Sumps, Valves and Pipes in Sludge Pits and Accessories**

7.08.1 Screens shall be out of 8 gauge 25 mm clear opening SS wire netting welded to frame o f structural steel se ction/flats. Framewor k shal l be hot di p galvanized and prov ided wi th primer and bitumino us painting. Two numbers of sc reens shall be supplied per t ower. Li fting lugs or e ye bolt s sh all be provided on top of the screen frame for ease of handling.

7.08.2 For handling screens, one set of monorail with supporting structure and chain pulley hoist complete with lifting chain and push type trolley for mounti ng the hoist shall be furnis hed, if as ked for in the Data Spec ification S heets. The chain pulley hoist shall be manually operated a nd shall conform to IS : 3832, Class-2.

7.08.3 Sluice gates or Butterfly valves in cold water o utlet sumps sha ll be pro vided as ment ioned in Data Specification Sheet. Sluice gate s sha ll be as per appropriate class of IS: 3042. Butterfly valves shall conform to AWWA C-504 (latest revision).

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

The sl uice gates/B utterfly valves s hall be co mplete wi th head-st ock for manual operation. The head- s tock sha ll have pill ar, b ase pl ate and hand wheel made up of cas t iron. The he ad-stock shall ha ve rising/non-ri sing spindle with position indicator.

7.08.4 The fl ow area through eac h gate/ valve and screen shall be such as to maintain a f low velocity through the m within 1.2 M/se c during the rated flow from cooling tower, with the minimum water level in the cold water basin.

7.08.5 The isolating v alves i n sludge pit s shall conform to appropri ate class of IS : 780. E ach valve shall b e complete with pedes tal type manual opera tor, wi th rising/non-rising spindle and valve position indicator.

7.08.6 The pipe spools, to be embedded in sludge pit for piping connection, shall be

C.I. pipe as per IS: 1536, Class-LA, unless otherwise mentioned elsewhere.

7.09.0 **Hardware**

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

ANNEXURE-A

DATASHEET FOR NATURAL DRAFT COOLING TOWER

1.0 General Information

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

2.0 Design Working Conditions

Hot water inlet temperature	:	42.0^{o}C
Design Ambient wet bulb temperature (WBT)	:	28^{o}C
Design Ambient temp. for electrical equipment	:	50^{o}C
Design Ambient Relative Humidity (RH)	:	44.96%
Whether inlet air wet bulb temperature to be corrected considering re-circulation as per CTI bulletin PFM-116	:	Yes
Design CT inlet wet bulb temperature	:	By Bidder
Basin Holding Capacity	:	6 mins of design CT capacity
Design Wind speed	:	As per site data

3.0 Performance Requirement

Rated Cooling Water flow	:	By Bidder
Cooling range	:	10.5°C
Approach to ambient wet bulb temperature	:	5.0°C
Maximum permissible drift loss	:	0.002%

Design pressure for hot water distribution system	:	By Bidder
Operating range to be established by cooling tower characteristics curves and performance curves	:	As per Clause no. 5.03.00

4.0 **Special Features**

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

5.0 **Material of Construction**

Cold water basin, outlet channel/sump & sludge pit:		R.C.C.
Casing & superstructure	:	R.C.C.
Basin diagonal partition, if any	:	R.C.C.
Staircase	:	R.C.C./HDG Steel
Hot water distribution piping		
Inside Tower	:	HDG Steel/PVC
Outside Tower	:	MS pipes with PVC/FRP Wrap on outside.
Hot water distribution nozzles Equal	:	Polypropylene/Approved
Fills	:	PVC with minimum spacing of 20 mm
Fill Support	:	R.C.C./HDG Steel
Louvers	:	R.C.C.

Drift eliminator	: PVC
Hot water piping	: IS: 3589
Butterfly valve for hot water distribution system/cold water outlet channel	:
• Body	: CI as per IS-210, FG-260
• Di sc	: - do -
• Shaft and spindle	: SS304 as per ASTM A-479
• Shaft bearing	: Lea ded bronze, self-lubricated (BS-1400, LB-2)
• Seat ring	: ASTM A-479, Type 304
• Gland packing	: Impregnated Teflon
• Seal	: Ni trile Rubber, Shore Hardness 50-60 Deg.
• Bolts & Nuts (in contact with water)	: Stainless Steel
	Sludge pit isolation valves:
• Body	: CI IS-210, FG-260
• Spindle & Trim	: Stainless Steel.
• Sludge outlet pipe	: CI IS-1536, LA
• Sc reen	: Anodis ed Aluminium
• Guide for screen	: CI IS-210, FG-260
• Bolts, nuts & other hardware	: Stainless Steel

6.1 **Inspection And Testing**

Quality surveillance by	: Manufacture r/Purchaser
Material testing and identification	: Required
Stage inspection to be witnessed by Purchaser	: Yes

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

TITLE BLOCK ANNEXURE-1

CUSTOMER	TELANGANA STATE POWER GENERATION CORPORATION LTD TELANGANA INDIA YADADRI TPS (5X800 MW)
CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BANGALORE INDIA
	BHARAT HEAVY ELECTRICALS LIMITED
	SPECTRUM TECHNO CONSULTANTS PVT LTD NAVI MUMBAI INDIA

TATA CONSULTING ENGINEERS LIMITED
VENDOR DOCUMENT REVIEW STATUS

- ☑ A Drawing/Document approved as submitted. Proceed with fabrication/construction.
- ☐ B Drawing/Document approved subjected to comments noted. Proceed with fabrication/ construction considering our commnets.
- ☐ C Our comments are noted on this marked up print.
- ☐ D Our commnets are noted in memo attached to the forwarding transmittal letter No. .....Dated.....
- ☐ E Correct original of this drawing/document to reflect our comments and resubmit for approval.
- ☐ F Correct original of this drawing/document to reflect our comments and resubmit for records.
- ☐ G Drawings/Documents of this category are for information only and not for approval. Information furnished on the drawing/document is noted.
- ☑ H Drawing/Document reviewed against our previous comments and other revisions highlighted and identified by the vendor.
- ☐ I Drawing/Document returned without review.
- ☐ J Print not enclosed.

Approval conveyed herein neither relieves the Vendor/Contractor of his contractual obligations and his responsibilities for correctness of dimensions, materials of construction, weights, quantities, design details, assembly fits, performance requirements and conformity of the supplies with the Indian Statutory Laws as may be applicable, nor does it limit the purchaser's rights under the contract.

Reviewed by MB Date 30-05-2019

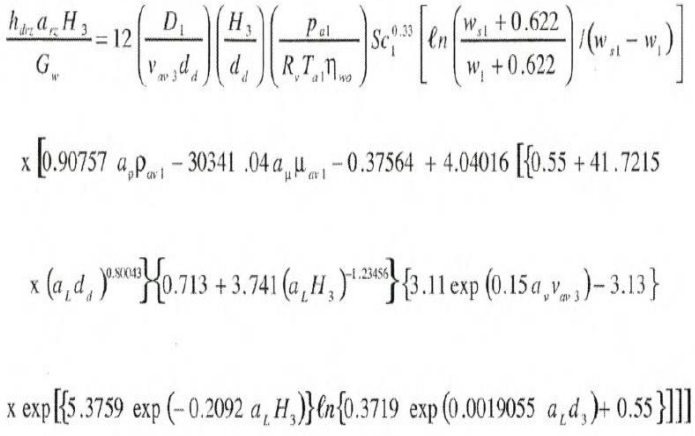
DEPT. CODE		NAME	SIGN	DATE
M	DESN	UNB		28-Nov- 18
	CHD	UNB		28-Nov- 18
	APPD	UKR		28-Nov- 18

TITLE : NATURAL DRAUGHT COOLING TOWER - THERMAL AND HYDRAULIC CALCULATIONS & DATA SHEETS

		DEPT.			DOCUMENT NO. PE-V1-417-165-N003	
		SIGN				
					SHEET 1 OF 14	REV. 2

R0 : 29-MAR-18; R1: 18-JUL-18; R2: 28-NOV-18

Digitally signed by NISHANT SEHEKHAR
DN: cn=NISHANT SEHEKHAR, o=BHEL, ou=PEM, email=nishnatshekhar@bhel.in, c=US
Date: 2018.12.14 11:34:48 +05'30'

S.No.	TSGENCO/TCE Comment dt: 17.07.2018	BHEL/Spectrum Response	TSGENCO/TCE Comment dt: 10.10.2018	BHEL/Spectrum Response dt: 28.11.18
1.	Is there any KaV/L advantage provided for rain zone	The KaV/L gain and the associated pressure drop in the rain zone of a NDCT are significant values and hence, these are accounted for.	Please inform us, what is the percentage gain considered in the rain zone.	There is no fixed percentage for transfer co-efficient gain in the rain zone. It is calculated by the thermal program in an iterative manner since there are many properties of water and air that are involved in the equation. It is not possible to use these transfer equations outside of a program to calculate results. For example, the equation for rain zone transfer co-efficient is as under:  It is obvious that the above equation cannot be used independently in an excel sheet to estimate rain zone transfer co-efficient because there are parameters like viscosity, sauter mean diameter, Schmidt no., humidity ratio, air pressure and temp, etc that need to be calculated, again in an iterative manner, before using this equation. Hence, no fixed percentages can be

Noted

				indicated for rain zone transfer co-efficient.	
2.	This calculation shall be revised and confirmed based on the actual Civil GA drawing	This is a negligible value compared to the gross fill area available. This value is shown just for information and present the process of area calculation. The grid size is fixed at 4.5 m x 4.5 m as shown in the GA drawing. This is an input to civil and any civil details from civil GA will not be an input to thermal/mechanical. Hence, the thermal calculations presented will not change at any stage.	Please confirm that obstruction of columns will not affect significantly the performance of the Cooling tower.	It is already confirmed that this is a negligible value. Hence, there will be no change in thermal design due to civil designs.	Noted
3.	Please indicate formulae for pressure drops	Kindly note that the KaV/L and pressure drop calculations are confidential.	We understand KaV/L values are confidential. However, pressure drop calculations are provided by other cooling tower suppliers. Please indicate the formulas for the same.	Pressure drops can be calculated only after establishing KaV/L. This means that when KaV/L is considered confidential, the pressure drops also become confidential as these are a consequence of KaV/L. However, as explained at point no.1 above, the pressure drop equations cannot be used independently in an excel sheet for results as the formulae involve many other parameters that need be estimated first in an iterative manner. For example, the pressure drop in the rain zone is calculated using the formula,	Noted

				$$K_{rzfi} = 3a_v v_{w3}(H_3/d_d)\left[0.2246 - 0.31467a_\rho \rho_{av1} + 5263.04a_\mu \mu_{av1}\right.$$ $$+0.775526\{1.4824163\exp(71.52a_L d_d) - 0.91\}$$ $$\text{x}\ \{0.39064\exp(0.010912a_L d_3) - 0.17\}\{2.0892(a_v v_{av3})^{-1.3944} + 0.14\}$$ $$\text{x}\ \exp[\{0.8449\ell\text{n}(a_L d_3/2) - 2.312\}\{0.3724\ell\text{n}(a_v v_{av3}) + 0.7263\}$$ $$\left.\text{x}\ \ell\text{n}\{206.757(a_L H_3)^{-2.8344} + 0.43\}\right]](\rho_{av15}/\rho_{av1})(m_{av1}/m_{av15})^2(4A_{fr}/\pi d_3^2)^2$$ The very same properties of air and water used in the equation for rain zone transfer co-efficient are involved here and these can be estimated only in an iterative manner in the program. Hence, no formulae for pressure drop calculations can be furnished as these are as confidential as transfer co-efficient.

1	**General**						
1.1	**Design Duty Parameters**						
	Circulating Water Flow	90000	m^3/hr				
	HWT	42.5	^oC				
	CWT	33	^oC				
	Design WBT	28	^oC				
	Relative Humidity	45	%				
	Range	9.5	^oC				
	Approach	5	^oC				
	Basin Kerb above Max. WL	300	mm				
	Site Elevation above MSL for thermal design	0	m				
	Ambient Pressure	101325	N/m^2				
	Salinity	0	ppm				
1.2	**Tower Sizing Data**						
	Type of Fill	**PVC SPLASH BAR**					
	Fill Height (total hanging height)	5.2	m				
	Fill Height above Air Inlet	4.8					
	Top of Air Inlet above basin kerb	9.7	m				
	Bottom of Fill above Sill level	9.7	m				
	Top of Fill above Sill	14.5	m				
	Bottom of distribution Pipe (BOP) above Fill	0.7	m				
	Static Head up to BOP w.r.t Sill	15.2	mWC				
	Center line Dia.of tower at basin Sill level	145.67	m				
	Internal Diameter of tower at basin sill level	144.67	m				
	Internal Diameter at top of Fill level	135.97	m				
	Gross Fill Area	14520.316	m^2 ==========>>	**A**			
	Length of each HW Duct	123.5	m approx.				
	Outer Width of each HW Duct	3.1	m approx.				
	Area of HW Ducts	765.5690513	m^2 ==========>>	**B**			
	Column Obstructions	179.5	m^2 ==========>>	**C**			
	Net Fill Area Available	13575.247	m^2 ==========>>	**(A-B-C)**			
	Effective Fill Area considered in design	13075.410	m^2				
	Water Loading Rate	6.883	$m^3/hr/m^2$				
	Liquid to Gas Ratio	2					

1.2.1	**Basin Sizing Calculations**						
	Max. Water Level	RL 81.1	m				
	Min. Water Level	RL 80.5	m				
	Difference between Max. & Min. Water Levels	0.6	m ==========>>	**d**			
	Storage Capacity required between Max. & Min. Water Levels	6 minutes hold up					
	6 minutes' hold up water volume (= 90,000 m3/hr/60*6)	9000	m3 ==========>>	**V**			
	Basin Area required for 6 minutes' hold up capacity	15000	m2 ==========>>	**(V/d)**			
	Basin Diameter Required	138.198	m	**(SQRT((V/d)*4/PI)**			
	Basin Diameter Required < Basin Diameter Provided		Hence, size is conservative				
2	**Thermal Calculations**						
	Inlet air properties						
	Design WBT	28	°C				
	Relative Humidity	45	%				
	DBT	38.53	°C				
	Abs. Humidity	0.0197	kg/kg				
	Dry Air Density	1.0902	kg/m^3				
	Air-Vapour mixture Density	1.1192	kg/m^3				
	Enthalpy	21.441	kCal/kg				
2.1	**KaV/L Calculations**						
	KaV/L as per Tchebycheff Method	1.95	Calculations enclosed				
	KaV/L provided	1.95					
2.1.1	**Exit Air Properties**						
	WBT	40.74	°C				
	Relative Humidity	100	%				
	DBT	40.74	°C				
	Abs. Humidity	0.0513	kg/kg				
	Dry Air Density	1.0380	kg/m^3				
	Air-Vapour mixture Density	1.0908	kg/m^3				
	Enthalpy	41.484	kCal/kg				
	Enthalpy Gain	20.043	kCal/kg				
	Density Difference ($\Delta \rho$)	0.0284	kg/m^3				
	Average of Air-Vapour mixture Densities	1.105	kg/m^3				
	Dry Air Flow through the tower	12500.08	kg/s				

2.2	**Draught Calculations**						
	Draught Losses						
	Air Inlet + Rain Zone + Columns & Beams below Fill	2.3130	mmWC				
	Fill + Other Phenomenon	2.3410	mmWC				
	Distribution + D/E	0.2931	mmWC				
	Throat+Other Phenomenon	0.2687	mmWC				
	Total of draught losses	5.2157	mmWC				
	Draught Height Required (Δpd/Δ)	183.653	m				
	Tower Height Required (Draught Height + 0.5*Fill Height + Air Inlet)	**195.75**	**m**				
	Tower Height Provided	**198.19**	**m**				
2.3	**Check for Heat Balance**						
	Dry Air Flow, G	45000288	kg/hr				
	Evaporation Loss	1422009.101	kg/hr				
	Specific Heat of Water	1	kCal/kg/^{o}C				
	Heat Lost by circulating Water	855000000	kCal/hr				
	Heat of Evaporated Water	46926300.33	kCal/hr				
	Total Heat Lost by Water	**901926300**	kCal/hr				
	Heat Gain by Air	20.043	kCal/kg				
	Total Heat Gain by Air	**901940772**	kCal/hr				
3	**Draught Loss Calculations**						
3.1	**Loss through Inlet + Rain Zone + Other Phenomena below Fill**						
	G	kg/s	12500.08				
	Abs. Humidity at Inlet	kg/kg	0.0197				
	Air-Vapour mixture Density at Inlet	kg/m^3	1.1192				
	Inside Base Diameter	m	144.67				
	Air Inlet Height	m	9.7				
	Shell Angle (average)	deg.	16.7				
	Air Inlet Area	m^2	4319.912				
	Air Flow Rate through inlet	m^3/s	11388.7880				
	Air Velocity through inlet	m/s	2.6363				
	Effective rain area	m^2	13575.2472				
	Air Velocity through Rain Zone	m/s	0.8389				
	Draught Loss through Inlet + Rain Zone + Other Phenomena below Fill	**mmWC**	**2.3130**				

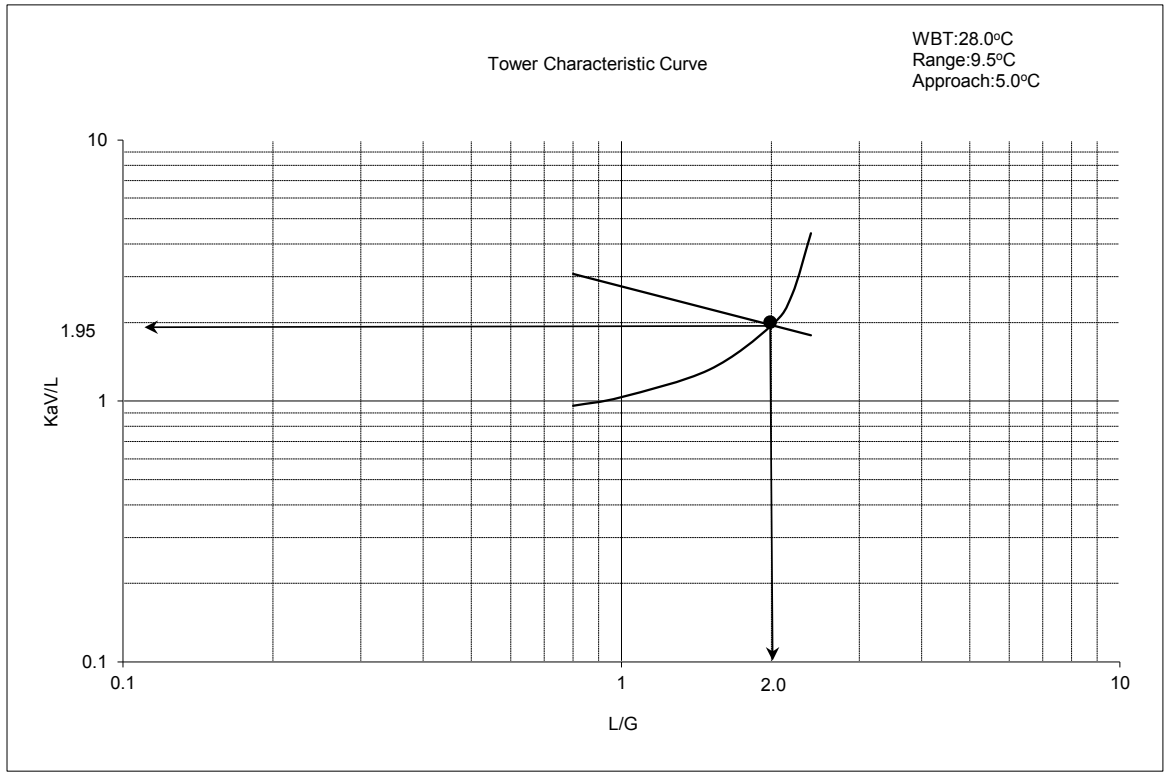
3.2	**Loss through Fill**						
	Gross Fill Height	m	5.2				
	Average Abs. Humidity	kg/kg	0.0355				
	Average Air-Vapour mixture Density through Fill	kg/m^3	1.105				
	G	kg/s	12500.08				
	Air Flow Rate through Fill	m^3/s	11713.876				
	Effective Fill Area	m^2	13075.410				
	Average Air Velocity through Fill	m/s	0.896				
	Draught Loss through Fill	**mmWC**	**2.3410**				
3.3	**Loss through Distribution System + Drift Eliminator Packing (DDE)**						
	G	kg/s	12500.08				
	Abs. Humidity at Exit	kg/kg	0.0513				
	Air-Vapour mixture density at exit	kg/m^3	1.0908				
	Diameter at Distribution	m	135.550				
	Gross Area at Distribution	m^2	14430.746				
	Net Area at Distribution	m^2	9754.48				
	Effective Area considered in design	m^2	9754.48				
	Air flow rate through DDE	m^3/s	12047.42767				
	Air Velocity through DDE	m/s	1.2351				
	Draught Loss through DDE	mmWC	**0.2931**				
3.4	**Loss through Throat/Neck + Expansion**						
	G	kg/s	12500.08				
	Abs. Humidity at Exit	kg/kg	0.0513				
	Air mixture/vapour density	kg/m^3	1.0908				
	Throat Diameter	m	85.27				
	Throat Area	m^2	5710.609				
	Air flow through throat	m^3/s	12047.42767				
	Air velocity through Throat/Neck	m/s	2.110				
	Draught Loss across Throat + Expansion	**mmWC**	**0.2687**				

4	**KaV/L Calculations (Chebyshev / Tchebycheff Method)**						
	L/G	2					
	Range	9.5	°C				
	WBT	28	°C				
	h1	21.564	kCal/kg				
	h2 = h1+L/G*Range*Cp	40.564	kCal/kg				
T °C		T °K	hw, kCal/kg	ha, kCal/kg		hw-ha	1/(hw-ha)
33	T2	306.15		h1	21.564		
33.95	T2+0.1*Range	307.1	29.40722517	h1+0.1*L/G*Range*Cp	23.46437	5.9428571	0.1682692
36.8	T2+0.4*Range	309.95	33.99825076	h1+0.4*L/G*Range*Cp	29.16437	4.8338827	0.206873
38.7	T1-0.4*Range	311.85	37.42191551	h2-0.4*L/G*Range*Cp	32.96437	4.4575475	0.2243386
41.55	T-0.1*Range	314.7	43.18375552	h2-0.1*L/G*Range*Cp	38.66437	4.5193875	0.2212689
42.5	T1	315.65		h2	40.564		
	KaV/L = Range/4*Σ1/(hw-ha)*Cp					Σ1/(Ew-Ea)	0.8207498
	KaV/L Required =	1.95					
	KaV/L Provided =	1.95					
5	**Duty Coefficient (D_t)**						
	D_t=	$A\sqrt{H}/(C\sqrt{C})$					
	where	A =	16437.91931	m^2 (area at sill)			
			176845.7111	ft^2			
		H =	198.19	m (tower height above sill)			
			650.0632	ft			
		C =	3.6829798	Performance co-efficient from S.No.6 below			
	Therefore, Dt=	637930					
6	**Performance Coefficient (C)**						
	C=	$(1/(KaV/L) + L/(2G))*G/L*N^{1/3}$					
	We have	KaV/L =	1.95				
		L/G =	2				
		N =	Pd * 2g/(ρ·v^2)	No. of velocity heads			
	where	Pd =	5.2157	mmWC (tower pressure drop)			
		ρ =	1.105	air-vapour density in fill section			
		v =	0.896	afflux air velocity in fill section			
	Therefore, N=	115.39					
	Hence, C=	3.68					
7	**Draught Factor (F)**						
	F=	Δρ/(1.64*10^-8*Δh)					
	We have	Δρ =	0.0284	kg/m^3 (difference in air-vapour mixture density at inlet and			
			0.001775	lb/ft^3			
		Δh =	20.043	kcal/kg (difference in enthalpy at inlet and outlet)			
			36.0774	BTU/lb			
	Therefore, F=	3000					

1	**Pumping Head Calculations**						
			Header Pipe	**Riser Pipe**			
	Inlet Pipe Diameter	m	3.95	3.4			
	Flow per inlet pipe	m^3/hr	90000	45000			
		m^2	12.254	9.079			
	Velocity of Flow	m/s	2.040	1.377			
1.1	**Friction Loss Through Pipes [as per Hazen-Willam Method]**						
	D[m]	V[m/s]	C (for new pipe)	*S*	*L[m]*		P_d[m]
	3.95	2.040	120	0.000724737	5		0.0036237
	3.4	1.377	120	0.000416742	80		0.0333393
	Total Friction Loss Through Staright Pipes						**0.036963**
1.2	**Head Loss Through Fittings**						
1.2.1	**Welded Elbows [theeta=90, K=20f]**						
	Flow [m3/s]	Dia. [m]	Vel [m/s]	Vh [mmWC]	f	K	Pd
	90000	3.95	2.040	0.212135264	0.0094	0.18738464	0.0397509
	45000	3.4	1.377	0.096610781	0.0096	0.19219992	0.0185686
	45000	3.4	1.377	0.096610781	0.0096	0.19219992	0.0185686
							0.0768881
1.2.2	**TEE [K=60f]**						
	45000	3.4	1.377	0.096610781	0.0096	0.57659976	**0.0557058**
1.3	**Butterfly Vlaves [20f)**						
	45000	3.4	1.377	0.096610781	0.0096	0.19219992	**0.0185686**
		Exit Dia.	Vel [m/s]	Vh [mmWC}			
1.4	**Expansion Loss**	3.8	1.102	0.015425581			**0.0154256**

1.5	**Discharge Loss**						
	Discharge Velocity	m/s	1.102				
	Discharge Loss	mWC	**0.0619**				
1.6	**Friction Loss through RCC Duct**						
	Water Flow per duct (F)	m^3/hr	45000				
	Duct Depth	m	3.5				
	Duct Width	m	2.5				
	Duct Wetted Area (WA)	m^2	8.75				
	Duct Perimeter (P)	m	12				
	Hydraulic Radius (R = WA/P)		0.729				
	Flow Velocity through Duct (V = F/WA)	m/s	1.429				
	Slope S = $(n * V / R^{2/3})^2$, n = 0.015	per m	0.000699655				
	Duct Length	m	123.5				
	Friction Loss through RCC Duct	mWC	**0.086393**				
1.7	**Head Loss due to sudden turns and contraction**						
	Turning into Sec. RCC Channel from Main. RCC Channel	mWC	**0.0312**				
	Second turn into PVC Pipe from RCC Duct	mWC	**0.0312**				
	Sudden Contraction (Duct to Pipe)	mWC	**0.0374**				
1.8	**Friction loss through PVC distribution piping (longest pipe considered)**	mWC	**0.0755**				

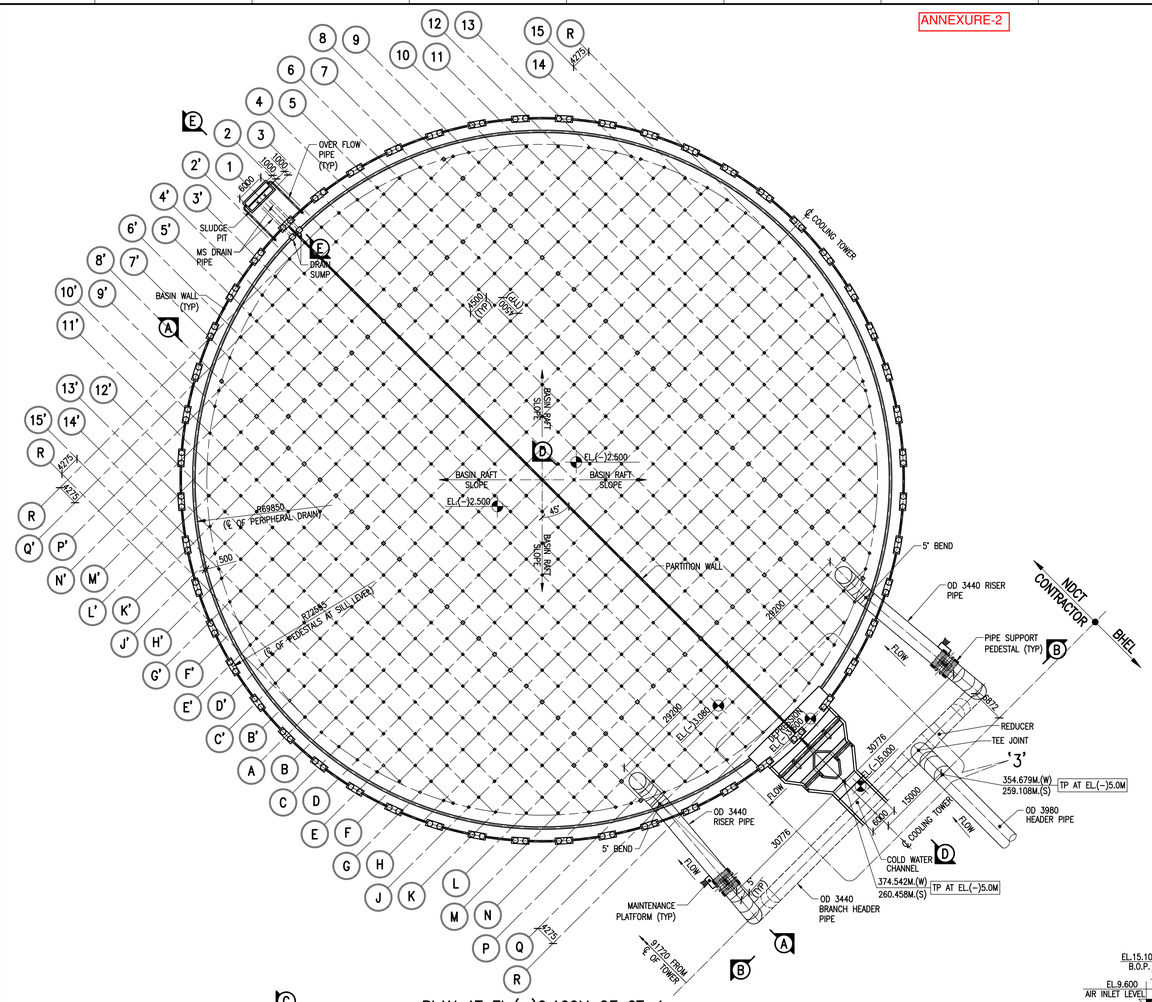
1.9	**Sum of Friction + Head Losses from S.No. 1.1 to 1.8**	mWC	**0.5272**				
	Friction Losses with 10% Margin	mWC	**0.5799**	**==========> SFH**			
2	**Spray Nozzle Head**	mWC	**0.5**	**==========> SNH**			
3	**Sum of SFH + SNH**	mWC	**1.0799**				
4	**Static Head**						
	Sill Level above FGL	1.4	m				
	Air Inlet Height above Sill	9.7	m				
	Fill Height above Air Inlet	4.8	m				
	Top of Fill to bottom of distribution Pipe	0.7	m				
	Total Static Head above FGL	**16.6**	m				
5	**Total Head Utilized**						
	Friction/Head Losses + Static Head	**17.680**	mWC				
	Total Head Utilized is	≈	Total Head Available				


Tower Characteristic Curve
WBT:28.0ºC
Range:9.5ºC
Approach:5.0ºC
10
1.95
1
0.1
KaV/L
0.1
1
2.0
10
L/G

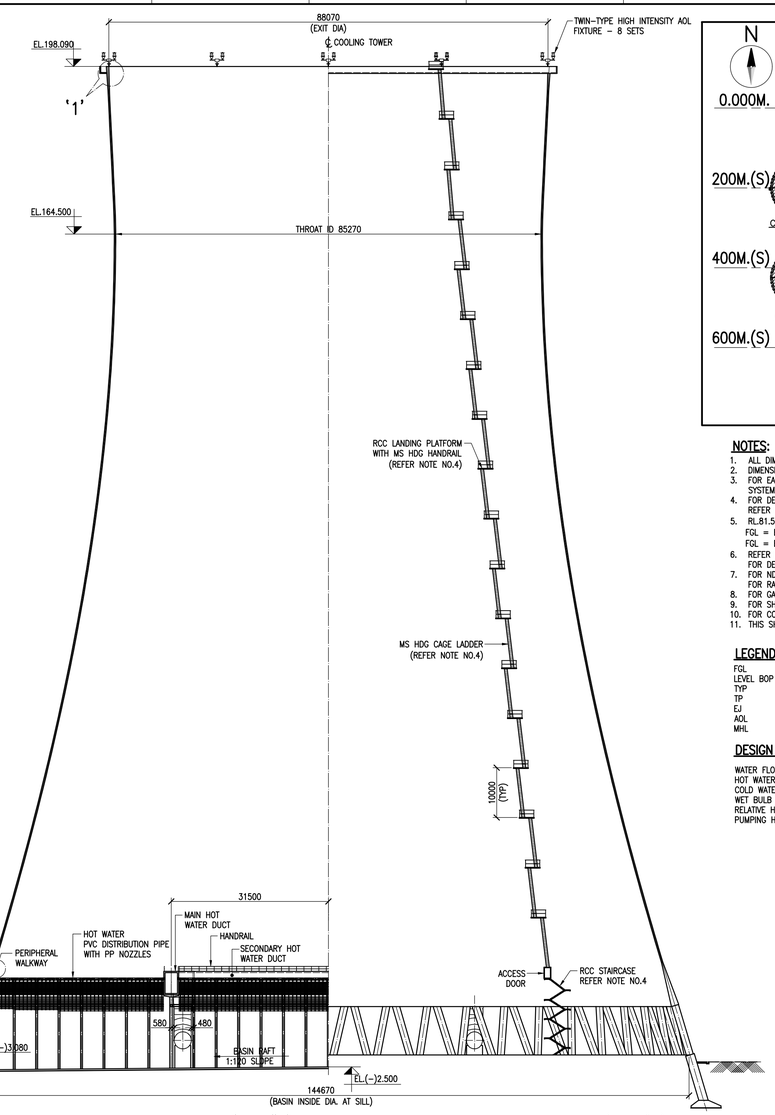
NOTE: ALL ELEVATIONS GIVEN HERE ARE CONSIDERING SILL LEVEL = EL 0.00 M, WHEREAS IN THE GA DRWG IT IS (-) 0.1 M AS PER SPECIFICATIONS

SL. NO.	PARAMETERS	VALUE	UNIT OF MEASUREMENT
1	BASIN DIA. AT SILL LEVEL (ID)	144.67	M
2	TOTAL NDCT HEIGHT FROM SILL TOP	198.19	M
3	HEIGHT OF AIR INLET FROM SILL TOP	9.7	M
4	HEIGHT OF TOP OF FILL FROM SILL TOP	14.5	M
5	HEIGHT OF BOTTOM OF FILL FROM SILL TOP	9.4	M
6	L/G RATIO	2.0	
7	EVAPORATION LOSS	1422.009	M^3/HR
8	INLET AIR ENTHALPY	21.441	KCAL/KG
9	OUTLET AIR ENTHALPY	41.484	KCAL/KG
10	AVG. AIR-VAPOUR MIX. DENSITY AT	1.105	KG/M^3
11	AVG. AIR-VAPOUR MIX. DENSITY AT	--	KG/M^3
12	DIA. AT TOP OF FILL LEVEL	135.97	M
13	GROSS FILL AREA	14520.316	M^2
14	AREA OF HOT WATER DUCTS	765.569	M^2
15	COLUMN/BEAM OBSTRUCTION AREA	179.5	M^2
16	NET FILL AREA AVAILABLE	13575.247	M^2
17	AVG. AIR VELOCITY AT TOWER INLET	2.636	M/S
18	AVG. AIR VELOCITY IN FILL SECTION	0.896	M/S
19	AVG. AIR-VAPOUR DENSITY IN FILL SECTION	1.105	KG/M^3
20	LOSSES IN NUMBER OF VELOCITY HEAD AT AIR INLET	REFER	NO. OF VEL. HEAD
21	LOSSES IN NUMBER OF VELOCITY HEAD AT RAIN ZONE	DETAILED	NO. OF VEL. HEAD
22	LOSSES IN NUMBER OF VELOCITY HEAD AT FILL ZONE	THERMAL	NO. OF VEL. HEAD
23	LOSSES IN NUMBER OF VELOCITY HEAD THROUGH WATER DISTRIBUTION /BEAMS /COLUMNS	CALCULATIONS	NO. OF VEL. HEAD
24	LOSSES IN NUMBER OF VELOCITY HEAD THROUGH DRIFT ELIMINATORS	ENCLOSED	NO. OF VEL. HEAD
25	LOSSES IN NUMBER OF VELOCITY HEAD AT AIR EXIT	WITH THESE	NO. OF VEL. HEAD
26	LOSSES IN NUMBER OF VELOCITY HEAD THROUGH THROAT/NECK	DATA SHEETS	NO. OF VEL. HEAD
27	TOTAL TOWER PRESSURE DROP	5.2157	MMWC

ANNEXURE-2

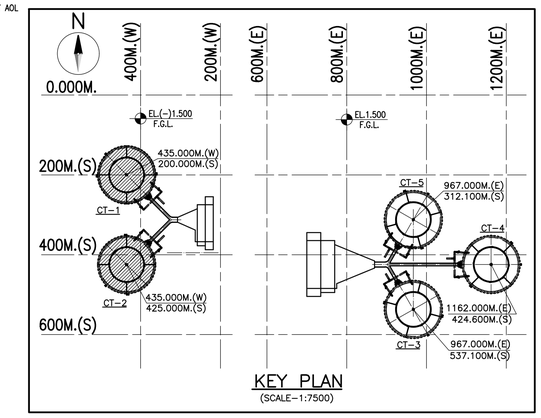


PLAN AT EL.(–)0.100M OF CT–1
(SCALE–1:600)



HALF SECTION OF CT1 & CT2 (UNIT#1)
(SCALE–1:600)

HALF ELEVATION OF CT1 & CT2 (UNIT#1)
(SCALE–1:600)

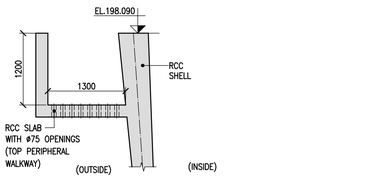


KEY PLAN
(SCALE–1:7500)

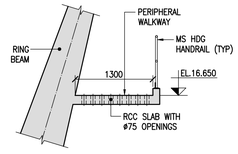
NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER UNLESS OTHERWISE SPECIFIED.
2. DIMENSIONS ARE NOT TO BE SCALED. ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED.
3. FOR EARTHING & LIGHTNING PROTECTION DETAILS REFER DRAWING NO. PE–V1–417–165–N055 AND FOR AOLs SYSTEM DETAILS REFER DRAWING NO. PE–V1–417–165–N065
4. FOR DETAILS OF STAIRCASE REFER DRAWING NO. PE–V1–417–165–N023 & FOR DETAILS OF CAGE LADDER REFER DRAWING NO. PE–V1–417–165–N045A
5. RL.81.500 CORRESPONDS TO EL.(–)0.000 OF POWER HOUSE BUILDING
   FGL = EL.(–)1.500 CORRESPONDS TO RL.80.000. IN THE COOLING TOWER AREA FOR CT#1 & CT#2
   FGL = EL.(+)1.500 CORRESPONDS TO RL.83.000. IN THE COOLING TOWER AREA FOR CT#3 , CT#4 & CT#5
6. REFER DRAWING NO.PE–V1–417–165–N059 (GENERAL ARRANGEMENT OF EXTERNAL HW DISTRIBUTION SYSTEM) FOR DETAILS OF PAINTING FOR PROTECTION OF INTERNAL & EXTERNAL SURFACES OF PIPING.
7. FOR NDCT FOUNDATION & PEDESTAL DETAILS REFER DRG.NO.PE–V1–417–165–N034 & FOR RAKER COLUMN DETAILS REFER DRG.NO.PE–V1–417–165–N036.
8. FOR GA OF FILL SUPPORTING STRUCTURE REFER DRG.NO.PE–V1–417–165–N026.
9. FOR SHELL PROFILE REFER DRG.NO.PE–V1–417–165–N038.
10. FOR COLD WATER OUTLET DETAILS REFER DRG.NO.PE–V1–417–165–N016.
11. THIS SHEET SHOULD BE READ IN CONJUNCTION WITH SHEETS 2,3,4,5 & 6 OF THIS DRAWING.

LEGENDS
FGL – FINISH GROUND
LEVEL BOP – BOTTOM OF PIPE
TYP – TYPICAL
TP – TERMINAL POINT
EJ – EXPANSION JOINT
AOL – AVIATION OBSTRUCTION LIGHT
MHL – MAIN HEADER LEVEL

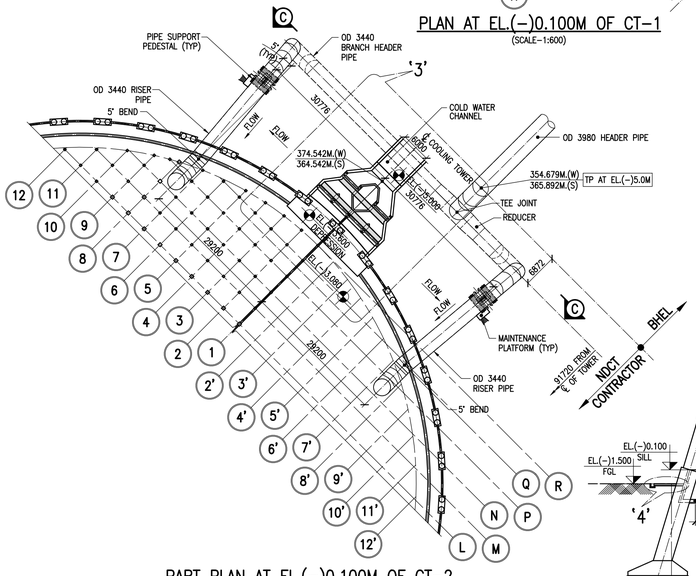
DESIGN DUTY PARAMETERS
WATER FLOW : 90000 M^3/HR
HOT WATER TEMPERATURE : 42.5°C
COLD WATER TEMPERATURE : 33°C
WET BULB TEMP. : 28°C
RELATIVE HUMIDITY : 45%
PUMPING HEAD : 16.3 MWC w.r.t BASIN SILL



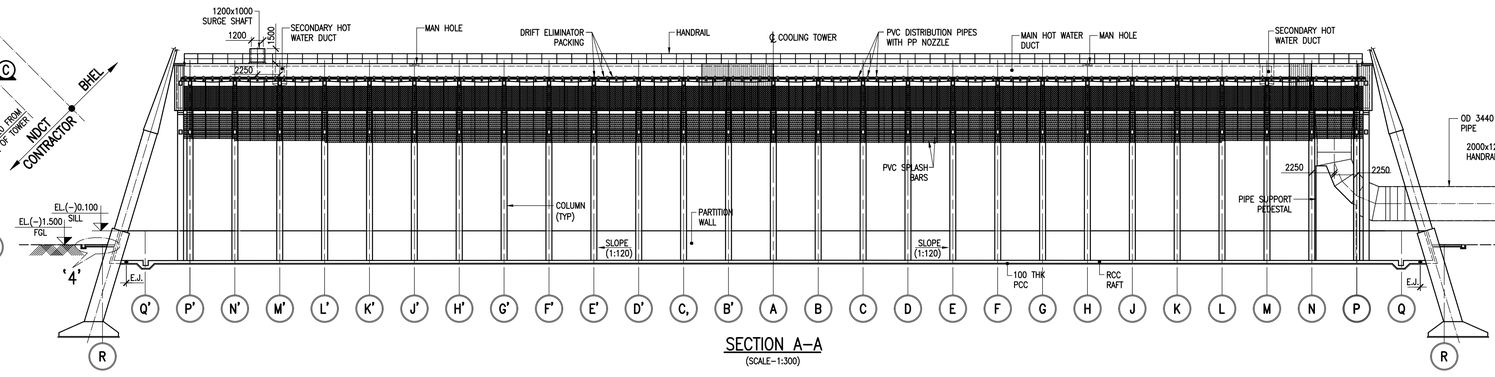
DETAIL–'1'
(SCALE–1:50)



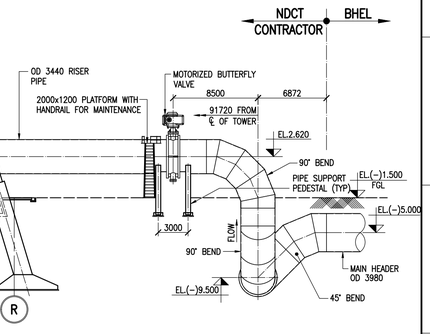
DETAIL–'2'
(SCALE–1:50)



PART PLAN AT EL.(–)0.100M OF CT–2
(SCALE–1:600)



SECTION A–A
(SCALE–1:300)



REV. NO.	DATE	DESCRIPTION	DRAWN
2	01/12/18	BASED ON TCE & TSGENCO COMMENTS Dt. 22/11/18	SCJ
1	10/08/18	BASED ON TCE COMMENTS Dt. 03/08/18	CDS
0	26/06/18	FOR APPROVAL	SHM

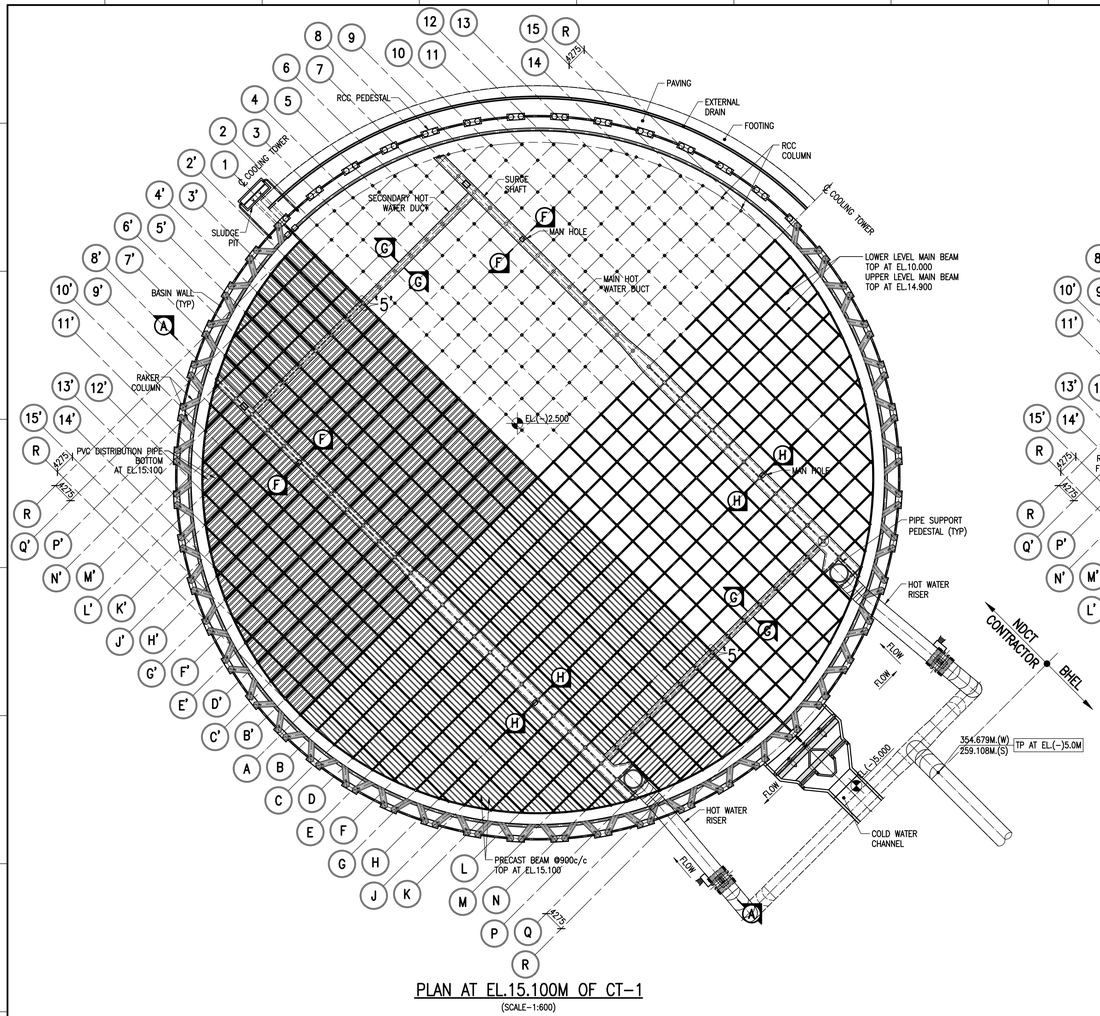
CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD, TELANGANA INDIA
CONSULTANT: TATA CONSULTING ENGINEERS LIMITED, BANGALORE INDIA
EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED
NDCT CONSULTANT: SPECTRUM Techno Consultants Pvt Ltd, 401, Raikar Bhavan, Plot No. 9, Sector-17, Vashi, Navi Mumbai 400 705 India. Email : info@spectrumworld.net
PROJECT: 5x800 MW YADADRI THERMAL POWER STATION

DRAWN BY :	SHM
CHECKED BY	UNB
APPROVED BY	UKR
DATE	10/08/2018
SCALE	AS SHOWN

TITLE: GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER (STAGE#1)
STCPL DRG.NO. 760-E-DD-101 REV.NO.
BHEL DRG.NO. PE-V1-417-165-N001 (SHEET 1 OF 6) 2

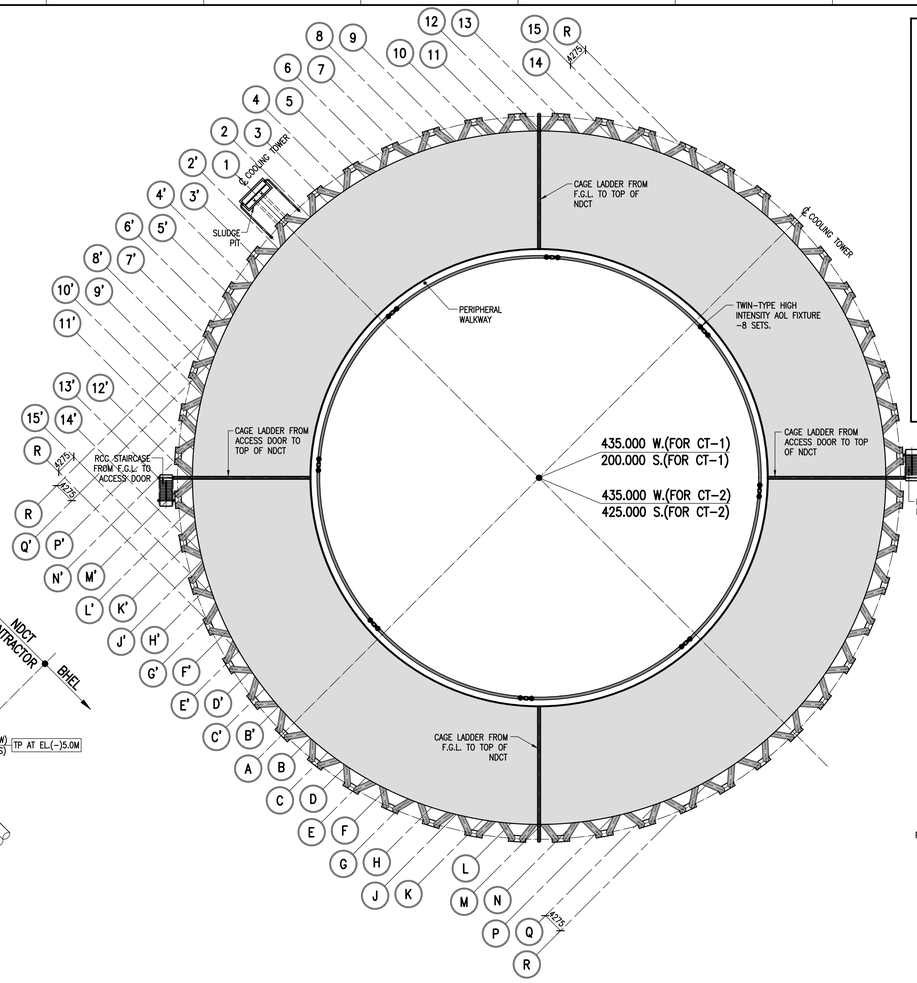
SHEET SIZE : A1

FILE NAME : X:\760-YADADRI\NDCT\WORKING\760-E-DD-101-R2 (GAD FOR NDCT -1 to 5).dwg



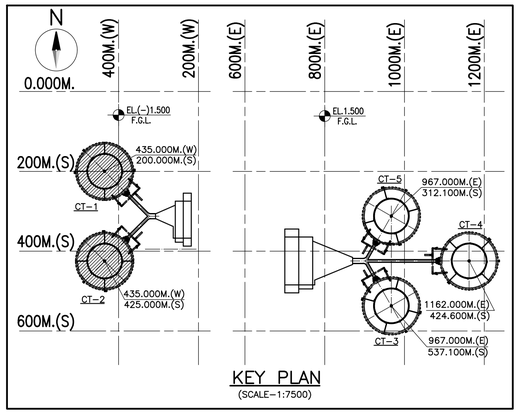
PLAN AT EL.15.100M OF CT–1

(SCALE–1:600)



PLAN AT EL.198.090M OF CT–1 & CT–2

(SCALE–1:600)

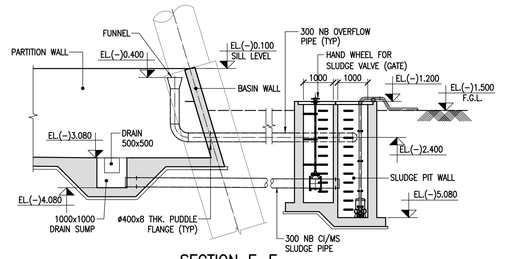


KEY PLAN

(SCALE–1:7500)

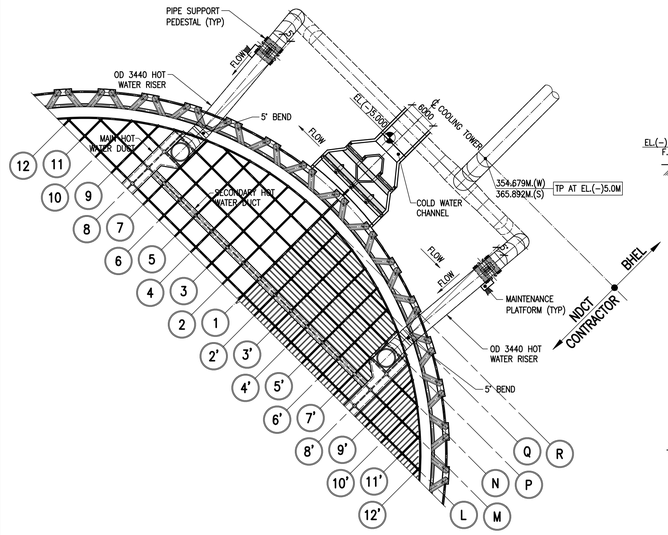
NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER UNLESS OTHERWISE SPECIFIED.
2. DIMENSIONS ARE NOT TO BE SCALED. ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED.
3. THIS SHEET SHOULD BE READ IN CONJUNCTION WITH SHEETS 1,3,4,5 & 6 OF THIS DRAWING.



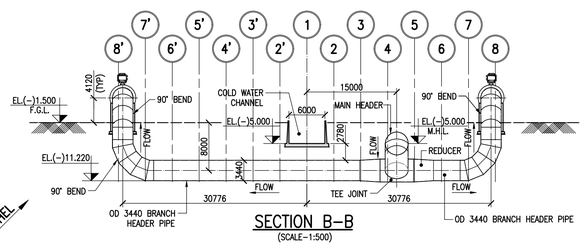
SECTION E–E

(SCALE–1:100)



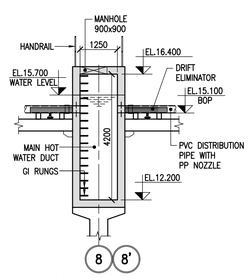
PART PLAN AT EL.15.100M OF CT–2

(SCALE–1:600)



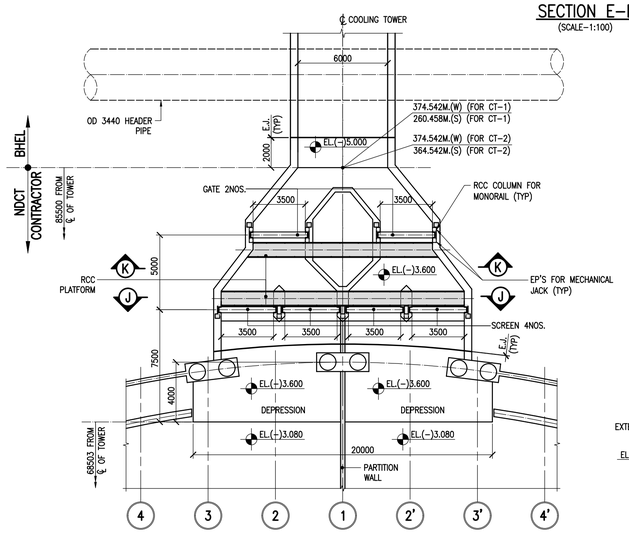
SECTION B–B

(SCALE–1:500)



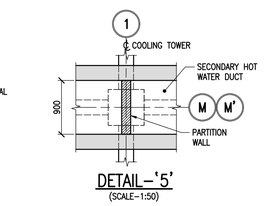
SECTION F–F

(SCALE–1:100)



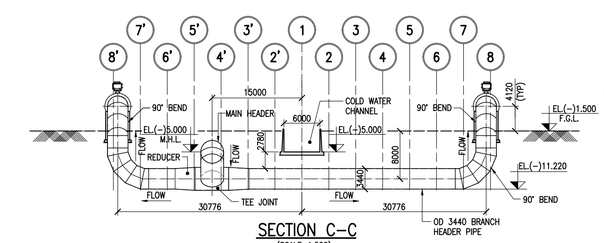
DETAIL–'3'

(SCALE–1:200)



DETAIL–'5'

(SCALE–1:50)

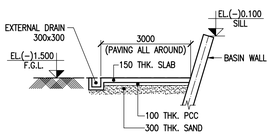


SECTION G–G

(SCALE–1:100)

SECTION C–C

(SCALE–1:500)



DETAIL–'4'

(SCALE–1:100)

REV. NO.	DATE	DESCRIPTION	DRAWN
2	01/12/18	BASED ON TCE & TSGENCO COMMENTS Dt. 22/11/18	SCJ
1	10/08/18	BASED ON TCE COMMENTS Dt. 03/08/18	CDS
0	26/06/18	FOR APPROVAL	SHM

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD, TELANGANA INDIA

CONSULTANT: TATA CONSULTING ENGINEERS LIMITED, BANGALORE INDIA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED

NDCT CONSULTANT: SPECTRUM Techno Consultants Pvt Ltd
401, Raikar Bhavan, Plot No. 9, Sector-17, Vashi, Navi Mumbai 400 705 India. Email : info@spectrumworld.net

PROJECT: 5x800 MW YADADRI THERMAL POWER STATION

DRAWN BY :	SHM
CHECKED BY	UNB
APPROVED BY	UKR
DATE	10/08/2018
SCALE	AS SHOWN

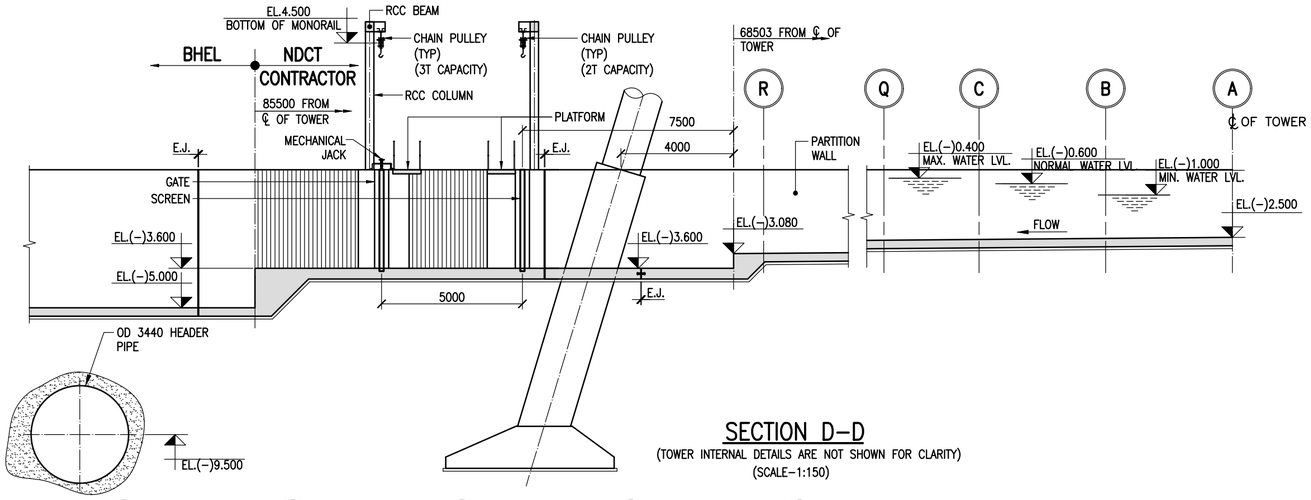
TITLE: GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER (STAGE#1)

STCPL DRG.NO. 760-E-DD-101 REV.NO. 2

BHEL DRG.NO. PE-V1-417-165-N001 (SHEET 2 OF 6)

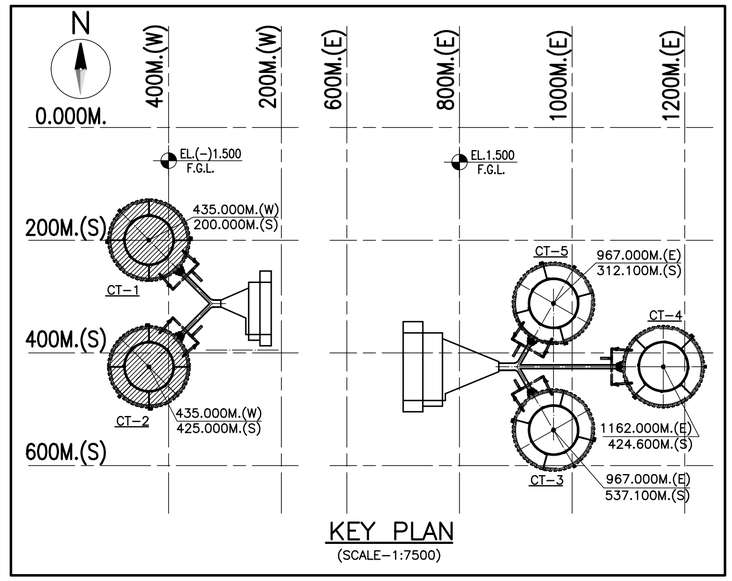
SHEET SIZE : A1

FILE NAME : X:\760-YADADRI\NDCT\WORKING\760-E-DD-101-R2 (GAD FOR NDCT -1 to 5).dwg



SECTION D−D

(TOWER INTERNAL DETAILS ARE NOT SHOWN FOR CLARITY)
(SCALE−1:150)



KEY PLAN

(SCALE−1:7500)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER UNLESS OTHERWISE SPECIFIED.
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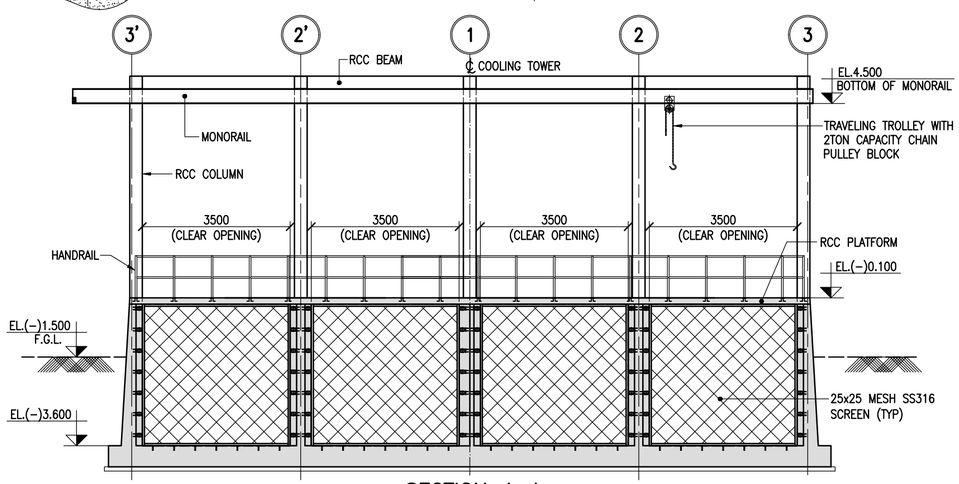
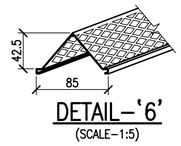
3. THIS SHEET SHOULD BE READ IN CONJUNCTION WITH SHEETS 1,2,4,5 & 6 OF THIS DRAWING.



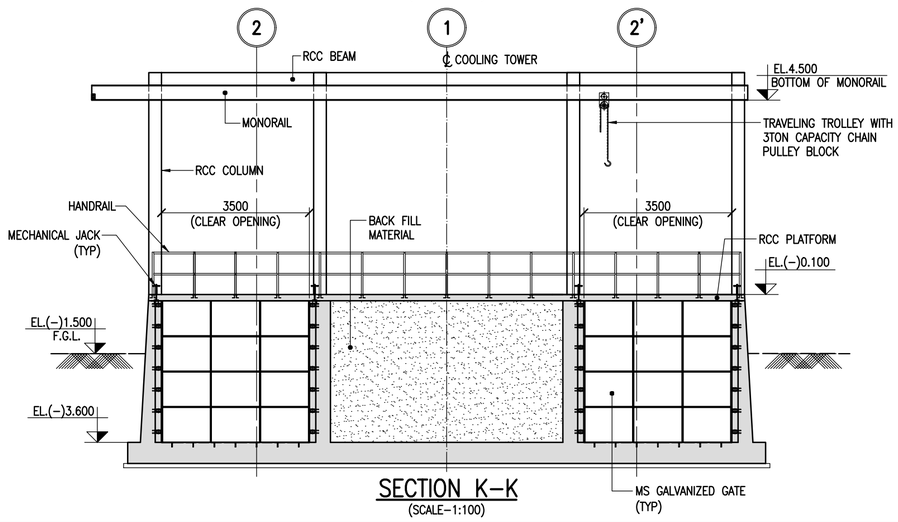
SECTION J−J

(SCALE−1:100)



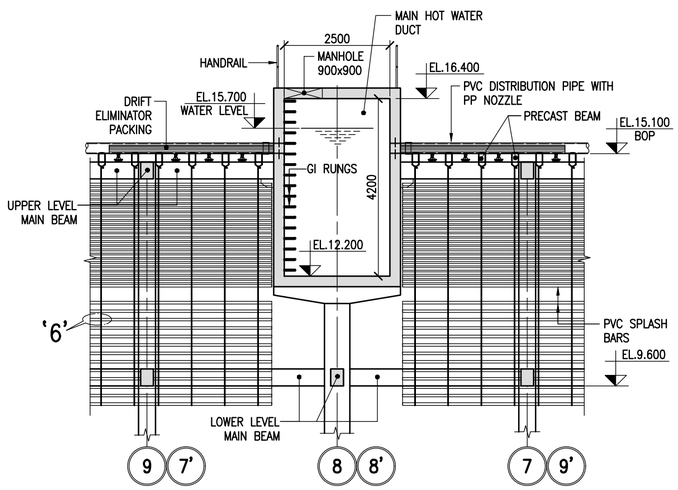
DETAIL−'6'

(SCALE−1:5)



SECTION K−K

(SCALE−1:100)



SECTION H−H

(SCALE−1:100)

REV. NO.	DATE	DESCRIPTION	DRAWN
2	01/12/18	BASED ON TCE & TSGENCO COMMENTS Dt. 22/11/18	SCJ
1	10/08/18	BASED ON TCE COMMENTS Dt. 03/08/18	CDS
0	26/06/18	FOR APPROVAL	SHM

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD, TELANGANA INDIA

CONSULTANT: TATA CONSULTING ENGINEERS LIMITED, BANGALORE INDIA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED

NDCT CONSULTANT: SPECTRUM Techno Consultants Pvt Ltd
401, Raikar Bhavan, Plot No. 9, Sector-17, Vashi, Navi Mumbai 400 705
India. Email : info@spectrumworld.net

5x800 MW YADADRI THERMAL POWER STATION

DRAWN BY :	SHM
CHECKED BY	UNB
APPROVED BY	UKR
DATE	10/08/2018
SCALE	AS SHOWN

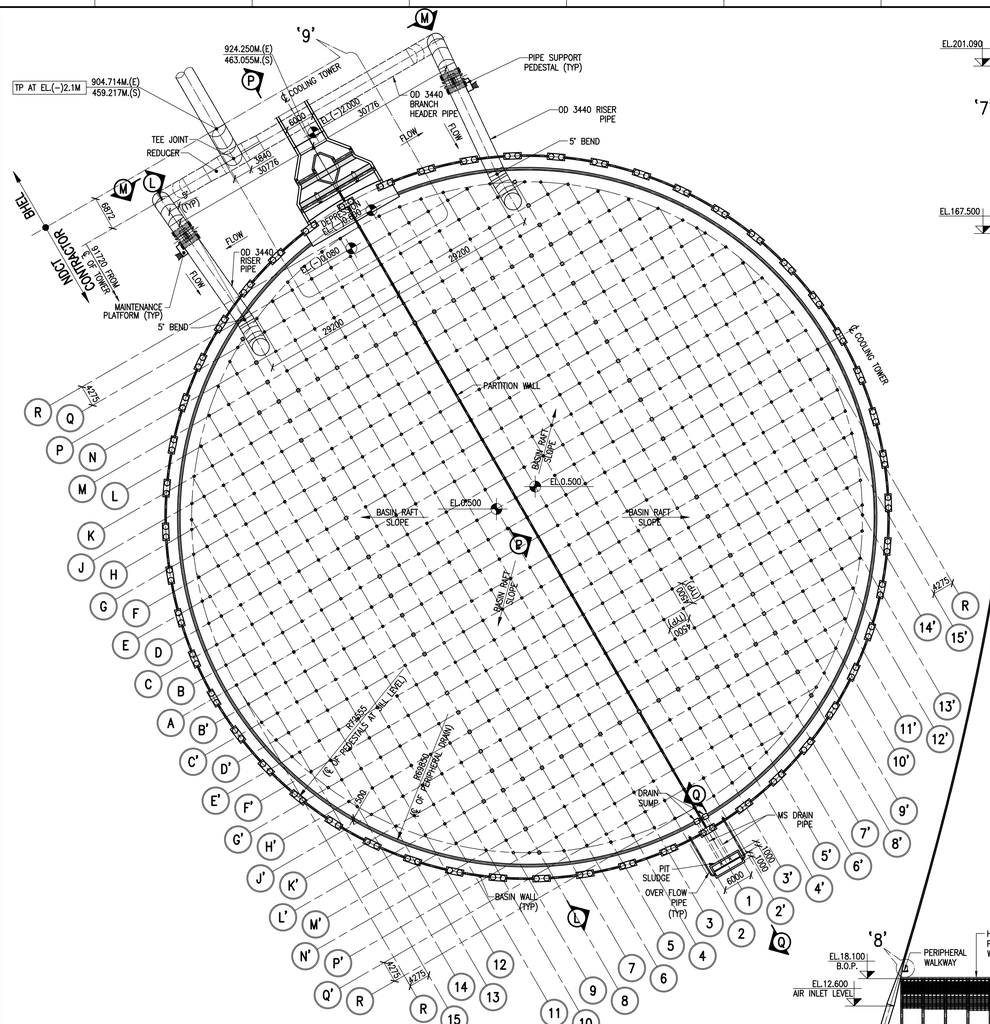
TITLE: GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER (STAGE#1)

STCPL DRG.NO. 760-E-DD-101 — REV.NO. 2

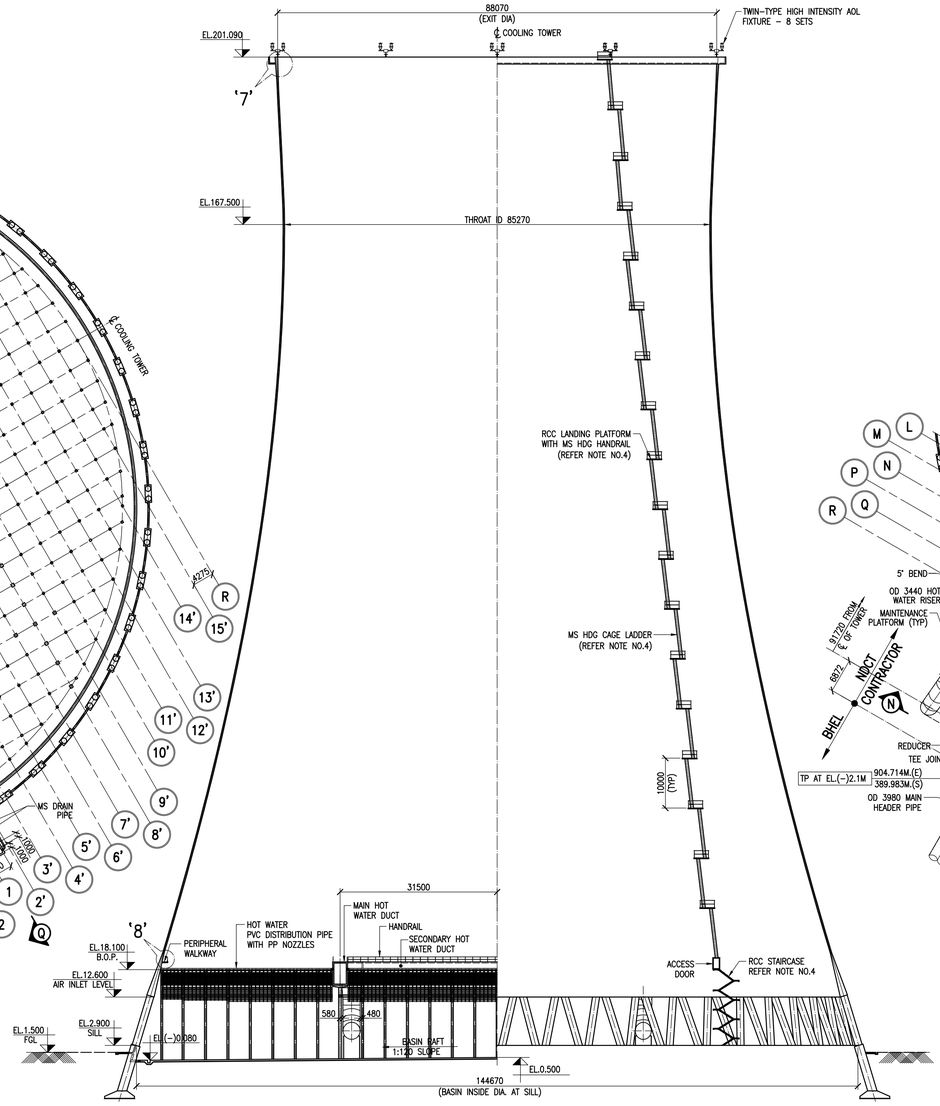
BHEL DRG.NO. PE-V1-417-165-N001 (SHEET 3 OF 6)

SHEET SIZE : A2

FILE NAME : X:\760-YADADRI NDCT\WORKING\760-E-DD-101-R2 (GAD) FOR NDCT -1 to 5).dwg

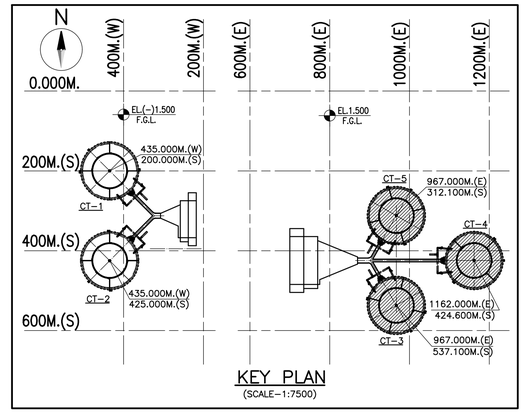


PLAN AT EL.2.900M OF CT–3
(SCALE–1:600)



HALF SECTION OF CT–3, CT–4 & CT–5
(SCALE–1:600)

HALF ELEVATION OF CT–3, CT–4 & CT–5
(SCALE–1:600)



KEY PLAN
(SCALE–1:7500)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER UNLESS OTHERWISE SPECIFIED.
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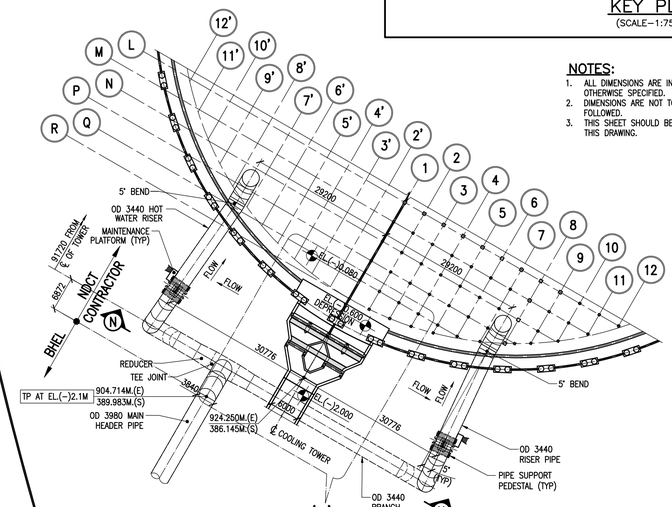
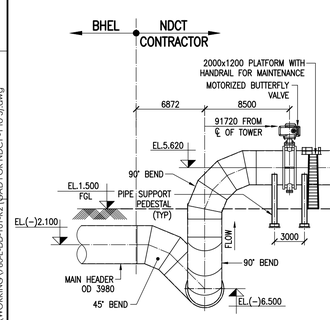
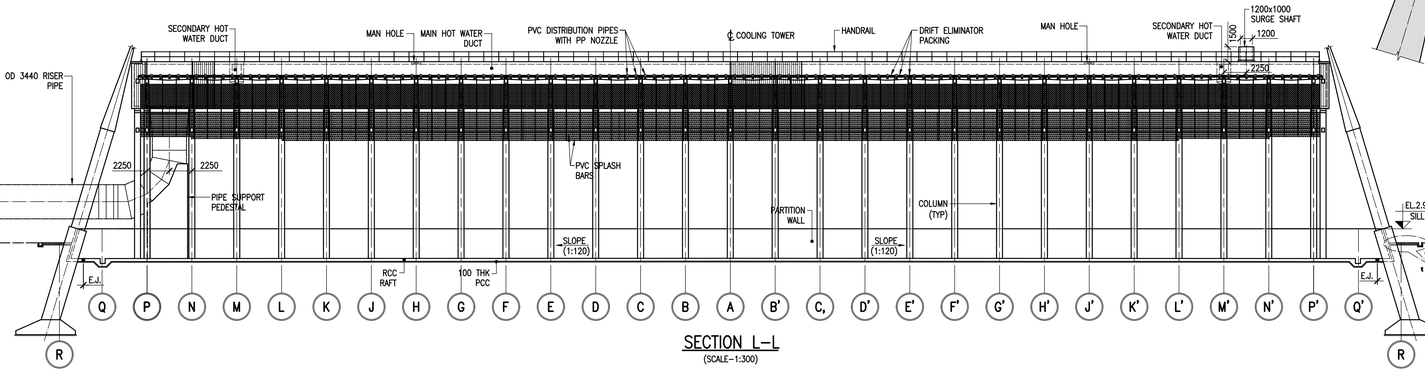
3. THIS SHEET SHOULD BE READ IN CONJUNCTION WITH SHEETS 1,2,3,5 & 6 OF THIS DRAWING.

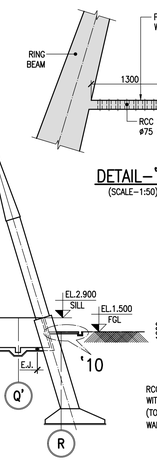


PART PLAN AT EL.2.900M OF CT–5
(SCALE–1:600)

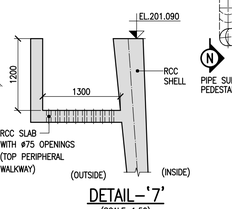




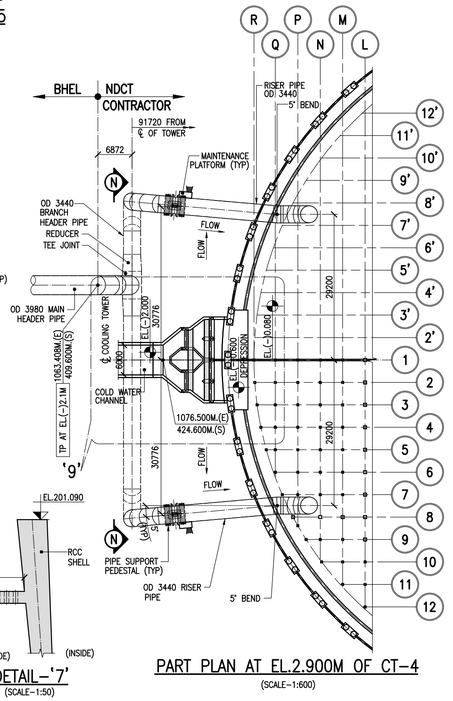
SECTION L–L
(SCALE–1:300)



DETAIL–'8'
(SCALE–1:50)



DETAIL–'7'
(SCALE–1:50)



PART PLAN AT EL.2.900M OF CT–4
(SCALE–1:600)

REV. NO.	DATE	DESCRIPTION	DRAWN
2	01/12/18	BASED ON TCE & TSGENCO COMMENTS Dt. 22/11/18	SCJ
1	10/08/18	BASED ON TCE COMMENTS Dt. 03/08/18	CDS
0	26/06/18	FOR APPROVAL	SHM

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD, TELANGANA INDIA

CONSULTANT: TATA CONSULTING ENGINEERS LIMITED, BANGALORE INDIA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED

NDCT CONSULTANT: SPECTRUM Techno Consultants Pvt Ltd, 401, Raikar Bhavan, Plot No. 9, Sector-17, Vashi, Navi Mumbai 400 705 India. Email : info@spectrumworld.net

PROJECT: 5x800 MW YADADRI THERMAL POWER STATION

DRAWN BY :	SHM
CHECKED BY	UNB
APPROVED BY	UKR
DATE	10/08/2018
SCALE	AS SHOWN

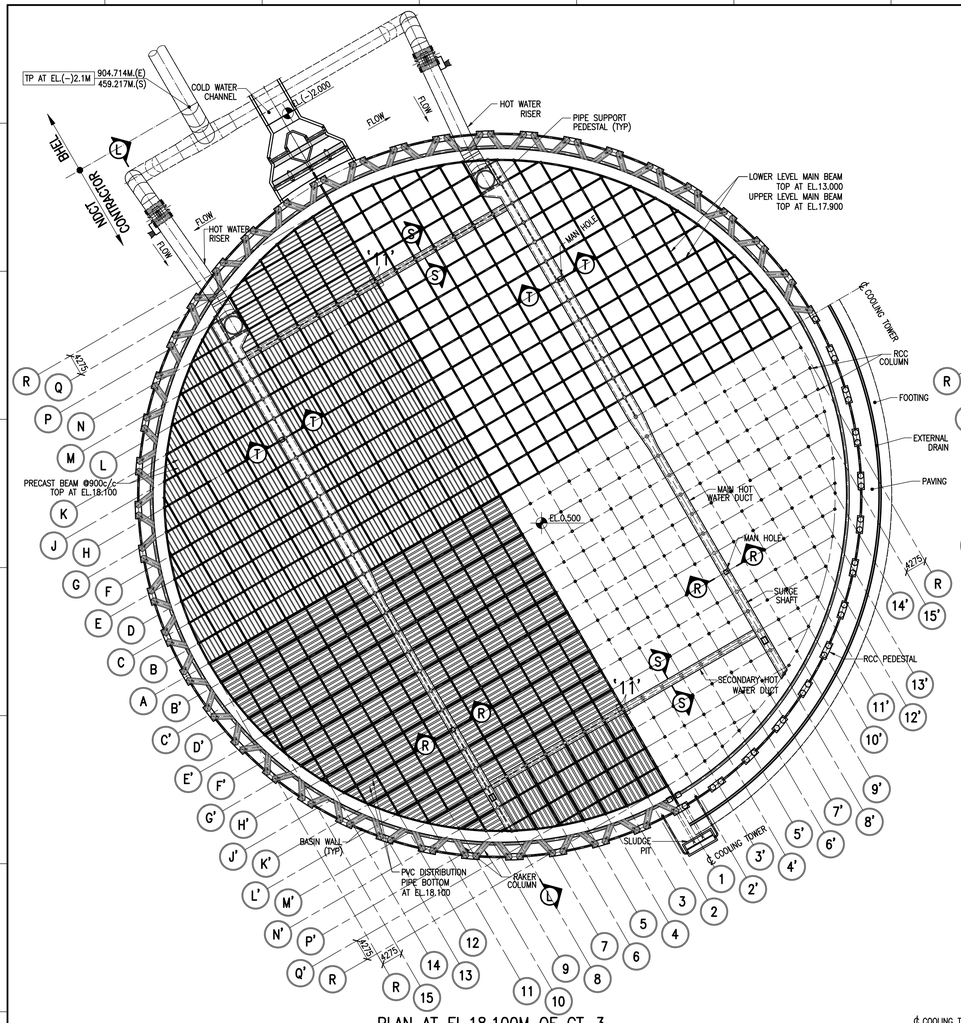
TITLE: GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER (STAGE#2)

STCPL DRG.NO. 760-E-DD-101 REV.NO. 2

BHEL DRG.NO. PE-V1-417-165-N001 (SHEET 4 OF 6)

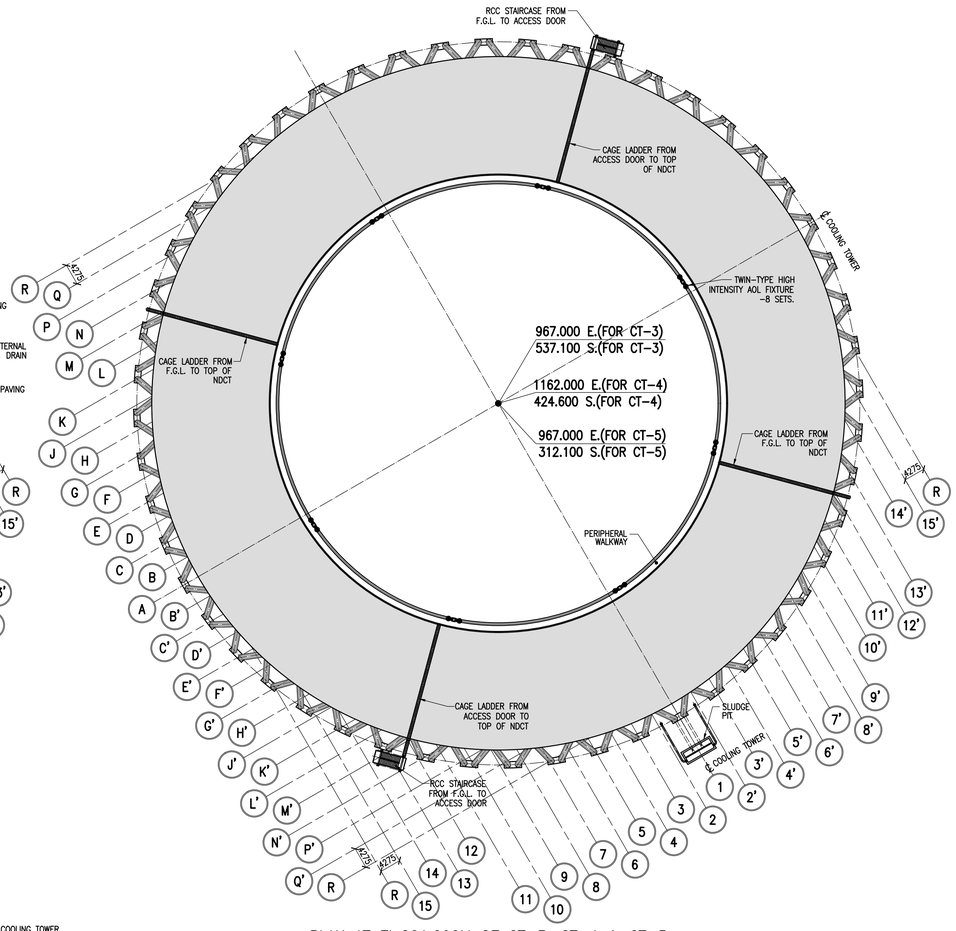
SHEET SIZE : A1

FILE NAME : X:\760-YADADRI\NDCT\WORKING\760-E-DD-101-R2 (GAD FOR NDCT -1 to 5).dwg



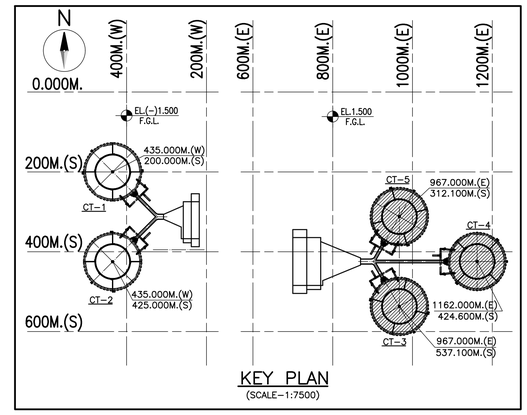
PLAN AT EL.18.100M OF CT–3

(SCALE–1:600)



PLAN AT EL.201.090M OF CT–3, CT–4 & CT–5

(SCALE–1:600)



KEY PLAN

(SCALE–1:7500)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER UNLESS OTHERWISE SPECIFIED.
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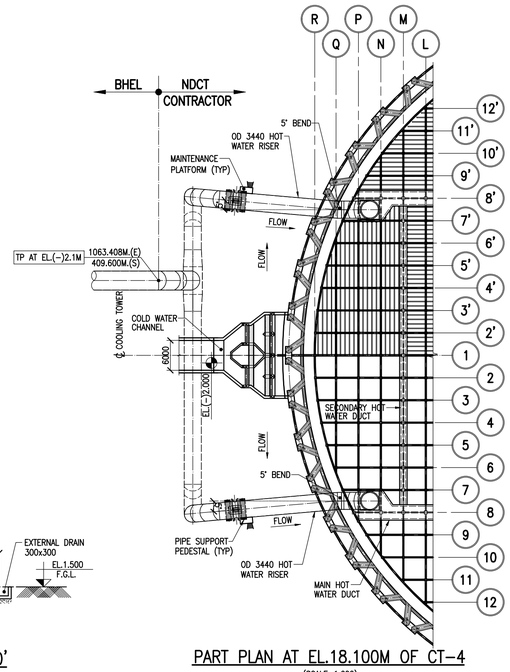
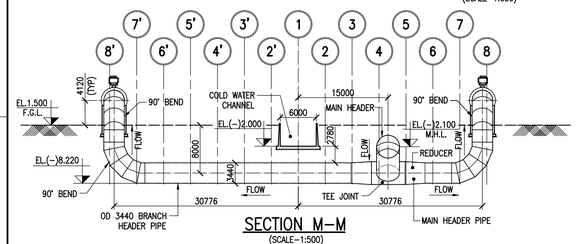
3. THIS SHEET SHOULD BE READ IN CONJUNCTION WITH SHEETS 1,2,3,4 & 6 OF THIS DRAWING.



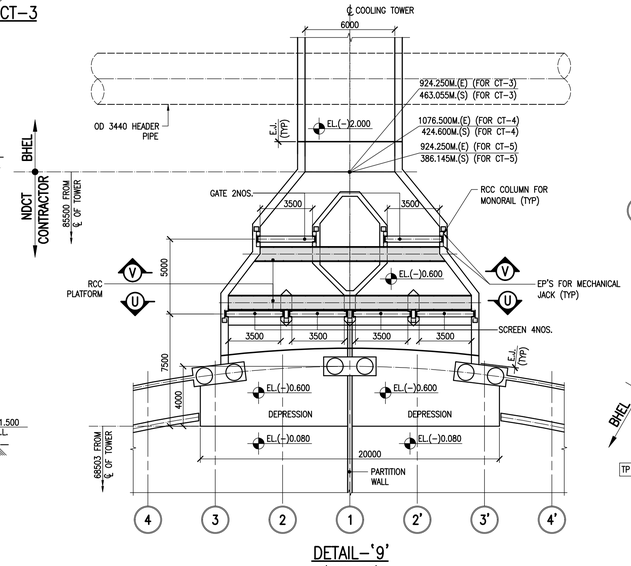
PART PLAN AT EL.18.100M OF CT–4

(SCALE–1:600)



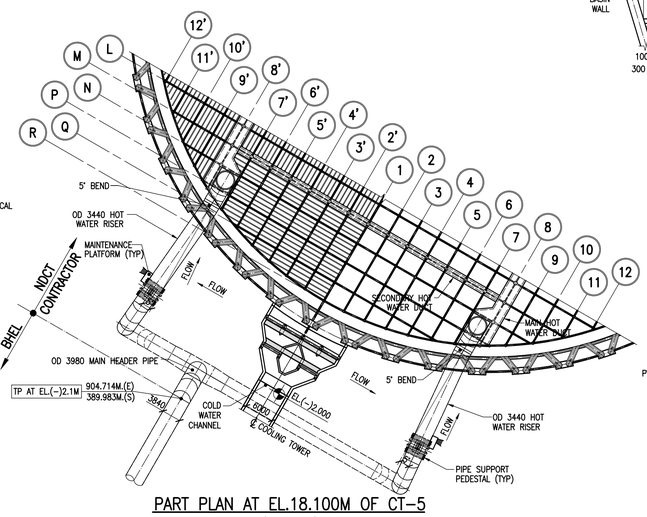
SECTION M–M

(SCALE–1:500)



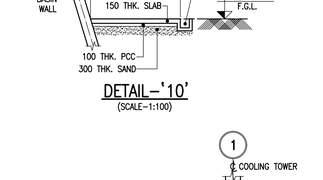
DETAIL–'9'

(SCALE–1:200)



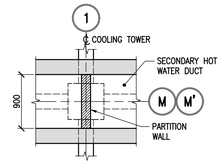
PART PLAN AT EL.18.100M OF CT–5

(SCALE–1:600)



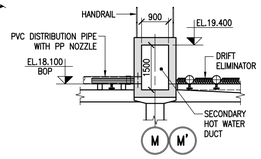
DETAIL–'10'

(SCALE–1:100)



DETAIL–'11'

(SCALE–1:50)



SECTION S–S

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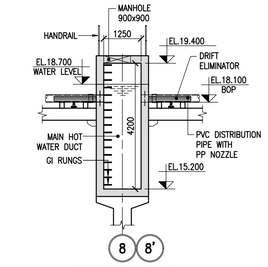

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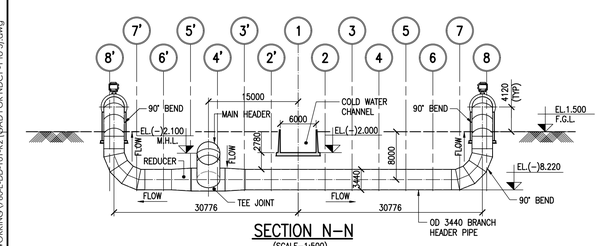

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1	10/08/18	BASED ON TCE COMMENTS Dt. 03/08/18	CDS
0	26/06/18	FOR APPROVAL	SHM

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD, TELANGANA INDIA

CONSULTANT: TATA CONSULTING ENGINEERS LIMITED, BANGALORE INDIA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED

NDCT CONSULTANT: SPECTRUM Techno Consultants Pvt Ltd
401, Raikar Bhavan, Plot No. 9, Sector-17, Vashi, Navi Mumbai 400 705 India. Email : info@spectrumworld.net

PROJECT: 5x800 MW YADADRI THERMAL POWER STATION

DRAWN BY :	SHM
CHECKED BY	UNB
APPROVED BY	UKR
DATE	10/08/2018
SCALE	AS SHOWN

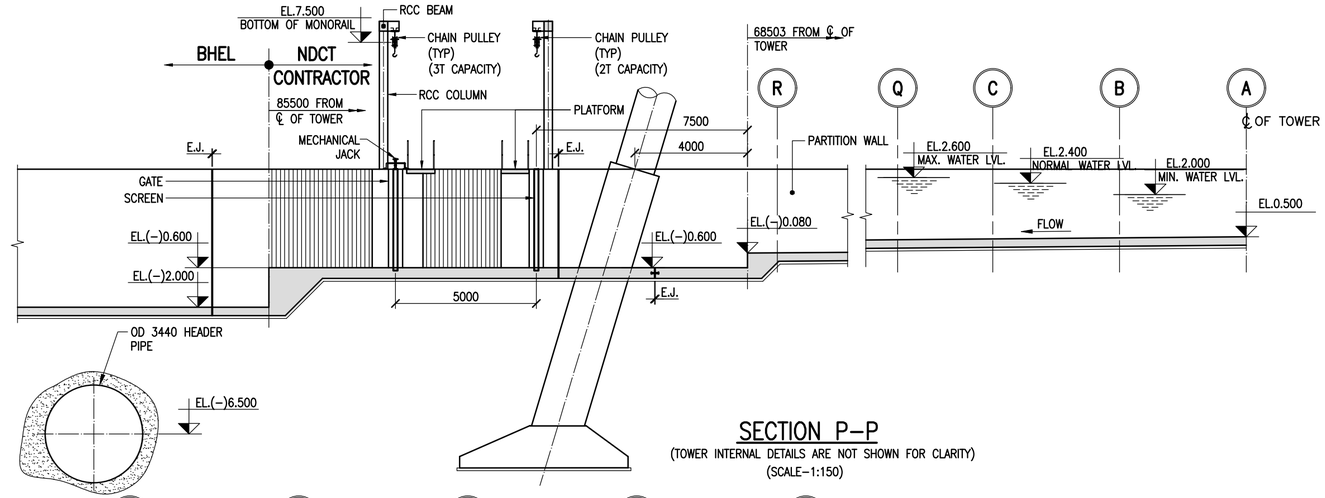
TITLE: GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER (STAGE#2)

STCPL DRG.NO. 760-E-DD-101 REV.NO.

BHEL DRG.NO. PE-V1-417-165-N001 (SHEET 5 OF 6) 2

SHEET SIZE : A1

FILE NAME : X:\760-YADADRI\NDCT\WORKING\760-E-DD-101-R2 (CAD FOR NDCT -1 to 5).dwg



SECTION P–P

(TOWER INTERNAL DETAILS ARE NOT SHOWN FOR CLARITY)
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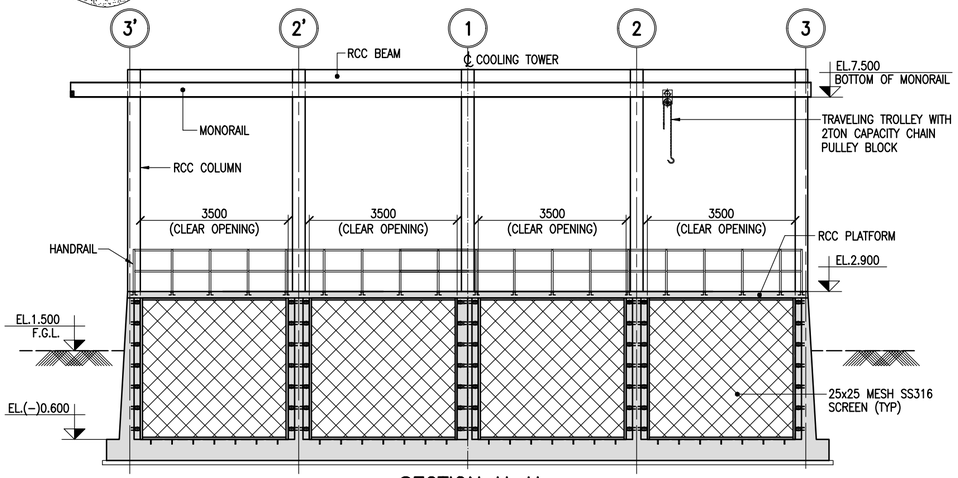

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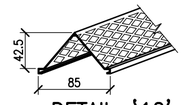

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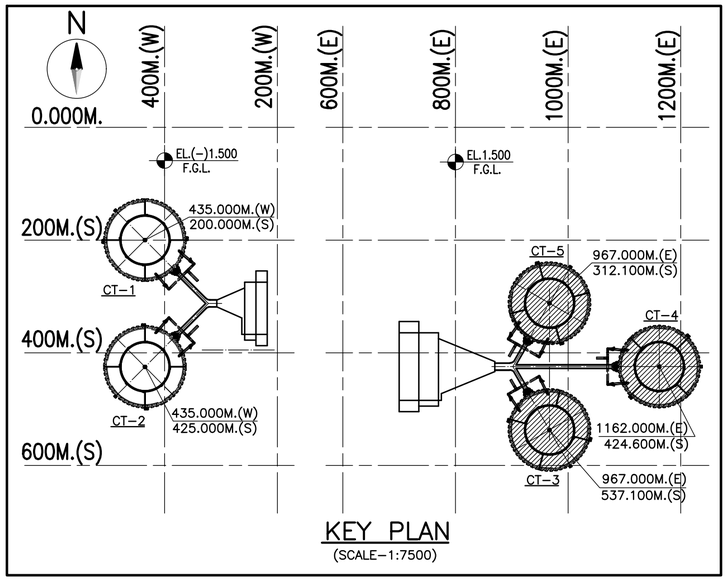

KEY PLAN

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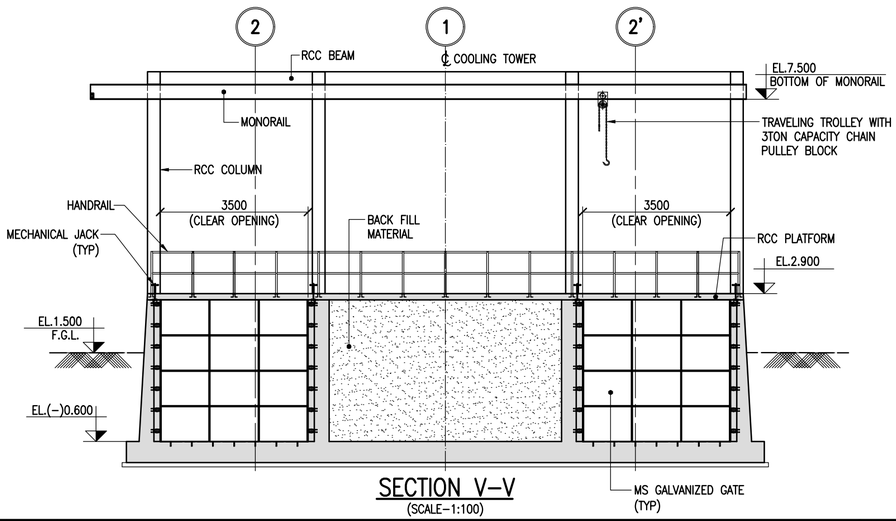
NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER UNLESS OTHERWISE SPECIFIED.
2. DIMENSIONS ARE NOT TO BE SCALED. ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED.
3. THIS SHEET SHOULD BE READ IN CONJUNCTION WITH SHEETS 1,2,3,4 & 5 OF THIS DRAWING.



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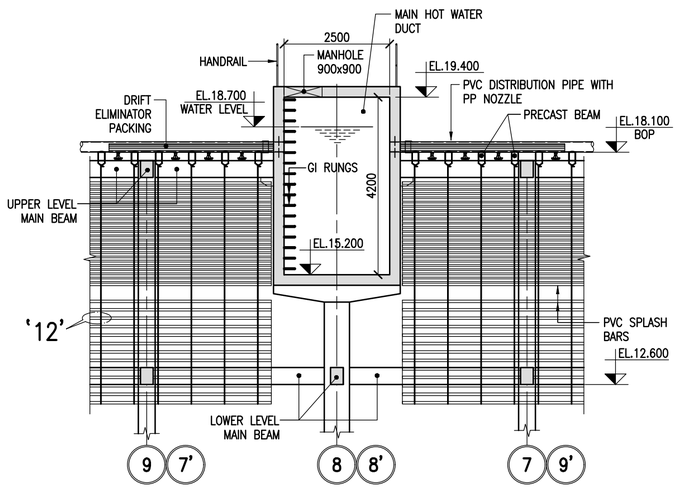

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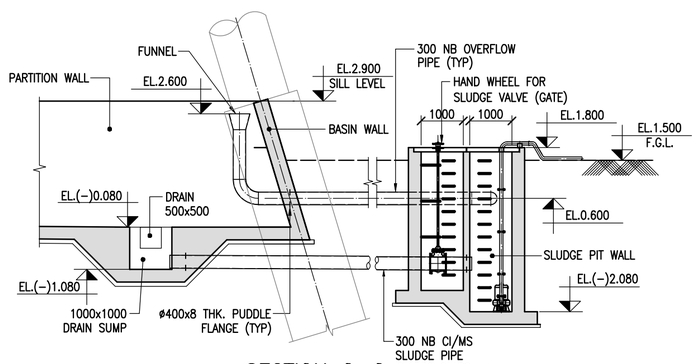

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REV. NO.	DATE	DESCRIPTION	DRAWN
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1	10/08/18	BASED ON TCE COMMENTS Dt. 03/08/18	CDS
0	26/06/18	FOR APPROVAL	SHM

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD, TELANGANA INDIA

CONSULTANT: TATA CONSULTING ENGINEERS LIMITED, BANGALORE INDIA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED

NDCT CONSULTANT: SPECTRUM Techno Consultants Pvt Ltd
401, Raikar Bhavan, Plot No. 9, Sector-17, Vashi, Navi Mumbai 400 705
India. Email : info@spectrumworld.net

5x800 MW YADADRI THERMAL POWER STATION

DRAWN BY :	SHM
CHECKED BY	UNB
APPROVED BY	UKR
DATE	10/08/2018
SCALE	AS SHOWN

TITLE: GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER (STAGE#2)

STCPL DRG.NO. 760-E-DD-101 — REV.NO. 2

BHEL DRG.NO. PE-V1-417-165-N001 (SHEET 6 OF 6)

SHEET SIZE : A2

FILE NAME : X:\760-YADADRI NDCT\WORKING\760-E-DD-101-R2 (GAD) FOR NDCT - 1 to 5).dwg

	OWNER	**TELANGANA STATE GENERATION CORPN. LTD.** (TSGENCO)
	OWNER'S CONSULTANT	**TATA CONSULTING ENGINEERS LIMITED** BANGALORE, INDIA
	EPC CONTRACTOR	**BHARAT HEAVY ELECTRICALS LTD.** (BHEL)
	NDCT CONSULTANT	**SPECTRUM TECHNO-CONSULTANTS PVT. LTD.**

Doc. Prepared By		**Doc. Reviewed By**		**Doc. Approved By**	
JHB		**UNB**		**UKR**	

Revision History

Revision	Description	Date
0	For Approval	23.07.2018
1	Based on TCE Comments Dt. 02.08.2018	07.08.2018

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1. Introduction

This document provides the design basis for NDCTs for 5 x 800 MW Yadadri Thermal Power Project of Telangana State Generation Corporation Ltd. (TSGENCO)

2. Detailed Scope of Civil Works

- Excavation and backfilling for columns, foundation and substructure below cold water basin level.
- RCC foundation raft & Cold water Basin, RCC Shell, and RCC support framework for fill and other thermos-hydraulic components.
- Hot water distribution duct.
- Painting of concrete surfaces with approved type of paint.
- Providing and installation of access doors in the shell of cooling tower including the necessary fitting and appliances on Tower Shell. The access doors will be of heavy duty MS doors duly painted with 3 coats of epoxy paints.
- Main access RCC staircase outside the tower up to Hot water Duct level, internal RCC walkways and platform, all with necessary galvanized MS pipe handrails.
- Cold water channel outlet up to terminal points.
- De-sludging arrangement for each compartment of cold water basin.
- Provision of permanent galvanized mild steel access ladder up to top of tower with adequate back-guards and landing platforms.
- Provision of peripheral drainage around cooling tower.
- Necessary site clearing and grading all-round the tower in accordance with specifications and drawings.
- Water fill test of cold water basin, cold water outlet channel.
- Hydro test of Hot water Duct.
- Supply and erection of all anchor bolts, nuts, fasteners, embedded parts and any other likewise material required for completion of work.

3. DESCRIPTION OF STRUCTURE

Ref: Drg. No. PE-V1-417-165-N002 (General Arrangement of Natural Draught Cooling Tower)

All elevations are with respect to EL. 0.000 of Power House Building, which corresponds to RL 81.500.

As given in the table below, elevations for CT-1 & CT-2 (together referred as Unit-1) are identical. Similarly elevations are identical for CT-3, CT-4, & CT-5 (together referred as Unit-2).

Item	CT-1 & CT-2	CT-3, CT-4, & CT-5
Tower Pedestal c/c diameter at sill level	144.670 m	144.670 m
Inside diameter at throat level	85.270 m	85.270 m
Inside diameter at top	88.070 m	88.070 m
Center diameter of pond wall at Basin Floor	146.458 m	146.458 m
Sill level elevation	EL. (-)0.100	EL. 2.900
Throat level elevation	EL. 164.500	EL. 167.500
Elevation of top level of tower	EL. 198.090	EL. 201.090
Air inlet level elevation	EL. 9.600	EL. 12.600 m
Basin Invert Level (at center)	EL. -2.500 m	EL. 0.500 m
Maximum Water Level (MWL)	EL. (-)0.400 m	EL. 2.600 m
Grade level (FGL)	EL. (-) 1.500 m	EL. 1.500 m
Type of fill	PVC V Bar	PVC V Bar
Effective Height of Fill Packing For Load Calculation	5.2m	5.2m
Distribution Pipe Size for Load Calculation	250 OD Max., PVC, Class 3	250 OD Max., PVC, Class 3
Drift Eliminators Material & Load	PVC, 11 kg/m^2 max.	PVC, 11 kg/m^2 max.

4. MATERIAL

4.1 Concrete:

Minimum Grade of concrete (f_{ck})

Tower Foundation	: M30
Pedestal	: M30
Pond wall	: M30
Raker Columns	: M30
Shell	: M30
Pond basin floor	: M30
Grillage columns, bracings & Beams	: M30
Precast beams	: M30
Hot water duct	: M30
Platforms	: M30
Cold water channel	: M30
Drainage Sump	: M30
Staircase	:M30
PCC	:M10
Density of Concrete:	25kN/m3
Elastic Modulus of Concrete:	$5000\sqrt{f_{ck}}$ MPa.
Coefficient of linear thermal expansion of concrete & Steel	11×10^{-6} ^{o}C

4.2 Steel:

Shell	: Corrosion Resistant Steel/HCRM, Grade Fe415 / 500 to IS: 1786
Foundation & other structures	: Corrosion Resistant Steel/HCRM, Grade Fe415 / 500 to IS: 1786

5. LOADING

The following loads will be considered for the design of cooling towers

a) Dead loads

b) Imposed loads (including construction loads)

c) Wind loads

d) Earthquake forces

e) Temperature (Including solar radiation)

Note: Since the strata below founding level is comprised of fresh rock as per summary of geotechnical investigation report, differential settlements due to symmetric loads are not expected. Hence, separate loads due to sinking of supports will not be considered in analysis.

5.1 Dead Load

For calculating the self-weight of the structure, the specific weight of the material will be taken as below. All other dead loads will be assessed in accordance with relevant codal provision. Dead load will include the self-weight of structure, weight of fill material, weight of water in hot water channel and distribution system including the self-weight of channel and distribution system, etc.

Concrete	: 25 KN/m^3
Water	: 9.81 KN/m^3
Steel	: 78.5 KN/m^3

5.2 Imposed Loads (Including Constructional Loadings)

Imposed loads on various structures shall be as follows:

I.	Basin, sump duct & underground pipe	: Besides earth pressure under dry & wet condition, an additional surcharge of 2.5 T/m^2 shall be taken
II.	Covers for HW distribution basin	: 0.5 T/m^2
III.	Walkways inside CT distribution basin	: 0.5 T/m^2
IV.	Landing platform & staircase	: 0.5 T/m^2
V.	Surcharge load	: 2.5 T/m^2

CW basin surcharge load shall be considered in addition to the other relevant codes. Construction loadings that may occur during execution of work will be considered in the design of the cooling tower structure.

5.3 Wind Pressure

The wind pressure on the towers will be assessed on theoretical basis as well as with the help of model test in a wind tunnel of turbulent boundary layer.

The complete cooling tower will be designed for all possible wind directions and on the basis of worst load conditions as obtained from theoretical methods.

Under the theoretical method, the circumferential net wind pressure distribution and wind pressure coefficient (p1) for the tower shell will be obtained from the "Criteria for structural design of Reinforced concrete Nature Draft Cooling Towers IS: 11504-1985. The Fourier series coefficients used to obtain the net pressures are as follows: (will be verified post wind tunnel test)

-0.00071; 0.24611; 0.62296; 0.48833; 0.10756; -0.09579; -0.01142; 0.04551

This design net pressure coefficient (p) includes the effect of internal suction and the distribution along the circumference of tower will be used at all heights of the tower.

In order to compute the quasi static design wind pressure at a given height along the circumference of the tower, the design pressure coefficient (p) will be multiplied by the wind pressure acting at that height [P(z)].

The wind pressure at a given height [P(z)] will be computed as per the stipulations of IS:875 (Part 3) - 2015. For computing the design wind pressure at a given height the basic wind speed (Vb) will be taken as **Vb= 44 m/sec** at 10.0 meters height above mean ground level. For computing design wind speed (Vz) at a height z, the risk co-efficient **K1=1**. For coefficient **K2, Terrain category 2 and class 'C'** as per table 2 of IS: 875 (Part-3) - 2015 will be considered. The wind direction for design purposes will be the one which induces worst load conditions. Topography coefficient **K3=1.0** for the tower under consideration. Since the project location is well over 120km away from the nearest sea coast, **the importance factor for cyclonic region, k4, will be considered as 1.00** as per cl. 6.3.4 of IS: 875 (Part 3) - 2015. The wind pressure at a given height will be computed theoretically in accordance to the IS codal provision given as under:

$Pz = 0.6\ Vz^2\ N/mm^2$; where $Vz = Vb \times K1 \times K2 \times K3 \times K4$

Computation of wind pressure (pz) along the wind direction by Gust Factor (GF) Method for estimating the wind load on the tower and other elements, will be based on IS: 875 (Part-3)-2015. While calculating the gust factor, the term 'b' will be taken as the diameter of the throat. Design of the tower will satisfy Peak Wind method & Gust Effective Factor method.

A load enhancement factor of 1.43 will be applied to the wind loading calculated, to account for:

i) Natural turbulence in the incident wind resulting from the bluff obstruction and wake

ii) Increase in wind speed as well as turbulence induced in the incident wind by adjacent cooling tower and the structures of significant dimensions.

A 10% increase over the enhancement factor will be considered for imperfection in construction as per IS: 11504-1985. The factor will be further increased by 10% for design of raker columns, pedestals and foundation in case wind tunnel report is not available at the time of design.

5.4 Earthquake Forces

The seismic analysis will be carried out in accordance with IS: 1893 – 2015 by modal analysis of the hyperbolic cooling towers. The earthquake analysis of the shell and its support columns including the foundations will be carried out by response spectrum method. Earthquake analysis for the fill supporting structures (RCC frames) will also be carried out by response spectrum method. For all analyses, acceleration will be considered in all 3 directions in 1:0.3:0.3 ratio. The modulus of elasticity for concrete will be as per IS: 456-2000 Clause 6.2.3.1 with an Age Factor of 1.0. All the analysis will be carried out as per the theory of elasticity.

The project lies in Zone-III

Seismic zone factor : 0.16

Response reduction factor : 3 (as per Table 4 of IS: 1893 Part 4 – 2015)

Damping : 5% of critical

Importance factor : 1.50 (Cat. 2 as per Table 3 of IS: 1893 Part 4 – 2015)

5.5 Temperature Loads

a) For temperature loading, the average annual ambient temperature variation will be considered from 15.9 deg. C to 44.3 deg. C. as per climatological data at Nalgonda.

b) Total temperature variation of 2/3 times the annual variation will be considered as loading.

c) Temperature effects due to solar radiation will be considered in addition to above. Shell will be designed for one sided solar radiation effect. Nevertheless an effective temperature difference of at least 25 deg. C across the shell thickness constant over the height and following a sine function along half the circumference will be considered.

d) The shell will be checked for thermal stresses arising due to partial operation of the tower in case the operation philosophy so demands. The calculation for stress analysis resulting from non-symmetric temperature loading will be based upon the operating condition.

e) For calculating effects of temperature loads, modulus of elasticity of concrete E_c will be reduced by 50% as per cl. 6.4.2.5.(vi) of IRC: 112 – 2011. Since this is equivalent to reduction of temperature loads by 50% and keeping E_c as it is, the later method will be adopted by multiplying working temperature loads by a factor of 0.5.

6. LOAD COMBINATIONS

Following minimum load combinations shall be considered for the design of cooling towers structures as per IS 875 (Part 5) – 1987 (reaffirmed - 2008).

6.1 Load Combination for Stability Checks

Case	Load Combination	Factor of Safety
Sliding	0.9DL + 1.0WL 0.9DL + 1.0EQL	1.5
Overturning	0.9DL + 1.0WL 0.9DL + 1.0EQL	1.5
Uplift	0.9DL + 1.0WL 0.9DL + 1.0EQL	1.25

6.2 Load Combination for Cooling Tower and Foundation System Design

Sr.No.	Load Combinations
Working Stress Design	
1	DL+ WL
2	DL +TL
3	DL +EQL
4	DL + WL + TL
5	DL + EQL + TL
Limit State Design	
4	0.9DL+1.5WL
5	1.5DL+1.5WL

6	0.9DL +1.5EQ
7	1.5DL+1.5EQ

- All these load combinations shall be checked for both basin full and empty conditions. Temperature loads, wind loads and earthquake loads of different types (and/or directions) shall be considered separately forming all possible combinations.

DL = Self Weight

WL = Wind Load

TL = Temperature Load

EQL = Earth quake load

6.3 Load Combination for Internal Fill Structure

Sr. No.	Load Combinations	Elements		
		Basin Slab	HW Duct	RCCC Grillage frame
Working Stress Design				
1	DL+SI + LL	√	√	
2	DL+SI + LL ±EQx	√	√	
3	DL+SI + LL ±EQy	√	√	
Limit State Design				
4	1.5DL+1.5SI + 1.5LL			√
5	1.2DL+1.2SI + 0.6LL ±1.2EQx			√
6	1.2DL+1.2SI + 0.6LL ±1.2EQy			√
7	0.9DL +0.9SI±1.5 EQx			√
8	0.9DL +0.9SI±1.5 EQu			√

DL - Self Weight

EQ - Earth quake load

SI - Superimposed dead load

7. Permissible stresses

For load combinations 1 to 5 in section 6.2, the stress in concrete and reinforcement shall be restricted as per working stress method of IS: 456. Any increase in allowable stresses in extreme load cases will not be considered. Crack width shall be limited to 0.1mm in case of cooling tower shell.

In limit state method of design, the stress in the reinforcement steel shall not exceed 87% of the specific characteristic strength of reinforcement steel and the compressive stress in the concrete shall not exceed 45% of the specified 28 days cube strength of the concrete as per IS:456.

Permissible stress for steel structures shall be as per IS: 800 – 2007 (WSD) based on working stresses.

For Pond wall, pedestal and distribution system (Hot water duct and secondary ducts) and cold water outlet, stresses in concrete (section 6.3, 1 to 3) will be limited as per Table 2 of IS-3370 Part II (2009) and stresses in reinforcement shall be limited to 130Mpa.

8. TOWER DESIGN CONSIDERATION

8.1 General

The complete cooling tower, including the shell, columns, ring beam and foundation, will be structurally analyzed using finite element (FE) modeling technique using the commercially available and widely popular German FE software SOFISTIK. Concrete may be assumed to be un-cracked, homogenous and isotropic. The design geometric profile, thickness variation and support conditions of shell will be considered in the structural analysis.

Analysis based on the recognized bending theory of the elastic shells will be adopted for the design of the tower and supporting structures. The shell analysis will include the following information at 10^{o} plan angle and not more than 0.05 of shell height:

A. Meridional and circumferential direct stress resultants and tangential shear stress resultants,

B. Meridional and circumferential bending moments, and

C. Displacement normal to shell mid surface.

A detailed dynamic analysis will be carried out for the complete tower for seismic forces by response spectrum method.

A single finite element model of cooling towers representing critical conditions shall be prepared for analysis in SOFISTIK.

8.2 Buckling of Tower Shells

a) Critical dynamic wind pressure will be calculated as per BS 4485 – Part 4: 1996.

b) Buckling of cooling tower will be checked as per Finite Element Analysis using SOFISTIK. The factor of safety for snap through buckling will be considered as 5. Alternatively, bifurcation buckling factor will be calculated using linear Eigen value analysis with modulus of elasticity E=0.8Ec, to account for cracked section, with a factor of safety of 7.

8.3 Opening in Shells

Opening through the shells will be provided for hot water pipes and access door.

Openings will be provided with additional reinforcement at each edge equal to 75% of the reinforcement intercepted by the openings in the direction parallel to the edges. In addition diagonal reinforcement will be provided at each corner as close as possible. The total cross-sectional area in cm^2 of this reinforcement will be 0.5d, at each corner where'd' is the shell thickness in cm.

No horizontal thrust due to the inlet piping shall be transmitted to the shell.

8.4 Minimum Thickness of Shell

A minimum thickness of 300mm shall be provided for the shell.

8.5 Minimum Reinforcement in Shell Spacing and Placement

The reinforcement used will be corrosion resistant/ HCRM of grade Fe 500 conforming to IS: 1786.

For top 1/3rd height of the shell, the circumferential reinforcement shall not be less than 0.4% of the concrete cross sectional area and meridional reinforcement shall not be less than 0.35% of the concrete cross sectional area.

Shell reinforcement for remaining 2/3rd portion will be 0.35% of concrete cross sectional area in both meridional & circumferential direction.

Spacing of reinforcing bars shall not exceed 200 mm in circumferential and 250 mm in meridional directions.

Minimum Bar Diameter : Circumferential : 10 mm

Meridional : 12 mm.

8.6 Raker Columns

Inclination of the circular raker columns will closely match the meridional slope at the shell so that the load transfer to foundation takes place through predominantly axial force in columns.

Raker columns will be designed for the most critical forces transferred to an individual raker column from superstructure considering various load combinations as under Clause 6 above. Design of raker columns shall be carried out in both limit state and working stress methods for worst load combinations acting on critical elements.

For calculating effective length of raker columns, columns will be considered as restrained at both the ends. The effective length will be taken as 0.8 and 0.6 times the length of column radially and tangentially respectively.

Minimum size of 1.2m is considered for raker column.

8.7 Foundations

The foundation shall be continuous annular raft type.

Founding level of the towers is considered to be minimum 4m below existing ground level (EGL). Net Safe Bearing Capacity (SBC) for foundation design will be considered as per recommendations provided in the approved soil investigation report (PE-DC-417-602-C001).

Modulus of subgrade reaction will be applied as springs below the raft with spring constant calculated as follows:

$K_s = \frac{SBC\ below\ 6m\ depth}{s}$, s = settlement of12mm for all towers.

Founding level for raft will be at least 1m below EGL. SBC at basin raft founding level will be considered as per recommendations of the approved soil investigation report.

The design of the cooling tower foundation structures will follow working stress method for worst load combination as per IS: 456 – 2000. Limit state method shall also be adopted for design in cases involving wind loads (DL + 1.5 WL).

The foundation of the tower shall be of minimum M-30 grade concrete resting on 100mm thick PCC of grade M10. Clear cover shall not be less than 50mm.

Foundation will be checked for safety against stability and uplift. For calculating downward load due to overburden, weight of soil directly above the annular raft will only be considered.

For the uplift check following condition will be ensured.

- Basin walls are constructer up to sill level and there is no water in the basin, superstructure column not constructed.
- No pressure relief valves will be provided in the cold water basin. The water tightness of the basin will be ensured to prevent mixing of ground water with sweet water of CW system.

8.8 Serviceability Design

Serviceability design shall be in accordance with IS: 456-2000

8.9 Durability Requirements

Clear cover for reinforcement shall be 50mm for shell.

Crack width shall be limited to 0.1 mm for Shell.

8.10 Tolerances:

The construction will be carried out with in the tolerances stipulated below as per cl. 7.3 of IS 11504

a) Shell wall center line in horizontal plane measured radially at midpoint on a 3.0m wide chord : $\pm$15mm
b) Shell wall center line in meridional plane over a height of 1.0m. : $\pm$ 10mm
c) Thickness of shell. : + 10mm or -5 mm
d) Horizontal radius of shell at any section other than shell base : $\pm$ 50 mm
e) Horizontal radius at shell base : $\pm$ 40mm

9. LIQUID RETAINING STRUCTURES

a) The cold water basin, sludge pit, cold water outlet will be designed as per IS 3370 (Part 2) - 2009. Water/soil facing parts will be designed by limiting stresses in reinforcing steel to 130 MPa as per cl. 4.4.3.1 of IS 3370 (Part 2) - 2009.

b) The structures will be designed for the following conditions:

   I. Water filled inside up to full height and no earth outside.

   II. Earth pressure at top surface level with surcharge load of 2.5t/m^2 and with ground water table outside and no water inside.

   III. The effect of provision of flap valves/ pressure release valves shall not be considered in the design of cold water basin.

c) The basin and associated structures will be checked against uplift for basin empty condition. Stability will be checked during construction stage as well.

d) Loads during construction, erection and maintenance stage will also be considered.

e) Basin floor slab will be designed to rest on raft/mat foundation including fill-pack support structures. In the space underneath the basin floor slab a layer of 100 mm thick PCC of M15 grade will be provided.

f) Minimum thickness of the basin slab shall be 300mm.

10. WATER DISTRIBUTION SYSTEM

The structural design of the water distribution system will consider the worst combination of the following loads.

I. Self-weight, other imposed loads and live load.

II. Hydraulic pressures during normal operations including pressure surges.

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

The water distribution system will be provided with adequate pressure surge relief facilities to prevent pressure loading in excess of values used in the design.

11. PLATFORMS, WALKWAYS, STAIRWAYS, STAIRCASES, INTERNAL GRILLAGE

11.1 Internal Grillage

Internal grillage system comprises of cast-in-situ RCC beams and columns. Grillage system will be modeled and analyzed as moment resisting frame in STAAD Pro. The elements will be designed for self-weight and imposed loads by limit state method as per IS: 456-2000.

Minimum weight of fill will be considered as 100 kg/m^2. The structure shall be designed for a temporary point load of 1.5 kN at any point.

11.2 Platform

Peripheral platform of 1.2m clear width will be provided all around the tower circumference at top of the tower

A platform of width 1.5m shall be provided inside the tower at distribution pipe level

A minimum live load of 5.0kN/m^2 will be considered for the design of all platforms, walkways and staircases, in addition to their own weight.

11.3 Staircase

Two external dog-legged staircases shall be provided from the ground level to the water distribution level. The staircase shall have a minimum width of 1000mm and a landing width of 1000mm, with the landings not exceeding 2.5m in height. The stair riser shall not exceed 167mm and the treads shall be a minimum of 250mm.

11.4 Ladders

The tower shall be provided with 4 nos. safety ladders out of which 2 nos. will be laid from top landing of staircases up to top of NDCT and the balance 2 nos. will be laid from FGL up to top of NDCT.

MS hot dip galvanized rung ladders will be 600 mm wide, fabricated out of 60 mm x 10 mm flats with 20 mm dia. Rungs at 300 mm c/c. Stays will be provided at every 2.25 m intervals connecting the ladder with the concrete shell.

Safe cage will be provided for all ladders and will be fabricated out of 5nos. verticals of 50mm x 6mm flats with 50 mm x 6mm flats straps at 800 mm c/c.

Reinforced concrete landing platforms of size not less than 750mm x 1500mm shall be provided at every 8 to 10m height of the ladder.

12. STEEL STRUCTURES

These structures will be designed, fabricated and erected as per IS 800:2007 (WSD) and other relevant Indian Standard codes for structural steel work. All exposed steel work will be protected by hot dip galvanizing. The minimum coating will be 610gm/sq.m. and comply with IS 2629:1985, IS: 2633:1986 and IS 4759:1996.

12.1 Stop logs

Stop log gates and screen shall be designed for the worst combination of operating and maintenance conditions as per IS 800:2007.

12.2 Hand Railing

The MS pipe hand rails will be minimum 1.0m high with an intermediate member at 550mm height. The posts will be at 1200 mm spacing. The posts and runners will be minimum 40 nominal dia. And all welded construction with round corners. The tube will be as per IS 1161:1998 (for structural purpose) or equivalent. Handrails will be hot dipped galvanized after fabrication.

12.3 Miscellaneous

All access doors shall be of size 1200mm wide and 2100mm height (clear). Access door shall be of heavy duty MS doors duly painted with 3 coats of epoxy paints.

13. PAINTING

One Coat of Primer and Two Coats of Bituminous Paint conforming to IS 3384:1986 & IS 9862: 1981 will be provided to the following.

a) Basin floor internal face.

b) Internal surfaces of basin wall & basin partition wall

c) Cold water channel up to TP

d) Internal surfaces of drain chambers

e) Complete internal surface of Shell

Two coats of water proof cement paint for external surface of cooling tower shell.

Anti-corrosion treatment of RCC structures in contact with soil/earth.

14. REFERENCE CODES

1) IS: 456 – 2000Code of Practice for plain and reinforced concrete.
2) IS: 3370 – 2009 Code of practice for concrete structure for storage of liquids Parts 1 to 4.
3) IS: 800 – 2007Code of practice for general construction in steel.
4) IS: 875 – 2015 Code of practice for design loads for building and structures Parts 1 to 5.
5) IS: 1893-2015 Code of practice for criteria for earthquake resistant design of structure.
6) IS: 11504-1985 Criteria for structural design of reinforced concrete natural draught cooling towers.
7) IS: 2210 – 1988 Criteria for Design of RCCC shell structure and folded plates.
8) IS: 2204 -1962 Code of practice for construction of reinforcement concrete shell roof.
9) IS: 3043 – 1987 Code of Practice for Earthing
10) IS: 2309 - 1989 Code of Practice for the Protection of Buildings and Allied Structures against Lightning
11) IS: 5620 – 1985 Recommendation for Structural Design Criteria for Low Head Slide Gates
12) IS: 2405 - 1980 Part-1 Specification for Industrial Sieves (Wire Cloth Sieves)
13) CTI Code STD-136 Thermoplastic Materials Used for Film Fill, Splash Fill, Louvers and Drift Eliminators
14) IS: 4985 – 2000 Unplasticized PVC Pipes for Potable Water Supplies
15) CTI Code ATC-105 Acceptance Test Code for Water Cooling towers

15. COMPLIANCE REPORT FOR TCE COMMENTS DT. 02.08.2018 on R0

Sl.no.	Reference Document	Page	Comment	Response/Compliance
1	PE-V1-417-165-N002 (Design Basis Report of NDCT)	4	Please indicate BHEL drawing/doc number.	BHEL number for GAD is shown in Page 6 of the revised document.
2		5	Please check basin sill levels, Unit 1 & 2 are same, Unit 3, 4& 5 are same. Level shall be may confirmed by mechanical.	Corrected. The elevations in the table and the references are now updated for clarity.
3		6, 8, 9, 10, 12, 15, 17, 18	Please indicated latest code years.	Incorporated at all locations in the revised document.
4		7, 8	BHEL to redesign cooling tower based on wind tunnel test if any design modification has to be done based on test results same needs to consider by BHEL without extra cost & schedule Impact to TSGENCO.	Accepted.
5		9	Please update temperature load as per specification.	The temperature values are taken from climatological data of Yadadri project. The specification *PCA.CD-005.e-PCT-TS-K-02-2014-15-VII-D* mentioned in the comment doesn't appear to be in relation with this project. Kindly check and confirm.
6		13	Please confirm minimum reinforcement criteria as per specification.	The provided value, 0.35% of cross-sectional area, is taken from the specification.
7		14	Please check Unit 1 & 2 SBC will be different from SBC for Unit 3, 4&5. Please check & update as per approved soil report.	Agreed, the section in DBR is modified referring to the approved soil investigation report.
8		17	Painting shall be as per TSGENCO/TCE Approved painting specification.	Agreed. The painting details mentioned in DBR are taken from the specifications.

ANNEXURE-4

N. Raveendhar,
Chief Environmental Scientist-
Laboratory

EPTRI
ENVIRONMENT PROTECTION TRAINING & RESEARCH INSTITUTE

Lr. No: EPTRI/A. Lab/Analysis/18/DWC-25/2018-19 530 / date:12.07.2018

To

Sri Ramakrishna Keesara,
Superintending Engineer-Civil,
Construction (5x800 MW)
Yadadri Thermal Power Station,
Veerlapalem (V).
Dameracherla (M),
Nalgonda dist.

Cell - 9493120032

Sir,

Sub. EPTRI- Partial Analysis report for the surface water samples submitted – reg.
Ref: Your Letter No.SE/C/YTPS/Constn/F.Water Supply/D.No. 88/2018, dt. 15.06.2018

***

With reference to the above, please find enclosed the analysis report for the Surface Water samples submitted by your office on 18.06.2018. It may be observed that the parameters which are in the scope of NABL Accreditation are given with NABL symbol whereas for other parameters without NABL symbol. We will submit the final report at the earliest possible.

Yours faithfully,

Chief Environmental Scientist

Encl: a/a

EPTRI
CPCB & DSIR
ecognized Laboratory

ENVIRONMENT PROTECTION TRAINING AND RESEARCH INSTITUTE (EPTRI)
91/4, Gachibowli, Hyderabad -500 032, Telangana, INDIA.
Ph: +91-40-23180116, 23180119 Fax:+91-40-23180135
Email: eptri.lab@gmail.com; enquiry@eptri.com

NABL ACCREDITED
NABL T-0612, T-1451
As per ISO/IEC 17025:2005

ANALYSIS REPORT

Registration Number	: 18/DWC-25	Issue date	:	12.07.2018
Sample received	: 18.06.2018	Customer ref	:	SE/C/YTPS/Constn/F Water
Date of Commencement	: 18.06.2018			Supply/D No. 88/2018,
Date of Completion	: 11.07.2018	and date	:	15.06.2018

Name & Address of the customer : Sri Ramakrishna Keesara,
Superintending Engineer-Civil,
Construction (5x800 MW)
Yadadri Thermal Power Station,
Veerlapalem (V),
Dameracherla (M),
Nalgonda dist.

Sample Particulars : Surface water samples
Qty-received : ~ 5 Ltrs each – in plastic containers
Type of Sampling : Not mentioned
Sample condition : Suitable for analysis.
Sampling Procedure : Samples collected and submitted by the customer
Sample Code : **Sample Location**
SW-1 : Water sample collected from Krishna River at proposed intake point near Madacheiu
SW-2 : Water Sample collected from Krishna river at upstream of proposed intake point near Madachlu
Date of Sampling : 15.06.2018
Sampled by : Customer

Industry representative : Sri Ramakrishna Keesara, S.E-Civil
Sub-Contracting : Sub-contracting was not awarded

Deviation from Standard methods : No deviation in the test method
Sample Tested : As per the Standard Methods for the Examination of water & wastewater by APHA, WEF, & AWWA, 23rd Edition

Remarks : Nil

Chief Environmental Scientist

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gnized Laboratory

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NABL ACCREDITED
NABL T-0612 T-1451
As per ISO/IEC 17025:2005

ANALYSIS REPORT

Encls: 18/DWC-25

Test Results

S.No	Test Parameter(s)	Unit	Test Method	Requirement acceptable Limit as per IS:10500: 2012	Permissible Limit in the absence of Alternative source as per IS 10500:2012	Results	
						SW-1	SW-2
1	pH	--	4500. H+B	6.5 to 8.5	No relaxation	8.0	7.9
2	Temperature	°C	2550. B	-	-	25.0	25.3
3	Electrical Conductivity	µmhos/cm	2510. B	-	-	790	765
4	Total Dissolved Solids at 180°C	mg/L	2540. C	500	2000	460	445
5	Turbidity	NTU	2130. B	1	5	0.9	0.85
6	Total Hardness as $CaCO_3$	mg/L	2340. C	200	600	170	155
7	Ca Hardness	mg/L	2340. C	200	600	95	85
8	Methyl Orange Alkalinity as $CaCO_3$	mg/L	2320. B	200	600	184	168
9	Alkalinity - Phenolphthalein	mg/L	2320. B	200	600	NIL	NIL
10	Chlorides as Cl^-	mg/L	4500. Cl^-.B	250	1000	97	95
11	Calcium as Ca	mg/L	3500. Ca.B	75	200	38	34
12	Magnesium as Mg	mg/L	3500. Mg.B	30	100	18	17
13	Fluoride as F^-	mg/L	4500. F^-.C	1.0	1.5	0.485	0.515
14	Sulphates as SO_4	mg/L	4500. SO_4^{2-}.E	200	400	56	59
15	Nitrites as NO_2	mg/L	4500. NO_2^-.B	-	-	BDL	BDL
16	Nitrates as NO_3	mg/L	4500. NO_3^-.B	45	No relaxation	4.3	4.4
17	Hexavalent Chromium as Cr^{+6}	mg/L	3500.Cr^{+6}.B	-	-	BDL	BDL
18	Biochemical Oxygen Demand (3 days at 27°C)	mg/L	IS: 3025	-	-	4	3

Opinion and Interpretation: Not Applicable.
NTU - Nephelometric Turbidity Unit
BDL: - Below Detection Limit
Detection Limit : Hexavalent Chromium as Cr^{+6} -0.05 mg/L, Nitrites as NO_2 -0.02 mg/L
NOTE : 1.The test result relates to the items tested only

Chief Environmental Scientist

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Email: eptri.lab@gmail.com; enquiry@eptri.com

ANALYSIS REPORT

Registration Number	: 18/DWC-25	**Issue date**	:	12.07.2018
Sample received	: 18.06.2018	**Customer ref**	:	SE/C/YTPS/Constn/F Water Supply/D.No. 88/2018,
Date of Commencement	: 18.06.2018			
Date of Completion	: 11.07.2018	**and date**	:	15.06.2018

Name & Address of the customer : Sri Ramakrishna Keesara,
Superintending Engineer-Civil,
Construction (5x800 MW)
Yadadri Thermal Power Station,
Veerlapalem (V),
Dameracherla (M),
Nalgonda dist

Sample Particulars	: Surface water samples
Qty-received	: ~ 5 Ltrs each – in plastic containers
Type of Sampling	: Not mentioned
Sample condition	: Suitable for analysis.
Sampling Procedure	: Samples collected and submitted by the customer
Sample Code	: **Sample Location**
SW-1	: Water sample collected from Krishna River at proposed intake point near Madacheiu
SW-2	: Water Sample collected from Krishna river at upstream of proposed intake point near Madachlu
Date of Sampling	: 15.06.2018
Sampled by	: Customer
Industry representative	: Sri Ramakrishna Keesara, S.E-Civil
Sub-Contracting	: Sub-contracting was not awarded
Deviation from Standard methods	: No deviation in the test method
Sample Tested	: As per the Standard Methods for the Examination of water & wastewater by APHA, WEF, & AWWA, 23rd Edition
Remarks	: Nil

Chief Environmental Scientist

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Email: eptri.lab@gmail.com; enquiry@eptri.com

ANALYSIS REPORT

Encls: 18/DWC-25 **Test Results**

S.No	Test Parameter(s)	Unit	Test Method	Requirement acceptable Limit as per IS:10500: 2012	Permissible Limit in the absence of Alternative source as per IS 10500:2012	Results	
						SW-1	SW-2
19	Colour	Pt.Co	2120. B	5	15	<5	<5
20	Odour	TON	2150. B	Agreeable	Agreeable	No Odour is observed	No Odour is observed
21	Chemical Oxygen Demand	mg/L	5220. B	-	-	30	30
22	Residual free chlorine	mg/L	4500-Cl B	0.2	0.1	BDL	BDL
23	Phosphates as P	mg/L	4500 P.D	-	-	BDL	BDL
24	Total Kjeldahl Nitrogen as N	mg/L	4500. N_{org}.B	-	-	BDL	BDL
25	Total Suspended Solids at 105 °C	mg/L	2540. D	-	-	14	11
26	Ammonical Nitrogen as N	mg/L	4500. NH_3-C	-	-	BDL	BDL
27	Ammonia as N	mg/L	4500-NH_3-D	-	-	BDL	BDL
28	Anionic Detergents	mg/L	IS:13428 2005 K	0.2	1.0	<0.2	<0.2
29	Bicarbonates HCO_3	mg/L	2320.B	-	-	184	168
30	Dissolved Oxygen	mg/L	4500-O.C	-	-	5.8	6.1
31	Organic Nitrogen	mg/L	TOC Analyzer	-	-	BDL	BDL
32	Total Organic Carbon	%	Walkley and Black's (1934)	-	-	9.5	9.5
33	Silica Reactive	mg/L	4500 SiO_2 C	-	-	14.1	14.5
34	Oil & Grease	mg/L	5520. B	-	-	<1	<1
35	Sodium as Na	mg/L	3500-Na.B	-	-	82	80
36	Potassium as K	mg/L	3500-K.B	-	-	0.84	0.97

Opinion and Interpretation: Not Applicable.
TON – Threshold Odour Number
FTN – Flavour Threshold Number
BDL: - Below Detection Limit.
Detection Limit ;Residual free chlorine -1 mg/L; Phosphates as P-0.02 mg/L Total Kjeldahl Nitrogen as N – 5 mg/L; Ammonia – 0 02 mg/L Organic Nitrogen – 5 mg/L; Ammonical Nitrogen as N -5 mg/L.
NOTE :.The test result relates to the items tested only

Chief Environmental Scientist

Annexure-5

MANDATORY SPARES LIST FOR NDCT

APPLICABLE FOR UNIT- (U#1 to U# 5)

	5x800 MW YADADRI TPS - NDCT Mandatory Spares List		
Sl. No.	**Equipment/Package Name**	**Quantity**	**Remarks**
A.	**Mechanical Pakages**		
1	**Butterfly Valve**		
1.1	Complete Assembly	2 No. for Each type, Class and Size	
1.2	Electrical Actuators for the Valves as per Electrical List	Item & Quantity same as indicated in Electrical list 'B'	
2	**Chain pulley block**		
2.1	i. Load chain wheel	2 Nos.	
2.2	ii. Load chain stripping fork	10 Nos.	
2.3	iii. Hand chain wheel	4 Nos.	
2.4	iv. Ratchet pawl	2 Nos.	
2.5	v. Locking ratchet wheel	4 Nos.	
2.6	vi. Guide roller	4 Nos.	
2.7	vii. Brake disc	4 Nos.	
3	**Sump Pump**		
3.1	Complete set with Level Switch & Motor	20% of the total quantity used in the system for each type and rating or Minimum 2 Nos. whichever is higher	
3.2	Annunciation System	Item & Quantity same as indicated in C&I list 'C'	
B.	**Electrical Pakages**		
4	**415V System**		
4.1	Air Circuit Breaker		
4.1.1	Trip Coil	40 Nos	
4.1.2	Closing Coil	42 Nos	
4.1.3	Spring Charging Motor	20 Nos	
4.1.4	Spring Charging Motor with complete Mechanisim	20 Nos	
4.1.5	Spring Charged Limit Switch	20 Nos.	
4.1.6	Thermal Overload for Spring Charging Motor	10 Nos.	
4.1.7	Breaker Contact		
4.1.7.1	Main Contact (Fixed and moving) assembly	10 Sets for each type and rating	
4.1.7.2	Arcing Contact (Fixed and moving) assembly	10 Sets for each type and rating	
4.1.7.3	Breaker Jaw Contact (Bus-end & Breaker- end) assembly	10 Sets. for each type and Rating	
4.1.7.4	Sliding Contact (Fixed & Moving)	30 Sets.	
4.1.7.5	Breaker Auxiliary Contact Block	30 Nos.	

	5x800 MW YADADRI TPS - NDCT Mandatory Spares List		
Sl. No.	**Equipment/Package Name**	**Quantity**	**Remarks**
4.1.8	Arcing Chute	10 Sets for each type and rating	
4.1.9	Plug Socket with Prefab cable	10 Nos	
4.1.10	Position Limit Switch	20 Sets	
4.1.11	Indicating Lamps complete assembly		
4.1.11.1	Red	60 Nos.	
4.1.11.2	Amber	60 Nos.	
4.1.11.3	Green	60 Nos.	
4.1.11.4	White	60 Nos.	
4.1.11.5	Blue	60 Nos.	
4.1.12	CT	2 Nos. for each type and Rating	
4.1.13	Transducer	10 Nos. for each type and Rating	
4.1.14	Breaker Control Switch		
4.1.14.1	Trip / Neutral / close Switch	20 Nos. for each type and Rating	
4.1.14.2	Sw.gear / Trial / Normal Switch (Local/Remote)	20 Nos. for each type and Rating	
4.1.14.3	AC Supply On / Off Switch	20 Nos. for each type and Rating	
4.1.14.4	DC Supply On / Off Switch	20 Nos. for each type and Rating	
4.1.14.5	Motor Heater On /Off Switch	20 Nos. for each type and Rating	
4.1.14.6	DC Supply Source Selector Switch (3-position)	6 Nos. for each type and Rating	
4.1.14.7	Ammeter Selector Switch	2 Nos. for each type and Rating	
4.1.14.8	Voltmeter Selector Switch	2 Nos. for each type and Rating	
4.1.15	Voltmeter	2 Nos. for each type & Rating	
4.1.16	Ammeter	2 Nos. for each type & Rating	
4.1.17	Auxiliary Control Contactor		
4.1.17.1	Auxiliary Control Contactor DC complete	50 Nos.	
4.1.17.2	Auxiliary Control Contactor DC spare kits	50 Nos.	
4.1.17.3	Auxiliary Control Contactor DC Coils	50 Nos.	
4.2	PMCC/MCC/ACDB		
4.2.1	Contactor		
4.2.1.1	Power Contactor (AC)		
4.2.1.1.1	Power Contactor Complete Assembly	8 Nos.for each type and rating	
4.2.1.1.2	Power Contactor spare kits	20 Sets for each type and rating	
4.2.1.1.3	Power Contactor AC Coils	20 Nos. Coils for each type and rating	
4.2.1.2	Auxiliary Control Contactor (AC)		
4.2.1.2.1	Auxiliary Control Contactor Complete Assembly	60 Nos.for each type and rating	
4.2.1.2.2	Auxiliary Control Contactor spare kits	80 Sets for each type and rating	
4.2.1.2.3	Auxiliary Control Contactor AC Coils	70 Nos.for each type and rating	
4.2.2	MCCB (Power Circuit)	10 Nos. for each type and rating	
4.2.3	MCB (Control Circuit)	50 Nos.for each type and rating	
4.2.4	Switch		

	5x800 MW YADADRI TPS - NDCT Mandatory Spares List		
Sl. No.	**Equipment/Package Name**	**Quantity**	**Remarks**
4.2.4.1	Local / Remote Selector Switch	20 Nos.	
4.2.4.2	MCCB Status (On/off) Monitoring Switch/Contact	10 Nos.	
4.2.4.3	Trial / Normal /MCC Selector Switch	30 Nos.	
4.2.4.4	MCC module Service Position Limit Switch	10 Nos.	
4.2.5	Thermal Overload Relay	10 Nos. for each type and rating	
4.2.6	Sliding Contact (Fixed & Moving)	50 Sets	
4.2.7	Bus bar to MCC module Lira Contact Assembly (Bus-end & MCC Module-end)	10 Sets for each type and rating	
4.2.8	Indicating Lamps complete assembly		
4.2.8.1	Red	60 Sets	
4.2.8.2	Amber	60 Sets	
4.2.8.3	Green	60 Sets	
4.2.9	Push Button (On/Off) Complete Assembly	40 Sets	
4.2.10	CT	2 Nos.for each type and rating	
4.2.11	Ammeter	2 Nos. for each type and rating	
4.2.12	Control Transformer	2 Nos. for each type and rating	
4.2.13	Off Delay/ On Delay Timer	10 Nos.for each type and rating	
4.2.14	Switch Fuse Unit	10 Nos.for each type and rating	
4.2.15	Terminal Block		
4.2.15.1	Power Terminal Block	20% of total nos. for each type and rating used in the system orminimum two (2) no. whichever is more	
4.2.15.2	Control Terminal Block	20% of total nos. for each type and rating used in the system orminimum two (2) no. whichever is more	
4.2.15.3	End Plate for Power & Control Terminal Block	Each type 50 Nos.	
4.3	Energy Meter	2 No. For each type &rating	
5	**Control Panel/Desk Mounted Items**		
5.1	Push Button		
5.1.1	Complete assembly	10 Nos for each colour	
5.1.2	Contact Element (1NO + 1NC) Block	40 Nos.	
5.2	Selector Switch	20 Nos. for each type and rating	
5.3	Meter (Analog or Digital)		
5.3.1	Ammeter	20% for each type and range or minimum two (2) no. whichever is more	
5.3.2	Voltmeter	20% for each type and range or minimum two (2) no. whichever is more	

	5x800 MW YADADRI TPS - NDCT Mandatory Spares List		
Sl. No.	**Equipment/Package Name**	**Quantity**	**Remarks**
5.3.3	Frequency	20% for each type and range or minimum two (2) no. whichever is more	
5.3.4	MW	20% for each type and range orminimum two (2) no. whicheveris more	
5.3.5	MVAR	20% for each type and range orminimum two (2) no. whicheveris more	
5.3.6	Power Factor	20% for each type and range orminimum two (2) no. whicheveris more	
5.3.7	Synchroscope	20% for each type and range orminimum two (2) no. whicheveris more	
5.4	Indicating Lamps complete assembly	20 Nos. for each Colour and type	
5.5	Mimic Lamps	20 Nos. for each Colour and type	
5.6	MCB	4 Nos. for each type and rating	
5.7	Door Limit Switch	4Nos.	
5.8	Annunciation system		
5.8.1	Lamp Box with Facia & Lamps (LED type)	50 Nos.	
5.8.2	Hooter	2 No.	
5.8.3	Each type of PCB (for non-PLC driven system)	2(Two) no.	
6	**Actuator**		
6.1	Complete set of Actuator	2 Nos. for each type and rating	
6.2	Limit Switch	6 Nos each type and rating	
6.3	Torque Switch	6 Nos each type and rating	
6.4	Auxiliary Contact	2 nos each type and rating	
6.5	Motor	2 nos each type and rating	
6.6	Complete Seal kit	2 Set for each type and rating	
6.7	Complete O-Ring Set	2 Set	
6.8	Electronic Card	Two(2) for each type/make	
6.9	Feedback Assembly (4-20mA) for Inching type	Two(2) for each type/make	
7	**Motor**		
7.1	415 Volt Motor (above 30KW Rating upto 200KW)		
7.1.1	End Shield Cover Driving & Non-Driving End	2Set for each type and rating of Motor	
7.1.2	Driving End & Non-Driving End Bearing	2Set for each type and rating of Motor	
7.1.3	Cooling Fan	2 Nos. for each type and rating of Motor	
7.1.4	Motor Space Heater	2 Nos. for each type and rating of Motor	
7.1.5	Motor Terminal Block	2 Nos. for each type and rating of Motor	
7.1.6	Complete Set of Coupling	2 Set for each Application	
7.2	415 Volt Motor (Upto 30KW Rating)		
7.2.1	Driving End & Non-Driving End Bearing	6 Set for each type and rating of Motor	
7.2.2	Cooling Fan	4 Nos. for each type and rating of Motor	

	5x800 MW YADADRI TPS - NDCT Mandatory Spares List		
Sl. No.	**Equipment/Package Name**	**Quantity**	**Remarks**
7.2.3	Motor Terminal Block	10 Nos. for each type and rating of Motor	
7.2.4	Complete Set of Coupling	2 Set for each Application	
8	**NDCT Lighting**		
8.1	Medium intensity red flashing light	6 Nos.	
8.2	Low intensity steady red light	3 Nos.	
8.3	Control Unit for aviation warning light	4 Nos.	
8.4	Lighting transformer	2 Nos.	
8.5	M.C.C.B.	Two (2) of each type and rating	
8.6	M.C.B.	Ten (10 of each type and rating.	
8.7	Motor	Two (2) of each type and rating	
8.8	Indicating meters	Two (2) of each type and rating	
8.9	Push Button	Four (4) of each type and rating	
8.10	Contactor	Two (2) of each type and rating	
8.11	Control Transformer	Two (2) of each type and rating	
8.12	Receptacles	Two (2) of each type and rating	
C	**MANDATORY SPARE LIST (CONTROL & INSTRUMENTATION)**		
9	**Field Instruments**		
9.1	Transmitters/ Gauges/Switches etc. along with relevant accessories	20% of total or at least Four (whichever is higher) for eachtype along with accessories.	
10	**Process Connection Piping (Impulse piping/tubing, sampling piping / tubing & air supply piping as applicable)**		
10.1	Valves of all types	20% of each type, class, size & model	
10.2	Valve Manifolds (2 way/3 way/5 way)	20% of each type, class, size & model	
10.3	Fittings	20% of each type, class, size & model	
10.4	Filter Regulators	40% of each model	
11	**Control Panel/ Desk**		
11.1	Back-up panel mounted devices (Selector switches/ Push buttons/ Indicators etc.)	10% of installed capacity	
11.2	Lamps/ LEDs	200% of the total quantity	
11.3	Blank Tiles	20% of installed capacity	
11.4	MCBs	20% of each type & rating	
11.5	Fuses/ Fuse holder	200% of each type & rating	
12	**Alarm/ Annunciation system**		
12.1	Each type of module	2 nos. each	
12.2	Lamp box with Facia & Lamps (LED type)	20% of total quantity or minimum 20 nos.	
12.3	Hooter	2 nos.	
13	**Junction Box**		

	5x800 MW YADADRI TPS - NDCT Mandatory Spares List		
Sl. No.	**Equipment/Package Name**	**Quantity**	**Remarks**
13.1	Junction box	20% of total quantity for each size but minimum 4 nos.	
13.2	Terminals in Terminal blocks	20 nos. of each type	
NOTES:			
1	ANY ITEM ABOVE WHICH IS NOT REQUIRED, MAY BE INDICATED AS 'NOT APPLICABLE'. HOWEVER DURING DETAILED ENGINEERING IF THAT ITEM FOUND TO BE APPLICABLE, SAME SHALL BE SUPPLIED BY THE BIDDER WITHOUT ANY EXTRA COST TO BHEL/CUSTOMER.		
2	WHEREEVER THE QTY. IS MENTIONED IN PERCENTAGE / SETS, BIDDER TO INDICATE THE QUANTITY IN THE REMARKS COLUMN. THE QUANTITY SHALL BE VERIFIED DURING DETAILED ENGINEERING AND ANY CHANGE IN QUANTITY SHALL BE ACCOMODATED BY THE BIDDER WITHOUT ANY PRICE IMPLICATION.		
3	The Bidder shall offer mandatory spares of the same make, model and type for items which are offered in the main offer. Further, offered spare parts shall be of the same grade and shall have same performance as the instruments which they are to replace.		

Annexure-6
(Approximate quantities of Thermo-hydraullic components based on BHEL design)

			STAGE-I		STAGE-II		
SL. NO.	Description of item	Unit	Qtyfor NDCT#1	Qtyfor NDCT#2	Qtyfor NDCT#3	Qtyfor NDCT#4	Qtyfor NDCT#5
24	**FILLS**						
24.1	Providing & fixing UV stabilized PVC V Bars (85 mm bottom width x 42.5 mm height as shown in GA drwg) manufactured from virgin material of approved make in light greay/white/cream colour with 1.5 mm minimum uniform thickness and meeting the requirements of CTI code STD-136, including cutting, hoisiting, erection, etc. complete as per specification , data sheet and as directed by engineer	RMT	2579250	2579250	2579250	2579250	2579250
24.2	Providing & fixing SS316L Weld Mesh - (Top 2.4m 100 x 100 Mesh and Balance 2.8m with 200 x 100 Mesh) with 2.5 thk Vertical Wires x 2.5 thk Horizontal Wires, including cutting, hoisiting, erection, etc. complete as per specification , data sheet and as directed by engineer	Sq.M	98045	98045	98045	98045	98045
24.3	Providing & fixing SS 316 Sleeves with Bolts & Nuts for fastening SS weld mesh assembly to RCC beams, including hoisiting, erection, etc. complete as per specification , data sheet and as directed by engineer	Sets	86000	86000	86000	86000	86000
24.4	Providing & fixing PP Clips and SS 316 Tying Wire for fastening PVC Bars to weld mesh assembl, including hoisiting, erection, etc. complete as per specification , data sheet and as directed by engineer	Sets	2825000	2825000	2825000	2825000	2825000
24.5	Providing & fixing 14 SWG SS 316 Binding Wire for tying adjecent weld mesh assemblies and also to tying bottom of all weld meshes to RCC beams to result in a rigid assmebly, including cutting, hoisiting, erection, etc. complete as per specification , data sheet and as directed by engineer	RMT	9050	9050	9050	9050	9050
24.6	20 mm wide x 1 mm thk SS316 Straps with Clips for fixing pipes to RCC Beams	MT	3	3	3	3	3
24.7	19 mm Film Fill glued modules (ready to install) for use as "Bypass Arrestor" in the shell periphery	CuM	2000	2000	2000	2000	2000
25	**DISTRIBUTION SYSTEM**						
25.1	Providing & fixing OD 250, 225, 160 & 110 200 PVC pipes of Class 3 Grade as per IS:4985 with spigot end including drilling of holes for fixing nozzles, hoisting, grouting in RCC ducts, erecting, jointing with required accessories, testing, etc. complete as per specification and as directed for the full functionality of the system	RM	15085	15085	15085	15085	15085

Annexure-6 (Approximate quantities of Thermo-hydraullic components based on BHEL design)							
			STAGE-I		STAGE-II		
SL. NO.	Description of item	Unit	Qtyfor NDCT#1	Qtyfor NDCT#2	Qtyfor NDCT#3	Qtyfor NDCT#4	Qtyfor NDCT#5
25.2	Providing & fixing Puddle Pipes suitable for OD 250, 225, 160 & 110 pipes, in RCC Ducts. The puddle pipes shall be of same class as of the pipes. Accessories as required for jointing as per manufacturer's recommondation and as directed by engineer shall be included	Sets	686	686	686	686	686
25.3	Providing & fixing End caps with glue and additional rivets for OD 250, 225, 200, 160 & 110 PVC pipes of same class rating as of the pipes, including accessories required for jointing as per manufacturer's recommondation and as directed by engineer.	Sets	686	686	686	686	686
25.4	Providing & fixing Polypropylene Nozzles of down-spray type with solid-conical or solid-square spray pattern and of capacity and pressure head as per specifications, complete with all the necessary hardware required for fastening the nozzles to the PVC pipes including accessories, hardware, etc. as per specification & as directed. Several nozzle discharge diameters as per drawing shall be included.	Sets	16762	16762	16762	16762	16762
25.5	Providing & fixing PVC drift eliminators (wave shaped - 3 pass type (SPECTRA MODEL or equivalent with 77 mm pitch for low pressure drop) with necessary spacers, etc., to meet drift loss stipulation of 0.002% as per specification & as directed by engineer.	Sq.M	13575	13575	13575	13575	13575

SUB-SECTION – IB

SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

ANNEXURE-VI

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: COOLING TOWER (NATURAL DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 5 X 800 MW YADADRI TPS, NALGONDA

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V ACDB	Vendor	Vendor	415 V AC, 3 phase, 4 wire supply/ 240 V AC, 1 phase supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor. Makes shall be subject to Customer/ BHEL approval at contract stage.
2	Local starter panel/ Push Button Station (for motors)	BHEL	Vendor	Located near the motor. Makes shall be subject to Customer/ BHEL approval at contract stage.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. Termination at BHEL equipment terminals by BHEL. 2 Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	
5	Any special type of cable like compensating, co-axial, prefab, MICC, fibre Optic cables etc.	Vendor	Vendor	Refer scope/ C&I portion of specification for scope of fibre Optic cables if used between PLC/ microprocessor & DCS.
6	Cabling material (Cable trays, accessories & cable tray supporting system, conduits)	Vendor	Vendor	1. Layout details between vendors supplied equipment & installation drawing by vendor. 2. BHEL will provide cable trench along with cabling material up to the terminal point approx. 10 m away from cooling tower. Further cabling (supply and E&C) shall be in vendor's scope.
7	Cable glands, lugs, and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Equipment grounding & lightning protection	Vendor	Vendor	Material and sizes shall be as per specification and subject to BHEL approval during detailed engineering stage.
9	Below grade grounding	BHEL	Vendor	MS rod material shall be provided by BHEL. All other materials/ consumables are in vendor's scope.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: COOLING TOWER (NATURAL DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
10	LV Motors with base plate and foundation hardware (in case applicable for NDCT)	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
11	Lighting System	Vendor	Vendor	In addition to other lighting system items, vendor shall consider aviation lights & their control as per statutory requirement and Lighting panels (LP) & timer control as per requirement. Further wires, any other material required for lighting system shall also be considered by vendor in their scope. BHEL will provide the power supply for LP from LDB at one location near Cooling Tower. Further distribution from LP including material is in vendor's scope.
12	Aviation Lighting	Vendor	Vendor	Make shall be subject to customer/BHEL approval at contract stage
13	Receptacles/Industrial switch-sockets	Vendor	Vendor	Make shall be subject to customer/BHEL approval at contract stage
14	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	**Engineering activities** during detailed engineering stage, including those listed below: a. Electrical load data submission in PEM format b. Electrical equipment GA drawings and layout drawings c. Cable trench/ tray layout drawings d. Control cable schedules showing routing details [including cables supplied by PEM for CT equipment]. e. Grounding and lightning protection system layouts f. Cable termination/ interconnection details (diagram)/ Cable block diagram	Vendor	--	1. Documentation shall be submitted as per project schedule for BHEL/ customer approval. 2. Vendor shall be responsible for necessary coordination with BHEL for required engineering interfacing during contract stage. 3. Any approval required from electrical inspection authority for electrical equipment shall be arranged by vendor.

NOTES:

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE: COOLING TOWER (NATURAL DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/Customer after award of contract without any commercial implication.

2. All QPs shall be subject to approval of BHEL/Customer after award of contract without any commercial implication.

3. In case the requirement of Junction Box arises on account of Power Cable size mismatch due to vendor's engineering at later stage, vendor shall supply the Junction Box for suitable termination.

4. Wherever BHEL is indicated above, if the scope of supply and E&C of any of the above listed items is in BHEL's Customer scope, then the respective items shall be supplied, erected and commissioned by BHEL's Customer. For such items, BHEL as indicated in SUPPLY and E&C column above shall be read as "BHEL's CUSTOMER".

TECHNICAL SPECIFICATION

FOR

NATURAL DRAFT COOLING TOWER

(ELECTRICAL PORTION)

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".

b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.

c) Supply of mandatory spares as specified in the specifications of mechanical equipment.

d) Erection and commissioning spares.

e) Erection & Maintenance tools & tackles.

f) Electrical load requirement for NATURAL DRAFT COOLING TOWER.

g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.

h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL.

i) Various drawings, data sheet as per required format, quality plans, calculations, Type test & Routine test reports & certificates, operation and maintenance manuals, Complete technical literature with catalogues etc shall be furnished as specified at contract stage. All documents shall be subject to customer /BHEL approval without any commercial implications to BHEL.

j) Motor shall meet minimum requirement of motor specification.

k) LT power & control cables shall meet minimum requirement of LT power & control cables specification.

l) Cabling, earthing & lightning protection shall meet minimum requirement of cabling, earthing & lightning protection specification.

m) The sub-vendor list for various electrical items is subject to BHEL/Customer approval without any commercial implications.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following:

a) A copy of this sheet "Electrical Equipment Specification for NATURAL DRAFT COOLING TOWER" and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.

b) List of Erection and Commissioning spares.

c) List of Erection & Maintenance tools & tackles.

d) Electrical load requirement.

e) If there is any conflict, customer motor specification will prevail over BHEL motor specification.

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc. is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 LIST OF ENCLOSURES

4.1 Electrical scope sheet between BHEL & Vendor.
4.2 Customer Spec. for LV Motors.
4.3 General requirement of LV Motors.
4.4 Data Sheet - A for LV Motors.
4.5 Electrical Load Data Format.
4.6 Datasheet-C (to be filled by Vendor)
4.7 QP for LV motors
4.8 Customer Spec for Cooling Tower
4.9 Customer Specification for Cables
4.10 Customer Specification for Erection Cabling, Grounding And Lightning Protection
4.11 Customer Specification for Illumination
4.12 Customer Specification for LT Switchgear
4.13 QAP for Earthing and lightning protection materials
4.14 QAP for Illumination
4.15 QAP for Cable tray support-welded
4.16 QAP for Cable tray

	TITLE	SPECIFICATION NO.
	LV MOTORS	VOLUME II B
		SECTION D
	DATA SHEET-A	REV NO. 00 DATE 21.07.2017
		SHEET 1 OF 1

1.0	Design ambient temperature	:	50° C
2.0	Maximum acceptable kW rating of LV motor	:	Below 175 kW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection (Indoor/Outdoor)	:	IP55
5.0	Type of Cooling	:	TEFC/CACA/TETV
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% to –5%)
	c) Combined voltage & freq. variation	:	10% (absolute sum)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes	:	50 kA for 0.25 sec
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Class 'F' with temp rise limited to class B
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage
9.0	Power cables data	:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
11.0	Space heater supply	:	240 V, 1Φ , 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable upto 0.20 kW
13.0	Tests	:	As per Customer motor spec.(enclosed)
14.0	Energy efficient/ Flame proof motor	:	As per Customer spec. requirement
14.0	Makes	:	As per Annexure-I

NOTE:

1. Also detail Customer spec. for Motors is to be referred as enclosed with technical spec.

VOLUME : V-B

SECTION-XV

TECHNICAL SPECIFICATION FOR NATURAL DRAFT COOLING TOWER - ELECTRICAL WORKS

CONTENTS

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE OF WORK
2.00.00	DISTRIBUTION BOARDS
3.00.00	DAY MARKING AND AVIATION WARNING LIGHTS
4.00.00	INTERIOR AND EXTERIOR LIGHTS
5.00.00	CABLES AND CONDUITS
6.00.00	GROUNDING
7.00.00	CHIMNEY LIGHTNING PROTECTION
8.00.00	COOLING TOWER LIGHTNING PROTECTION
9.00.00	TESTS
10.00.00	DRAWINGS, DATA AND MANUALS

SECTION : XV

TECHNICAL SPECIFICATION
FOR
NATURAL DRAFT COOLING TOWER
- ELECTRICAL WORKS

1.00.00 **SCOPE OF WORK**

1.01.00 The scope of supply and services shall include but not be limited to the following for Natural Draught Cooling Tower :

a) Equipment and materials as required.

b) All relevant drawings, data and instruction manuals.

c) Erection, testing and commissioning of all electrical equipment and materials supplied under this specification.

d) Obtaining statutory approvals for Aviation warning system from concerned authority.

1.02.00 Natural Draught Cooling Tower shall be provided with but not be limited to the following :

a) Normal and Emergency Power distribution and control system

b) Electrical system for chimney Elevator

c) Aviation Obstruction Lighting system

d) Normal and Emergency Lighting system

e) Cabling and conduit system

f) Earthing system

g) Lightning protection system

h) All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary.

1.03.00 **Power Supply**

1.03.01 The following power supply arrangement is envisaged for NDCT electricals:

~~a)~~ One (1) 415 V ± 10%, 3 phase, 4 wire, 50 Hz +3% to -5% (fault level 50 KA) supply to AC Distribution Board for Normal AC Lighting and elevator for Chimney.

b) One (1) 415 V ± 10%, 3 phase, 4 wire, 50 Hz +3% to -5% (fault level 50 KA) supply to AC Distribution Board for Normal AC Lighting for Natural Draft Cooling Tower.

~~c)~~ One (1) 415 V ± 10%, 3 phase, 4 wire, 50 Hz +3% to -5% (fault level 50 KA) supply from emergency source to Lighting board for Emergency lights and Aviation Warning Lights and elevator for Chimney.

d) One (1) 415 V ± 10%, 3 phase, 4 wire, 50 Hz +3% to -5% (fault level 50 KA) supply from emergency source to Lighting board for Emergency lights and Aviation Warning Lights for Natural Draft Cooling Tower.

Any other, supply voltage, if required for the electrical system, the same shall be arranged by the Contractor through suitable means as necessary without any price implication.

2.00.00 DISTRIBUTION BOARD

2.01.00 AC Distribution Board

AC distribution board (ACDB) shall be provided for feeding lighting distribution boards, elevator and power receptacles. This AC distribution board shall be located at EL 0.0 m of Natural Draft Cooling Tower & inside the concrete shell of the chimney. The incoming to the ACDB shall be suitable for 415V, 3 phase, 4 wire, 50 Hz supply. 10% spare feeders with minimum one (1) of each type and rating shall be provided.

2.02.00 Lighting Board

One (1) lighting board shall be provided for Normal A.C. Lighting and one (1) Lighting board shall be provided for Emergency A.C light and Aviation Warning lighting system for chimney. Similarly One (1) lighting board shall be provided for Normal A.C. Lighting and one (1) Lighting board shall be provided for Emergency A.C light and Aviation Warning lighting system for Natural Draft Cooling Tower. These lighting boards shall also be located at El. 0.0m. Each lighting distribution board shall be provided with an adequately rated dry type, delta/star, lighting transformer with Z not more than 5% and off circuit taps for variation from (-5%) to (+)5% in steps of 2.5% on the primary side. The star point of the secondary side shall be solidly grounded to get the 3 phase, 4 wire supply required for the lighting distribution board. The lighting distribution boards shall have 10% with minimum two (2) spare feeders of each type and rating.

The dry type transformer shall have the following properties :

i) Insulation class of lighting transformer shall be “F”

ii) Temperature rise shall be limited class “B”.

iii) The transformer shall be cast resin type.

2.03.00 AC Distribution Board / Lighting Board Constructional Details

2.03.01 AC Distribution Board (ACDB) and Lighting Boards shall be metal enclosed, fabricated from CRCA sheet steel minimum 2 mm thick. AC Distribution Board shall be modular construction, fixed type module, floor-mounted and free-standing type. Each module of ACDB shall be provided with hinged door. Lighting Boards shall be suitable for either wall/column mounting on brackets or floor mounting on channel sills with hinged door on the front.

2.03.02 AC Distribution Board and Lighting Boards shall be dust and vermin-proof, IP-54 or better.

2..03.03 AC Distribution Board and Lighting Boards shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements.

2.03.04 AC Distribution Board and Lighting Boards shall have provision of cable entry from bottom as required, with removable gland plates. Necessary double compression type brass cable glands, heavy duty tinned copper cable lugs (for aluminium and copper conductor) shall be furnished by the Contractor.

2.03.05 Two ground pads with M10 G.I. bolts and nuts shall be provided on AC Distribution Board and Lighting Boards for connection to 75mmx10mm G.I. flat.

2.03.06 AC Distribution Board shall be complete with designation and caution notice plates fixed at front and back side and feeder name plate fixed on the front cover. Each Lighting Board shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of the circuit.

The plates shall be of anodized aluminium with inscriptions indelibly etched on it.

2.03.07 Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85 Deg.C.

2.03.08 Incoming and outgoing circuits shall be terminated in suitable terminal blocks.

2.03.09 AC Distribution Board shall consist suitable rated MCCB for over load and short circuit protection for incomer, voltmeter with selector switch and suitable PT, C.T. operated ammeter. Outgoing feeder from the AC Distribution Board shall also have MCCB with a over load and short circuit release. It is the Contractor’s responsibility to ensure proper discrimination between outgoing MCCB of AC Distribution Board and downstream MCCB of Lighting Boards.

2.03.10 Each Lighting Board shall have an incoming triple pole MCCB with neutral link with over load and short circuit release., Lighting transformer and a number of outgoing miniature circuit breakers (MCB), 9 KA rating. The lighting transformer shall be dry type housed in the cubicle.

2.03.11 Access door of AC Distribution Board and Lighting Board shall be interlocked with incoming MCCB such that the door can be opened only when the MCCB is in OFF position. Means shall be provided to defeat this interlock.

2.03.12 MCBs (9 KA rating) in Lighting boards shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.

2.03.13 AC distribution board and lighting boards, after application of primer, shall be finished with electrostatic or powder painting process (thickness not less than 50 microns). For exterior shade refer to clause no.1.16.00 of section E0, Volume V-A.

3.00.00 **AVIATION OBSTRUCTION LIGHTING FOR COOLING TOWER**

3.01.00 **DELETED**

3.01.01

3.01.02 **DELETED**

3.02.00 **Illumination system for Cooling Tower**

3.02.01 Aviation Obstruction Lighting System

Aviation obstruction lighting system conforms to the requirements of the latest Indian Standard, the International Civil Aviation Organization (ICAO), the instruction issued by the Director General of Civil Aviation – India and the Directorate of Air Routes & Aerodromes' (DARA) Circular No. 3 of 1987.

White flashing high intensity LED lights of Type 'A' of table 6.3, Annex-14 of ICAO guide lines shall be provided on top of cooling tower. Six numbers of AOLs shall be provided. All AOLs are distributed over 3 phases.

Aviation control panel is provided with photoelectric switch that de-activates and activates the circuit depending on north sky luminance.

Temporary obstruction lighting will be provided during construction. Obstruction lights will be provided at the uppermost part of the tower or the surrounding scaffolding as construction proceeds upwards. As such level specified to have permanent obstruction lights is passed, that level will be provided with temporary lighting.

The aviation obstruction lights shall meet the recommendations of ICAO and all the requirement of Director General of Civil Aviation, India. Aviation lights shall be fixed only on top of cooling tower. Type of fixtures shall be as listed below.

3.03.00 The illumination system of chimney and cooling tower is governed by DCGA guidelines. In case of any changes in the guidelines in future, the same shall be adhered to.

3.04.00 **Aviation Obstruction Light Fixtures (AOL Fixtures)**

3.04.01 Each AOL fixture shall have 100% standby light i.e. twin type. Incase of failure of one light, the standby should be activated automatically with auto changeover facility giving hooter feed back. AOL shall be L.E.D type for low and medium intensity and Xenon type for high intensity lights. The degree of protection shall conform to minimum IP 55 grade protection class. High intensity lights shall have intensity step changers.

The control panel for the AOLs shall be mounted near the main distribution board at ground level.

3.04.02 Photoelectric light detectors shall be furnished and installed for cooling tower to monitor the north sky. The detector shall cause the control unit to energize the aviation lighting system when the north sky luminance. The lighting system may be energized during short periods of decreasing illumination due to abrupt periods of shadow during daylight hours, but shall not be de-energized as the result of short periods of increasing illumination levels due to lighting flashes or stray light sources when overall illumination level is such that the system is operating.

4.00.00 **INTERIOR AND EXTERIOR LIGHTS**

4.01.00 Interior platforms and staircase shall be illuminated by PHILIPS type NDC 21 or equivalent industrial well glass luminaries with 150 W HPSV lamp and separate control gear box. The number of fixtures shall be selected based on an illumination level of 70 lux for the staircase and platform. Fixture and control gear shall conform to degree of protection IP55 (min.).

At least two (2) fixtures on each platform level shall be fed from aviation warning lighting board (emergency source). All staircase lights shall also be fed from emergency system.

4.02.00 Necessary junction boxes with MCBs shall be provided on each platform to control the platform and staircase lights.

4.03.00 One (1) 15A, 240V, single phase industrial, weatherproof type, suitable for wall/ column mounting, 3-pin receptacle with suitable interlock shall be provided on each internal and external platforms. At least two 63A, 415V, three phase industrial, weatherproof type, 5-pin receptacles shall be provided at the internal platforms.

4.04.00 **DELETED**

4.05.00 **Other Areas**

Distribution & Lighting Boards area

Industrial well glass luminaries with 150 W HPSV lamp and integral control gear shall be provided in the Distribution & Lighting boards area. The lux level shall be 150 lux.

5.00.00 **CABLES AND CONDUITS**

5.01.00 Power cables shall have stranded aluminium conductor, 1100 V grade XLPE insulated, extruded PVC inner sheath galvanized steel wire armoured, overall extruded PVC sheath.

Control cables shall have stranded annealed tinned copper conductor, 1100V grade PVC insulation, extruded PVC inner sheath, galvanized steel wire armoured, overall extruded PVC sheath. Minimum size of control cable shall be 2.5 sq. mm copper. The minimum sizes of LT cable to be chosen are as below:

AL - 16 sq.mm

CU - 2.5 sq.mm

Flexible trailing cable shall have annealed tinned copper conductor, EPR insulated, reinforced with nylon cord, cores laid up, HDCSP inner sheathed, cotton taped and HDCSP overall sheathed conforming to IS:9968.

Power, control and trailing cables shall be FRLS type.

Lighting wires shall have stranded copper conductor PVC insulated, 1100 V grade, laid in galvanized GI conduits and shall be of following minimum sizes:

- From Lighting panels to junction boxes : IC, 6 SQ.mm
- From junction boxes to lighting fixtures (Number of wires per lead as required) : IC, 2.5 SQ.mm
- From Lighting panels to receptacles (15A) (A1) : IC, 6 SQ.mm

5.02.00 Required number of GI pipe conduit of size not less than 32 mm dia shall be provided. Each conduit riser shall run from the lowest embedded pull box to the highest junction box. The lowest pull box shall be located 450mm above grade in the chimney / Cooling Tower. Pull boxes shall be installed at every 10m intervals vertically. The conduit risers shall run adjacent to the stairs such that the pull boxes become easily accessible from the stairs.

5.03.00 Each conduit riser shall have one circumferential conduit at each platform level. The circumferential conduit at each level shall be provided with three (3) more junction boxes equally spaced at the locations of the aviation warning lights. Suitable conduits shall also be provided from the junction box to the respective light point. The GI pull boxes and junction boxes shall be of size atleast 150mm x 150mm x 100mm, 3mm thk, preferably embedded in the concrete shell.

5.04.00 The conduits shall be electrically connected to all circumferential reinforcing rods which are in turn connected to the down conductors.

5.05.00 Conduit joints and connections shall be made thoroughly watertight and rust proof by application of white lead for embedded portion or red lead for exposed portion.

5.06.00 Conduits shall be hot dip galvanised conforming to relevant IS.

5.07.00 Conduit system shall be electrically bonded to the grounding system.

6.00.00 **GROUNDING**

6.01.00 The Contractor shall provide a complete grounding system including underground matas needed for the RCC chimney & Cooling Tower.

6.02.00 The grounding installation work shall conform to the requirements of the Indian Electricity Rules and Code of Practice for Earthing (IS: 3043) as amended up-to-date and grounding notes & details. DWG No. 13A06- DWG-E-0600 attached with the specification. Each piece of electrical equipment/ structure shall be bonded to the grounding system at two (2) points min.

6.03.00 The main ground mat shall be of bare MS round bar of diameter identical to power house ground mat conductor, buried in earth at a min. depth of 1000 mm below finished grade level. Earth electrode of size 40 MM dia x 3 M length driven into the ground and connected to the ground grid conductor shall be provided, as required, to bring down the ground resistance.

6.04.00 Riser from the ground grid shall project 300 mm above grade / concrete floor level. All ground connections below grade shall be made by electric arc welding with low hydrogen content electrode. Above grade 75mmx10 mm galvanised mild steel (450 g/m^2 zinc coating min) flats shall be run as main ground conductors securely fixed at intervals not exceeding 1500 mm.

One end of the galvanized mild steel flat shall be connected to the MS round bar riser by electric arc welding and the other end to the equipment by welding / bolting, as necessary. All welded portion shall be painted with bituminous paints against possible corrosion.

6.05.00 The chimney / Cooling Tower ground mat shall be connected to the nearest main plant ground mat by MS round bar at least at two distinct locations.

6.06.00 Ground grid resistance of the grounding system shall not be more than 0.5 ohm.

6.07.00 The ground conductor sizes for grounding of electrical equipment, lighting fixtures, junction boxes etc. shall be as follows :

i)	Distribution Boards, Lighting Panels and motors above 90 KW	:	50 mm x 6 mm GI Flat
ii)	Motors above 30 KW upto 90 KW	:	35 mm x 6 mm GI Flat
iii)	Motors above 5 KW upto 30 KW	:	25 mm x 3 mm GI Flat
iv)	Motors upto 5 KW	:	8 SWG GI wire
v)	Lighting Fixtures, junction boxes, conduits, etc.	:	16 SWG G.I. wire

7.00.00 **DELETED**

7.01.00 **Air Termination Rod**

The vertical air terminal rods shall be installed at the top of chimney to protect from lightning strokes.

Installation of air terminal at top the chimney for lightning protection shall be 20mm dia lead coated solid copper rod. The projected length of the rod shall be as required to protect the object from lightning stroke.

All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 75 x 10 mm galvanised steel flats.

The air terminal rod shall be properly fixed on the top of the chimney to withstand very high wind pressure.

7.02.00 **Circumferential Band**

The circumferential band shall be 75 x 10 mm galvanised steel flat fixed to the circumference of top of chimney at interval not more than 1.0 m. This shall be mounted with suitable anchors at such a height as to be accessible from the top of platform for maintenance. The anchors shall be embedded in concrete wall of the stack.

7.03.00 **Down Conductors**

Minimum four number of 75mm x 10mm GS flat down conductors shall be provided. These shall be not more than 15m apart on the periphery of the stack at the ground level. The down conductor shall be connected to circumferential band at the top portion of the stack and other end connected to the nearest mild steel rod riser from ground electrode. These conductors shall be continuous as far as practicable. Intermediate breaks shall be electrically bonded to form continuous circuit from top to bottom. Lapping of down conductor by bolting is not acceptable.

The down conductor shall be clamped along the surface at intervals of 1500mm by GS clamps. The connection between GS flat & GS clamps shall be done by arc welding.

At each chimney platform level, a circular band shall be provided which will be made of 75 x 10 mm GS flat and electrically connected to each down conductor.

7.04.00 **Testing Points**

Test joint shall be provided for each down conductor before termination on earth electrode at a height 1.5m from graded level. Test point shall be covered in 150 x 150 x 150 mm GS box. No sharp bends shall be formed in the down conductors and shall be kept as straight as possible.

7.05.00 **Clamps, Anchors Etc.**

All connections, clamps, anchors etc. of the lightning protection system shall be made of GS fittings. All joints or any other form of electrical connections, unless otherwise specified, shall be clamped or bolted by high pressure contact to form a connection of adequate current carrying capacity and mechanical strength. Soldered connections will not be permitted.

7.06.00 **Vertical and Horizontal Reinforcing Bars**

All reinforcing bars shall be properly bonded and connected to earthing system which shall be separate than lightning protection.

The testing point of the down conductors shall be convenient for testing. Testing point shall be phosphor-bronze gunmetal or copper or other suitable.

7.07.00 **Temporary Lightning Protection**

During construction of chimney, temporary lightning protection shall be maintained by connecting the reinforcement bars to two earth electrodes by means of two 75x10mm GS conductors. These temporary protections shall be provided even after the completion of the chimney till such time the permanent protections are installed.

To avoid maleffect of highly corrosive atmosphere around the chimney due to flue gas and weather, the exposed conductors, connections, clamps, base plate etc. shall be protected by hot dip galvanizing. All site-welded joints conductors shall be coated with anti corrosive paints over a coat of primer.

8.00.00 **COOLING TOWER LIGHTNING PROTECTION**

Lightning protection system shall confirm to the requirements of IS: 2309 amended up-to-date and Lightning protection notes and details. DWG. No. 13A06-DWG-E-1000 attached with the specification.

8.01.00 **Air Terminations**

The vertical air terminal rods shall be installed at the top of cooling towers to protect these objects from lightning strokes.

The vertical air terminal except for chimney shall be made of 20 mm dia galvanised steel rod. The projected length of the rod shall be as required to protect the object from lightning stroke.

The air terminal rod shall be properly fixed on the top of the structure to withstand very high wind pressure.

All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 75 x 10 mm galvanised steel flats.

8.02.00 **Down Conductors**

The down conductors shall be 75 x 10 mm galvanised steel flats. One end of this shall be connected with air terminal rod/horizontal conductor at the top of structure and other end connected to the nearest mild steel rod riser from ground electrode.

Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductor of grounding system above ground level.

The connection between each down conductor and rod shall be made via test link located at approximately 1500 mm above ground level.

The down conductor shall be laid straight and sharp bends shall be avoided as far as practicable. The down conductor shall be clamped along the surface at intervals of 1500mm by GS clamps.

The down conductors shall be protected at the ground level against mechanical injury by means of non-metallic pipes, viz. PVC pipes filled with bituminous compound.

8.03.00 **Testing Points**

Test joint shall be provided for each down conductor before termination on earth electrode at a height 1.5m from graded level. Test point shall be covered in 150 x 150 x 150 mm GS box. No sharp bends shall be formed in the down conductors and shall be kept as straight as possible.

8.04.00 **Clamps, Anchors Etc.**

All connections, clamps, anchors etc. of the lightning protection system shall be made of GS fittings. All joints or any other form of electrical connections, unless otherwise specified, shall be clamped or bolted by high pressure contact to form a connection of adequate current carrying capacity and mechanical strength. Soldered connections will not be permitted.

8.05.00 **Temporary Lightning Protection**

During construction of cooling tower, temporary lightning protection shall be maintained by connecting the reinforcement bars to two earth electrodes by means of two 75x10mm GS conductors. These temporary protections shall be provided even after the completion of the chimney till such time the permanent protections are installed.

9.00.00 **TESTS**

9.01.00 **Type Tests**

The type tests for fire proof / penetration seal for floor and wall opening/ fire stop system for bottom of electrical switchgear/ panel base are as under:

i) Fire rating test.

ii) Hose Stream test

iii) Accelerated aging test.

iv) Fire rating test on the penetration seal system built out of accelerated aged components followed by hose stream test.

v) Temp. rise test for cable in the fire stop.

vi) Water absorption test followed by fire rating test.

vii) Flame Resistance test for fire retardant coating material.

viii) Anti-rodent test.

Illumination in different areas are as per designed lux level should be established.

9.02.00 **Test Certificates**

Certified copies of all tests carried out at works and at site shall be furnished in requisite number of copies.

Test reports shall be complete with all details and shall also contain limit valves specified in the relevant standards, wherever applicable, to facilitate review of Test Report/ Certificates.

The fire proof sealing system shall be installed only after receipt of approval of the test reports.

10.00.00 **DRAWINGS, DATA AND MANUALS**

10.01.00 **To be submitted with the Bid**

10.01.01 Typical general arrangement drawing of Chimney / Cooling Tower showing location of lighting fixtures, lightning protection system, grounding system etc.

10.01.02 Typical general arrangement drawing of A.C. distribution board, lightning board.

10.01.03 Catalogue cuts of various types of lightning fixtures, major components, cables, conduits etc

10.01.04 Type Test Certificate of various equipment

10.02.00 **To be submitted for Approval (A) / Reference (R) and subsequent Distribution**

10.02.01 Dimensional general arrangement drawing of chimney / Cooling Tower showing disposition of aviation warning lights, interior lights on platforms and stairs, receptacles, A.C. distribution boards, lighting boards including their fixing arrangements (A).

10.02.02 Arrangement drawings for lightning protection and grounding system (A)

10.02.03 Single line drawing of A.C. distribution boards and lighting boards (A)

10.02.04 Cable and Conduit layout (A)

10.02.05 Technical data sheet of all equipment / components (A).

10.02.06 Instruction Manuals and Catalogue cuts of all equipment (R)

The manuals shall clearly indicate the method of installation, check-up and tests to be carried out before commissioning of the equipment.

10.02.07 Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.

10.03.00 The Contractor may note that the drawings, data and manuals listed are minimum requirement only. The Contractor shall ensure that all other necessary information required to fully describe the equipment / system offered are submitted with his Bid.

SUB-SECTION – IC

SPECIFIC TECHNICAL REQUIREMENTS (C &I)

TELANGANA STATE POWER GENERATION CORPORATION LTD

5X800 MW YADADRI, NALGONDA

C&I TECHNICAL SPECIFICATION
FOR
NATURAL DRAFT COOLING TOWER

SPECIFICATION No: PE-TS-417-145-IXXX

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT DIVISION
NOIDA, INDIA

	5x800 MW TSGENCO YADADRI TPS **CONTROL & INSTRUMENTATION** Technical specification for **NATURAL DRAFT COOLING TOWER**	SPEC NO.: **PE-TS-417-145-IXXX** VOLUME SECTION 'D' REV. NO. 00 | DATE : 20.07.2017 SHEET OF

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6. SPECIFICTION AND DATA SHEET FOR LOCAL CONTROL PANEL
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9. KKS PHILOSOPHY

BHEL	**5x800 MW TSGENCO YADADRI TPS** **CONTROL & INSTRUMENTATION** Technical specification for **NATURAL DRAFT COOLING TOWER**	SPEC NO.: **PE-TS-417-145-IXXX** VOLUME SECTION REV. NO. 00 | DATE : 20.07.2017 SHEET OF

SPECIFIC TECHNICAL REQUIREMENTS

SPECIFIC TECHNICAL REQUIREMENTS (C&I):

1.0 Operation & Control of **NATURAL DRAFT COOLING TOWER** system shall be from plant DCS (BHEL Scope).

2.0 Bidder to include all the instruments (for the measurement of pressure, temperature, level, flow vibration etc.) required for the package along with necessary fittings, accessories and valve manifold etc. All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. Anticorrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.

3.0 All local gauges as well as transmitters, sensors and switches for parameters like pressure, temperature, level, flow, vibration etc. as required for the safe and efficient operation and maintenance under the scope of specification shall be provided. The necessary root valves, impulse piping, drain cock, gauge-zeroing cocks, valve manifolds and all other accessories required for mounting / erection of these local instruments shall be furnished even if not specifically asked for. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg / Cm2.

4.0 The solenoid operated valves/ damper/gates shall have limit switches for open/ close feedback. Solenoid valve shall be rated for 24 V DC only.

5.0 The junction boxes/LIEs for termination of instruments /solenoid valve limit switches etc are in bidder's scope.

6.0 Removable type Pitot Tube at each hot water inlet pipe header to measure the flow (during Performance Guarantee Test only). The Pitot tube shall be left with customer after the completion of the test.

7.0 Pressure and Temperature measuring Instruments at hot & cold water duct/piping at terminal points shall be provided. Further, instrument tapings

provision on hot duct/piping and cold water duct/piping for carrying out flow and temperature measurement during Performance Guarantee test.

8.0 Anemometer (for measuring of wind velocity) and Psychrometer shall be supplied.

9.0 All testing and calibrating instruments required for site performance tests shall be arranged by the supplier without any extra cost and time implication.

10.0 The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

11.0 Vendor representative shall be available for 3-4 days at BHEL Electronic Division (EDN) Bangalore during testing of DCS.

12.0 Vendor representative shall be available for 6-7 days during commissioning time at site.

13.0 The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.

14.0 For instrument & control cable scope of supply refer ‘Electrical scope sheet between BHEL & vendor’.

15.0 Instrument installation drawings are to be provided by bidder. All instrument fitting and erection hardware as per instrument installation diagram shall be in bidder’s scope.

16.0 The make of all the items shall be from approved sub-vendor list.

17.0 Bidder shall provide Cable Schedule in BHEL excel format provided in Electrical portion of the specification. Also, cable interconnections details for complete system shall be in Bidders’ scope.

18.0 Editable & pdf copy of Drawings/Documents and data to be furnished after award of the contract:

- Control & operational write-up for the system
- Recommended control scheme/ logic diagram
- Process manuscript for implementation in DCS
- List of Drives (Solenoid valves etc)

- I/O list (DCS)
- GA & wiring diagram of local panel.
- Power requirement.
- Field instruments quality plan.
- Instruments data sheet.
- JB grouping document.
- Cable schedule and cable interconnection drawing.
- Instrument schedule
- Alarm Schedule
- SOE schedule
- Instrument hook-up diagram.
- Any other document decided during detailed engineering.

NOTES:

1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage.

2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.

3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.

4. Uniformity of make and type of instruments and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.

FORM NO. PEM-6666-0

	5x800 MW TSGENCO YADADRI TPS	SPEC NO.: **PE-TS-417-145-IXXX**
	CONTROL & INSTRUMENTATION Technical specification for	VOLUME
		SECTION
	NATURAL DRAFT COOLING TOWER	REV. NO. 00 / DATE : 20.07.2017
		SHEET OF

FIELD SENSOR & INSTRUMENTS SPECIFICATIONS

approval

3.03.00 LEVEL SWITCH

3.03.01 FLOAT OPERATED

1.	Float material	:	SS-316
2.	Wetted parts	:	SS-316
3.	Float chamber	:	Stainless steel/Carbon steel, construction welded
4.	Float chamber mounting	:	Side mounted
5.	Fluid connection	:	Side – Side
6.	Fluid connection size	:	1" ANSI RF Flange (rubber line, if required)
7.	Drain	:	½ inch NPT with Plug
8.	Pressure rating of chamber	:	Minimum 1.5 times of design pressure
9.	Repeatability	:	+/- 1.5 mm or better
10.	Switch housing	:	Stainless Steel
11.	Switch housing type	:	IP- 65
12.	Type of switch	:	Snap acting magnetically operated hermetically sealed
13.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
14.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve c) ½"NPT cable gland

			d)	Stainless steel nameplate with alpha-numeric engraved for service and tag
	15. Application	:	During Detail Engineering on Owner's approval	

3.04.00 FLOW SWITCH

1.	Type	:	Paddle /Piston/Disk	
2.	Wetted part material	:	Stainless steel or Hastelloy for acidic application	
3.	End connection	:	a)	Threaded upto 1" line size with integral Tee
		:	b)	Flanged for line size > 1 ½"
4.	Enclosure material	:	Stainless Steel	
5.	Enclosure class	:	IP 65	
6.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)	
7.	Repeatibility	:	2%	
8.	Cable connection	:	½"NPTF	
9.	Accessories	:	a)	Tee, Counter flange, nuts & bolts, suitable gasket etc
			b)	½"NPT cable gland
			c)	Stainless steel nameplate with alpha-numeric engraved for service and tag

3.05.00 RF LEVEL SWITCH

1.	Type	:	RADIO FREQUENCY
	Sensing probe		
2.	Material	:	SS-316
3.	Mounting	:	Threaded
4.	Application Temperature	:	250°C (Max.)
	Electronic Controller		
5.	Input Supply Voltage	:	240V AC ±10%, 50 Hz.
6.	Relay Output	:	2 SPDT (240V AC, 5A)
7.	Ambient Temperature	:	50 °C
8.	Enclosure Protection	:	IP-66
9.	Enclosure Housing	:	SS
10.	Local LED Indication	:	Normal Level Power On Alarm Level Probe Healthy
11.	Switching Repeatability	:	±0.5%
12.	Accessories	:	Co-axial cable for probe connection to controller SS Tag plate ½" NPT Cable Glands
13.	Application	:	Solid level

3.06.00 CONDUCTIVITY TYPE LEVEL SWITCH

1.	Type	:	Conductivity discrimination
2.	Probe MOC	:	SS-316
3.	Mounting	:	Flanged on external cage
4.	Application Temperature	:	250°C (Max.)
5.	Test Pressure	:	Two times rated pressure

	6. Input Supply Voltage	:	240V AC ±10%, 50 Hz.
	7. Input	:	Four independent channel with selectable switching threshold for water conductivity
	8. Relay Output	:	2 SPDT (240V AC, 5A)
	9. Ambient Temperature	:	50 °C
	10. Enclosure Protection	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
	11. Enclosure Housing	:	SS
	12. Local LED Indication	:	HI,LO, HIGH-HIGH, LOW-LOW Power Fault
	13. Accessories	:	a) Interconnecting cable from probe to electronics b) Mounting accessories c) External cage d) Washer & Gasket e) ½" NPT Cable Glands f) SS Tag Plate
	14. Application	:	During Detail Engineering on Owner's approval

3.07.00 TEMPERATURE SWITCH

	1. Type	:	Bimetallic or gas filled
	2. Sensing Element Material	:	SS-316
	3. Bulb Material	:	SS-316
	4. Capillary	:	Stainless Steel armored

approval

4.00.00 LOCAL INSTRUMENTS

4.01.00 PRESSURE GAUGE AND DIFFERENTIAL PRESSURE GAUGE

1.	Type	:	Bourdon/Bellows/Diaphragm
2.	Sensing & Socket	:	SS-316
3.	Movement Material	:	SS-316
4.	Case Material	:	Stainless steel. IP-65 (Explosion proof for NEC Class-1, Division 1 area)
5.	Dial Size	:	Generally 150 mm
6.	Scale	:	Black lettering on white in 270 O arc.
7.	Window	:	Shatterproof glass
8.	Range Selection	:	Normal process pressure: 50~70 % of range
9.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
10.	Adjustment	:	For Zero adjustment (Micrometer screw external) For Range adjustment (Micrometer screw internal).
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT (M) Bottom for local, back for panel mounting
13.	Performance	:	Accuracy of $\pm$ 1.0 % of span or better
14.	Operating ambient	:	0 - 50 ^{O}C
15.	Safety Feature	:	Blow out disc /diaphragm at the back
16.	Accessories	:	a) Snubbers for pulsating fluid application.discharge b) Stainless steel Diaphragm seals

			for corrosive/ viscous/ solid bearing or slurry type fluid applications
		c)	3-Way SS316 Gauge cock for pressure gauges
		d)	5-valve SS316 manifold from barstock for differential pressure gauge
		e)	Siphons for steam and hot water services
	17. Nameplate	:	Tag number, service engraved in stainless steel tag plate

4.02.00 LEVEL INDICATOR (FLOAT & BOARD TYPE)

1.	Type	:	Float and Board
2.	Float Material	:	SS-316
3.	Float Cable	:	SS-316
4.	Indicator Assembly	:	Epoxy painted Aluminium
5.	Guide wire spring assembly	:	SS-316 (2 Nos.)
6.	Guide Wire Anchor	:	SS-316
7.	Scale Board	:	Anodized Aluminium with engraved marking (Minimum graduation 10mm), mounting brackets and suitable hardware required as per tank height
8.	Elbow Assembly	:	Anodized Aluminium
9.	Flanges	:	RF , ANSI 150 , SS (3 Nos.)
10.	Accuracy	:	± 10 mm or better
11.	Accessories	:	All mounting accessories including counter flange, nuts & bolts, suitable

gasket etc. as applicable, SS Tag plate

4.03.00 GAUGE GLASS

1.	Type	:	Reflex /Transparent
2.	Material		
	Glass	:	Toughened borosilicate resistant to thermal shock
	Body Material	:	~~Carbon Steel~~ Stainless Steel
	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
3.	Integral cocks & valves/Fittings	:	i. SS 316
4.		:	ii. Rubber lined corrosion resistant stainless steel (for DM/RO service)
5.	Vessel Connection	:	ANSI Flanged SS316
6.	Accessories	:	i. Integral cocks ii. Drain Valves iii. Companion Flanges, Bolts, nuts, gaskets, SS Tag plate iv. Illuminating lamps, Mica shield as required v. Calibrated scale
7.	Pressure rating	:	Twice the maximum working pressure
8.	Temperature	:	300 ^{O} C
9.	Other details	:	For larger lengths (greater than 1200mm), additional gauge glasses shall be provided with minimum of 50 mm overlap.

			Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
7.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
8.	Thermowell connection	:	½" NPT (M) or 150 RF Flanged
9.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

5.03.00 TEMPERATURE GAUGE

1.	Type	:	Expansion type (Liquid filled system)
2.	Sensing Element Material	:	Bourdon – SS-316
3.	Bulb and Capillary Material	:	SS-316
4.	Capillary Tubing	:	Inner sheath - solid drawn Material copper tube Outer sheath - PVC tube
5.	Movement Materials	:	Stainless Steel / Direct Bourdon tip connection to pointer spindle
6.	Case Material	:	Stainless Steel stove enameled, black finish, threaded bezel ring, clear glass

			cover conforming to IP 65.
7.	Dial size	:	150 mm
8.	Scale	:	Black lettering on white background in 270 Deg.C arc
9.	Over range protection	:	125 percent of FSD
10.	Capillary Glanding	:	1/2" NPT(M) x compression fitting (SS) to suit capillary
11.	Instrument Connection	:	Bottom connection for local mounting, back connection for panel mounting
12.	Process Connection	:	½" NPT (M) or 150 RF Flanged
13.	Extension Neck Length	:	50 mm
14.	Compensation	:	a) Capillary compensation
15.		:	b) Case compensation
16.	Performance	:	a) Accuracy : + /- 1.0 percent of full scale Deflection
		:	b) Repeatability : Less than 0.5 percent of full range
		:	c) Response time: 15 seconds (max.).
17.	Capillary length	:	3.0 meters (local) / 15.0 metres (local panel)
18.	Other features	:	Shatter proof glass
19.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
20.	Accessories	:	SS316 Thermowell

5.04.00 THERMOWELL

1.	Material	:	SS-316
2.	Manufacture	:	Drilled from bar stock, Hex Head, Tapered design (As per ASME PTC 19.3)

3.	Process connection	:	M33x2
4.	Certification	:	Not applicable
5.	Bore concentricity	:	+5% of wall thickness
6.	Identification mark	:	Tag number punched on head
7.	Surface treatment	:	Polish after machining
8.	Element connection	:	½" NPT (M) or 150 RF Flanged
9.	Head	:	Hex
10.	Length of the hex head	:	31.75 mm (min.)
11.	Accessories	:	SS Plug and chain for test thermo wells SS Nameplate, Flange with companion flange & all required accessories for flanged connections.

Note: Wake frequency calculations shall be furnished for all thermowells for approval.

Thermowells shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid.

5.05.00 METAL TEMPERATURE THERMOCOUPLE

1.	Measuring medium	:	Metal temperature
2.	Type	:	Chromel Alumel (Type-K) Duplex, Ungrounded
3.	Insulation	:	Mineral Insulation Magnesium Oxide
4.	Wire gauge	:	16 AWG
5.	Protective sheath	:	SS
6.	Protective sheath diameter	:	8 mm O.D.
7.	Characteristics	:	Special limits of error as in ANSI thermocouple MC 96.01
8.	Accessories	:	½" BSP SS sliding end connector, weld pad, clamps of heat resistant steel

	5x800 MW TSGENCO YADADRI TPS **CONTROL & INSTRUMENTATION** Technical specification for **NATURAL DRAFT COOLING TOWER**	SPEC NO.: **PE-TS-417-145-IXXX** VOLUME SECTION REV. NO. 00 | DATE : 20.07.2017 SHEET OF

QAP FOR INSTRUMENTS

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOW SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	RANGE						
	MODEL / TAG No.						
	END CONNECTION						
	DIMENSIONS						
	SIZE						
2	ACCURACY & REPEATABILITY (WET CALIBRATION)	100%		P	W	V	
3	HV / IR	100%		P	W	V	
4	CONTACT RATING / No. OF CONTACTS	RANDOM		P	W	V	
5	MATERIAL TC FOR BODY, WET PARTS, SENSING ELEMENT	ONE / LOT		P	W	V	
6	ACCESSORIES AS APPLICABLE	100%		P	W	V	
7	DEGREE OF PROTECTION	ONE / LOT		P	W	V	
8	OVER PRESSURE TEST	100%		P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out routine test for 100%
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MODEL/TAG NO.						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS CHECK	100%		P	W	V	
3	ACCURACY	100%		P	W	V	
4	SWITCHING DIFFERENTIAL	100%		P	W	V	
5	CONTACT RATING / No. OF CONTACTS	RANDOM		P	W	V	
6	MATERIAL TC FOR BULB, CAPILLARY, ARMOUR	ONE / LOT		P	V	V	
7	HV / IR	RANDOM		P	W	V	
8	DEGREE OF PROTECTION	TYPE TEST		P	V	V	
9	THERMOWELLS						
	DIMENSIONS,PROCESS CONN	100%		P	W	V	
	MATERIAL TC	ONE / LOT		P	V	V	
	HYD TEST	100%		P	W	V	
	IBR CERTIFICATE, IF APPLICABLE			P	V	V	
10	REPEATABILITY	100%		P	V	V	
11	HYSTERISIS	100%		P	V	V	
12	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		P	W	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.
4. Manufacturer to carry out routine test for 100%

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST			P	V	V	
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to carry out ROUTINE TEST on 100 %.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOAT OPERATED LEVEL SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	MODEL NO/TAG NO						
	TYPE						
	END CONNECTION						
2	ON/OFF DIFFL			P	W	V	
3	REPEATABILITY			P	W	V	
4	IR TEST			P	W	V	
5	HV TEST			P	V	V	
6	PR. TEST ON CHAMBER	SEE NOTE-5		P	V	V	
7	MATL. TC FOR CHAMBER & FLOAT	FOR LOT	---	V	V	V	
8	CONTACT CONFIG. & RATING FOR MICROSWITCH	FOR LOT	---	V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST	---	V	V	V	
10	MANUFACTURER TO ENSURE WELDING PROCEDURE,WELDERS & NDT AS PER ASME FOR PR >40 KG/CM2		---	P	V	V	
11	CHECK FOR TEMP. SUITABILITY FOR MICROSWITCH AND LEAD WIRE	SEE NOTE-1 BELOW	---	V	V	V	
12	ACCESSORIES AS APPLICABLE		APPROVED SPEC./ DATA SHEETS	V	V	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. IBR certificates shall be provided wherever required.
6. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANALYTICAL INSTRUMENTS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	VISUAL						
	MAKE, MODEL No.						
	POWER SUPPLY						
	TYPE						
2	DIMENSIONS CHECK			P	V	V	
3	FUNCTIONAL CHECK			P	V	V	
4	LEAKAGE TEST			P	V	V	
5	HV / IR TEST			P	V	V	
6	LINEARITY			P	V	V	
7	RESPONSE TIME			P	V	V	
8	ENCLOSURE CLASS			P	V	V	
9	ACCESSORIES, AS APPLICABLE			P	V	V	
10	ACCURACY / CALIBRATION			P	V	V	
11	ALARM CONTACT TEST			P	V	V	
12	ANALOG OUTPUT CHECK			P	V	V	
13	BURN-IN TEST OF ELECTRONIC PARTS	1/LOT		P	V	V	
14	IN-BUILT INDICATOR, ZERO, SPAN, RANGE SCALE SELECTION ETC	SEE NOTE-1 BELOW		P	V	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANNUNCIATORS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. When material corelation are not available manufacturer's compliance to be provided.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE ELEMENT

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MODEL No./TAG No.						
	PROCESS CONNECTION						
2	STABILITY			P	W	V	
3	INSULATION RESISTANCE			P	W	V	
4	ENCLOSURE CLASS			P	W	V	
5	RESPONSE TIME			P	W	V	
7	ACCURACY			P	W	V	
8	HYDROSTATIC TEST			P	W	V	
9	ELECTRICAL CHARACTERISTIC OF SENSOR (CONTINUTY OF T/C WIRES & INSULATION RESISTANCE OF RTD LEADS w.r.t. BODY			P	W	V	
10	TEMP CURVES / CHARTS			P	V	V	
11	AMBIENT TEMP. EFFECT CHECK			P	W	V	
12	HV TEST			P	W	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.
4. IBR certificate to be provided, if applicable

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR MAGNETIC TYPE FLOW METER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	MODEL						
	TAG No						
	VISUAL						
2	DIMENSIONS,			P	W	V	
3	PROCESS CONNECTION			P	W	V	
4	RANGE / SCALE			P	W	V	
5	ACCURACY			P	W	V	
6	MATERIAL TC FOR METERING TUBE, ORIFICE PLATE, FLANGES AND FASTNER			P	V	V	
7	CALIBRATION REPORT	ONE / SIZE		P	V	V	
8	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	

Legend :

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR SOLENOID VALVES

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MAKE						
	MODEL No.						
2	MATERIAL (BODY. PLUNGER/TRIM)			P	W	V	
3	PORT SIZE			P	W	V	
4	CABLE CONNECTION SIZE			P	W	V	
5	ENCLOSURE CLASS			P	W	V	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
6	No. OF COILS & INSULATION CLASS			P	W	V	TEST CERTIFICATE TO BE FURNISHED FOR INSULATION CLASS BY VENDOR
7	POWER SUPPLY CHECK			P	W	V	
8	IR / HV TEST			P	W	V	
9	FUCTIONAL TEST			P	W	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	DIAL SIZE						
	MODEL NO./TAG NO./TYPE						
	RANGE/SCALE						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	HYSTERESIS						
3	OVER TEMP. TEST			P	W	V	
4	AMBIENT TEMP. COMPENSATION CHECK	1 OF TYPE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	THERMOWELL						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V	
	MATERIAL TC & DIMN. CHECK						
	HYD.TEST						
	OVER RANGE TEST						

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. IBR certificate to be provided if called for in specn.
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST			P	W	V	
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR LEVEL GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS / DRWGS	P	W	V	
	TYPE						
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR	ONE / LOT		P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE			P	W	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR SIGHT FLOW INDICATOR

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	MODEL						
	TAG No.						
	VISUAL						
2	DIMENSIONS,			P	W	V	
3	PROCESS CONNECTION			P	W	V	
4	RANGE / SCALE			P	W	V	
5	ACCURACY			P	W	V	
6	MATERIAL TC FOR METERING TUBE, ORIFICE PLATE, FLANGES AND FASTNER			P	V	V	
7	CALIBRATION REPORT	ONE / SIZE		P	V	V	
8	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

BHEL	**5x800 MW TSGENCO YADADRI TPS** **CONTROL & INSTRUMENTATION** Technical specification for **NATURAL DRAFT COOLING TOWER**	SPEC NO.: **PE-TS-417-145-IXXX** VOLUME SECTION REV. NO. 00 | DATE : 20.07.2017 SHEET OF

ACTUATOR SPECIFICATION & DATA SHEET

VOLUME: V-A

SECTION-III

TECHNICAL SPECIFICATION FOR ELECTRIC MOTOR ACTUATORS

1.00.00 SCOPE

1.01.00 This Section covers the general requirements of Electric Motor Actuators for valves/dampers.

1.02.00 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification. All the electrical actuators shall be INTEGRAL type only.

2.00.00 STANDARDS

2.01.00 All electrical equipment shall conform to the latest applicable IS, ANSI and NEMA Standards, except when stated otherwise herein or in driven equipment specification.

2.02.00 Major standards, which shall be followed, are listed below. Other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed

i) IS-9334

ii) IS-325

3.00.00 SERVICE CONDITIONS

3.01.00 The actuator shall be suitable for operation in hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the general specification.

3.03.00 For actuator motor installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 RATING

4.01.00 For isolating service, the actuator shall be rated for three successive open-close operation of the valve/damper or 15 minutes, whichever is longer.

4.02.00 For regulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.

5.00.00 **PERFORMANCE**

The actuator shall meet the following performance requirements:

5.01.00 Open and close the valve completely and make leak-tight valve closure without jamming.

5.02.00 Attain full speed operation before valve load is encountered and imparts an unseating blow to start the valve in motion (hammer blow effect).

5.03.00 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

5.04.00 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.

5.05.00 The entire mechanism shall withstand shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

6.00.00 **SPECIFIC REQUIREMENT**

6.01.00 **Construction**

6.01.01 The actuator shall essentially comprise the drive motor, torque/ limit switches, gear train, clutch, hand wheel, position indicator/ transmitter, in-built thermostat for over load protection, space heater and internal wiring.

6.01.02 The actuator enclosure shall be totally enclosed, dust tight, weather-proof suitable for outdoor use without necessity of any canopy. Degree of protection of enclosure for motor actuator shall be IP-65.

6.01.03 All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

6.01.04 The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

6.02.00 **Motor**

6.02.01 The drive motor shall be three phase, squirrel cage, induction machine with minimum class B insulation and IPW-55 enclosure, designed for high torque and reversing service. Canopy shall be provided for outdoor service.

6.02.02 The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current.

6.02.03 The motor shall be capable of starting at 85 percent of rated voltage and running at 80 percent of rated voltage at rated torque and 85 percent rated voltage at 33 percent excess rated torque for a period of 5 minutes each.

6.02.04 Motor leads shall be terminated in the limit switch compartment.

6.02.05 Motor actuators for valves/dampers shall be with integral starter with 3phase/3wire, 415V AC and operable from remote.

6.02.06 Earthing terminals shall be provided on either side of the motor.

6.03.00 **Limit Switches**

Each actuator shall be provided with following limit switches: -

6.03.01 2 torque limit switches, one for each direction of travel, self-locking, adjustable torque type.

6.03.02 4 end-of-travel limit switches, two for each direction of travel.

6.03.03 2 position limit switches, one for each direction of travel, each adjustable at any position from fully open to fully closed positions of the valve/damper.

6.03.04 Each limit switch shall have 2 NO + 2 NC potential free contacts. Contact rating shall be 5A at 240V A.C. or 0.5A at 220V D.C.

6.04.00 **Hand Wheel**

Each actuator shall be provided with a hand wheel for emergency manual operation. The hand wheel shall declutch automatically when the motor is energized.

6.05.00 **Position Indicator/Transmitter**

The actuator shall have:

6.05.01 One (1) built-in local position indicator for 0-100% travel.

6.05.02 One (1) position transmitter, 4-20 mA current signal as position feedback, for remote indicator.

6.06.00 **Space Heater**

A space heater shall be included in the limit switch compartment suitable for 240V, 1 phase, 50 Hz supply.

6.07.00 **Wiring**

All electrical devices shall be wired up to and terminated in a terminal box. All wiring shall be done with 1100V grade fire resistance PVC insulated stranded copper conductor of not less than 2.5 Sq.mm cross section. All wiring shall be identified at both ends with ferrules. All the electrical actuators shall have uniform wiring.

6.08.00 **Terminal Box**

The terminal box shall be weather proof, with removable front cover and cable glands for cable connection. The terminal shall be suitable for connection of 2.5 Sq.mm copper conductor.

7.00.00 **ACCESSORIES**

As required for the driven equipment, the actuator shall be furnished with starting equipment mounted on the actuator. This shall include:

7.01.00 One (1) triple pole MCCB

7.02.00 One (1) reversing starter with mechanically interlocked contactors, 3 thermal overload relays, 2 NO + 2 NC auxiliary contacts for each contactor.

7.03.00 One (1) remote-local selector switch.

7.04.00 CLOSE-STOP-OPEN oil tight push buttons with indication lights.

7.05.00 415/240 V control transformer with primary & secondary fuses.

8.00.00 **TEST**

The actuator and all components thereof shall be subject to tests as per relevant Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

9.00.00 **DRAWINGS, DATA & MANUALS**

9.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.02.00 **To be submitted with Bid**

Data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque limit switch contact development and manufacturer's catalogues. Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.03.00 **To be submitted for Owner / Purchaser's Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply		Description	Consumer
L.V. Supply	(i)	415V, 3Ø, 3W, 50 Hz Effectively earthed Fault level 50 kA symm. for 1 sec.	Motors above 0.2kW upto less than 175kW.
	(ii)	240V AC/415V AC	Motors upto 0.2kW.
		240V, 1Ø, 2W, 50 Hz effectively earthed	Lighting, Space heating , A.C supply for Control & protective devices.
D.C. Supply		220V, 2W, unearthed Fault level 25* kA. for 1 sec.	D.C. alarm, control & protective devices

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

2.0 RANGE OF VARIATION

A.C. Supply :

Voltage	:	± 10%
Frequency	:	+3% to -5%.
Combined Volt + frequency	:	10% (absolute sum)

During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

D.C. Supply :

Voltage : 187 to 242

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Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL*	* PROJECT	5X800 MW YADADRI TPS
	OFFER REFERENCE	
	* TAG NO. SERVICE	
	* DUTY	☐ ON / OFF ☐ INCHING
	* LINE SIZE (inlet/outlet): MATERIAL	
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY
	* OPENING / CLOSING TIME	
	* WORKING PRESSURE	
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, DUST TIGHT, WEATHER PROOF,SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, IP:65
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR REGULATING SERVICE - 150 STARTS/HR MINIMUM
HANDWHEEL	* REQUIRED	■ YES ☐ NO
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.	
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE FULL LOAD CURRENT-INCLUSIVE OF **I.S.** TOLERANCE
	ACTUATOR APPLICABLE WIRING DIAGRAM	■ ENCLOSED ■ DRG. NO. 3-V-MISC-24227 R00 (INDICATIVE)
	COLOUR SHADE	■ BLUE (RAL 5012), To be decided during detail engg.
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ■ EPOXY ☐ …….
	SHAFT RPM	BIDDER TO SPECIFY
	OLR SET VALUE	BIDDER TO SPECIFY
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V (BIDDER TO SPECIFY SINCE INTEGRAL STARTER IS ENVISAGED)

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.:
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Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	@ ENCLOSURE CLASS OF MOTOR	■ IP 65 ☐ FLAME PROOF	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ ----------	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED	
INTEGRAL STARTER	INTEGRAL STARTER	■ REQUIRED ☐ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	■ CONTACTORS ☐ THYRISTORS	
	TYPE	■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART	NOT APPLICABLE	
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐.....	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED	
	OPEN / CLOSE PB	■ REQUIRED ☐ NOT REQUIRED	
	STOP PB	■ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	■ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	■ REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	■ REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (O/L RELAY OPERATED, CONT. /POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY)	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	■ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER	
	QUANTITY	■ 2 NOs. ☐ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	☐1 No ■2 Nos. / 2 Nos. (ADJ.) / ☐1 No. ■2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	

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BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.:
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Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
POSITION TRANSMITTER	POSITION TRANSMITTER	■ REQUIRED ☐ NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) CONTACTLESS	
	SUPPLY	■ 24V DC ☐	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	240V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING	BIDDER TO SPECIFY	
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@☐ IP 68 @☐.....	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☐ REQUIRED ■ NOT REQUIRED ☐ 2 NOS. ☐ ----------	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE: DURING DETAILED ENGINEERING	
	@ SPACE HEATER CABLE GLAND	SIZE: NOT REQUIRED	
	OTHER CONTROL CABLE GLANDS-1	REFER NOTE &&	
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE:	
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

NOTES:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL, WITH NICKEL COATING SHALL BE PROVIDED.
5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
6. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.
7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

$$ **TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.**

**EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.**

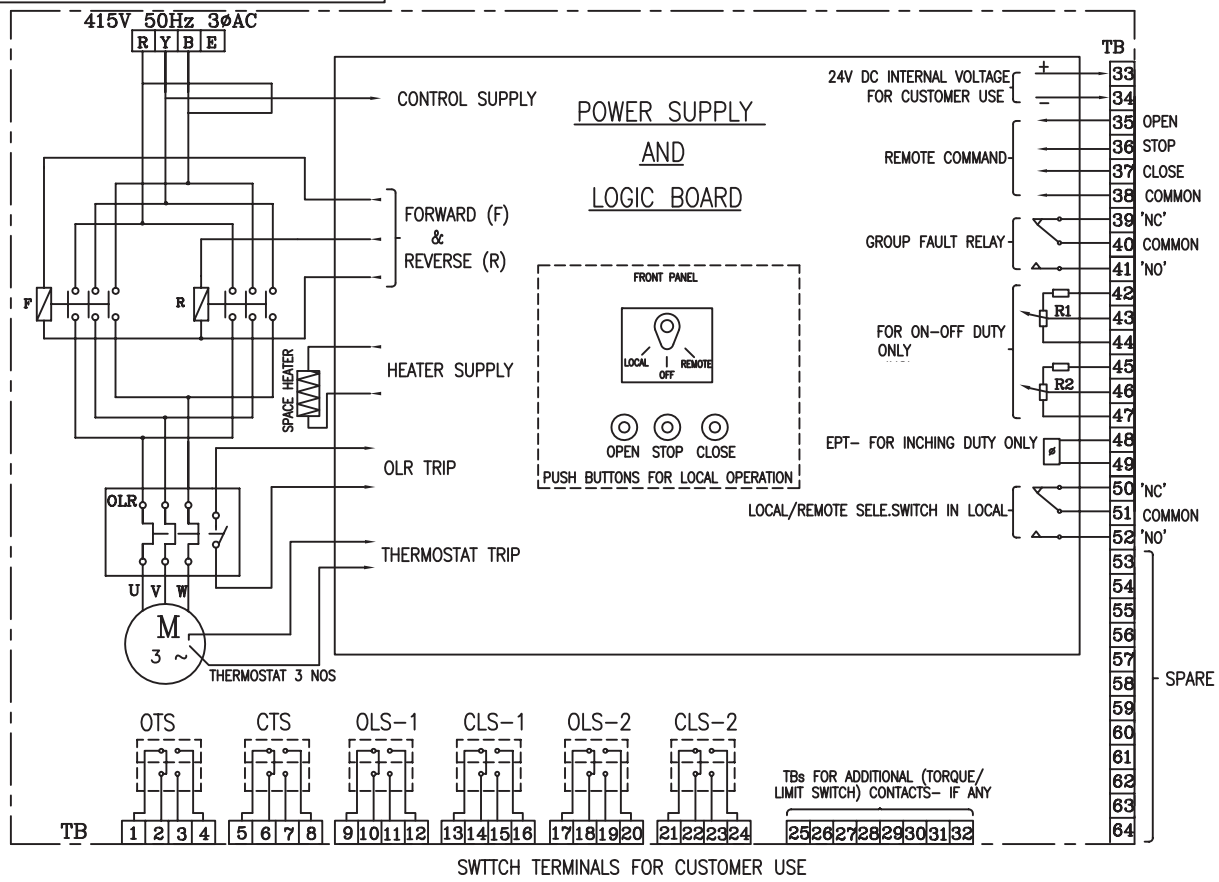
&& INSTRUMENT CABLE SIZE FOR ON/OFF DUTY VALVES SHALL BE 8PXO.5 SQMM - ONE CABLE GLAND OF OD SIZE 20 MM AND FOR INCHING DUTY TYPE VALVES SHALL HAVE TWO NO. CABLES (ONE NO. 8PXO.5 SQMM AND 2ND 2PXO.5 SQMM) - TWO NO. GLANDS OF OD SIZES 20 MM & 15 MM.

	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @= TO BE FILLED BY ES

ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

DRAWING NO. 3-V-MISC-24227



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	
	11-12	
CLS-1	13-14	
	15-16	
OLS-2	17-18	
	19-20	
CLS-2	21-22	
	23-24	

INDICATES CONTACT CLOSED

INDICATES CONTACT OPEN

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

INDICATIVE DRAWING

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

- CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

* - BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)

NOTE:-

1. ALL TORQUE AND LIMIT SWITCHES (OTS,CTS,OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE. ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
2. CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
3. OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
4. OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
5. CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
6. EPT - ELECTRONIC POSITION TRAMSMITTER
7. R1-R2-POTENTIOMETER 2 x 100 OHMS
8. FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
9. M - MOTOR 3ø 415V 50 Hz AC SUPPLY

REV	DATE	ALTERED
		CHD & APPD

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS (DRAWN FOR INTERMEDIATE POSITION OF VALVES)

BHARAT HEAVY ELECTRICALS LTD.,
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI-620014.
365-121

	NAME	SIGN	DATE	NO.OF VAR.
DRN	N.P.ESWAR	N.P	07.10.04	
CHD	D.DINAKARAN	D.D	07.10.04	
APPD	K.ARUNACHALAM	K.A	07.10.04	

DEPT: VL
CODE:
SCALE:
WEIGHT (KG).
REFERENCE INFORMATIONS
NO. OF ITEMS

TITLE: WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER

CARD CODE: U 01

DRAWING NO. 3-V-MISC-24227

REV 0

Size A3

SPECIFICATION AND DATA SHEET
FOR
LOCAL CONTROL PANEL

	CONTROL WRITE-UP FOR SUMP PUMPS SYSTEM	DRAWING NO:
	PROJECT: 5X800 MW YADADRI TPS	REV. NO. 00 / DATE:
		SHEET 1 OF 2

CONTROL & INSTRUMENTATION FOR SUMP PUMP SYSTEM

Introduction- Sump pumps are used to dewater various sump pits to nearest surface drain in the power house and other plant areas to ensure general housekeeping.
The system shall normally have 2 pumps. The measuring instruments recommended are level switches (float/displacer type) for level measurement and control of the system and pressure gauges at pump discharge for local pressure measurement. Any other instruments can be included dependent on the requirement or if demanded by the Customer.
The sump pumps can be fixed submersible type where the pumps are fixed and submerged or can be portable submersible type where the pumps are trolley based and can be moved as per the need. In fixed type the level switches can be mounted at a suitable mounting place while in portable type the level switches are ported to the sump along with the pumps. The mounting of switches and location of LCP shall be chosen so as to have minimum cable length between the level switches and the LCP.

CONTROL WRITEUP

The operation of Sump pumps (fixed and portable type) shall be as follows:

Sump Pumps shall be controlled through a starter cum control panel. The local control panel shall be front opening, relay based. The starter cum control panel shall be suitable for indoor or outdoor as per the location of the sump pumps. Normally one pump will be running and the other shall be on auto standby. The following controls/interlocks shall be provided in the local control panel.

Controls philosophy

CONTROLS

(a) Start/stop facility for each pump from LCP.

(b) Selector switch for main/standby selection.

(c) Auto/Manual selector switch for each pump.

AUTO START/STOP

a) One number level switch (high level) provided in the sump shall start one number sump pump in the event of high water level in the sump.

b) One number level switch (very high level) provided in the sump shall start second sump pump in the event of very high water level in the sump.

c) One number level switch (low level) provided in the sump shall stop the running pumps in the event of low water level in the sump.

d) If any of the working sump pumps trips the standby sump pump will come into operation automatically provided the very low level signal is not present.

Indications

a) Sump pumps status (ON/Off/Trip).

b) Level indications(Low,High,V.High)

	CONTROL WRITE-UP FOR SUMP PUMPS SYSTEM	DRAWING NO:
	PROJECT: 5X800 MW YADADRI TPS	REV. NO. 00 / DATE:
		SHEET 2 OF 2

General requirements for measuring instruments

Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experience manufacturers (from BHEL/customer approved vendor list) of specified type and range of equipment. Further, all instruments shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, makes/ numbers as approved by BHEL during detailed engineering.

1. Every panel-mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a ground terminal and shall be suitably connected to panel grounding bus.
2. The necessary root valves, impulse pipings and all the other accessories required for mounting/erection of local instruments shall be furnished even if not specifically asked for.
3. Instruments shall be terminated up to LCP with control cable (1.5sqmm). The LCP shall be fully wired. All the necessary cables, flexible conduits, junction boxes and accessories for the above purpose shall be included.

`

LOCAL PANEL

1.00.00 **GENERAL REQUIREMENT**

1.01.00 ENCLOSURES FOR INSTRUMENTS AND OTHER EQUIPMENT

1.01.01 All panels, cabinets, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures shall have suitable environmental protection as detailed in Section-I of this volume of the specification.

1.02.00 SURFACE PREPARATION & PAINTING

1.02.01 All sheet metal panel/ desk exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below.

1.02.02 Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale and all other residue due to the fabrication operation. Oil, grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods prior to blasting.

1.02.03 Two spray coats of inhibitive epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The finish colors for exterior and interior surfaces shall conform to the following shades:

- Exterior – Opaline green shade 275 of IS: 5 or equivalent international code..
- Interior - Brilliant White.

1.02.04 Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.

1.03.00 WIRING

1.03.01 All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All intercommunications between sections of panels/desks shall be furnished.

1.03.02 Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized ink print shall be used with cross- identification.

1.03.03 All wire termination shall be made with insulated sleeve and crimping type lugs. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

1.03.04 Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables. Internal wiring shall be grouped so that all outgoing wiring to each particular remote location is terminated on adjacent terminal blocks. Interior wiring and jumperings shall be arranged so that external connections can be made from internal side of terminal blocks. Common connections shall be limited to two (2) wires per terminal.

1.03.05 Wiring shall be arranged to ensure free access to all instrument or devices for maintenance. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices

1.03.06 Wires shall be dressed and run in trays or troughs with clamp-on type covers. Wirings may be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.

1.03.07 Shield wires shall be terminated on separate terminal blocks. Common connections shall be limited to two wires per terminal. Signal circuit shields shall be grounded at the power supply end only or as recommended by manufacturer.

1.03.08 All low level signal cables shall be separately bundled to from control cable and maintained at 300 mm minimum spacing from control bundles.

1.03.09 Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.

1.03.10 Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt shall be electrically and physically isolated from other AC and DC wiring. Shielded wires used in such cases for panel internal wiring shall be continuous and ungrounded with the shield terminated individually and separately in panel terminal block.

1.03.11 Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings will not cause fatigue failure of the conductor.

1.03.12 Internal wiring in factory pre-wired electronic systems cabinets may be installed according to the Contractor's standard wire size, insulation, and method of termination on internal equipment. Insulation for all wiring, including circuit board wiring, back panel wiring, power supply wiring and interconnecting cables between devices shall pass the vertical flame test per IPCEAS-1981. Identification of conductors may be done by insulation color-coding identified on drawings or by printed wiring lists.

1.04.00 TERMINAL BLOCKS

1.04.01 All terminal blocks shall be rail mounted/ post mounted type, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 Deg C. The terminal blocks in field mounted junction boxes, instrument enclosures racks etc. shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room termination/ marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by Bidder shall be subject to Owner.

1.04.02 All terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, small partitions, transparent covers, support brackets, distance sleeves, warning level, marking etc. For RTDs ring - tong type lugs shall be used at Junction Boxes.

1.04.03 The characteristics of the terminal blocks shall be as follows.

i) High contact force, independent of conductor cross-section and large contact surface area.

ii) Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point.

iii) Inspection and maintenance free (resistant to thermal aging and vibration)

iv) Low and constant voltage drop

1.04.04 The insulation of the terminal blocks shall be of suitable thermoplastic material.

1.04.05 The spacing between Terminal blocks channels in panels and cubicles shall be adequate for routing the cable troughs and to allow adequate free workspace for termination and removal of wires. The terminal blocks shall be arranged with atleast 100 mm clearance between two sets of terminal blocks and junction box walls.

1.04.06 Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.

1.04.07 Terminal blocks shall be provided with white marking strips / self-adhesive marker cards and where permitted by the safety codes and standards, shall be without covers. Power terminals and high voltage (above 48 volts) terminals shall have protection covers. All terminals shall be provided with permanent terminal identification numbers on both sides.

1.04.08 At least 20% spare unused terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable.

1.04.09 The bottom of the terminal block shall be at least 200 mm above the cable gland for bottom entry type panels.

1.04.10 For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.

1.04.11 Other requirements of the terminal blocks are as follows:

i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.

ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.

iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.

iv) It shall be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.

v) Where more than one connection to a terminal block is required, two tier terminals shall be used.

1.05.00 GROUNDING

1.05.01 Separate Protective and Electronic system ground as required shall be provided.

1.05.02 All panels, desks, cabinets shall be provided with a continuous bare copper ground bus (Frame ground), bolted to the panel structure at bottom on both sides and effectively ground the entire structure. The bolts shall face inside of panels.

1.05.03 For electronic system cabinets the electronic system ground bus (Electronic ground) shall be similar but insulated from the cabinet and shall be separately connected to the system ground .The same ground may be used to earth the shield of shielded signal cables, otherwise a separate ground bus shall be provided for connecting the signal cable shields. Cable shields shall be grounded at the panel end only and shall never be left open .The electronic ground between panels of a shipping section shall be firmly looped.

2.00.00 **CONTROL DESKS & PANELS**

2.01.00 GENERAL

2.01.01 All control desk, panels etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, utility receptacles, grounding, ventilation, space heating, anti-vibration pads, internal piping &

accessories as required for completeness of the system.

2.01.02 The design shall conform to the EN ISO 11064 (Ergonomical design of Control Room), Part 1, 2 and 3.

2.01.03 The exact dimensions, material, construction details, grounding, general arrangement etc. shall be as per actual requirement and shall be finalized during detail engineering and subjected to Owner's approval.

2.01.04 Incoming power supply feeders shall be duplicated. Alarm shall be provided for failure of a power supply feed.

2.01.05 For Control desk/ panel mounted instruments/ devices etc. which are to be powered from UPS, all required conversion of interface equipments/ accessories to make such devices compatible with UPS supply shall be provided. All necessary hardware like input switches/ fuse unit for each feeder as well as switch fuse unit for each instrument/ device on the power supply line shall be provided. From UPS redundant feeders shall be provided wih suitably rated MCB and provision of fast auto changeover of UPS feeders.

2.01.06 Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

2.01.07 Nameplate

a) Nameplate shall be provided for instrument or device mounted on the panel.

b) Nameplates for panels shall be provided both in front and rear.

2.02.00 CONTROL DESK

2.02.01 Control desk shall be free standing, floor mounting, table top type with doors at back and shall be constructed of 3 mm thick (minimum) CRCA steel or Aluminium extrusion. Aluminium structure shall be anodized or powder coated paint finish. The top surface of control desk shall be 30 mm (minimum) thick with the top 12 mm (minimum) of acrylic solid surface and the remaining 18 mm of laminated medium density fibre (MDF) board.

2.02.02 Monitors with retractable keyboard shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate.

2.02.03 Desks shall be of modular, scalable and industrially ruggedized design and shall have connections for PA system handsets & telephone sets.

2.02.04 Desks shall have concealed cable trays for wire dressing. Both Horizontal & Side Managers (2 separate horizontal cable routing wire baskets for power & data cables) shall be provided.

Each User station will be provided with 2 separate power distribution units (1 for Main line & 1 for UPS line). Each power distribution unit will have 6 points of 5/13 Amp sockets, Mains MCB On/Off Switch & Indicator.

Adequate heat management provision for Exhaust of heat from within the Console Desk Assembly shall be provided. There will be multiple fans provided in the Main Control Desk. Each Fan will be of 230 VAC 250 CFM Ball Bearing based. Ventilation louvers will be provided on both Front & Rear Modesty with special Air Filters. Adequate space for CPU & Other equipments placed with in the desk.

2.02.05 Design shall include Earthing bolts.

2.02.06 Back installed items shall be suitably concealed from front view.

2.02.07 All operator workstations for SG, TG, Auxiliaries & Off-site Plants shall be mounted on this Control Desk. The cabling / wiring between OWS & CPUs, power supply cables etc. shall be aesthetically routed and concealed from view.

2.02.08 HARDWIRED DEVICES ON CONTROL DESK (DRAW OUT SECTION)

Release and Lamp Test push buttons shall be provided for a set of push buttons (decided during detail engineering stage). Depending on the type of control/ function, required number of push buttons/ indicating LEDs & their color, push button stations shall be selected. The size of push button stations shall be 24 x 48 mm or 25 x 50 mm and shall have service inscription details at the front. Emergency push buttons (with cover) shall be mounted on top of Control Desk.

2.03.00 BACK UP PANEL

2.03.01 Construction shall be from CRCA steel of thickness not less than 3mm.

2.03.02 Upright back-up panel shall be provided where hardwired devices shall be mounted on a mosaic grid type console. The mosaic grid tiles shall be of 24 mm x 48 mm (or 25 mm x 50 mm) size, made of heat & flame retardant, self extinguishing and non-hygroscopic material with flat matt finish without glare and non reflecting type.

2.03.03 DDCMIS Back-up Panel (referred as Unit Control Panel-UCP) shall also mount annunciation fascia (minimum 500 nos.) and the flame monitoring cameras along with other hardwired devices as decided during detail engineering stage by Owner. Color coding shall also subject to Owner's approval.

2.03.04 Colored Mimic for different Off-site plant control systems (as enumerated elsewhere in this specification) and hardwired annunciation system shall also

be mounted on the back up panels.

2.04.00 PANELS/CABINETS

2.04.01 All DDCMIS system modules, power supply components and other Local Control panels (PLC/Relay based) shall be housed in cabinets as specified below.

2.04.02 The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings prior to shipment to the project site.

2.04.03 The Bidder shall ensure that the cabinets are complete & ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets shall only involve connections through multi-pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to Control Desk/ Back up Panel.

2.04.04 All electronic cards, network components, power supply modules etc. located shall be suitably housed in cabinets and shall be neatly arranged in sub-racks. Network components shall be visible in door closed condition (e.g. Glass doors etc.) as approved by Owner.

2.04.05 Bidder shall design the cabinet internal arrangement, floor cutout and cable gland plate such that all the cables entering or leaving the cabinet can be properly glanded in the gland plate.

2.04.06 The packaging density of panels shall be such that the temperature rise within the panels shall never exceed 10°C above ambient even under worst operating conditions. Cooling Fans shall be provided wherever required and this shall be of industrial grade.

2.04.07 TECHNICAL PARTICULARS

1.	Material of Construction	:	Cold Rolled Coal Annealed (CRCA) steel sheet	
2.	Thickness of Sheet	:	a)	2.0 mm for faces supporting instruments / terminals
		:	b)	1.6 mm for other sides and top
3.	Construction	:	Welded throughout as per approved National Standards	
4.	Post welding operation	:	a)	Grounding of all welds to smoothness
		:	b)	Rounding of corners

		:	c)	Cleaning of weld spatters
5.	Panel height	:	2300 mm (approx)	
6.	Corners	:	7 mm inner radius	
7.	Dimensional Tolerances	:	a)	In height & length - 3 mm
			b)	In height between adjacent sections - 2 mm
			c)	Total for a group - 6 mm
8.	Doors	:	Double, recessed, turned back edges, full height front & rear	
	i) Thickness of Sheet	:	2 mm	
	ii) Hinges	:	Stainless steel	
	iii) Door latches	:	Three point type	
	iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure	
	v) Opening of the doors	:	Outward	
	vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof	
9.	Gland plates	:	Removable in sections 4 mm thick (bottom)	
10.	Cable entry	:	Bottom	
11.	Hardware	:	a)	Anti vibration pad- 15 mm
			b)	Predrilled base channel ISMC – 100 or equivalent for all sides
			c)	Stainless steel buff- finished 2 mm thick kick plate for all sides
			d)	Stainless steel scratch strips along desk edges fixed with pan-head recessed screws
			e)	Rubber strips to ensure air

tightness between kick plate and finished floor

f) Lifting hook / Eye bolt

g) Drawing pocket

h) Door switch, lamps, thermostat, heaters and industrial grade cooling fans,, illumination fixures

12.	Name Plate	:	Both at front and back surface of the panel
13.	Fixing of name plate	:	Stainless steel pan head screws
14.	Name plate material	:	Laminated phenolic (3 layers)
15.	Lettering	:	Black with white engraved
16.	Mounting of terminal blocks	:	Vertical angle support bracket tack welded on sheet steel plate, screwed on internal wall of enclosure

2.05.00 FURNITURE

All the furnitures in the Central / Local control Room (s), Engineers' rooms, Instrument laboratory , SWAS Room & any other rooms with C&I equipments located in different plant buildings under Bidder's scope shall be included in Bidder's scope of supply. Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe.

2.05.01 WORK STATION FURNITURE

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

2.05.02 PC RACK

PC Racks shall be provided to mount CPUs of workstations/PCs of OWS/LVS etc. in control room. For each PC / workstation / monitor at least one chair shall be included.

2.05.03 CHAIRS

falling objects and shall be epoxy painted. Canopy shall be of CRCA steel sheet of at least 3 mm thickness.

4.03.02 Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Center posts or any member, which would reduce access, shall be avoided.

4.03.03 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.

4.03.04 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.

4.03.05 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack

4.03.06 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.04.00 JUNCTION BOX

1.	Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
2.	Material	:	3 mm sheet steel / fiberglass reinforced polyester(UV stabilized)
3.	Type of Cover	:	Solid unhinged with retention chain / Screwed at all four corners
4.	Paint	:	i) Exterior : Opaline green shade 275 of IS: 5 ii) Interior - Brilliant Glossy White.

			Surface / Two (2) inch Pipe stanchion
5.	Mounting	:	(At a dry compartment at one side of the enclosure / rack with front opening type door)
6.	Cable Entry	:	3 mm (min) Bottom / side Gland plate
7.	Gasket	:	Neoprene
8.	Grounding	:	Brass earth lug with green screw head External-2 nos , Internal-1no. (M6)
9.	Number of Drain Holes	:	Two at bottom capped
10.	Identification	:	Label for JB and Tags for cable
11.	Accessories	:	a) Rail mounted cage clamp type screwless terminals (suitable for conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals b) Cable gland (Brass) & raceways c) Ferrules & lugs (Brass) d) Aluminum back panel e) Canopy at top f) Mounting brackets g) bolts and nuts made of brass etc.

SUB-SECTION - IIA

STANDARD TECHNICAL SPECIFICATION (MECHANICAL)

STANDARD TECHNICAL SPECIFICATION FOR COLING TOWER

STANDARD QUALITY PLANS

1.0 GENERAL:

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

2.0 CODES AND STANDARD:

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

a) Cooling Tower Institution of USA, Bulletin ATP-105: Acceptance Test Code for Industrial Water Cooling tower.

b) PTC-23: ASME Performance Test Code for Atmospheric Water Cooling equipment.

c) For Electrical, Civil Codes/ Standards refer respective Specification.

d) BS-4485 – Specification for Water Cooling Tower.

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

3.0 DESIGN REQUIREMENTS:

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

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

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

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

3.5 The Cooling tower shall be suitable for handling the fluid as per Data Sheet-A and also for achieving the specified parameters in Data Sheet-A.

3.6 The Cooling tower shall be designed such that the drift losses and the evaporation losses are limited to the values as specified in Data Sheet-A.

3.7 The Cooling Tower structure shall be of adequate strength to withstand the wind load and the effect of earthquake on the structure. Design wind pressure and horizontal/vertical seismic coefficient shall be taken as mentioned in the specification for civil works enclosed to this specification.

4.0 CONSTRUCTIONAL FEATURES:

4.1 Casing and Louver (If required):

4.1.1 The Louvers shall be designed for air entry to the tower with low velocity for minimum pressure drop and less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards.

4.1.2 The louvers and casing shall be made of material as specified in the Data Sheet-A.

4.2 Partitions:

4.2.1 Partitions shall be provided so that one section can be taken out of service without affecting the operation of capacity of other section.

4.3 Fill:

4.3.1 Cooling tower fills type and material shall be as specified in Data Sheet-A.

4.3.2 Design and arrangement of the fills shall be so as to expose high air/ water surface with minimum air pressure drop.

4.4 Fill Supports:

4.4.1 Fills shall be supported at frequent intervals, which shall minimise sag. Possibility of dislodgement and damage to fill materials as a consequence of induced vibration in the fill.

4.5 Drift Eliminations:

4.5.1 Multipass drift eliminators with minimum two-pass zig zag path type shall be provided so as to limit the drift loss to that specified in Data Sheet-A.

4.5.2 The eliminator frame shall be of rugged construction and shall be firmly secured to the structural

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

4.6 **Hot Water Distribution System:**

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

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

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

4.7 **Cold Water Basin:**

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

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

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

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

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

4.8 **Submersible sludge Pumps:**

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

4.9.0 **Screens & Gates in Cold Water outlet Chamber:**

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

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

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

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

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

4.10 **Hardware:**

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

4.11.0 **Access:**

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

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

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

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

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

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

5.0 **INSPECTION AND TESTING:**

5.1 The inspection/ testing of cooling tower and its various components shall be as per the approved Quality Plans.

5.2 Hydrostatic test for the hot water distribution piping shall be conducted at site after complete erection. The test pressure and duration shall be as per Data Sheet-A.

6.0 **TEST AT SITE:**

6.1 The Cooling Tower as a whole shall be tested at site to check and ascertain that the performance meets the requirements of the specification. It is the responsibility of the vendor to conduct the performance test of the cooling tower and prove the specified parameters to the satisfaction of the purchaser. The test shall be witnessed by the purchaser/ customer's representative or both, for which 15 days clear notice will be given to purchaser by the vendor.

6.2 The performance test of the cooling tower shall be carried out in accordance with cooling tower Institute Bulletin No. ATP 105 Acceptance test for Industrial Cooling Tower.

The details of the proposed test procedure shall be submitted by the vendor sufficiently in advance of the commencement of test for the review and approval of the purchaser.

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

6.4 All testing and calibrating instruments required for the site performance test shall be arranged by the cooling tower supplier without any extra cost. All instruments used by the supplier shall be duly calibrated from a recognised Institution and the same is to be arranged by the supplier.

7.0 **PERFORMACNE GUARANGTEE, TOLERANCE & PENALTIES:**

7.1 Each equipment shall be guaranteed to meet the performance requirement as specified.

7.2 The tests shall be conducted at the manufacturer's works/ site in accordance with this specification and rectification of all defects shall be satisfactory done without charging any extra amount to purchaser.

7.3 The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within a time period decided by purchaser. No extra amount shall be charged to purchaser for such rectification. After rectification, retesting will be done by purchaser/ customer's representative without any extra cost to purchaser till satisfactory performance is achieved.

7.4 The vendor shall submit performance curves for the cooling tower showing variation in performance from the design duty point with change in approach to wet bulb temperature,

cooling range, water loading of the tower.

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

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

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

8.0 SPECIAL CLEANING PROTECTION & PAINTING:

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

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

a) Removal of oil, grease, dirt and swarf etc., as per Section 6.1 of IS-1477 (Part-I).

b) Removal of rust and scale etc., as per Section 6.2 of IS-1477 (Part-I).

c) Sand blasting/ shot blasting as per Section 6.2.4 of IS-1477 (Part-I) or wire brushing and picking as specified in Data Sheet-A.

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

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

8.3 Outside Surface of Piping (Buried):

8.3.1 Surface treatment as specified in Data Sheet-A.

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

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

8.4.1 Surface treatment as specified in Data Sheet-A.

8.4.2 One coat of red oxide primer.

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

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

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

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

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

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

10.0 **SPECIAL TOOLS & TACKLES**:

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

PROJECT

VENDOR

BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE
STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED (03)	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS (07)	ACCEPTANCE MORMS (08)	FORMAT OF RECORD (09)	AGENCY (10)			REMARKS (11)
									P	N	V	
1	MATERIAL AND BOUGHT OUT CONTROL											
1.1	FAN BLADE (NON- METALLIC)											
	RESIN	CHEM. PROPS.	MA	CHEM. ANALYSIS	1/BATCH	MFR. SPECH	MFR. SPECH.	MFRS. TC	3		2,1	CORRELATION REQD.
1.2	FAN BLADE (METALLIC)	PHYS.,CHEM. PROPS.	MA	PHYS., CHEM ANALYSIS	1/HEAT	APPD. DATA SHEET	APPD. DATA SHEET	TC	3		2,1	DO
1.3	FAN HUB (CENTRE PORTION, SPOKES,BRACES ETC.)	DO	CR	DO	DO	DO	DO	IR	3/2		2,1	DO
1.4	DRIVE SHAFT & COUPLING	DO	CR	DO	DO	DO	DO	IR	3/2		2,1	DO
1.5	REDUCTION GEAR UNIT- TURN SHAFT,WHEEL, PINION, BEVEL GEARS, CASING	DO	CR	DO	1/CASE	DO	DO	IR	3/2		2,1	DO
	1. SHAFT & GEAR BLADES	SUB- SURFACE DEFECTS	CB	UT	100%	ASTM A388, BACKWALL ECHO 100%	DEFECT ECHO NOT MORE THAN 20% OF BACK WALL ECHO FALL IN BACK WALL ECHOE NOT MORE THAN 20%	IR	3/2	2,1		FOR DIA 50MM AND ABOVE

Q.P.NO.	CQS/SQP/42	SIGNATURE		DATE		DATE			DATE
REV.NO./ DATE	0/1-11-85 ,01 JULY,88	NAME							
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PROJECT

VENDOR

BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE
STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS	ACCEPTANCE MORMS (08)	FORMAT OF RECORD	AGENCY (10)			REMARKS (11)
									P	N	V	
1.6	HARDWARES	1. PHYS., CHEM. PROPS.	MA	PHYS. ,CHEM.ANALYSIS	IS:2614 TABLE 2	APPD. DATA SHEET	APPD. DATA SHEET	LAB. REPORT	3/2		2,1	
		2. DIMENSIONS, VISUAL DEFECTS	MI	MEAS. ,VISUAL EXAM.	p	MFG. DRG.	MFG. DRG.	LOG BOOK	3/2		2,1	
		3. UNIFORMITY, WT.,ADHESION,SURFACE DEFECTS OF ZINC COATING.	CR	DIP.TEST, STRIP TEST ADHESION TEST, VISUAL EXAM.	IS:5358	IS:5358, APPD DATA SHEET	IS:5358, APPD DATA SHEET	TC	3/2	2,1		
1.7	TIMBER(FOR ALL TIMBER COMPONENTS)											
	1. MATERIAL	1. DEFECTS	MA	VISUAL EXAM.	100%	TECH. SPECN. IS:2372	TECH. SPECN. IS:2372	IR	3/2	2,1		
		2.DIMENSIONS	MA	MEAS.	RANDOM	DO	DO	IR				
	2. PRESERVATIVE TREATMENT	1. PRESERVATIVE RETENTION& PENETRATION	CR	ANALYSIS	1/BATCH	IS:2372,IS:401	IS:2372	IR	3/2	2,1		
1.8	WIRES, WIRE MESH											
	1. WIRES	1. PHYS., CHEM. PROPS	MA	PHYS. ,CHEM. ANALYSIS MEAS.	RANDOM	APPD. DATA SHEET	APPD. DATA SHEET	TC	3/2		2,1	
		2. UNIFORMITY, WT. , ADHESION SURFACE DEFECTS OF ZINC COATING	CR	DIP, STRIP, ADIESION TESTS VISUAL EIAM.	IS:4826	APPD. DATA SHEET IS:4826	APPD. DATA SHEET IS:4826	TC	3/2		2,1	

Q.P.NO.	CQS/SQP/42	SIGNATURE		DATE		DATE			DATE
REV.NO./ DATE	0/1-11-85 ,01 JULY,88	NAME							
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BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE

STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS	ACCEPTANCE MORMS (08)	FORMAT OF RECORD	AGENCY (10)			REMARKS (11)
									P	N	V	
	2. WIRES - PVC COATING (IF APPLICABLE)	SURFACE DEFECTS, PIN HOLES	CR	VISUAL EXAM. , SPARK TEST	100%	IS:4682 PT.IV	IS:4682 PT.IV	IR	3/2	2,1		
	3. WIRE MESH	MESH, SIZE, SURFACE DEFECTS	MI	MEAS. , VISUAL EXAM.	RANDOM	MFG. DRG.	MFG. DRG.	IR	3/2		2,1	
1.9	NOZZLES,FILLS,FILLS SUPPORT,SPLASH BARS AND OTHER ACCESSORIES	DIMENSIONS, WORKMAMSHIP AND FINISH	MI	DO	RANDOM	MFG. DRG./APPD. DATA SHEET	MFG. DRG./APPD. DATA SHEET	IR	3/2		2,1	
1.10	VIRRATION SWITCH	1. CONTACT RESISTANCE 2. CONTACT RATING 3. INSULATION RES. 4. DI-ELECTRIC STRENTH 5. OPTION	MA	ELEC. TESTS	100%	APPD. DATA SHEET /DRG.	APPD. DATA SHEET /DRG.	IR	3/2	2,1		
		6. DEGREE OF PROTECTION & VIBRATION TEST	MA	ELEC. TESTS	1/TYPE/SIZE	DO-	DO	LAB. REPORT	3/2		2,1	
1.11	PIPES ,FITTINGS & PIPE WORK	REFER STANDARD QUALITY PLAN FOR PIPES, FITTINGS & PIPE WORKS										
1.12	VALVES (ALL TYPES)	REFER RESPECTIVE STANDARD QUALITY PLANS										
1.13	PUMPS	REFER STANDARD QUALITY PLAN FOR CENTRIFUGAL PUMPS.										
1.14	LIGHTING PLAN	REFER STANDARD QUALITY PLAN FOR CONTROL PANELS										

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BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE
STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS	ACCEPTANCE MORMS (08)	FORMAT OF RECORD	AGENCY (10)			REMARKS (11)
									P	N	V	
1.15	CABLES	1. TYPE TESTS INCLUDING FRLS TESTS	MA	VERF. OF TYPE TEST CERT.	IS:1554	TECH. SPECH. , APPD. DATA SHEET IS:1554, IS:5931	TECH. SPECH. , APPD. DATA SHEET IS:1554, IS:5931	TYPE TC	3		2,1	
		2. ROUTINE TESTS	MA	ELECT. TESTS	DO	DO-IS: 1554	DO-IS: 1554	ROUTINE TC	3		2,1	
		3. ACCEPTANCE TESTS	MA	DO	DO	DO	DO	ACCEPT. TC	3		2,1	
1.16	IN PROCESS CONTROL											
1.17	FAN BLADE(CURED & FORMED)/MACHINED	1. HARDNESS	MA	PHYS. TEST	SAMPLE	APPD. DATA SHEET/MEG.STD. IS:10661	APPD. DATA SHEET/MEG.STD. IS:10661	LOG BOOK/IR	3/2		2,1	11 TO 31 FOR GRP/FRP ONLY.
		2. PROFILE	CR	TEMPLATE/ MEAS.	SAMPLE	MFG. STD./DRG.	MFG. STD./DRG.	IR	3/2		2,1	
		3. DIMENSIONS	MA	MEASUREMENT	SAMPLE	DO	DO	IR	3/2		2,1	
		4.DEFLECTION/PROOF LOAD CAPACITY	CR	DEFLECTION TEST/PROOF LOAD TEST	100%	DO	NO PEMT. DEFCTN./NO CRACK	IR	3/2	2,1		
		5. WORKMANSHIP AND FINISH	MA	VISUAL EXAM.	100%	DO	DO	IR	3/2	2,1		ON METALLIC BLADES ONLY
		6. SURFACE DEFECTS OF HUB ENDS	MA	PT	100%	ASTME 165	NO SURFACE DEFECT	IR	3/2	2,1		
2.2	HUB DRIVE SHAFT & COUPLING (BEFORE GALVANISING)	1. DIMENSIONS	MA	MEASUREMENT	100%	MFG. DRG./STD.	MFG. DRG./STD.	IR	3/2	2,1		
		2. WORKMANSHIP AND FINISH	MA	VISUAL EXAS.	100%	DO	DO	IR	3/2	2,1		
		3. SURFACE DEFECTS	MA	PT	100%	ASTME 165	NO SURFACE DEFECT	IR	3/2	2,1		
		4. STATIC DYNAMIC RESIDUAL UNBALANCE	CR	STATIC DYNANIC BALANCING	100%	ISO 1940	ISO 1940 G 6.3	IR	3/2	2,1		
2.2.1	HUB DRIVE SHAFT & COUPLING (AFTER GALVANISING)	1. UNIFORMITY, WT. ,ADHESION	CR	DIP, STRIP, ADHESION TESTS	1/ BATCH, IS:2633	APPD. DATA SHEET IS:2633	APPD. DATA SHEET IS:2633	IR	3/2	2,1		
		SURFACE DEFECTS OF ZINC COATING		VISUAL EXAM.	100%							

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REV.NO./ DATE	0/1-11-85 ,01 JULY,88	NAME							
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PROJECT

VENDOR

BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE
STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS	ACCEPTANCE MORMS (08)	FORMAT OF RECORD	AGENCY (10)			REMARKS (11)
									P	N	V	
2.3	REDUCTION GEAR UNIT- ALL COMPONENTS	1. WORKMANSHIP AND FINISH,DIMENSIONS	MA	VISUAL EXAM.MEAS.	100%	MFG. DRG.	MFG. DRG.	LOG BOOK /IR	3/2		2,1	
2.3.1	GEARS WORMS	1. HEAT TREATEMENT CYCLE, HARDNESS, CASE DEPTH	MA	VERF OF HT CHART MEAS.	100% RANDOM	MFR. SPECN/APPD. DATA SHEET	MFR. SPECN./APPD. DATA SHEET	HT CHART LOG BOOK	3/2		2,1	
2.3.2	GEARS	1. UNIFORMITY OF CONTACT	MA	BLUE- MATCHING	100%	MFR. SPECN.	MFR. SPECN.	LOG BOOK	3/2		2,1	
2.3.3	SHAFT AND GEARS	1. SURFACE DEFECTS	MA	PT	100%	ASTME 165	NO SURFACE DEFECT	IR	3/2	2,1		
3	ASSEMBLY CONTROL, FINAL TEST											
3.1	FAN ASSEMBLY BLADES WITH HUB	1. STATIC RESIDUAL UNBALANCE	CR	STATIC BALANCING	100%	TECH. SPECN.	NO REDIDUAL UNBALANCE	IR	2	1		
3.2	COMPLETE GEAR BOX	1. GEAR RATIO, ORIENTATION, NOISE,TEMP. RISE, LEAKAGES	MA	VISUAL EXAM. NO LOAD RUNNING FOR ONE HR.	100%	MFG.STD., APPD. DATA SHEET	MFG. STD. APPD. DATA SHEET NO LEAKAGES	IR	3/2	2,1		
3.3	COMPLETE FAN ASSEMBLY	1. AIR DELIVERY 2. POWER CONSUMED 3. FAN EFFICIENCY 4. NIOSE, VIBRATION	CR	PERFORMANCE TEST	1/ TYPE/SIZE	BS 848 PT 1,2 TYPE-C/DULLETIN ATP 105-COOLING TOWER INSTT. OF USA	APPD. DATA SHEET BS 840 PT.1,2 TYPE-C/BULLETIN ATP 105-COOLING TOWER INSTT. OF USA	TYPE TEST REPORT	2		1	IN THE ABSENCE OF TYPE TEST REPORT,TO BE WITNESSED BY BHEL

Q.P.NO.	CQS/SQP/42	SIGNATURE			DATE		DATE					DATE
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BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE
STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS	ACCEPTANCE MORMS (08)	FORMAT OF RECORD	AGENCY (10)			REMARKS (11)
									P	N	V	
4.0	COMPLETE COOLING TOWER											
4.1	COMPLETE COOLING TOWER	PERFORMANCE TESTS , DIMENSIONS, WORKMANSHIP & FINISH	CR	PERFORMANCE TEST MEAS.VISUAL EXAM.	100%	TECH. SPECN./APPD. DATA SHEET/DRG.	TECH. SPECN./APPD. DATA SHEET/DRG.	IR	2	1		AT SITE

Q.P.NO.	CQS/SQP/42	SIGNATURE		DATE		DATE			DATE
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PAGE NO.	6 OF 6	PARTY	CUSTOMER/CONSULTANT		BHEL		VENDOR		

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANDARD

NAME OF CONTRACTOR:STANDARD

ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE 1… OF….4**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	D	FORMAT OF RECORD	AGENCY			REMARKS
					M	C	N					M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.	9.	10.	11.			12.
1	**RAW MATERIAL INSPECTION**														
1.1	Casting For Fan Hub Centre	Chemical Properties	Major	Chemical	1 sample per Heat			Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	T.C.	P	V	V	As Cast Heat Mark Required
		Heat Treatment	Do	Heat Treatment	100%	-		Do	Do		HT Chart	P	V	V	
		Mechanical Properties	Do	Mech. test	1 sample per Heat/ HT batch			Do	Do	✓	T.C.	P	V	V	
		Dimensions	Do	Measurement	100%	-		Mfg /Drg.	Mfg. Drg.		IR	P	V	V	
		Surface Defect	Do	Visual	100%	-		Approved drg./ mfg. drg.	Free from Surface Defects		IR	P	V	V	
1.2	Pipes For Spokes & Braces	Review of Mnf. TC for Chemical / Mechanical / Flattening	Major	Review of TC	1 sample per Heat			Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	T.C.	P	V	V	
		Dimensions	Do	Measurement	100%	-		Mfg. drg.	Mfg. Drg.		I.R.	P	V	V	
		Surface defect	Do	Visual	100%	-		-	No harmful Defects		Do	P	V	V	
1.3	BLADE CLAMP	Chemical & Mechanical Test	Major	Mech./ Chem.	1 Sample per Heat			Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	TC	P	V		
		Appearance	Major	Visual	100 %			Mfg. Drg.	Mfg. Drg.		TC	P	V		
		Dimension	Major	Measurement	Random			Mfg. Drg	Mfg. Drg		TC	P	V		
1.4	HARDWARE	Appearance & Dimension	Major	Visual	Random			Approved Drg./ Mfg. Drg.	Approved Drg./ Mfg. Drg.		IR	P	V		Compliance Report
1.5	GLASS ROVING FIBER GLASS	Weight	Major	Measurement	100 %			Manufacturer ES	Manufacturer's ES		TC	P	V		Manufacturer T.C Shall be submitted for Review.

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

M: MANUFACTURER/SUB-CONTRACTOR
C: MAIN SUPPLIER OF PACKAGE/SYSTEM,
N: BHEL/CUSTOMER/CONSULTANT

P: PERFORM
W: WITNESS
V: VERIFICATION.

	PREPARED BY	REVIEWED BY	APPROVED BY	BHEL	STANDARD
	Divyanshu Arora	Maheep Singh	Vishal kumar Yadav	APPROVED BY	APPROVED BY

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANDARD

NAME OF CONTRACTOR:STANDARD

ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE 2… OF….4**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	D	FORMAT OF RECORD	AGENCY			REMRKS
					M	C	N					M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.		9.	10			11
		Finish & Ribonization	Major	Visual	100 %			--- DO ---	--- DO ---		TC	P	V	-	Manufacturer T.C Shall be submitted for Review.
1.6	POLYSTER RESIN	Physical & Chemical	Major	Review of TC & Visual	Sample			Supplier Test Cerrtificate	Supplier Test Cerrtificate		TC	P	V	-	Manufacturer T.C Shall be submitted for Review.
1.7	FOAM	Free – rise Density	Major	Measurement	Sample			Supplier Test Cerrtificate	Supplier Test Cerrtificate		TC	P	V	-	Manufacturer T.C Shall be submitted for Review.
2	**IN PROCESS INSPECTION**														
2.1	Welding (Hub)	WPS/PQR/WQR	Major	Qualification Verification	100%	-		ASME-IX	ASME-IX		WPS PQR	P	-	-	Refer Note - 1
		NDT on Finished Weld	Critical	DPT	100%	-		ASTM E 165	NO INDICATIONS	✓	IR	P	V	V	
			Critical	RT	10%	-		ASME SEC VIII	ASME SEC VIII	✓	IR	P	V	V	On Butt Weld between Hub & Spokes
		Dimensions	Major	Measurement	100%	-		MFG. DRG.	MFG. DRG.		I.R.	P	V	V	
2.2	FAN BLADE	Appearance	Major	Visual	100 %	10%		Mfg. Drg & Manual K – 1109 P1	Mfg. Drg & Manual – 1109 P1		IR	P	V	V	
		Contour	Major	Measurement	100 %	10%		Mfg. Drg & Manual K – 1109 P1	Mfg. Drg & Manual – 1109 P1		IR	P	V	V	
		Proof Strength/Deflection	Major	Physical Test	100 %	10%		------- DO -------	------- DO ----------	✓	IR	P	V	V	

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION					BHEL	STANDARD
M: MANUFACTURER/SUB-CONTRACTOR **C:** MAIN SUPPLIER OF PACKAGE/SYSTEM, **N**: BHEL/CUSTOMER/CONSULTANT	**P:** PERFORM **W**: WITNESS **V:** VERIFICATION.		PREPARED BY	REVIEWED BY	APPROVED BY	APPROVED BY	APPROVED BY
			Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANDARD

NAME OF CONTRACTOR:STANDARD

ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE 3… OF….4**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	D	FORMAT OF RECORD	AGENCY			REMRKS
					M	C	N					M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.		9.	10			11.
3	**FINAL INSPECTION**														
3.1	Hot Dip Galvanizing of Fan Hub	Surface Defects	Major	Visual	100%	-		IS:2629	IS:2629	✓	I.R.	P	V	V	HDG Supplier TC' S Shall Be Submitted For Review
		Uniformity Of Coating	Major	Dip Test	Samples as per IS:2633			IS: 2633	IS: 2633	✓	I.R./TC	P	V	V	
		Thickness / Weight / Adhesion of Zn coating	Major	Mechanical	Samples as per IS:4759- 1996			IS:4759 - 1996	Approved drg./ mfg. drg.	✓	Do	P	V	V	
3.2	FAN ASSY. (Hub & Blades)	Overall Dimensions	Major	Visual	100%	20%		Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	IR	P	W	W	
		Static Balancing	Do	Measure	100%	20%		Do	Do	✓	Do	P	W	W	CHP
		Blade Track Variations & Tip Clearence.	Do	Measure	100%	20%		Do	Do	✓	Do	P	W	V	
3.3	Identification & Packing	Serial Numbering	Major	Visual	100%			Mfg. Std.	Mfg. Std.	✓		P	V		
		Packing	Do	Visual	100%			Mfg. drg.	Mfg. Drg.	✓		P	V		
3.4	HUB COVER (FRP)	Appearence	Major	Visual	100%			MFG. DRG.	MFG. DRG.	✓	IR	P	V		
		Dimensions	Major	Measurement	100%			MFG. DRG.	MFG. DRG.	✓	Do	P	V		
	Note1:- Only Qualified Welders / WPS shall be used Note2:- Fan Hub will be done at manufacturer's works, Blades & Fan Assy. At manufacturer's works Note 3:-Before sending the documents for approval, supplier to ensure that 'Reference documents' and 'Acceptance norms" do contain data required for the characteristics to be checked as indicated in QP.														

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION					BHEL	STANDARD
M: MANUFACTURER/SUB-CONTRACTOR **C:** MAIN SUPPLIER OF PACKAGE/SYSTEM, **N**: BHEL/CUSTOMER/CONSULTANT	**P:** PERFORM **W**: WITNESS **V:** VERIFICATION.		PREPARED BY	REVIEWED BY	APPROVED BY	APPROVED BY	APPROVED BY
			Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

	MANUFACTURING QUALITY PLAN **NAME OF CONTRACT: STANDARD** **NAME OF CONTRACTOR:STANDARD**	**ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062** **SUB-SYSTEM:COOLING TOWER** **DATE :** **PAGE 4… OF….4**

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION						BHEL	STANDARD
M: MANUFACTURER/SUB-CONTRACTOR **C:** MAIN SUPPLIER OF PACKAGE/SYSTEM, **N**: BHEL/CUSTOMER/CONSULTANT	**P:** PERFORM **W**: WITNESS **V:** VERIFICATION.		PREPARED BY	REVIEWED BY	APPROVED BY	APPROVED BY	APPROVED BY
			Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
BHEL		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 1 OF 3	SYSTEM **POWER CYCLE/ LP VALVES**	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0	**MATERIALS**											
1.1	BODY,BONNET, YOKE,WEDGE/DISC, SPINDLE, BODY SEAT, BACK SEAT, THRUST PLATE	1. PHYS,CHEM,PROPS	MA	PHYS,CHEM. TESTS	ONE/HEAT	APPD. DRG./ TECH.SPEC.	APPD. DRG./ TECH.SPEC.	TEST CERT.	3/2	2	1	CORRELATION REQD. FOR BODY BONNET, SPINDLE - FOR GREY C.I. ONLY PHYS. TEST.
		2. HEAT TREATMENT	MA	REVIEW OF H.T. CHART	100%	-DO-	-DO-	H.T. CHART	3/2	2	1	
		3. SURFACE DEFECTS	MA	VISUAL	100%	MSS-SP-55	MSS-SP-55	INSPN. REPORT	3/2	2	1	
1.2	BODY & BONNET FOR RATING 900 & ABOVE (ALSO FOR LOWER RATING IF REQUIRED IN SPEC.)	1. SURFACE DEFECTS	CR	PT/MT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	2,1	-	
		2. SUB-SURFACE DEFECTS	CR	RT/UT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	FILM REVIEW BY BHEL
1.3	ACTUATORS 1. ELECTRIC ACTUATORS	1. TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	MECH., ELEC. TESTS	100%	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	APPD. DRG./ DATA SHEET./ IS:9334	INSPN. REPORT	3	2,1	1 *	*BHEL TO WITNESS IF QTY. MORE THAN 10/ TYPE
		2. TRAVEL/STROKE	MA									
		3. TRAVEL TIME	MA									
		4. OPERATION OF LIMIT SWITCH	MA									
		5. MANUAL OPERATION THROUGH HAND WHEEL	MA									
		6. OPERATION TEST WITH POWER SUPPLY VARIATION ENERGISES TO OPEN/CLOSE	MA									
		7. IR,HV,IR	MA									
		8.DEGREE OF PROTECTION	MA	WATER, DUST TEST	1/TYPE	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	APPD. DRG./ DATA SHEET/ IS:9334	3RD PARTY TEST CERT.	3	-	2,1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 2 OF 3	SYSTEM **POWER CYCLE/ LP VALVES**	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
	2. PNEUMATIC ACTUATORS	1. LEAK TIGHTNESS	CR	PNEUMATIC TEST AT 1.2 X DESIGN	100%	APPD. DATA SHEET/MFG. STD.	NO LEAKAGE	INSPN. REPORT	3	2,1	1*	*BHEL TO WITNESS IF QTY. MORE THAN 10/ TYPE
		2. ACCURACY	CR	CALIBRATION	100%	-DO-	APPD. DATA SHEET/MFG. STD.	CALIBRATION REPORT	3	2,1	1*	
		3. SIMULATION (OPERATION, AIR TO OPEN/CLOSE)	CR	OPERATION AT RATED PRESSURE	100%	-DO-	-DO-	INSPN. REPORT	3	2,1	1*	
2.0	SS/STELLITE DEPOSIT ON DISC / BODY SEAT/BACK SEAT	1. SURFACE DEFECTS	CR	P.T	100%	ASTME:165 & TECH.SPEC.	ANSI B16.34 & TECH.SPEC.	-DO-	3/2	2,1	2,1	FOR 900 CLASS & ABOVE TO BE WITNESSED BY BHEL
3.O	IN-PROCESS INSPECTION											
3.1	MACHINING OF ALL COMPONENTS	1. DIMENSIONS, WORKMANSHIP AND FINISH	MA	MEAS.,VISUAL	100%	MFG.DRG.	MFG.DRG.	LOG BOOK	3/2	-	-	
3.2	WEDGE/DISC, BODY SEAT RING, BACK SEAT, SPINDLE, THRUST PLATE	1. HARDNESS	MA	TESTING	100%	APP.DRG.	APP. DRG./ ANSI B16.34	TEST CERT.	3/2	-	2,1	
3.3	SPINDLE, BODY SEAT RING, WEDGE/DISC, BACK SEAT	1. SURFACE DEFECTS	CR	P.T.	100%	ANSI B16.34 AND TECH. SPEC./	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	
3.4	WEDGE/DISC & SEAT RING, SPINDLE AND BACK SEAT	1. LAPPING	CR	BLUE MATCHING	100%	UNIFORM METAL TO METAL CONTACT		INSPN. REPORT	3/2	-	2,1	
4.0	ASSEMBLY	1. DIMENSIONS	MA	MEAS.	100%	APPD.DRG.	APPD.DRG.	-DO-	3/2	2,1	-	
		2. WEAR TRAVEL	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2,1	-	FOR GATE VALVES ONLY
		3. VALVE LIFT	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2,1	-	
5.0	TESTING											
5.1	BODY, SEAT, BACK SEAT	1. LEAK TIGHTNESS OF BODY	CR	HYDRAULIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2,1	-	
		2. LEAK TIGHTNESS OF BACK SEAT AND SEAT	CR	-DO-	100%	-DO	-DO-	-DO-	3/2	2.1	-	
		3. LEAK TIGHTNESS OF SEAT	CR	PNEUMATIC TEST	100%	-DO	-DO-	-DO-	3/2	2.1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 3 OF 3	SYSTEM **POWER CYCLE/ LP VALVES**	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
5.2	SEAT & BACK SEAT FOR MOTORISED/ PNEU. VALVES WITH ACTUATOR	1. LEAK TIGHTNESS OF SEAT	CR	HYDRUALIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2.1	-	
5.3	OPERATION AL TESTING											
	1. MANUALLY OPERATED VALVES	1. SMOOTH & FULL OPENING AND CLOSING	CR	MANUAL	100%	TECH. SPEC.	SMOOTH OPERATION OF VALVES & CLEAR BORE	INSPN. REPORT	3/2	2,1	-	
	2.MOTOR /PNEU OPERATED VALVES	1. ASCENDING& DESCENDING LIFT CHARACTERISTIC	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	APP. DRG./ TECH. SPEC./ IS:9334	INSPN. REPORT	3/2	2,1	-	
		2. LIMIT/TORQUE SWITCH SETTING FOR OPENING AND CLOSING TIME	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	TECH. SPEC./ APPD.DRG	INSP. REPORT	3/2	2,1	-	
6.0	COMPLETE VALVES	1. OVERALL DIMENSION	MA	MEAS	SAMPLE	APPD.DRG	APP.DRG.	-DO-	3/2	2,1	-	
7.0	END CONNECTION DETAILS	1. DIMENSIONS	MA	MEAS.	100%	APPD. DRG. / RELV.STD	APPD. DRG. / RELV.STD	-DO-	3/2	2,1	-	
		2. SURFACE DEFECTS FOR B.W. ENDS	CR	PT	100%	ASTME:165	NO DEFECTS	TEST CERT.	3/2	2	1	
8.0	FINAL INSPECTION	1. CLEANLINESS & COMPLETENESS	MA	VISUAL	100%	APPD. DRG./ TECH. SPEC.	APPD. DRG./ TECH. SPEC	INSPN. REPORT	3/2	-	2,1	
9.0	PAINTING	1. SURFACE PREPARATION	MI	VISUAL	100%	TECH. SPEC.	TECH. SPEC.	INSPN. REPORT	3/2	-	2,1	
		2. UNIFORMITY & THICKNESS	MI	MEASUREMENT	100%	-DO-	-DO-	-DO-	3/2	2	1	
10.0	PACKING	AS PER BHEL TECH. SPEC	MA	VISUAL	100%	AS PER BHEL TECH. SPEC.	AS PER BHEL TECH. SPEC	-DO-	3/2	-	2,1	

ABBREVIATIONS

CR = CRITICAL CHARACTERISTIC **P = PERFORMED BY** **W = WITNESSED BY** **V = VERIFIED BY**
MA =MAJOR CHARACTERISTIC **1 = PURCHASER (BHEL)** **2 = VENDOR** **3 = SUB VENDOR OF THE VENDOR**
MI = MINOR CHARACTERISTIC

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

QUALITY PLAN SHEET 1 OF 3	CUSTOMER :	PROJECT :	SPEC. NO
	BIDDER/VENDOR	QP NO.PE-QP-999-100-MO41 REV.00 DT. 31.03.99	VOLUME: II-B
	SYSTEM:	ITEM: PIPES & FITTINGS	SECTION D

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0.0	MATERIAL CONTROL											
1.1.0	PIPES (MILL MADE)	1. PHY., CHEM. PROPS, DIMENSIONS, SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE), LEAK TIGHTNESS	MA	PHY, CHEM . TESTS MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART HYDRO TEST	TECH. SPEC., IS:4711	APPD. DATA SHEET/ TECH. SPEC.	APPD. DATA SHEET/ TECH. SPEC.	MFR.TC/ LAB REPORT	3	-	2,1	SAMPLE IDENTIFICATION BY BHEL
1.2.0	FITTINGS	1. PHY, CHEM. PROP.,	MA	PHY., CHEM. TESTS	1/HEAT	-DO-	-DO-	-DO-	3/2	-	2,1	-DO-
		2. DIMNS., SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE)	MA	MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART	100%	-DO-	-DO-	-DO-	3/2	-	2,1	
1.3.0	PLATE FOR FLANGES, FABRICATED PIPING AND FORGINGS FOR FLANGES	1. PHY. CHEM. PROP.,	MA	PHY., CHEM. TESTS	1/CAST	-DO-	-DO-	-DO-	3	-	2,1	-DO-
		2. DIMNS., SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE)	MA	MEASUREMENTS, VISUAL EXAM VERI. OF HT CHART	100%	-DO-	-DO-	-DO-	3	-	2,1	
2.0.0	IN PROCESS CONTROL											
2.1.0	PIPES, FITTINGS, FLANGES - MACHINING, BENDING	1. DIMNS. INCLUDING THINNING, OVALITY, FINISH, WRINKLES ETC.	MA	MEASUREMENTS, VISUAL EXAM.	100%	MANUFAC-TURING DRG.	MANUFAC-TURING DRG.	I. R	3/2	-	2,1	
2.2.0	WELDING PROCEDURE SPECIFICATION	1. CORRECTNESS	MA	EXAM	100%	IS:7307/ ASME - IX	IS:7307/ ASME - IX	FORMAT OF IS:7307/ ASME - IX	3/2	-	2,1	
2.3.0	PROCEDURE QUALIFICATION AND WELDER'S QUALIFICATION	1. WELD SOUNDNESS	MA	PHY. TESTS	ASME IX IS:7310 IS:7307	IS:7310/ ASME - IX	IS:7310/ ASME - IX	FORMAT OF IS:7310/ ASME - IX	3/2	2,1	-	
2.4.0	WELD FIT-UPS	1. DIMNS.,	MA	MEASUREMENT,	100 %	W.P.S,	W.P.S,	I.R	3/2	2	1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

QUALITY PLAN SHEET 2 OF 3	CUSTOMER :	PROJECT :		SPEC. NO	
	BIDDER/VENDOR	QP NO.PE-QP-999-100-MO41	REV.00 DT. 31.03.99	VOLUME: II-B	
	SYSTEM:	ITEM: PIPES & FITTINGS		SECTION D	

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
		ALIGNMENT, ORIENTATION		VISUAL		APPD. DRGS.	APPD. DRGS.					
2.5.0	**WELDS**											
	A) BUTT WELDS WITH JOINT EFFICIENCY OF 1.0 & 0.9											
	I) ROOT RUN	I) WELD DEFECTS	MA	PENETRANT TEST	100%	IS:3658/ ASTM E 165	ASME VIII DIV.I ASME B 31.1	INSPN. REPORT	3/2	2	1	
	ii) FINAL RUN	I) WELD DEFECTS	MA	-DO-	100%	-DO-	-DO-	-DO-	3/2	2/1	-	
				RADIOGRAPHY TEST	100% FOR JT. EFF. 1.0 & 10% FOR JT. EFF. 0.9	ASME B 31.1	ASME B 31.1	-DO-	3/2	-	2/1	FILMS TO BE SHOWN TO BHEL FOR APPROVAL
	B) OTHER BUTT WELDS WITH JOINT EFF. LESS THAN 0.9	1. WELD DEFECTS (FOR ROOT RUN & FINAL RUN)	MA	PENETRANT TEST	100%	IS:3658/ ASTM E 165	ASME B 31.1	INSPN. REPORT	3/2	2,1	-	
3.0.0	COMPLETE PIPE WORK & PIPES INCLUDING GALVANIZED/ RUBBER LINED PIPING (BEFORE GALVANIZING/ RUBBER LINING)	1. WORKMANSHIP AND FINISH, DIMNS., ORIENTATION, LEAK TIGHTNESS	CR	MEAS, VISUAL, HYDRO TEST AT 1.5 X DESIGN PRESS.	100%	APPD. DRGS.	APPD. DRGS., NO LEAKAGE	I.R.	3/2	2,1	-	
3.1.0	COMPLETE PIPE WORK (DULY GALVANIZED AS APPLICABLE)	1. FREEDOM FROM SURFACE DEFECTS	MA	VISUAL	100%	IS:4736/ IS 2629 & TECH. SPECN.	IS:4736/ IS 2629 & TECH. SPECN.	INSPN. REPORT	3/2	2,1	-	
		2. UNIFORMITY OF COATING	MA	DIP TEST	SAMPLING AS PER IS	IS 2633 & TECH. SPECN.	IS 2633 & TECH. SPECN.	-DO-	3/2	2,1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

QUALITY PLAN SHEET 3 OF 3	CUSTOMER :	PROJECT :		SPEC. NO
	BIDDER/VENDOR	QP NO.PE-QP-999-100-MO41	REV.00 DT. 31.03.99	VOLUME: II-B
	SYSTEM:	ITEM: PIPES & FITTINGS		SECTION D

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
		3. MASS OF ZINC COATING	MA	STRIP TEST	-DO-	IS 4736/ IS 6745 & TECH. SPECN.	IS 4736 & TECH. SPECN.	-DO-	3/2	2,1	-	
		5. ADHESION	MA	ADHESION TEST	-DO-	IS-2629/ IS 4736 & TECH. SPECN.	IS-2629/ IS 4736 & TECH. SPECN.	-DO-	3/2	2,1	-	
3.2.0	COMPLETE PIPE WORK (RUBBER LINING AS APPLICABLE)	---------- AS PER QUALITY PLAN FOR RUBBER LINING----------										
4.0.0	PAINTING AND PACKING	1. SURFACE PREPARATION, DFT, NO. OF COATS, SOUNDNESS OF PACKING, MARKING ETC.	MA	VISUAL EXAM, MEASUREMENT	100%	APPD. PROCEDURE	APPD. PROCEDURE	I.R, MFRS CHECK LIST	3/2	-	2,1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

BHARAT HEAVY ELECTRICALS LIMITED

MANUFACTURERS NAME & ADD

MANUFACTURING QUALITY PLAN

ITEM : Sump pumps/Submersible Pump | QP NO: PE-QP-999-100-N005 | REV-02 | DATE: 14.06.16 | PAGE 1 OF 2

PROJECT :
END CUSTOMER:
CONTRACT No.:
MAIN SUPPLIER: BHEL, Noida

SR. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	D*	AGENCY M	AGENCY B	AGENCY C	REMARKS
1	2	3	4	5	6	7	8	9	D*	10			
1.0	**Raw Material and Bought out Control**												
1.1a	Pump Casing	Physical Properties - Tensile Strength & Hardness / Chemical Composition	CR	Physical / Chemical Analysis	1 / Heat / Batch	Appd. C S Drg.	Approved drawing/Data sheet	Lab Report	√	P	V	V	
1.1b	Impeller	Physical Properties - Tensile Strength, Yield Strength & Elongation Chemical Composition	CR	Physical / Chemical Analysis	1 / Heat / Batch	Appd. C S Drg.	Approved drawing/Data sheet	Lab Report	√	P	V	V	
1.2	Heat treatment of Stainless Steel Castings	Heat Cycle	MA	Verification of HT chart	All Batches	Appd. C S Drg.	Approved drawing/Data sheet	Corelated HT charts	√	P	V	V	
1.3	Bars / forgings for pump and motor shafts	Physical/Chemical Properties	CR	Physical / Chemical Analysis	1 / Bar	Appd. C S Drg.	Approved drawing/Data sheet	Mill TC or lab report	√	P	V	V	
		Dimensions	MA	Measurment	100%	Manufacturers Drawing	Manufacturers Drawing	IR		P	V	V	
		Internal defects for 40 mm and above diameter	CR	UT	100%	ASTM A-388	Refer Note 1	IR	√	P	V	V	
1.4	Cable Type: PVC insulated, multicore, copper conductor	Routine TC and acceptance TC as per IS 694/Is1554, Length and size	MA	Measurement	100%	Approved Datasheet / IS 694/IS1554	Approved Datasheet / IS 694/IS1555	IR & TC	√	P	V	V	Compliance cert. To be submitted by Vendor
1.5	Bearings	Make, Bearing No., Surface finish	MA	Visual Examination	100%	Manufacturers Std	Manufacturers Std	IR		P	V		
2.0	**Inprocess Control**												
2.1	All Components	Visual Defects	MA	Visual	100%	Manufacturers Drawing	No harmful defects	Log book / IR		P	V	V	
		Dimensions	MA	Measurement	100%	Manufacturers Drawing	Manufacturers Drawing	Log book / IR		P	V	V	
2.2	Pump discharge casing	Leak tightness	CR	Hydro test (Duration 30 minutes min.)	100%	Refer Remark.	No leakage	IR	√	P	W	V	Test Pr.2 x duty pts. Pr. OR 1.5 x shut off whichever is higher
	Motor Housing	Leak tightness	CR	Air test (Duration 30 Minutes min)	100%	Air test at 0.5 kg/cm2 (guage pressure)	No leakage	IR	√	P	V	V	
2.3	Casing & Impeller (machined surfaces)	Surface Defects	CR	DPT	100%	ASTME:165	No Surface defect	IR	√	P	V	V	On machined surface only
2.4	Impeller	Static & Dynamic residual unbalance	CR	Static, Dynamic balancing	100%	ISO : 1940	ISO 1940 Gr. 6.3	IR	√	P	V	V	
2.5	Pump Motor Shaft	Internal Defects	CR	DPT	100%	ASTME:388	ASTME:388, Refer note 1	IR	√	P	V	V	On machined surface only
		Surface Defects	CR	DPT	100%	ASTME:165	No Surface defect	IR	√	P	V	V	On machined surface only
3.0	**Sub-Assembly, Assembly Control**												
3.1	Pump, Motor, Rotor	Eccentricity	MA	Measurement	100%	Manufacturers Drawing	Manufacturers Drawing	Log book / IR		P	V	V	
3.2	Pump and Motor assembly	Completeness, correctness	MA	Visual Examination	100%	Manufacturers Drawing	Manufacturers Drawing	IR		P	V	V	

LEGEND: RECORDS IDENTIFIED WITH "TICK" ( ) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION

** **M:** MANUFACTURER/SUB CONTRACTOR
B: BHEL, **C**:CUSTOMER (END USER)
P : PERFORM **W:** WITNESS **V :** VERIFICATION AS APPROPRIATE

BHEL DOC No.:PE : V8 - XXX - 100-N005

MANUFACTURER/ SUBCONTRACTOR	BHEL / CONTRACTOR	NAME AND SIGN OF APPROVING AUTHORITY AND SEAL
SIGNATURE		

ENGG DIV / QA & I

	BHARAT HEAVY ELECTRICALS LIMITED	MANUFACTURERS NAME & ADD		MANUFACTURING QUALITY PLAN									
				ITEM :	Sump Pump/Submersible Pump		QP NO: PE-QP-999-100-N005			PROJECT :			
							REV-02			END CUSTOMER:			
							DATE: 14.06.16			CONTRACT No.:			
							PAGE 2 OF 2			MAIN SUPPLIER:			BHEL, Noida

SR. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	D*	AGENCY M	AGENCY B	AGENCY C	REMARKS
1	2	3	4	5	6	7	8	9	D*	10			
4.0	**Final Inspection, Test, Packing, Despatch Control**												
4.1	Pump set (Pump+ Motor)	Q Vs Head, Q Vs Power Q Vs Efficiency	CR	Performance test	100%	Tech. Spec., Appd. Data Sheet, Appd. Curves, HIS, Test procedure	Tech. Spec., Appd. Data Sheet, Appd. Curves, HIS	Performance test record, Plotted Curves	Ö	P	W	V	
4.2	Routine Test on motor	HV, IR, Locked Rotor, No Load, Make type, Rating	CR	Electrical tests	100%	IS 325	Approved Data Sheet	IR	Ö	P	V	V	Widing resistance ** Degree of protection shall be IP 68, HV at 2.5 KV AC for 1 Minute.
4.3	Strip down after Performance test	Undue wer, tear and breakages	CR	Visual examination of Casing & Impeller after stripping	100%	Undue wer, tear and breakages	No undue wear, tear and breakages	IR	Ö	P	W	V	Witnessing one no. of each type
4.4	Complete Pump	Completeness, Correctness, Workmanship and finish, overall dimensions	MA	Visual examination	100%	Approved G.A. drawing	Approved G.A. drawing	IR	Ö	P	V	V	Compliance report for accessories will be submitted.
4.5	Completion of all stages	Completion	MA	Verification of IR's TC's	100%	Approved QP	Approved QP	IR	Ö	P	V	V	
4.6	Painting	Surface Preparation		Visual examination	100%	Approved data sheet/Manufacurer standard		IR		P	V	V	Compliance report by Manufacurer
		Adhesion, Uniformity and thickness		Visual Measurement	100%	As per painting schedule/Manufacurer standard		IR		P	W	V	Compliance report by Manufacurer
4.7	Wooden Packing	Soundness, Aesthetic		Visual	100%	As per packing procedure		IR		P			Compliance report by Manufacurer

Note :

1. For accessories and bought out items, Manufacurer will submit Compliance for review.

2. For UT test on shaft, defect echo < 20 % full screen height when back wall echo set @ 100 % screen height. Reduction in back wall echo to be <20%.
Defect height > 20 % of FSH is not acceptable, also loss in backwall echo>20 % not acceptable.

3. IP 68 protection certificate for test conducted on similar motor shall be submitted for review

4. Compliance for provision of thermic switch for over heating protection of winding, reverse rotation protection device shall be submitted by Manufacurer

5. For control panel separate QAP is applicable.

6. Before sending the documents for approval, supplier to ensure that "Reference documents" & "acceptance Norms" does contain data required for the Characteristic to be checked" as indicated in QP.

			LEGEND: RECORDS IDENTIFIED WITH "NCK" ( ) SHALL BE	BHEL DOC No.:PE : V8 - XXX - 100-N005
			ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION	
		BHEL	** **M:** MANUFACTURER/SUB CONTRACTOR	NAME AND SIGN OF APPROVING AUTHORITY AND SEAL
	MANUFACTURER/	CONTRACTOR	**B**: BHEL, **C:**CUSTOMER (END USER)	
	SUBCONTRACTOR		**P :** PERFORM **W:** WITNESS **V :** VERIFICATION AS APPROPRIATE	
	SIGNATURE			

ENGG DIV / QA & I

	MANUFACTURERS NAME & ADDRESS	STANDARD QUALITY PLAN		PROJECT
BHEL	(AS PER BHEL APPROVED VENDOR LIST)	ITEM: Chain Pulley Block With Trolley	QP NO REV 0 DATE 20.02.2001 PAGE 1 of 3	PACKAGE PROJECT No CONTRACTOR

Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9		** 10			11
1	**RAW MATERIAL & B/OUT ITEMS:**												
1.1	HOOKS	DIMENSIONS	MA	MEASUREMENT		IS 8610 GR M/P	IS 8610 GR M/P	T.C.		P	-	-	
		CHEMICAL COMPOSITION	MI	LAB ANALYSER									
		IDENTIFICATION & CORELATION WITH TC	MA	VERIFICATION		DRAWING	DRAWING & SPECIFCATION						
1.2	LOAD CHAIN	DIMENSIONS		MEASUREMENT	100%	IS 6216	IS 6216	MFR'S TC		P	-	-	
		BREAKING STRENGTH		TENSILE TEST									
1.3	RAW MATL FOR GEAR/RATCHET PAWL/RATCHET WHEEL	CHEMICAL COMPOSITION	MA	LAB ANALYSIS	ONE SAMPLE PER LOT	SPECS AS PER APPD. DRG.	RELEVANT STANDARD	TC		P			
1.4	LOAD CHAIN WHEELS	TENSILE STRENGTH	MA	TENSILE TEST	ONE SAMPLE PER LOT	SPECS AS PER APPD. DRG.	RELEVANT STANDARD	TC		P			

LEGNDS

* RECORDS INDENTIFIED WITH 'TICK'( ) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

** M: MANUFACTURER/SUBCONTRACTOR
C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL)
N: CUSTOMER
INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N"

MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	REVIEWED BY	
SIGNATURE			NAME & SIGN OF APPROVING AUTHORITY &SEAL

	MANUFACTURERS NAME & ADDRESS	**STANDARD QUALITY PLAN**		PROJECT
	(AS PER BHEL APPROVED VENDOR LIST)	ITEM: Chain Pulley Block With Trolley	QP NO	PACKAGE
			REV 0	PROJECT No
			DATE 20.02.2001	CONTRACTOR
			PAGE 2 of 3	

Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9		** 10			11
2	PROCESS												
2.1	HOOKS	PROOF LOAD	MA	LOAD TEST	100%	IS 8610	IS 8610	IR		P	W		
		DPT AFTER PROOF LOAD	MA		100%	ASTM 709	ASTM 709	IR		P	W		
2.2	RACHET PAWL/RACHET WHEEL	HARDNESS	MA	HARDNESS TESTER	100%	IS :1832	IS : 3832	IR		P	W		
		SURFACE CRACKES	MA	DPT	100%	ASTME				P	W		
2.3	LOAD CHAINS	PROOF - LOAD	MA	LOAD TEST	100%	IS : 6216	IS:6216	MFR'S		P			
3	FINAL INSPECTION												
3.1	COMPLETE ASSEMBLY	PROOF LOAD TEST	CR	LOAD TEST	100%	IS: 3832	IS: 3832	IR		P	W	W	
		OPERATIONAL EFFORT	MA	LOAD TEST	RANDOM	IS: 3832	IS: 3832	IR		P	W	W	
		HEIGHT OF LIFT	MA	MEASUREMENT	100%	IS: 3832	IS: 3832	IR		P	W	W	
		SWIVELLING OF HOOK	MA	VISUAL	100%	IS: 3832	IS: 3832	IR		P	W	W	

LEGNDS

* RECORDS INDENTIFIED WITH 'TICK'( ) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

** M: MANUFACTURER/SUBCONTRACTOR

C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL)

N: CUSTOMER

INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N"

MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	REVIEWED BY	
SIGNATURE			NAME & SIGN OF APPROVING AUTHORITY &SEAL

	MANUFACTURERS NAME & ADDRESS	**STANDARD QUALITY PLAN**		PROJECT
	(AS PER BHEL APPROVED VENDOR LIST)	ITEM: Chain Pulley Block With Trolley	QP NO	PACKAGE
			REV 0	PROJECT No
			DATE 20.02.2001	CONTRACTOR
			PAGE 3 of 3	

Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9		** 10			11
3.2	PAINTING	CLEANED	MA	VISUAL	AT RANDOM	SPEC.	PE	IR		P	-	-	
		SHADE OF PAINT GOLDEN YELLOW	MA	VISUAL	AT RANDOM	SPEC.	PE	IR		P	W	W	
3.3	NAME PLATE	VERIFICATION	MI	VISUAL	100%	PR	PR	IR		P	W	-	
3.4	PACKING	VERIFICATION	MI	VISUAL	100%	PR	PR	IR		P	W	-	

LEGNDS

* RECORDS INDENTIFIED WITH 'TICK'( ) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

** M: MANUFACTURER/SUBCONTRACTOR

C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N: INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" NTPC SHALL IDENTIFY IN COLUMN"N"

MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY &SEAL
SIGNATURE			

STANDARD QUALITY PLAN

PROJECT :
VENDOR :

SYSTEM :
ITEM : BUTERFLY VALVES

S N	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CAT. EGO-RY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
1.0	RAW MATERIAL BOUGHT-OUT CONTROL											
1.1	BODY & SHAFT SEAT RING	1.CHEM COMPOSITION & PHYS. PROPS	MA	CHEM. & PHYS TESTS	ONE/HEAT BATCH	TECH SPEC APPD DRG	TECH SPEC / APPD DRG.	LAB REPORT / INSPN REPORT	3/2	-	2.1	CORRELATION NOT REQUIRED FOR GREY C.I. FOR OTHER POURING WITNESS BY BHEL
		2.INTERNAL DEFECTS OF SHAFT DIA ≥ 50MM	CR	UT	100%	ASTM A388 & XE 100%		INSPN. REPORT	3/2	2.1	-	MATERIAL IDENTIFICATION OF SHAFTS BY BHEL NOTE. COMPLIANCE TO CHEMS & GI CORRELATION & IDENTIFICATION FOR SS
		3.CASTING DEFECTS/ FORGING DEFECT	MA	1. VISUAL 2. MPI	100% 100%	MSSSP65 TECH. SPEC. APPD DATA SHEET	MSSSP55 TECH. SPEC / APPD DATA SHEET	-DO-	3/2	-	2.1	
1.2	DISC & SHAFT SEAL	1. VISUAL INSPECTION 2. DIMENSIONS 3. HARDNESS 4. O ZONE RESISTANCE 5. AGEING TEST	MA MA MA MA MA	VISUAL MEAS MEAS TESTING TESTING	100% 100% 100% 1/BATCH -DO-	TECH SPEC -DO- -DO- -DO-, ASTM D1149 IS 3400	TECH. SPEC -DO- -DO- -DO-, RELV. STD. -DO-	LOG BOOK -DO- TEST CERT. -DO- -DO-	3/2 3/2 3/2 3/2 3/2	- - - - -	- - - - -	COMPLIANCE TO
1.3	COUNTER FLANGES	1. CHEM., PHYS. PROPERTIES	MA	CHEM. PHYS. TEST	1/HEAT	APPD. DRG. /DATA SHEET	APPD. DRG. /DATA SHEET	LAB. REPORT, INSPN. REPORT	3/2	-	-	COMPLIANCE TO FOR MATERIAL IDENTIFICATION BY BHEL

		PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY
O.P NO	PEM/MSE/SQP/03	PEM	CQS & PEM	PEM	VENDOR
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		SIGNATURE			SIGN.
PAGE NO	1 OF 7	DATE			DATE

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT :
VENDOR

SYSTEM :
ITEM BUTERFLY VALVES

S. NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CAT-EGO-RY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
		2 DIMENSION	MA	MEASURE-MENT	100%	-DO-	-DO-	INSPN. REPORT	3/2	2 1	-	
		3. INTERNAL DEFECTS FOR THICKNESS 50MM AND ABOVE	CR	UT	100%	ASTM A435	ASTM A435	INSPN. REPORT	3/2	2 1	-	
		4 HEAT TREATMENT		SR/M.T. CHART	100%	STANDARD PRACTICE	STANDARD PRACTICE	CORRELATED SR/M.T. CHART	3/2	-	-	
4	FASTENERS (APPD. MAKE	1 VERIFICATION OF MAKE GRADE	MI	VISUAL	100%	TECH. SPEC /DATA SHEET	TECH. SPEC DATA SHEET	INSPN. REPORT	3/2	2	1	
5	OPERATORS (GEAR BOX GE	COMPOSITION	MA	CHEM ANALYSIS	ONE/BATCH	AS PER MATERIAL SPEC	AS PER MATERIAL SPEC	TC'C'	3	3	2/1	
5 1	GEAR / PINION SHAFT	HARDNESS	MA	MEAS	SAMPLING	AS PER APPD DRG /MATL SPEC	AS PER APPD DRG /MATL SPEC	TC'C'	3	3	2/1	
		DIMENSION	MA	-DO-	-DO-	-DO-	-DO-	REPORT	3	3	2/1	UT ON GEAR BLANKS
		NDT	MA	UT/MPI	100%	-DO-	-DO-	TC'C'	3	3/2	2/1	UT ON SHAFTS & SOLID DIA
5 2	HYDROSTATIC TEST OF GEAR BOX AT 1.5 TIMES RATED TORQUE	TORQUE TRANSMITTING	MA	TESTING	ONE/TYPE	AWWA C504 STD 87	AWWA C504 STD 87	TC'C' CHP	3	3/2	2/1	MPI OR LPI ON GEAR & SHAFT AFTER MACHINING
												***NO DAMAGE TO TEFACE OF GEAR
5 3	ELECTRICAL ACTUATORS	1 TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	MECH./ELEC. TESTS	100%	TECH. SPEC /APPD DRG /DATA SHEET/ IS 9334	APPD DRG /DATA SHEET/IS 9334	INSPN. REPORT	3	2 1	-	BHEL TO WITNESS * PER TYPE IF QTY IS MORE THAN 10/TYPE

			PREPARED BY	REVIEWED BY	APPROVED BY		ACCEPTED BY
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		SIGNATURE				SIGN.	
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NO	CHECK / OPERATION	CHARACTERISTICS CHECKED	CAT-EGO-RY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9		10		
		2 TRAVEL/STROKE	MA									
		3 TRAVEL TIME	MA									
		4 OPERATION OF LIMIT SWITCH										
		5 MANUAL OPERATION THROUGH HAND WHEEL	MA									
		6 OPERATION TEST WITH POWER SUPPLY VARIATION, ENERGISE TO OPEN/CLOSE, CURRENT DRAWN	MA									
		7 IR, HV, IR	MA									
		8 DEGREE OF PROTECTION	MA	WATER DUST TEST	1/TYPE	-DO-	-DO-	3rd PARTY TEST CERT	3	-	2.1	
6	HYD. [illegible]	1 CHEM & PHYS. PROPS	MA	CHEM. PHYS TESTS	1/HEAT/ BATCH	APPD. DRG. /DATA SHEET	APPD. DRG. /DATA SHEET	TEST CERT	3/2	-	2.1	
		2. HARDNESS	MA	MEAS	100%	-DO-	-DO-	-DO-	3/2	-	2.1	
		3. DIMENSIONS	MA	MEAS.	100%	MFG. DRG	MFG. DRG.	LOG BOOK	3/2	-	-	
		4. LEAK TIGHTNESS	MA	HYDRO TEST	100%	APPD. DATA SHEET	NO LEAKAGE	INSPN. REPORT	3/2	2.1	-	
	[illegible]	1. CHEM., PHYS. PROPS.	MA	CHEM., PHYS. TESTS	1/HEAT	APPD. DATA SHEET	APPD. DATA SHEET	TEST CERT.	3/2	2	1.1	
		2. DIMENSION	MA	MEASURE-MENT	100%	MFG. DRG.	MFG. DRG.	LOG SHEET	3/2	-	-	

			PREPARED BY	REVIEWED BY	APPROVED BY		ACCEPTED BY
Q.P. NO	PEM/MSE/SQP/03		PEM	CQS & PEM	PEM		VENDOR
REV. NO DATE.	00/8-10-97	NAME				NAME	
		SIGNATURE				SIGN	
PAGE NO	3 OF 7	DATE				DATE	

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

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PROJECT :
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S NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
	C) PIS[illegible] ROD	1. C[illegible]EM PHYS PROPS	MA	CHEM PHYS TESTS	1/BATCH	MATL SPEC/APPD. DRG.	MATL SPEC/APPD. DRG	LOG BOOK	3/2	2	1	
		2. D[illegible]ENSIONS	MA	MEAS.	100%	MFG DRG.	MFG DRG	-DO-	3/2	2	1	
		3. H[illegible]RDNESS	MA	MEAS	100%	-DO-	-DO-	TEST CERT	3/2	2	1	
2.0	IN-PROCESS CONTROL											
2.1	BODY & DISC	1. S[illegible]RFACE DEFECTS	MA	PT	100%	ASTME-165	NO DEFECTS	INSPN REPORT	3/2	2	1	
		2. D[illegible]ENSIONS	MA	MEAS	100%	MFG DRG	APPD DRG	LOG BOOK	3/2			
		3. L[illegible] TIGHTNESS OF BO[illegible]	MA	HYDRO TEST	100%	TECH. SPEC /APPD DRG /DATA SHEET	NO LEAKAGE	INSPN REPORT	3/2		2,1	
2.2	SHAFT	1. D[illegible]ENSIONS	MA	MEAS	100%	MFG DRG	APPD DRG	LOG BOOK	3/2			
		2. S[illegible]FACE DEFECTS [illegible]	MA	PT	100%	ASTME-165	NO SURFACE DEFECTS	INSPN REPORT	3/2		2 1	
2.3	SEAT RING	1. DI[illegible]ENSIONS	MA	MEAS	100%	MFG DRG	APPD DRG	LOG BOOK	3/2			
		2. B[illegible]D STRENGTH IN CA[illegible]E OF RUBBER SE[illegible]	MA	PEEL STRENGTH	ONE/BATCH	ASTMD 429	ASTMD429	TEST CERT	3/2		2,1	
		3. HA[illegible]DNESS	MA	MEAS	100%	MFG DRG	MFG DRG	-DO-	3/2	2	1	

			PREPARED BY PEM	REVIEWED BY CQS & PEM	APPROVED BY PEM.	ACCEPTED BY VENDOR	
Q.P. NO.	PEM/MSE/SOP/03						
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		SIGNATURE				SIGN.	
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BHARAT HEAVY ELECTRICALS LIMITED
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PROJECT :
VENDOR :

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ITEM : BUTERFLY VALVES

S NO	COMPONENT OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
		4 SURFACE DEFECTS	MA	PT	100%	ASTME 165	NO SURFACE DEFECTS	-DO-	3/2	2	1	
			MA	PHYS TESTS	100%	ASME IX	ASME IX	FORMATS OF ASME IX	3/2	2.1	1	
2.4	WELDED FLANGES/COUNTER FLANGES											
		1 FIT UP	MA	MEAS, TEMPLATE, VISUAL	100%	MFG DRG	MFG DRG	LOG BOOK	3/2		2.1	FOR FABRICATED FLANGES ONLY FILMS TO BE SHOWN TO BHEL
		2 INTERNAL DEFECTS OF WELDMENTS	CR	RT/UT	100%	ASME VIII DIV. I	ASME VIII DIV I	RADIO GRAPH REPORT FILMS	3		2.1	
2.4.1	WELDING PROCEDURE SPECIFICATION	CORRECTNESS	MA	EXAM	100%	ASME SEC IX	ASME SEC IX	QW 482 OF ASME SEC IX	3/2		2.1	
2.4.2	WELDING PROCEDURE QUALIFICATION	WELD SOUNDNESS	MA	VISUAL, PHYS. TESTS RT (AS APPLICABLE)	100%	ASME SEC IX	ASME SEC IX	QW 483 OF ASME IX	3/2	2.1		WELDING PROCEDURE APPROVEL BY BHEL AS WELL AS 3RD PARTY (LLOYDS, BVQI OR EQ.)
2.4.3	WELDER PERFORMANCE QUALIFICATION	WELL SOUNDNESS	MA	-DO	100%	ASME SEC. IX	ASME SEC. IX	QW 484 OF ASME	3/2	2.1		

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PAGE NO.	5 OF 7	NAME				NAME
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		DATE				DATE

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM :
ITEM : BUTERFLY VALVES

S NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
2.4.4	WELD FIT-UPS	1 DIMENSION/ALIGNMENT	MA	MEAS, VISUAL EXAM	100%	WPS, MFG. DRAWING	WPS, MFG. DRAWING	IR/LOG BOOK	3/2	-	-	
2.4.5	ROOT RUNS	1 SURFACE DEFECTS	MA	PENETRANT TEST	100%	ASTME 165	NO SURFACE DEFFECT	-DO-	3/2	-	2	
2.4.6	WELDMENTS	1 SURFACE DEFECTS	MA	-DO-	100%	ASTME 165	ASME-VIII, DIV. I,	INSPN REPORT	3/2	2,1	-	
2.4.7	BUTT WELDS	INTERNAL DEFECT	MA	UT/RT	100%			IR	3/2	-	2,1	WITNESSING OF U T
2.4.8	SR WELDING	SR	-	SR	100%	ASME SEC. V	ASME SEC VIII, DIV I	IR	3,2	-	2,1	
3.0	FINAL ASSEMBLY											
3.1	VERIFICATION OF ALL PREVIOUS TEST AND DOCUMENTS	VERIFICATION OF RECORDS	MA	-DO-	100%	TECH. SPEC.	TECH. SPEC		2	-	1	
3.2	TESTS (HYDRAULIC)	1 BODY TEST 2 DISC STRENGTH 3 SEAT LEAKAGE 4 PERFORMANCE TEST	MA MA MA MA	HYDRO TEST HYDRO TEST -DO- PERFORMANCE	100% 1/TYPE 100% 3 TIMES UNDER NO LOAD/FLOW COND. BOTH MANUAL & THROUGH OPERATORS	TECH. SPEC /REL. STD -DO- -DO- -DO-	TECH /SPEC / REL. STD -DO- -DO- -DO-	TEST CERT. -DO- -DO- -DO-	3 2 3/2 3/2 3 2	2,1 2,1 2,1 2,1	- - - -	

			PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY
			PEM	CQS & PEM	PEM	VENDOR
O.P NO	PEM/MSE/SQP/03	NAME				NAME
REV NO/DATE	00/8-10-97	SIGNATURE				SIGN.
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BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM
ITEM BUTERFLY VALVES

	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
2		3	4	5	6	7	8	9				
		5 TESTING OF ACCESSORIES	MA	TESTING	100%	TECH SPEC /REL STD	TECH SPEC /REL STD	TC	3.2	2		
		6 PROOF OF DESIGN TEST	MA	TESTING	1 TYPE	DO.	DO.	TC	3.2	2		NOTE: IF CYCLE LIFE TEST ALREADY CONDUCTED ON SIMILAR SIZE, RANGE & VALVE REPORT SHALL BE SUBMITTED
4	SHIPPING RELEASE											
5	FINAL INSPECTION	1 OVERALL DIMENSIONAL	MA	MEASUREMENT	100%	APPD DRG	APPD DRG		3.2	2		
		2 DOCUMENTATION VIEW	MA	REVIEW	100%	TECH SPEC APPD DRG	TECH SPEC APPD DRG		2.1			
		3 CLEANLINESS	MA	VISUAL	100%	DO.	DO.		3.2	2		
		4 NAME PLATE DETAILS	MA	VISUAL	100%	DO	DO		2.1			
		5 STAMPING	MA	STAMPING	100%	DO.	DO.		2			
6	PAINTING	1 SURFACE PREP	MI	VISUAL, MEAS.	100%	TECH SPEC	TECH SPEC	INSPN REPORT	3.2		2.1	
		2 UNIFORMITY & THICKNESS	MI	DO.	100%	DO.	DO.	DO.	3.2		1	

			PREPARED BY	REVIEWED BY	APPROVED BY		ACCEPTED BY
			PEM	CQS & PEM	PEM		VENDOR
Q.P. NO.	PEM/MSE/SQP/03	NAME				NAME	
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SUB-SECTION - IIB

STANDARD TECHNICAL SPECIFICATION (ELECTRICAL)

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE OF SUPPLY
2.00.00	CODES & STANDARDS
3.00.00	DESIGN CRITERIA
4.00.00	SPECIFIC REQUIREMENTS
5.00.00	TESTS
6.00.00	DRAWINGS DATA & MANUALS

ATTACHMENTS

ANNEXURE-A	RATINGS AND REQUIREMENTS - H.V POWER CABLES (11KV & 3.3 KV)
ANNEXURE-B	RATINGS AND REQUIREMENTS - L.V POWER CABLES
ANNEXURE-C	RATINGS AND REQUIREMENTS - CONTROL CABLES
ANNEXURE-D	RATINGS AND REQUIREMENTS - 1.1KV FS POWER & CONTROL CABLE
ANNEXURE-E	RATINGS AND REQUIREMENTS - FLEXIBLE TRAILING CABLES
ANNEXURE-F	CABLE SIZES

SECTION-IV

TECHNICAL SPECIFICATION
FOR
CABLES

1.00.00 **SCOPE OF SUPPLY**

1.01.00 Power and Control Cables shall cover the requirement of entire Plant including the switchyard.

Other cables including special cables, if any, which may be necessary as per proven engineering practice for satisfactory and trouble free operation of the entire cable system of the plant shall also be within the scope of supply. These shall include all such cables for electrical integral with mechanical equipment systems and subsystems.

1.02.00 Cable shall be furnished in accordance with this specification and the following annexures :

a)	11kV & 3.3 kV Power cables	:	Annexure - A
b)	1100V Power Cables	:	Annexure – B
c)	Control Cables	:	Annexure – C
d)	Fire Survival Cables	:	Annexure – D
e)	Flexible Trailing cable	:	Annexure – E

1.03.00 All relevant drawings, data and instruction manuals

2.00.00 **CODES & STANDARDS**

2.01.00 All cable and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

2.02.00 Cable and material conforming to any other standard which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 **DESIGN CRITERIA**

3.01.00 Cables will be generally laid on ladder type trays or drawn through rigid PVC/GI /HDPE pipe/conduits. Cable tunnels shall be avoided as far as possible, except at locations where overhead trays are not possible, with prior approval of the Owner.

3.02.00 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification which one is more stringent.

3.03.00 The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

3.04.00 Armouring shall be single round wire of galvanized steel for multicore cables and aluminum for single core cable for power and control cables. For fire survival control cable, the armouring over inner sheath shall consist of single layer of wire / round galvanised steel wire as per IS 3975 amended upto date. For Fire survival power cable, Single core cables to be used in A.C. system, the armouring over inner sheath shall consist of single layer of round copper wire, for multi-core cables to be used in A.C. system and single core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanised steel wire.

3.05.00 The outer sheath shall have flame retardant low smoke halogen evolution (FRLSH) characteristics or fire survival characteristics as applicable and shall meet the requirements of additional tests specified for the purpose.

3.06.00 Core identification for multicore cable shall be provided by colour coding.

3.07.00 HT cables shall be manufactured by triple extrusion dry cured (CCV) process using pressurized nitrogen.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 General Description

All Cables shall be furnished in strict compliance with ratings and requirements and sizes as given in Annexures to this Specification.

4.02.00 Drum Length and Tolerance

The cables shall be supplied in non-returnable packing steel drum for 11 kV & 3.3 kV power cables, wooden drums for 1100V power and control cables, each containing minimum 500 meters length of larger sizes of cable unless specifically asked for. For smaller sizes of cables, each drum shall contain 1000 meters length of cable. Allowable tolerance on individual drum length is $\pm$5%.

4.03.00 Non-Standard Length

Non-standard lengths upto 5% of the total ordered quantity may be accepted. However the Contractor will be required to obtain approval before packing the Cables on drums. Non-standard lengths shall not be less than 100 metres in any case.

4.04.00 Cable identification

Cable identification shall be provided by embossing on every meter on the outer sheath the following :

a) TSGENCO

b) Manufacturer's name or trade mark

c) Voltage grade

d) Year of manufacture

e) Type of insulation, e.g. XLPE/PVC/HR85/IE2 etc.

f) No. of core and size of cables.

g) Type of improved fire performance, e.g. FR/FRLSH/FS

h) IS number

4.05.00 **Packing**

4.05.01 Cables shall be supplied in non returnable drums. The drums shall be of heavy construction. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage. Wooden cable drum shall be treated by immersing in copper-nitrate solution.

4.05.02 Cable shall be wound and packed on drums in such a manner that it will be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment.

4.05.03 The cable drums should carry the following details in printed form:

a) TSGENCO

b) Manufacturer's name or trade make

c) Type of cable & voltage grade

d) Year of manufacture

e) Type of insulation e.g. XLPE/HRPVC/IE2

f) No. of core and size of cables

g) Cable code e.g. FRLSH/FS

h) Length of cable on drum

i) No. of length on drum, if more than one

j) Direction of rotation, by arrow

k) Approx. gross mass.

l) IS/IEC number and ISI mark

4.06.00 **Joints and Terminations**

Materials of construction for a joint/termination shall perfectly match with the dielectric chemical and physical characteristics of the associated cables. The material and design concepts shall incorporate a high degree of operating compatibility between the cable and joints. The protective outer covering (jacket) used on the joints/terminations shall have the same qualities as that of the cable outer sheath in terms of ambient/operating temperature withstand capability and resistance to hazardous environments and corrosive elements. Straight through joints and terminations for HT cables shall be heat shrinkable type.

4.07.00 **Selection Criteria**

4.07.01 a) HT and LT power cables shall be selected on the basis of current carrying capacity, short circuit rating and permissible voltage drop.

b) While sizing power cables, following aspects shall be reckoned:

i) Ground/Ambient Air temperature

ii) Depth of Laying.

iii) Power Cables touching each other.

c) Cables, for circuit breaker controlled feeders, shall withstand the short circuit current for the fault clearing time 0.16 Sec. for outgoing feeder, 0.5 Sec. for Tie feeder and 1.0 Sec. for Incomer.

d) HT cables shall be sized based on the following considerations:

Rated current of the equipment and ground/ambient temperature.

Touching/spacing of cable.

Laying on multi-tier racks, trench

Depth of laying.

The voltage drop of the cable , during motor starting condition , shall be limited to 15% and during full load running condition shall be limited to 3 % rated voltage. For BFP motor, the voltage drop during motor starting condition shall be limited to 20% and for Mill motor shall be limited to 10%. Other outgoing feeder / transformer feeder shall be limited to 3% rated voltage.

Short circuits withstand capability

e) For fuse/MCCB/Breaker protected circuits the conductor size shall depend upon full load current subject to voltage drop limited to 3% during running of all feeders and 15% during starting for motor feeders. In addition, transformer regulation shall also be considered for loads fed from 415V PMCC. Incase of other out going line feeder voltage drop shall be limited to 3%.

f) For loads fed from local panels, the total running voltage drop in cable from 415V PMCC to local panel and from local panel to individual motor shall be limited to 3% at full load motor current while the same during starting shall be limited to 15%.

g) As per national electric code (NEC) current rating capacity of motor feeder/cables should be 125% of full load current.

h) For welding receptacle, 3% running drop shall only be considered.

The minimum sizes of L.T cable to be chosen are as below:

AL - 16 mm^2 (3 core) & 16mm^2 (2 core) Cu - 2.5 mm^2

4.07.02 Apart from above, consideration shall also be given to limit the cable to some standard sizes instead of using too many types.

4.07.03 The standard cable sizes, amp capacities, derating factors. as given in IS/IEC will be generally followed.

4.07.04 a) For breaker protected circuits minimum size of the cable shall be as follows:

1100V Power Cable	:	240 Sq mm XLPE AL
3300V Power Cable	:	185 Sq mm XLPE AL
11000V Power Cable	:	240 Sq mm XLPE AL

b) For motor circuits the selection of size will be made ensuring that the cable shall withstand a short circuit fault directly following a second hot start.

4.07.05 For fuse/MCCB protected circuit, the conductor size will depend on full load current subject to voltage drop not exceeding 3%. For practical purposes, the minimum size chosen is as below :

a)	Aluminium	:	6 Sq mm.
b)	Copper	:	2.5 Sq mm.

4.07.06 All control cables shall be 2.5 Sq mm copper cable.

4.07.07 Multicore control cables will generally have spare conductor (s) in accordance with the following chart :

Conductors required	**Cables**
1 or 2	1-3/C
3 or 4	1-5/C
5 or 6	1-7/C
7 or 8	1-9/C

9 or 10	1-12/C
Above 10	Two or more of above cables

4.07.08 Separate cables for each type of following services/functions as applicable shall be used for each feeder. Same multicore cable using different services shall not be acceptable.

a) Power.

b) Control, interlock and indication.

c) Metering and measuring.

d) Alarm and annunciation.

e) C.T. Cables.

f) V.T. Cables.

4.08.00 **Cable Identification**

Cable identification shall be provided by embossing on the outer sheath the following :

a) Manufacturer's name or trade mark

b) Manufacturer's name or trade mark

c) Voltage grade

d) Year of manufacture

e) Type of insulation, e.g. XLPE, HRPVC & IE2 etc.

f) No. of core & size of cables

g) Type of outer sheath e.g. FRLSH, FS etc.

4.09.00 Selected sizes of power and control cables are given in Annexure-G.

4.10.00 Fire Survival Cables shall be used for important auxiliaries / area as recommended in Standard Technical Specification by CEA for the following services. The fire survival time of these cables shall not be less than 3 hours at 750 deg. C.

i. DC emergency lube oil pump

ii. DC hydrogen seal pump

iii. Turbine lube oil pump/barring gear

iv. DC emergency lighting for main building and service building

v. DC cables for battery to charger & DC distribution boards

vi. Jacking oil pump

vii. Emergency turbine trip in control room

viii. Boiler Turbine : Generator inter trip which include the interconnection between

- Boiler master fuel trip and turbine trip relays
- Generator trip relays & turbine trip relays
- Generator trip relays & generator breaker
- Generator trip relays & field breaker
- Generator trip relays & unit auxiliary transformer breaker
- Incomer cables for DG board, emergency board, DC lighting board etc.

5.00.00 **TESTS**

5.01.00 **Shop Tests**

The Cables shall be subject to shop tests in accordance relevant IS/IEC standards to prove the design and general qualities of the Cables as below:

5.01.01 Routine tests on each drum of cables.

5.01.02 Acceptance Tests on 1 drum out of every 10 drums chosen at random for acceptance of the lot for every size.

5.01.03 Type test on each type and size of cable, inclusive of measurement of armour DC resistance of power cables on one drum out of every 10 drums of cable.

5.02.00 **Additional Tests**

Following additional acceptance tests shall also be performed on each type of cables having outer sheath with improved fire performance (category C1, Type FR/ Category C2, Type FRLSH)

5.02.01 Oxygen index test (both C1 & C2)

The Oxygen index shall not be less than 29.

5.02.02 Temperature Index Test (both C1 & C2)

The measured value of temperature index shall be 21 at a temperature of 250°C for FRLS cables and 350°C for FS cables

5.02.03 Flame Retardance test on single cable and on bunched cables (both C1 & C2)

After the test, there should be no visible damages on the test specimen within 300mm from its upper end.

After burning has ceased, the cables should be wiped clean and the charred or affected portion should not have reached a height exceeding 2.5 meter above the bottom edge of the burner, measured at the front and rear of the cable assembly. 3 Hours fire rating test shall be carried out for FS cable as per IEC-331

5.02.04 Halogen acid gas evolution test (for Category C2)

The level of HCL evolved shall not exceed 20 per cent by weight. HCL evolved shall not be exceed 2% for FS cable.

5.02.05 Smoke density test (for Category C2)

The cables shall meet the requirements of light transmission of minimum 40% after the test. Minimum transmission shall be 80% for FS cable.

5.02.06 Test for specific optical density of smoke

The cables shall meet the requirements of IS/IEC.

5.02.07 Test for rodent & termite repulsion property

The test shall be carried out to note the presence of rodent and termite repelling chemical in PVC compound. Normal procedure is that a few chippings of the PVC compound are slowly ignited in a porcelain dish or crucible in a muffle furnace at about 600°C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). A drop of aqueous sodium sulphide solution is placed on a thick filter paper and it is allowed to soak. The spot is touched with a drop of above extract. A black spot indicates the presence of anti-termite & rodent compound.

Flammability test shall be carried on finished cables as per following standards-

a) Swedish Chimney test – SS: 424-14-75

b) IEEE std.383 – 1974 latest

c) IEC std. 332-1, 332-3 and IEC 331

6.00.00 **DRAWINGS, DATA & MANUALS**

6.01.00 Drawings, Data and Manuals shall be submitted with the bid and for approval/ reference and subsequent distribution after the issue of Letter of Intent in quantities and procedures as specified in General condition of contract and/or

6.02.00 **To be submitted with the Bid**

a) Manufacturer's catalogues giving cable construction details and characteristics.

b) Cable current ratings for different types of installation, inclusive of derating factors for ambient temperature, grouping etc.

c) Write-up on Manufacturer's recommended method of splicing, jointing, termination etc. of the cables.

d) Type test reports on 11 KV & 3.3 KV Power, LT FRLSH Power & control, FS power and control cables.

e) Filled-up proposal particulars.

6.03.00 To be submitted for Owner/Purchaser's Approval and Distribution

All relevant drawings and data pertaining to the equipment like GTP, QAP, etc. shall be submitted by the Bidder for the approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

RATINGS AND REQUIREMENTS
HV POWER CABLES (11 KV & 3.3 KV)

1.0 11000/11000V & 3300/3300V grade 90^0C continuous rating under normal condition and 250^0C rating under short circuit condition heavy duty XLPE power cable suitable for use in 11000V/3300V non-effectively earthed system conforming to following requirement and in line with IS-7098, IS-8130, IS-5831 & IS-3975, manufactured by Triple Extrusion Dry Cure (CCV) process using pressurized Nitrogen.

1.1	Conductor	:	Stranded and compacted aluminium conductor of grade H2 & class 2 for all sizes, generally conforming to IS: 8130.
1.2	Conductor Screen	:	Extruded semi-conducting compound.
1.3	Insulation	:	Extruded cross linked polyethylene (XLPE) conforming to IS: 7098 (Part-2)
1.4	Insulation Screen	:	Extruded semi-conducting compound with a layer of non-magnetic metallic tape. For single core armoured cables, the armouring shall constitute the metallic part of screening. The semi-conducting tape shall be easily strippable.
1.5	Core Identification	:	By coloured strips applied on (For three core cables) cores.
1.6	Inner Sheath	:	Extruded HRPVC/FRLS compound conforming to type ST2 of IS: 5831 for three core cables. Single core cables shall have inner sheath. Filler material shall also be of type ST2 PVC.
1.7	Armour	:	Galvanised single round steel wire armour for twin and multicore cables. Non-magnetic hard drawn aluminum single round wire conforming to H4 of IS-8130 latest for single core cables
1.8	Overall Sheath	:	Extruded FRLSH HRPVC compound conforming to type ST2 of IS: 5831.
1.9	Drum	:	Steel Drum

ANNEXURE-B

RATINGS AND REQUIREMENTS
LV POWER CABLES [1.1KV (XLPE TYPE)]

1.0 1100 V grade, 90ºC continuous rating under normal condition and 250°C under short circuit condition rating, XLPE heavy duty, power cable conforming to following requirement and in line with IS 7098 Part-I. IS 8130 & IS 5831 and IS 3975.

1.1	Conductor	:	Stranded and compacted plain aluminium of grade H2 and class 2 stranded, high conductivity annealed plain copper for cable sizes upto 2.5 mm^2 conforming to IS:8130.
1.2	Insulation	:	Extruded cross-linked polyethylene (XLPE) conforming to IS: 7098 (Part-1)
1.3	Core Identification	:	By color coding
1.4	Inner Sheath	:	Extruded HRPVC FRLS compound conforming to type ST2 of IS: 5831 for multicore cable. Single core cables shall have no inner sheath. Filler shall be of same material as of inner sheath i.e. ST2
1.5	Armour	:	Galvanized single round steel wire armour for twin and multicore cables. Non-magnetic hard drawn aluminum single round wire conforming to H4 of IS-8130 latest for single core cables
1.6	Overall Sheath	:	Extruded FRLSH HRPVC compound conforming to type ST2 of IS: 5831.
1.7	Drum	:	Conforming to IS-10418 (Wooden drum)

ANNEXURE-C

RATINGS AND REQUIREMENTS
CONTROL CABLES

1.0 1100 V grade 85ºC continuous rating under normal condition and 160°C under short circuit condition rating HRPVC Control cable (YWY) conforming to following requirement and in line with IS:1554, IS:8130, IS:5831 and IS:3975.

1.1	Conductor	:	Stranded, non-compacted & circular, high conductivity annealed plain copper, generally conforming to IS: 8130.
1.2	Insulation	:	Extruded HRPVC type-C compound conforming to IS: 5831. The minimum volume resistivity of insulation shall be 3.5×10^{14} ohm-cm at $27^{O}C$ and 3.5×10^{11} OHM-CM at $85^{O}C$.
1.3	Core Identification	:	By color coding and numbering at interval of 100mm or less
1.4	Inner sheath	:	Extruded HRPVC compound conforming to type ST2 FRLS of IS: 5831 for multicore cables. Single core cables shall have no inner sheath. Filler shall be of same material as of inner sheath i.e. ST2.
1.5	Armour	:	Galvanised single round steel wire for twin and multicore cables.
1.6	Overall sheath	:	Extruded FRLSH HRPVC compound conforming to type ST2 of IS: 5831.
1.7	Drum	:	Conforming to IS: 10418 (Wooden drum)

ANNEXURE-D

RATINGS AND REQUIREMENTS
(1.1KV GRADE COPPER CONDUCTOR FS POWER CABLES)

1100 V, copper conductor, heat resisting insulation, extruded inner sheath of low smoke and very low halogen content fire resisting material, single layer of copper wire armour for single core/ single layer of round galvanised steel wire for multicore, outer sheath of low smoke and very low halogen content fire resistant material, suitable for minimum temperature of 750 deg.C for 3 hours. The cables shall be in compliance with IEC-60331, Part 11.

RATINGS AND REQUIREMENTS
(1.1KV GRADE COPPER CONDUCTOR FS CONTROL CABLES)

1100 V, copper conductor, heat resisting insulation, extruded inner sheath of low smoke and very low halogen content fire resisting material, single layer of copper wire armour for single core/ single layer of round galvanised steel wire for multicore, outer sheath of low smoke and very low halogen content fire resistant material, suitable for minimum temperature of 750 deg.C for 3 hours. The cables shall be in compliance with IEC-60331, Part 11.

ANNEXURE-E

RATINGS AND REQUIREMENTS
FLEXIBLE TRAILING CABLES

i) 3300 V Unearthed Grade

Flexible trailing cable, annealed plain copper conductor, Class-5 of IS-8130, insulated with EPR, conductor and insulation shielded with EPR, cores screened with ATC wire braiding, cores laid up, HD CSP inner sheathed, proof cotton taped and FRLS HD CSP sheathed overall, conforming to IS:9968. Alternatively PCP sheathing may be acceptable.

ii) 1100 V Grade

1100 V Grade trailing cable shall be plain copper of Class-5 of IS-8130, heat resistant elastomeric compound based on EPR insulation, inner sheath of heat resistant elastomeric compound PCP sheath, nylon cord reinforcement and heat resistant, oil resistant and flame retardant heavy duty elastomeric compound FRLS CSP outer sheath.

ANNEXURE-F

CABLE SIZES

Following sizes are given as a general guideline. Standard sizes as per IEC/IS shall be adopted.

Sl. No.	Cable Size	Conductor	Insulation
1.0	**H. T. CABLES (11kV)**		
1.1	1 core 1000 sq.mm	AL	XLPE (FRLS)
1.1	1 core 630 Sq.mm	AL	XLPE (FRLS)
1.2	3 core 400 Sq.mm	AL	XLPE (FRLS)
1.3	3 core 240 Sq.mm	AL	XLPE (FRLS)
1.4	1 core 70 Sq.mm	AL	XLPE (FRLS)
1.0	**H. T. CABLES (3.3kV)**		
1.1	1 core 630 Sq.mm	AL	XLPE (FRLS)
1.2	3 core 300 Sq.mm	AL	XLPE (FRLS)
1.3	3 core 240 Sq.mm	AL	XLPE (FRLS)
1.4	3 core 185 Sq.mm	AL	XLPE (FRLS)
1.5	1 core 70 Sq.mm	AL	XLPE (FRLS)
2.0	**L. T. POWER CABLES**		
2.1	3 core 2.5 Sq.mm	CU	XLPE (FRLS)
2.2	2 core 16 Sq.mm	AL	XLPE (FRLS)
2.3	3 core 16 Sq.mm	AL	XLPE (FRLS)
2.4	4 core 16 Sq.mm	AL	XLPE (FRLS)
2.5	2 core 35 Sq.mm	AL	XLPE (FRLS)
2.6	3 core 35 Sq.mm	AL	XLPE (FRLS)
2.7	4 core 35 Sq.mm	AL	XLPE (FRLS)
2.8	3 core 70 Sq.mm	AL	XLPE (FRLS)

Sl. No.	Cable Size	Conductor	Insulation
2.9	3.1/2 core 70 Sq.mm	AL	XLPE (FRLS)
2.10	3 core 95 Sq.mm	AL	XLPE (FRLS)
2.11	3.1/2 core 95 Sq.mm	AL	XLPE (FRLS)
2.12	3 core 185 Sq.mm	AL	XLPE (FRLS)
2.13	3.1/2 core 185 Sq.mm	AL	XLPE (FRLS)
2.14	3 core 240 Sq.mm	AL	XLPE (FRLS)
2.15	3.1/2 core 240 Sq.mm	AL	XLPE (FRLS)
2.16	3 core 300 Sq.mm	AL	XLPE (FRLS)
2.17	3.1/2 core 300 Sq.mm	AL	XLPE (FRLS)
2.18	1 core 630 Sq.mm	AL	XLPE (FRLS)
3.0	**CONTROL CABLE**		
3.1	2 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.2	3 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.3	5 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.4	7 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.5	9 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.6	12 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.7	20 core 2.5 Sq.mm	CU	HRPVC (FRLS)
4.0	**FS POWER CABLES**		
4.1	3 core 2.5 Sq.mm	CU	EPR
4.2	2 core 16 Sq.mm	CU	EPR
4.3	3 core 16 Sq.mm	CU	EPR
4.4	4 core 16 Sq.mm	CU	EPR
4.5	2 core 35 Sq.mm	CU	EPR

Sl. No.	Cable Size	Conductor	Insulation
4.6	3 core 35 Sq.mm	CU	EPR
4.7	4 core 35 Sq.mm	CU	EPR
4.8	3 core 95 Sq.mm	CU	EPR
4.9	3.1/2 core 95 Sq.mm	CU	EPR
5.0	**FS CONTROL CABLE**		
5.1	2 core 2.5 Sq.mm	CU	EPR
5.2	3 core 2.5 Sq.mm	CU	EPR
5.3	5 core 2.5 Sq.mm	CU	EPR
5.4	7 core 2.5 Sq.mm	CU	EPR
5.5	9 core 2.5 Sq.mm	CU	EPR
5.6	12 core 2.5 Sq.mm	CU	EPR

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SECTION-IX

TECHNICAL SPECIFICATION
FOR
ERECTION - CABLING, GROUNDING AND LIGHTNING PROTECTION SYSTEM

CONTENT

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SECTION-IX

TECHNICAL SPECIFICATION
FOR
ERECTION - CABLING, GROUNDING AND LIGHTNING PROTECTION SYSTEM

1.00.00 **SCOPE OF WORK**

1.01.00 The scope of work covers complete and efficient design, supply, erection, testing and commissioning of Plant lightning protection system, all cabling and electrical grounding works. The scope shall broadly cover, but not be limited to :

1. Main Power House Building
2. Boiler area, ESP stack
3. Transformer yard
4. All auxiliary buildings (including electrical rooms of respective buildings) and structures as detailed in the Lead Specification.
5. Overhead interplant cable trestle and pipe cum cable trestle.
6. All electrical equipment as described in Volumes V-A & V-B.
7. 400kV Switchyard.

1.02.00 The scope of work shall also include all civil and structural works necessary for successful installation and commercial operation of all electrical equipment to be erected under this specification.

2.00.00 **SCOPE OF SUPPLY**

2.01.00 The scope of supply shall include but not be limited to the followings

2.01.01 Timely procurement and transportation to site in properly packed condition of all materials and miscellaneous items required to complete the erection work under this specification.

These materials and miscellaneous items shall include but not be limited to the following :

a) Galvanised steel pre-fabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, etc.

b) Galvanised steel rigid/flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanised sheet steel junction boxes, cable fixing clamps, nuts & bolts, etc. as required.

c) Cable termination and jointing kits as necessary.

d) All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.

e) Mild steel rods, galvanised steel flats, galvanised steel rods, lead coated copper tube suitably brazed with galvanised steel Bend ring galvanised steel wires, etc. required for grounding and lightning protection system shall be supplied in standard lengths.

f) Fire Stop mortal seal, fire retardant cable coating system.

g) Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the contractor without any extra charge to the Purchaser.

2.01.02 a) Main Ground Mat

Laying underground conductors and arc welding the conductors at each crossing and straight run (lap joint). Bidder shall select the diameter of conductor for the underground mat with supporting calculation. Suitable pigtails shall be provided.

b) Grounding Electrode

Ground electrodes will be 3 metre long, 40mm dia. M.S. rod. These are to be fabricated and driven into the ground by the side of mat conductor. All connections to the conductors shall be done by are wilding process.

c) Column Grounding

i) Concrete Columns

Erection of 1 no. M.S. rod (of diameter identical to ground mat conductor) from grounding mat to all concrete columns including necessary fixing, welding of one end of the rod with ground mat and the other end with the column above ground by welding with a short GS flat to edge angles.

ii) Steel Columns

Erection and connection of 1 no. M.S. rod (of diameter identical to ground mat conductor) from grounding mat to all steel columns including necessary fixing, welding of one end with ground mat and the other end with the column above ground with a short GS flat.

d) Risers

Erection and connection of all risers from underground mat to above ground levels where the ends will be left free for connecting to the equipment. Connection to the ground mat shall be done by arc welding and the other end is to be kept free at least 300 mm above grade level/concrete floor level unless otherwise shown.

e) Electronic Equipment Grounding

Internal ground connection of electronic panels shall be insulated from the enclosure, frame, chasis and to be terminated to an insulated ground bus.

Insulated ground bus (400x100x10mm) of all electronic panels shall be connected by insulated wire to an insulated common electronic ground bar as shown in the Grounding Notes and details drawing.

All connection made above shall be in the form of a radial distribution system without any parallel ground paths.

Electronic equipments and systems, metal enclosures of all electronic panels shall be connected to a grounding system with which is isolated and separate from the electrical equipment grounding system. Separate Earth pit shall be made of 3M X 3M (diameter to be selected by Bidder).

f) All other ancillary works in connection with the items of work described above which are not specifically mentioned but are necessary to complete the work, shall be under the scope of this specification.

2.01.03 a) Air Terminal

Installation of vertical 20mm dia galvanised steel rod (except for chimney). The projected length of the rod shall be as required to protect the object. (on which the rod is fixed from lightning stroke).

Installation of air terminal at the top of the stack/chimney for lightning protection shall be 20mm dia coated solid copper rod.

b) Horizontal Air Terminal

Erection of horizontal air terminal of 75X 10 mm GS flat conductor in such a way that no part of of the roof will be more than nine meters from the nearest roof conductor.

c) Down conductor

Erection of down conductor 75 X 10 mm GS Flat and 25 X 6 mm GS flat (Conveyor Gallery) conductor. one end of this down conductor connected with air terminal rod/ horizontal conductor at the top of roof/structure and other end connected to the nearest MS rod riser through test link located at approximately 1500mm above ground level.

d) Electrode (for Lightning protection)

Fabrication and driving into ground 3000 mm long, 40mm dia. M.S. rod and connecting them to the grounding mat by arc welding.

e) Risers (for Lightning protection)

Erection and connection of all risers from underground mat to above ground levels where the ends will be left free for connecting to the equipment. Each riser will be projected minimum 300 mm above grade level/concrete floor level. Riser will be of M.S. rod with diameter identical to ground mat conductor.

f) Shielding Mast

Erection of shielding mast at the top of steel columns cap plates of power house building.

g) All other ancillary works in connection with the items of work described above which are not specifically mentioned but are necessary to complete the work, shall be under the scope of this specification.

2.02.00 All materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make.

2.03.00 Necessary drawings, data sheets and Technical leaflets on each piece of material.

2.04.00 **Scope of Services**

The scope includes but is not limited to the followings;

2.04.01 Furnishing of all erection tools and tackles, testing equipment, implements, supplies, hardware and transport for timely and efficient execution of the erection work.

2.04.02 The items of erection work shall be performed with respect to the following equipment/materials :

a) Power Cables

b) Cables laid in trench

c) Control, instrument and special cables

d) Supply and erection of entire cable tray and cable shaft arrangements indoor as well as outdoor area and all associated civil and structural works including foundation and cable trenches for complete plant.

e) Supply and Erection of Grounding system.

f) Supply and Erection of Lightning Protection system.

3.00.00 **GENERAL REQUIREMENTS**

3.01.00 **Codes and Standards**

3.01.01 All cable and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

3.01.02 Cable and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

3.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.02.00 **Erection Schedule**

3.02.01 The entire erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the tenderer for this purpose.

3.02.02 The erection schedule, as approved by the Owner's Engineer shall be strictly followed by the contractor. If, for any reason beyond the control of the Contractor, the work is held-up then the Contractor shall bring it to the notice of the Owner's Engineer without any delay.

4.00.00 **DESIGN CRITERIA**

4.01.00 **Grounding System**

4.01.01 Grounding shall follow the relevant standards/codes amended till date as below:

a) Indian Electricity rules

b) National Electrical Code

c) Code of Practice of Earthing IS 3043

d) Protection of building and allied structures against lightning IS 2309

e) IS- 732, IS 226, IS 2629, IS 2633 & IS 4759

f) IEEE -80-2000, IEEE-665

The station grounding system shall be an interconnected network of MS conductor and MS ground rods. The system shall be provided to protect plant personnel and equipment from the hazards, which can occur during power system faults and lightning strikes

4.01.02 The main objectives of grounding system are to :

a) Provide safety to personnel from contact of dangerous potential caused by ground fault.

b) Ensure sufficient grounding current for effective relaying.

c) Stabilize circuit potential with respect to ground.

Design Basis

The station grounding system shall be designed in compliance with the IEEE-80-2000/ IEEE- 665 considering fault current of 50kA for 1 sec. and shall be subject to approval of Owner.

Actual soil resistivity measurement shall be carried out at proposed site for new units during dry season.

The surface resistivity shall be considered as 3000-ohm meter for Gravel and 1000 ohm-meter for concrete.

a) Major items of equipment, such as generator, switchgear, transformer, motor, relay panels and control panels etc shall have integral ground buses or connection points which shall be connected to the under ground grid.

b) Electronic panels and equipment, where required, shall be grounded utilizing an insulated ground wire connected in accordance with the manufacturer's recommendations. Where practical, electronics ground loops shall be avoided. Where this is not practical, isolation transformers shall be furnished. All indoor and outdoor electrical equipment and associated non current carrying system, metal works, support structures, buildings columns, fence, neutrals, masts, arrestors, etc shall be connected to the plant ground system.

c) Instrumentation cable screens shall be single point bonded to the instrument earth network to minimize the effects of electrical interference.

d) For Signal/case/intrinsically safe signal, grounding of control room instruments, separate earth pit not connected to main ground grid shall be used. Control cabinets shall be connected to this separate earth pit.

e) A grounding conductor (steel wire armor) shall be routed parallel to all power conductors operating above 240 volts.

f) All ground wires installed in conduits shall be un-insulated.

g) Embedded grounding grid of 75x10mm GI flat at basement/grade slab as well as upper floor/suspended slabs shall be provided.

h) In addition mild steel ground pads at different locations i.e. on wall/floor/ceiling inside the buildings/tunnels/trenches shall be provided. These pads will be in turn connected to below ground level earth mat through galvanized steel flat or riser. Each ground pad shall have provision for connection of at least two 75x10mm GI flats.

i) Treated earth pit shall be provided for system earthing at locations where generator and transformer neutrals are grounded. Two separate earthing leads shall be provided for each of the transformer and generator neutrals and shall be directly connected to a separate treated earth pit which in turn shall be connected to two different runs of earth grid. Heavy duty 50mm G.I. pipe shall be provide for treated earth pits with charcoal, salt, etc. as per IS:3043.

j) Dedicated treated earth pit shall be provided for lightning protection system.

k) Clean earthing for instrumentation shall be provided with dedicated earthing system and separate treated earth pits below the main control room, feed water pump house in turbine house etc.

l) Connection between the equipment earth lead and the grid conductor shall be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.

4.01.03 In order to meet the above objectives, ground grid mesh will be provided for the main plant complex, viz., switchyard, transformer yard adjacent to power house building, power house building and boiler area up to stack, auxiliary buildings, etc. The earth mats of main plant and BOP area will be interconnected by two or more connections.

All electrical equipment, non current carrying metal parts, structures, building steel, lightning protection system, generator/transformer neutrals will be connected to this station ground grid.

The major aspects to be considered for grounding system design are given below :

4.01.04 Ground Grid Conductor

a) Ground grid conductor of mild steel rod shall be used.

b) The minimum conductor section is determined on the basis of ground fault current. This section is then increased by an allowance to account for the soil corrosion loss of 0.3 mm per year over the design life of 30 years.

4.01.05 Underground Grid

a) The ground grid mesh is designed to keep the touch and step voltages within safe limits as per recommendation of IEEE 80 & IEEE 665.

b) The ground grid conductors will be buried in earth at a minimum depth of 1000 mm. The length of ground conductors below earth will be sufficient to ensure a ground resistance less than 0.5 ohm.

c) The ground grid conductor will be so laid as to provide short and direct connection to building steel and major electrical equipment.

d) Ground rods shall be provided at the points where system neutrals/lightning protections are connected to the ground grid.

e) All ground grid conductor connections will be welded type.

f) Main Plant ground grid shall be connected with the switchyard and other auxiliary building /area ground grid at least at two (2) points.

g) For test pits, the Electrode will be 100 mm dia. Heavy duty C.I. pipe with perforations. Electrodes installed in test pits will have disconnecting facilities

4.01.06 Above Ground Connections

a) Galvanised steel flats shall be used for all connections above earth.

b) Inside building, ground conductors will be run for each floor supported on building steel and/or cable trays. These ground conductors in turn will be connected to the station ground grid through riser (at least two) coming up along building columns/cable shafts.

c) Two separate and distinct ground connections will be provided for each electrical equipment in compliance with I.E. Rules.

d) All connections above ground will be welded type except connection to equipment/structures which shall be bolted type.

4.01.07 Equipment Ground Lead

Equipment ground connections will be sized to carry the available ground fault current. Considerations shall also be given to mechanical ruggedness of the connections and to limit the number of sizes.

4.01.08 The minimum ground conductor sizes for various equipment and structures are given in Annexure-B.

4.01.09 Entire erection of grounding work shall be carried out in such a way as to be capable of withstanding the intended services of carrying full short circuit level currents to ground mat without any damage/deformation.

4.02.00 **Lightning Protection System**

Lighting protection system design shall be as per IS:2309

4.02.01 The main purposes of lightning protection system are to :

a) Provide protection to structures from lightning strokes.

b) Provide a low resistance-conducting path to lightning discharge.

4.02.02 Lightning protection shall be provided for Power House building, auxiliary building , chimney, cooling tower and other structures.

4.02.03 Lightning protection will also be provided for building/ structures where the overall rise factor exceeds 10^{-6} as per IS:2309.

4.02.04 For metal structures which are electrically continuous down to the ground level, no lightning protection is required except adequate grounding connections.

4.02.05 System Design

a) Air termination network with down conductors and earthing electrodes will be provided on the basis of IS Code of Practice.

b) Horizontal air termination shall be so laid out that no part of the roof will be more than 9 meters from the nearest conductor.

c) Shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 Degrees.

d) Down conductors will run along the outer surfaces of the building and shall have a test joint about 1500 mm above ground.

e) An earth electrode will be provided at the connection point of the down conductor with the station ground.

f) Galvanised steel rods and flats will be generally used for air termination and connections. All connections will be welded type.

g) For air terminals of chimney, lead coated copper tube suitably brazed with G.S. Band ring shall be provided.

4.03.00 **Cabling System**

4.03.01 Erection of cabling work shall be carried out in such a way as to provide a reliable and assured electric power supply system to all station auxiliaries.

4.03.02 Cable routing will be done on unit basis as far as possible.

4.03.03 Erection of cabling work shall be executed keeping in view all necessities and requirements of fire fighting codes for Generating Stations having an adverse industrial environment.

4.03.04 Suitable embedded steel inserts shall be provided on wall/floor/ ceiling surfaces for welding of cable tray bracket in order to make the cable tray system withstand horizontal/vertical accelerations due to seismic forces for indoor trays and also wind load for outdoor trays such as on Boiler platforms in addition to normal tray cable loadings.

4.04.00 All erection work to be carried out under this specification shall conform to the notes and details given in Annexure-A and drawings attached to this specification.

5.00.00 **SPECIFIC REQUIREMENTS - SUPPLY**

5.01.00 **Equipment and Material**

5.01.01 Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings and annexures.

5.01.02 Equipment and materials furnished shall be complete and operative in all details.

5.01.03 All accessories, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

5.01.04 All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

5.02.00 **Pre-fabricated Cable Trays**

5.02.01 Cable trays shall be pre-fabricated ladder type sheet steel with hot dip galvanising furnished in standard length of 2.5 metres.

5.02.02 Cable trays shall be of standard width specified in Annexure-A and drawings.

5.02.03 Cable trays shall be complete with all necessary hot dip galvanised sheet steel accessories such as coupler plates, ground continuity connections and associated nuts, bolts, washers, hangers, clamps, etc. Also horizontal / vertical bends, horizontal / vertical Tee, Reducers, Horizontal cross-pieces, protective covers shall be supplied along with straight runs in order to take care of cable tray alignments in different routes.

5.02.04 All fittings like horizontal/ vertical elbow, horizontal crosspiece, reducer, horizontal tee, etc. should be pre-fabricated. Each fitting shall be provided with two nos. hot dip galvanised side coupler plates & associated bolts, nuts and washers on each side.

5.02.05 Cable trays, fittings & accessories as well as elbows, reducers, tees, crosses, etc. shall be fabricated out of 14 gauge (2 mm thick) hot rolled mild steel sheets.

5.02.06 Contractor shall supply 14 gauge (2 mm thick) perforated type hot rolled mild steel sheet covers for vertical cable shafts up to a height of 2.5 metres from floor level. The perforated covers used for the vertical raceways may be of one or more pieces along the width of the raceway, depending on the width of the raceway and shall be bolted to the structural framework of the raceway.

5.02.07 The cable trays, fittings and accessories including all bolts, nuts, screws, washers, etc. shall be hot dip galvanised after fabrication as per IS:2629. Galvanising shall be uniform, clear, smooth and free from acid spots. Should the galvanising of the samples be found defective, the entire batch of steel will have to be re-galvanised at Contractor's cost.

The amount of zinc deposited shall not be less than 610 gms per square metre of surface area and in addition the thickness of the zinc deposit at any spot whatsoever, shall not be less than 75 microns. The Owner reserves the right to measure the thickness of zinc deposit by Elcometer or any other instrument and reject any component, which shows thickness of zinc at any location to be less than 75 microns.

5.02.08 The Contractor shall perform all tests necessary to ensure that the material and workmanship conform to the relevant standards and that such tests are adequate to demonstrate that the equipment will comply with the requirement of this specification.

The tolerance on dimensions shall be in accordance with appropriate Indian Standards. The extent of the tests to be performed by the contractor shall include but not be limited to the following:

Deflection Test

A 2.5 metre straight section of each type of cable trays shall be simply supported at the two ends. A uniformly distributed load of 100 Kg per metre will be applied along the length of the tray. The maximum deflection at mid span shall not exceed 7 mm.

5.02.09 For other details refer CABLING NOTES AND DETAILS annexed to this specification.

5.03.00 **Conduits and Accessories**

5.03.01 Conduits shall be of rigid steel, hot-dip galvanised, furnished in standard length of 5 metres, threaded at both ends.

5.03.02 Conduits diameter upto and including 25mm size shall be of 16 SWG and conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 20 mm.

5.03.03 Each piece of conduit shall be straight, free from blister and other defects, internal surface shall be of smooth finish and covered with capped bushings at both ends.

5.03.04 The contractor shall provide and install all rigid steel conduits, mild steel pipes, flexible conduits rigid PVC pipes, etc. complete with accessories such as tees, bends, adopters, locknuts, pull boxes, conduit plugs, caps, etc as required for the cabling work.

5.03.05 Steel conduits with interior coating of silicon epoxy ester for ease of wire/cable pulling shall be seamed by welding and flo-coat metal conduit/hot-dip galvanised. These shall be supplied in standard length of 5M with minimum wall thickness as specified in IS:9537. In chemical handling areas, Battery Room, etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. Conduits, fittings & accessories shall have ISI mark.

5.03.06 For sizes above 63 mm mild steel pipes with necessary fittings & accessories shall be provided and installed by the contractor. Pipes shall be manufactured by electric welding process. These pipes shall be of heavy duty class as per IS:1239 and shall have ISI mark. Pipes shall be supplied in lengths of approximately 5 metres. Pipes, fittings & accessories shall be hot dip galvanised both on inside and outside.

5.03.07 Flexible conduits shall comply with IS:3480. They shall be made with bright, cold-rolled, annealed and electro-galvanised mild steel strips. Flexible conduits shall be used between embedded conduits/pipes and the motor terminals. Flexible conduits shall also be used between fixed conduit and any equipment terminal boxes where vibration is anticipated or equipment that require regular removal.

5.03.08 Rigid PVC conduits conforming to IS:4985 shall generally be used for control & instrumentation cables in some areas where cable trays do not exist and where the runs are straight ones generally the PVC pipes with special Bell Mouthing shall be of 110 mm,160 mm & 200 mm outside diameter and shall be suitable for working pressure of 6 kg/sq. cm. The length of each pipe shall be 5 to 6 metres. Necessary fittings & accessories as may be required for the installation shall also be provided.

5.04.00 **Junction Boxes**

5.04.01 Glass Fibre Reinforced Junction Boxes

a) No. of Ways:12 / 24 / 36 / 48 with 20% spare terminals.

b) Design

Junction boxes shall be Glass Fibre Reinforced with saturated polyester informing to standards like DIN 16911 type 803 / 16913 type 834, 5 self extinguishing in accordance with ASTM D 635 / UL 94 VO.

c) Enclosure

Junction boxes for use in outdoor or damp locations shall be sturdy construction. Temperature resistance between – 10 to 100 deg C. Impact resistance shall be greater than 7 Nm, (EN 50 014). Protective insulation shall be in line with VDE 0100, dielectric strength shall be greater than 10 KV/ mm, halogen free toxicity, the enclosure and door cover shall be painted and electro-statically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M6) shall be provided on the cover as well as door.

d) Doors

With integrated viewing window of 3 mm resistant plexi – glass or equivalent. The doors shall have industrial heavy – duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

e) Protection Class :

Protection Category shall be IP 66 to EN60 529. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane / chloroprene. The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 yrs. Bidder shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 yrs (double sealing arrangement is preferred).

f) Mounting clamps and accessories :

Suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. The accessories like mounting plants etc. of steel shall be powdered coated. The support rails for terminal box shall be zinc coated.

g) General :

i) JBs shall have small canopy at the top.

ii) There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage in to the junction box shall be avoided and it shall fall outside.

iii) Cable entry shall be from bottom side only.

iv) Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

5.04.02 Steel Junction Boxes :

a) No. of Ways:12 / 24 / 36 / 48 with 20% spare terminals.

b) Design :

Junction boxes shall be designed in accordance with NEC, article 370, paragraph 18, 20 or equivalent standards.

c) Enclosure :

Junction boxes for use in outdoor or damp locations shall be sturdy steel construction. The enclosure and door cover shall be surface finished clean, degreased, phosphated, deep coated primed (preferably in RAL 7044) and electro-statically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door. The sheath steel thickness shall be minimum 2 mm.

d) Doors :

The doors shall be hinged and lockable. The doors shall have industrial heavy – duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

e) Protection Class :

Protection Category shall be IP 66 to EN60 529 / 10.91 complies with NEMA 4. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane. There shall be an arrangement like multifold protection channel for additional stability and prevention of ingress of dust and water when the enclosure is open.

The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 yrs. Bidder shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 yrs (double sealing arrangement is preferred).

f) Mounting clamps and accessories:

Suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required

5.04.03 The junction boxes shall have the following indelible marking

- Circuit nos. on top by white-stenciled paint at site.
- Circuit nos. with ferrules (inside) as per approved drawing.
- Danger sign in case of 415V circuit.

5.05.00 **Terminals**

5.05.01 Multiway terminal blocks of approved type, complete with screws, nuts; washers and marking strips shall be furnished for connection of incoming/outgoing wires.

5.05.02 Each control cable terminal shall be suitable for connection of 2 nos. 2.5 sq.mm. stranded copper conductors without any damage to the conductor or looseness of conductors.

5.06.00 **Cable Termination & Jointing Kits**

5.06.01 The Bidder shall supply cable termination and jointing kits in requisite quantity for H.T. Power Cables, L.T. Power, Control Cables, Instrumentation Cables, etc. along with all accessories & consumables required for making termination and joints complete. All the materials and components of the termination/joints shall be suitable and compatible with the type of cables for which the terminals/ joints are intended.

5.06.02 The straight through joints of H.T. and L.T. cables shall be of Tapex/ Paracast/Parawrap type/approved make.. The end termination kits for H.T. cables shall be of Raychem/3M/Elastimold type/approved make. Cable joint or end terminations on Electrical equipment shall be suitable for Indoor & Outdoor use, as the case may be.

5.06.03 Glands and lugs required for termination of H.T., L.T. and instrumentation cables shall be supplied by the Contractor in required quantity.

5.07.00 **Cable Glands**

Cable glands shall be tinned brass gland, double compression type complete with necessary armour clamp and tapered washer, etc. Cable glands shall match with the sizes of different HT/LT/Control cables.

5.08.00 **Cable Lugs**

Cable lugs shall be suitable for termination of different cross-sections of H.T./L.T./Control/Instrumentation cables and shall be of following types :

i) Aluminium tubular terminal end for solderless crimping to aluminium conductors.

ii) Copper tubular terminal end for solderless crimping to copper conductors.

Solderless crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.

iii) Cable lugs for control cable termination shall be insulated. These lugs shall be pin type/flat type/ring type/U type to suit the terminals provided in the panels.

5.09.00 **Consumables and Hardware**

5.09.01 The Contractor shall furnish all erection materials, hardware and consumables required to complete the installation.

5.09.02 The materials shall include but not be limited to the following :

Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials, etc.

Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims, etc. 5.09.03 Supply of cement, sand, stone, etc. required for the execution of the contract shall be the responsibility of the Contractor.

5.10.00 **Testing Equipment**

5.10.01 The major testing equipment that are required to be provided by the Contractor are listed below :

a) Insulation Tests

i) Power operated Meggar - 1 KV and 10 KV grade

b) Hand driven earth Resistance Meggar, range 0-1/3/30 ohms.

c) High potential testing set - roller mounted type

d) Tong testers of suitable ranges.

e) Contact resistance measuring set for micro-ohms.

f) Torque wrench of various sizes.

g) Multimeters, test lamp, field telephone with buzzer set, different gauges, etc.

5.10.02 The list of equipment is indicative only. Any other test equipments required will be arranged by the Contractor.

6.00.00 **METHODS AND WORKMANSHIP**

6.01.00 All work shall be installed in a first class, neat workmanlike manner by mechanics/ electricians skilled in the trade involved.

6.02.00 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

6.03.00 All details on installation shall be electrically and mechanically correct.

6.04.00 The installation shall be carried out in such a manner as to preserve access to other equipment installed.

7.00.00 **INSTALLATION**

7.01.01 Installation work shall be carried out in accordance with good engineering practices and also as per manufacturer's instructions/ recommendations where the same are available.

7.01.02 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

7.01.03 Cable installation work shall mean erection of cable trays/racks, supports, hangers, junction boxes, conduits, laying of cables either in ground or on trays inside trenches tunnels/overhead trays in conduits, etc. dressing and clamping, jointing and termination inclusive of supply of necessary jointing/ termination kits, lugs, glands, ferrules, tapes, etc. and other accessories, grounding of cable armour. In case of direct laying in ground, all excavation work, necessary back-filling, supply of bricks and protective concrete slabs, removal of excess earth shall be part of the installation work.

7.01.04 Grounding installation work shall mean erection, jointing/ brazing/ welding, connection and painting, testing of ground conductors including supply of necessary steel/copper.

7.01.05 Lightning protection system installation work shall mean erection, jointing, welding, connection and painting, testing of air termination network, down conductors, shielding masts, connection to ground grid, electrodes, risers, horizontal conductors, etc. of lightning protection system.

7.02.00 **Cable Trays**

7.02.01 Pre-fabricated cable trays and accessories shall be assembled & erected at site. Adequate spaces will be provided to facilitate installation of cable system and to allow routine inspection and modification after installation.

7.02.02 Cable trays either inside concrete trenches or inside buildings and racks inside cable shafts shall be aligned and leveled properly. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings.

7.02.03 As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

7.02.04 The cable trays shall be supported in general at a span of exceeding 1.25 metres horizontally and 1.0 metre vertically.

7.02.05 Sufficient spacing not less than 250 mm shall be provided between trays and maintained to permit adequate access, for installing & maintaining the cables.

7.02.06 Complete cable tray support structure after installation shall be inspected/ tested for welding strength, straightness, accuracy, use of proper sizes and compliance to drawings.

7.02.07 Complete cable tray and accessory installation work shall be inspected/tested for proper alignment, leveling, use of proper accessories, high quality workmanship, etc.

7.02.08 The Contractor shall remove the RCC/steel trench covers whenever required and shall again place the same in their positions after the erection work in the particular area is completed or when further work is not likely to be taken up for some time.

7.02.09 Whenever any pipe/conduit/cable tray emerges out or enters into a building care should be taken to ensure that no water enters into the building.

7.02.10 Cable trays in areas subject to excessive coal dust, oil spillage, mechanical damage or accessible to personal contact shall be provided with raised sheet metal tray covers, installed on upper tray in horizontal run and front in vertical run.

7.02.11 Cable trays/racks shall be so arranged that they do not obstruct or impair clearances of passage way.

7.02.12 Cable tray/conduit system will be so designed as to accommodate maximum pulling tension and minimum bending radius of cable.

7.02.13 Cable tray/conduit system will be constructed to prevent drainage of water into equipment or building.

7.02.14 Cable tray/conduit system shall be electrically continuous and grounded.

7.02.15 Different voltage grade cables will be laid in separate trays when trays are run in tier formation. Power cables will normally be on top trays and control/instrumentation cable on bottom trays.

7.03.00 **Cable and Conduits**

7.03.01 The Contractor shall install, terminate and connect up all cable and conduits as per drawings and cable schedules.

7.03.02 The drawings shall be strictly followed except where obvious interference occurs. In such cases, the routing shall be changed as directed and/or approved by the Engineer.

7.03.03 Approximate lengths of cable and conduit runs will be shown by the contractor in the cable schedule for guidance only. Before commencement of work the Contractor shall take actual measurements and prepare his own cable-cutting schedule to reduce wastage to a minimum.

7.03.04 The Contractor shall also maintain and submit when requested, a record of cable insulation value when drawn from store, after laying, before and after termination/jointing.

7.03.05 Where direct heat radiation exists, heat isolating barriers, shall be adopted for cabling system.

7.03.06 Cabling/wiring in offices, laboratories, control rooms etc. shall be taken through concealed G.I. or rigid PVC pipes as directed by the owner's Engineer.

7.03.07 At certain places where hazardous fumes/gasses may cause fire to the cables, cable trenches after installation of cables shall be sand filled.

7.04.00 **Conduit and Accessories**

7.04.01 Conduit/pipes shall be used only in short lengths in certain areas where required and/or as directed by the Engineer.

7.04.02 The Contractor shall furnish all conduits complete with accessories as required.

7.04.03 Conduits shall be flexible type in general. However, rigid type steel conduit if required shall also be supplied by the Contractor.

7.04.04 Except for inside an enclosure wherever the cable enters or leaves the conduit, the conduit end shall be sealed by suitable sealing compound, having fire withstand capability.

7.04.05 The entire metallic conduit system, when embedded or exposed shall be electrically continuous and grounded.

7.04.06 Where it is possible for water or other liquids to enter conduits, sloping of conduit runs and drainage of flow points shall be considered.

7.04.07 Pull boxes will be installed between termination points where required to facilitate cable pulling, but at a maximum interval of 30 meters.

7.04.08 Conduits shall be firmly fastened within 900 mm of each junction box/pull box/cabinet/fitting, etc. Conduits shall be supported at least every 2000 mm.

7.05.00 **Cables : Storage and Handling**

7.05.01 Cable drums shall be stored on hard and well-drained surface so that they may not sink. In no case shall the drum be stored on the flat, i.e., with flange horizontal.

7.05.02 Rolling of drums shall be avoided as far as practicable, for short distance, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.

7.05.03 In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cable.

7.05.04 For unreeling the cable, the drum shall be mounted on jacks or on cable wheel. The spindle shall be strong enough to carry the weight without bending.

7.05.05 The drum shall be rolled on the spindle slowly so that the cable should come out over the drum and not below the drum.

7.05.06 While laying cable, cable rollers shall be used at an interval of 2000 mm. The cables shall be pushed over the roller by a gang of people positioned in between rollers over a suitable distance. Care shall be taken so that kinks and twists or any mechanical damage does not occur in cables. Only approved cable pulling grips or other devices shall be used. Cables shall not be dragged on ground or along structure while laying out from cable drums.

7.05.07 Cable shall not be pulled from the end without having intermediate pushing arrangement. Bending radius of the cable during installation shall not be less than what is specified by the manufacturer.

7.05.08 Empty cable drums shall be returned to the Owner.

7.06.00 **Cable Laying**

7.06.01 Cables will generally be laid on ladder type prefabricated cable trays, cable rack, overhead supported from building steel/structures or cable bridge/cable trestle as per approved drawing. For outdoor area cable rack shall be used in Pipe Bridge for outdoor area cable interconnection. Cables shall be run in concrete trenches in transformer yard and switchyard only and in those electrical rooms at ground level, which are without any spreader room below. Cables buried directly in ground are not acceptable except for street lighting cable.

In indoor pumps, mechanical equipment areas overhead cable trays shall generally be used.

A.C. and D.C. circuit will not be run in same cable. Further, separately fused circuit will run in separate cables. Cables for redundant equipment system shall be run in separate trays, as far as possible.

7.06.02 Cables laid on trays and risers shall be neatly dressed and clamped with self-locking type fire resistant nylon ties at an interval of 750 mm. for horizontal and vertical runs, in case of both power, control and instrumentation cables.

7.06.03 All single core power cables for 3 Ph. AC circuits shall be laid in trefoil formation and suitably clamped with self-locking type fire resistant nylon ties at an interval of 750 mm.

7.06.04 All H.T. multicore power cables and L.T. multicore power cables with cross-sectional area including & above 95 sq.mm shall be clamped individually by self-locking type fire resistant nylon ties.

7.06.05 L.T. power cables of cross sectional area less than 95 sq. mm. and all control and Instrumentation cables shall be clamped in bunches with self-locking type fire resistant nylon ties. The number of cable in one bunch shall not exceed eight (8).

7.06.06 Prior to laying of cables inside the indoor and outdoor trenches, the contractor shall properly clean the trenches.

7.06.07 For underground crossing of railways, road, etc. additional protection shall be provided in form of hume pipe or concrete encased rigid steel conduits (duct bank.

7.06.08 After completion of installation and prior to connection, all power cables shall be subjected to a high potential test.

7.07.00 **Cable Tags & Markers**

7.07.01 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance, bends, every 30.0M and exit from any equipment, junction box. When a cable/conduit passes through a wall, tags shall be fitted on both sides of the wall.

7.07.02 The tags shall be of aluminium with the number punched on it and securely attached to the cable by not less than two turns of 16 SWG G.I. wire. For single core cable the wire shall be of non-magnetic material.

7.07.03 The location of cable joints, if any, shall be clearly indicated with cable marker with an additional inscription 'cable-joint'.

7.07.04 The Contractor shall furnish and install all tags and markers stated above.

7.08.00 **Cable Termination and Connection**

7.08.01 The termination and connection of cables shall be done strictly in accordance with manufacturer's instruction, drawings and/or as directed by the Engineer.

7.08.02 The work shall include all clamping, fitting, fixing, soldering, tapping, compound filling, cable jointing, crimping, shorting and grounding as required for the complete job. All equipment required for all such operations shall be of Contractor's procurement.

7.08.03 Furnishing of all consumable materials such as soldering material, electrical tape, sealing material as well as cable jointing kits shall be included in the offer.

7.08.04 Cable joint kits for all cables shall be supplied by Contractor under this specification. Responsibility for proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by Contractor.

7.08.05 The equipment will be generally provided with blank bottom plates for cable/conduit entry and cable end box for power cables.

7.08.06 The Contractor shall perform all drilling, cutting on the blank plate and any minor modification work required to complete the job.

7.08.07 If the cable end box or terminal enclosure provided on the equipment is found unsuitable and requires major modification, the same shall be carried out by the contractor.

7.08.08 Control/instrumentation cable cores entering control panel/ switchgear/ MCC, etc. shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.

7.08.09 The Contractor shall put ferrules on all control cable cores in all junction boxes and at all terminations. The ferrules shall carry terminal numbers as per drawings. All ferrules shall be coloured, plastic & interlocked type.

7.08.10 Spare cores shall be similarly ferruled, crimped with lug and taped on the ends. Spare cores shall be ferruled with individual cable number.

7.08.11 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

7.08.12 All cable entry Points shall be properly sealed and made vermin and dust proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.

7.09.00 **Termi-point Connection**

a) The conductor (solid or stranded) is forced against the contact area of the 2.4 x 0.8 mm or 1.6 x 0.8 mm connection pin by means of a tin-coated bronze clip, which maintains a constant pressure. In the Maxitermi-point method, 2.4 x 0.8 mm pins is used without exception.

b) The conductor is "shot" onto the pin together with the clip. The resulting friction causes both the wire and the contact area of the pin to be cleaned and any oxide layers to be penetrated.

c) Apart from this the wire and the clip are deformed in such a way that a gas-tight connection with very good electrical and mechanical properties is established.

d) A special manually or pneumatically driven gun is required. Up to 3 adjacent connections can be "shot" onto one pin. In most cases only one clip at the base of the pin is attached. The sections above usually remain vacant. Any part of a connection pin may be reused several times after removal of the existing clip connection. Contact areas below existing connections that have become vacant can be reused by pushing the connections above the vacant space downwards, so that the new connection can be "shot" on above the top connection. The single jumper wires need not be specially prepared as the end insulation is stripped within the tool.

e) This connection method requires special insulation of the wires. The diameter of solid conductors is 0.8 mm the cross-section of stranded conductors 0.5 Sq.mm.

f) The conductor is deformed greatly when attached and is to be shortened by 3 mm when disconnected and reused.

g) Strips and special tools for termi-point connection shall be supplied by the Contractor.

7.10.00 **Cable Joints**

7.10.01 Cable shall be installed without joints as far as practicable.

7.10.02 If however jointing becomes necessary, it shall be made only by qualified cable jointer and strictly in accordance with manufacturer's recommendation.

7.11.00 **Grounding**

7.11.01 The Contractor shall carryout the interconnection among various peripheral earthing grids/mats, steel structures, lightning protection system as well as grounding of all electrical equipment, etc. The grounding work shall be carried out as per provisions of I.E. rules Indian standards and enclosed grounding and lightning protection notes and details.

7.11.02 The grounding shall be done by conductors of adequate sizes (size shall be selected by the bidder with supporting calculation) and the same shall be connected to the risers of main ground mat.

7.11.03 For fabricated cable trays, a separate ground conductor (50x6 mm G.S. flat) shall run along the entire length of each route of cable tray being suitably clamped on the cable tray. Individual cable trays of each section shall be connected to above ground conductor through 50x6 mm G.S. flat to maintain continuity of ground path.

7.11.04 All ground conductor connections shall be made by electric arc welding/ brazing unless otherwise specified. Ground connections shall be made from nearest available station ground grid risers. The rods/connection shall be coated with cold galvanizing /weather resistance anti corrosive paints.

7.11.05 All ground conductors shall be painted black for easy identification.

7.11.06 Equipment ground connections, after being checked and tested by the Engineer, shall be coated with anti-corrosive paint.

7.11.07 Whether specifically shown or not, all conduits, trays, cable armour and cable end box, electrical equipment such as motors, switchboards, panels, cabinets, junction boxes, lockout switches, fittings, fixtures, etc. shall be effectively grounded.

7.11.08 If there is no provision to ground the L.T. transformer neutral at transformer end, to make an effectively earthed 415V system the neutral bus of all 415V distribution boards shall be connected to ground grid at two different and distinct points.

7.11.09 The underground mat will be made of mild steel rods laid underground in length and breadth of the area at a depth of minimum 1 metre below grade level. All crossings and straight run shall be arc welded for good electrical continuity. Ground conductors, when crossing underground trenches, directly laid underground pipe and equipment foundation, if any, shall be at least 300

mm below the bottom elevation of such trenches/pipes as shown in the relevant drawing.

The Contractor will plan and organise works to lay the grounding mat in the same sequence in which the building and equipment foundation is being done.

7.12.00 **Painting**

7.12.01 The Contractor shall paint steel fabrications at site with two (2) coats of red oxide primer. Finish paint shall be as per TSGENCO standard practice which will be informed to Bidder during detail engineering. Also refer to clause no. 1.16.00 of Section-I, Volume V-A.

7.13.00 **Galvanising**

7.13.01 The galvanising shall be uniform, clean, smooth, continuous and free from acid spots. Should the galvanising of the samples be found defective, the entire batch of steel has to be regalvanised, at Contractor's cost. The amount of zinc deposit shall not be less than 610 grams per square metre of surface area and in addition, the thickness of the zinc deposit at any spot whatsoever shall not be less than 75 microns. The Owner reserves the right to measure the thickness of zinc deposit by Elkometer or any other instrument and reject any component which shows thickness of zinc at any location less than 75 microns.

7.14.00 **Excavation and Back Filling**

7.14.01 The Contractor shall perform all excavation and backfilling as required for buried cable and ground connections.

7.14.02 Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.

7.14.03 The Contractor shall make use of his own arrangements for pumping out any water that may be accumulated in the excavation.

7.14.04 All excavation shall be backfilled to the original level with good consolidation.

7.15.00 **Steel Fabrication**

7.15.01 All racks, trays, supports, hangers & brackets wherever necessary shall be fabricated by the Contractor.

7.15.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge and burns so as not to cause any damage to personnel or cables.

7.16.00 **Cleaning up of Work Site**

7.16.01 The Contractor shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.

7.16.02 Upon completion of work, the Contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

8.00.00 TESTS

8.01.00 Shop Tests

8.01.01 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works.

8.01.02 Tests on panels/junction boxes shall include :

a) Wiring continuity tests.

b) High voltage and insulation tests.

c) Operational tests.

8.02.00 Site Tests

8.02.01 Contractor shall thoroughly test and meggar all cables, wires and equipment to prove the same are free from ground and short circuit.

8.02.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.

8.02.03 All power cables after installation and prior to connections shall be subjected to High Potential tests. Also the insulation resistance values shall be measured both before and after Hipot test for comparison. The leakage current shall also be measured during the Hipot test at site.

Cable cores shall be tested for :

a) Physical damage

b) Continuity

c) Correctness of connections as per relevant wiring diagram

d) Insulation resistance to earth

e) Insulation resistance between conductors

f) Proper earth connections of cable glands, cable boxes, cable armour, screens etc.

8.02.04 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.

8.03.00 Test Certificates

8.03.01 Type test certificate on any equipment, if so desired by the Owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

9.00.00 DRAWINGS, DATA & MANUALS

9.01.00 To be submitted with the Bid

9.01.01 Make, type and catalogue number of different electrical items and accessories along with technical leaflets, data sheets etc.

9.01.02 Typical General arrangement drawings showing constructional features, fixing arrangement of pre-fabricated cable trays.

9.01.03 Bill of Materials for cable trays and accessories, conduits & accessories.

9.01.04 Layout of Grounding system & lightning protection system showing connection and other details along with backup design calculations and detailed write up.

9.01.05 Bill of materials for grounding and lightning protection system.

9.01.06 Drawing showing details of equipment grounding.

9.02.00 **To be submitted after Award of Contract**

9.02.01 Make, type & catalogue number of cable termination kits, joints & accessories.

9.02.02 Detail dimensional drawings showing constructional features, grounding, fixing arrangement etc.

9.02.03 Bill of Materials for Pre-fabricated cable tray and accessories, Conduits & accessories.

9.02.04 Dimensional G.A. drawings and data sheets for different equipment and items supplied under this specification.

9.02.05 Layout drawing of Grounding system and Lightning protection system showing connection details along with backup design calculation and detailed write up.

9.02.06 Bill of material for grounding system and lightning protection system.

9.02.07 Drawing showing details of equipment grounding system.

9.02.08 Cable schedule and inter-connection charts for the entire power plant.

ANNEXURE-A

NOTES AND DETAILS FOR CABLING SYSTEM

1.00.00 **GENERAL**

1.01.00 These notes and details shall be read and construed in conjunction with Specification and the drawings meant for cable tray details and supporting arrangements in Trench, Racks etc., enclosed elsewhere. In case of conflict between these notes and drawings, the latter shall prevail.

1.02.00 The Cabling System installation work shall conform to the requirements of the latest revisions of the following standards/codes

a) Indian Electricity Rules, 1956, with up to date amendment.

b) I.S. Code of Practice.

2.00.00 **CABLE ROUTING/LAYING**

2.01.01 Cables shall generally be laid on ladder type cable trays either in trenches or overhead supported from building steel/structures except in some cases cables may have to be laid underground and for short runs in conduits for protection or crossing.

2.01.02 For interplant connections, the cables may be directly buried or routed through an overhead cable bridge or cable trenches/tunnels selection being dependent on site constraints.

2.01.03 For underground crossing of railways, roads etc. hume pipes shall be used and shall be laid at a depth of minimum 1000 mm such that cables shall not be damaged.

2.01.04 In boiler area, trench will be avoided as far as practicable. The cable racks shall be supported from Boiler structure in vertical configuration with suitable cover to avoid deposition of coal dust as far as practicable.

2.01.05 Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers. Power cables shall be on top trays and Control/Instrumentation cables on bottom trays, and it is recommended that trays for cables of different voltage levels be stacked in descending order with higher voltage level above.

2.01.06 Cables for redundant equipment/system shall be run in separate trays in separate route.

2.01.07 Cables from two different services viz. supply from station board and supply from unit board shall be fully segregated to prevent simultaneous damage due to fire in one of the services.

2.01.08 Low level signal cables and other special Instrumentation and Control cables shall run in separate trays. In general, a minimum of 1500 mm clearance shall be maintained between these cables and noise generating equipment (large motors, generators, transformers etc.).

2.01.09 The cable spreaders of each unit shall be compartmentalized by provision of fire proof partition wall.

2.01.10 The floor of the cable spreader rooms will have to be made water proof so that water does not percolate to lower levels in the event of fire fighting operations. Adequate arrangement for efficient drainage of water shall be provided. The cable raceways should also be suitably curved to avoid water entry through this place.

2.01.11 Cabling System for CHP

a) Cable in CHP area shall be generally routed through the conveyor gallery / tunnel, TP / Buildings by separate supporting structures, Pipe cum cable bridge. The cables shall be laid in vertical trays.

b) In substation & switchgear room cable shall be laid in horizontal cable trays installed in cable vault room.

c) Cables may also be routed through hume pipes to enter into various buildings from the nearest overhead cable trestle/substation building.

d) Overhead cable trestle/cable bridge shall be provided for routing of cables between the following Sub-Stations/buildings:

i) Main CHP Substation Building and Crusher House.

ii) Main CHP Substation Building and Pump House (if required).

iii) Wagon Tippler Substation Building and TP.

The bottom of the steel supporting structure shall be generally at 2.5m above the grade level except for road crossing and rail crossing where the same shall be 6.5 m and 9.0m respectively above grade level.

e) Cable trays shall be laid out horizontally in sub-station buildings and pump-house whereas the same shall be installed vertically inside transfer points, crusher house, conveyor gallery/tunnel etc. The cable trestle shall have a minimum 600mm clear walk way all along its routes and shall have maintenance platforms as required.

f) Separate trays shall be provided for H.T., L.T., control and instrumentation cables. LT mutlicore Power cables shall be laid in single layer & touching formation and single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil centre lines and clamped at every two meter while control and instrumentation cables shall be laid in maximum of two layers formation. Single core HT power cables shall be laid on trefoil formation with a distance of four times the diameter of cable between trefoil centre lines and clamped at every two meter and Multi core power cables shall be laid in single layer & touching formation. Normally cable trays shall be designed with 70% fill-in criteria and

conduit 40% fill-in criteria. Same cable laying philosophy shall be considered in other areas of the plant, if not specifically mentioned.

2.02.00 **Cable Trays/Supports**

2.02.01 Cable trays and covers shall be pre-fabricated type, constructed from minimum 14 SWG sheet steel for trays and 16 SWG for covers and hot-dip galvanized after fabrication.

2.02.02 Cable tray supports shall be cantilever type for each installation. All supports and hardware shall be hot-dip galvanised.

2.02.03 Standard cable tray width shall be 600 mm. However, trays with 450, and 300, 150 mm width may be used in some places considering the requirement and space restrictions. For instrumentation and control purpose, some perforated type cable trays of width 150 and/or 100mm may be used particularly in Boiler Platform area, and 600, 450, 300 mm perforated trays may be used depending on site requirement.

2.02.04 Cable trays shall be ladder type with 250 mm rung spacing, 100 mm depth and rung width not less than 50 mm. Ladder type trays for power & control cables and perforated type for instrumentation cables shall be provided.

2.02.05 All weld for cable tray supports shall have a min. throat thickness of 6 mm.

2.02.06 Cable trays in areas subjected to excessive coal dust, or mechanical damage will have hot-dip galvanised sheet metal tray cover installed on front tray in vertical run and inverted `V' type on upper tray in horizontal run.

Where covers are used on trays containing power cables, consideration should be given to ventilation requirements. Areas where corrosive chemicals are likely to be handled, cable tray and covers shall be epoxy painted.

2.03.00 **Conduits**

2.03.01 Conduits shall be rigid steel coated type; minimum size of conduit shall be limited to 19mm.

2.03.02 Steel conduits with interior coating of silicon epoxy ester for ease of wire pulling shall be seamed by welding and flo-coat metal conduit/hot-dip galvanised. These shall be supplied in standard length of 5M with minimum wall thickness as specified in IS:9537 Part-II. In chemical handling areas, Battery room etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion.

2.03.03 Conduit runs shall be supported at an interval of 750 mm for vertical run and 1000 mm for horizontal run.

2.03.04 Conduits shall be sized so that conduit fill (ratio of total cable area to conduit area) shall not exceed the following :

One Cable	:	53%
Two Cable	:	31%
Three Cables & Up	:	40%

2.03.05 Conduit runs shall be provided with necessary bends as required.

2.04.00 **Installation**

2.04.01 The Contractor shall install terminate and connect up all cables and conduits with supporting arrangements as per drawings, cable schedules and interconnection chart/drawings.

2.04.02 The HV power cables of 11 KV/3.3 KV shall be laid in trays or racks as follows :

a) In single layer only.

b) Multi core cables to be laid in touching with each other.

c) Single core cables to be laid in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil centerlines and clamp every two meter.

2.04.03 1100V grade power cables shall be laid in single layer in trays.

2.04.04 1100V grade mutlicore power cable shall be laid in touching formation to each other.

2.04.05 1100V grade Single core cables to be laid in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil centerlines and clamp every two meter.

2.04.05 Control and Instrumentation cables can be laid up to a maximum of two layers in each tray.

2.04.06 Normally cable trays shall be designed with 70% fill-in criteria and conduit 40% fill-in criteria. Same cable laying philosophy shall be considered in other areas of the plant, if not specifically mentioned.

2.04.07 The trays shall be run with a vertical spacing of 300 mm for overhead cable trays as well as inside cable trenches. A minimum of 225 mm clearance shall be provided between the top of tray and beams, cold piping, 500 mm clearance for hot piping/object to facilitate installation of cables in tray.

2.04.08 Adequate pull boxes shall be provided in conduit run to facilitate cable pulling in long runs and also to ensure that there will be no more than 270 Deg. bends between pull points.

2.04.09 Cable tray/conduit system shall be installed to accommodate cable manufacturer's recommended maximum pulling tension and minimum bending radius.

2.04.10 All openings in the floor and wall for cable access shall be sealed after installation of the cable system with non-inflammable materials, as follows :

i) Fire stop/Penetration seal shall be installed in the cable spreaders and cable raceways.

ii) Similarly in the trenches fire stop/penetration seals shall be provided at suitable interval to avoid spread of fire.

iii) For all H.T., L.T., Relay and Control panels, Control desk, instrumentation panels, battery charger, D.C. Dist. boards and other miscellaneous panels, fire-stops should be provided below base plate.

2.04.11 All floor/wall openings for cable entry to the electrical equipment and accessories shall be sealed with non-inflammable materials, after completion of cable installation. Thickness of such materials shall be equal to the thickness of floor/wall unless specified otherwise.

2.04.12 The portion of galvanised steel, which, if required, undergoes any welding at site shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

2.04.13 Refer Clause No. 3.00.00 below for details of fire-proof sealing and fire protection coating.

2.05.00 **Identification**

2.05.01 The complete cabling system shall be properly identified. Methods for identification of cabling system shall be furnished to the successful EPC Contractor shall strictly adhere to the said methods.

2.05.02 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

2.05.03 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanised iron plate, projected above ground level.

2.05.04 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, at each bend and at every thirty (30) metres in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, MCC, control & relay panels etc. wherever required for cable identification, such as where a number of cables enter together through a gland plate.

3.00.00 **FIRE-PROOF SEALING / FIRE PROTECTION COATING SYSTEM**

3.01.00 The Fire proof sealing / fire stop system / fire protection coating system is required to prevent spreading of fire from one placed to other place (or one zone to other zone) through the openings in wall / floor, cables laid in trays / racks and openings below Electrical Switchgear / MCC / Distribution boards / Cabinets / Panels, etc. The fire proof sealing system shall conform to the latest edition including amendments of BS-476.

3.02.00 **Scope of Work**

3.02.01 The scope of work includes but is not limited to the following supply and services:

i) Fire Stops in wall / floors.

ii) Fire stops below switchgear / MCC / Switchboards, junction boxes / panels / cabinets, etc. which are floor mounted type.

iii) Fire retardant coating to be applied for installed cables.

iv) Minor civil / structural works for installation of the entire work.

v) All necessary erection materials, consumables and sundry items to complete the entire work for satisfactory and trouble free operation.

vi) Any special tools & tackles.

vii) Conducting the type test of fire proof sealing system in presence of Owner's engineers.

viii) All relevant Drawings, Data sheets and instruction manuals.

ix) Fire proof barrier walls.

x) Fire proof doors.

3.03.00 **Design Criteria**

3.03.01 Fire Proof Sealing System

The material / components used for fire-proof sealing system shall be provided to meet the following requirements:

i) Life expectancy should not be less than 30 years from the date of installation.

ii) Free from shrinkage or cracking or asbestos in composition and should achieve smoke and gas tightness during fire and should be modifiable.

iii) Not to generate toxic gas and harms to the personnel handling the system.

iv) Prohibition of production of acid or alkali during gas generation.

v) Will not produce suffocating / corrosive gas.

vi) Repellant to paste / rodent / termite.

vii) Expansion co-efficient - very low which is to be comparable with masonry concrete.

viii) Not soluble / reactive to acid, water, alkali.

ix) Thermal conductivity - low.

x) The material in contact with the cables in the fire-proof sealing system shall be compatible with the material used for outer sheath of cables.

xi) It should not have any adverse effect on the cables and should not alter the current carrying capacity of the cables.

xii) Retrofit in design to accommodate not less than 15% more addition of cables depending upon the size of cables, physically and chemically stable.

xiii) Capable of withstanding vibrations, drop-loads, foot traffics, mechanical loads, etc.

xiv) The F.P.S. system shall maintain its integrity and perform satisfactory even after

a. Remaining in water for a long time.

b. Accelerated thermal aging.

c. Sustaining vibrations.

xv) The design and construction of F.P.S. system shall specifically take into account the fact that under seismic disturbances, normal load, short circuit and fire conditions, the cable / cable trays will be subject to movement, expansion and oscillation and this shall not result in any damage or cause dislocation of the F.P.S. system or the material constituting the FPS System.

xvi) Non-hygroscopic, non-inflammable and shall not get affected over a period of time due to humidity, moisture and ozone etc. and should not contain volatile solvents which may cause a fire hazard during application.

xvii) The fire rating shall not be less than one (1) hour and the system shall be stable after applicable of water jet in the exposed side in order to extinguish fire.

3.03.02 Fire Protection coating to be applied on installed Cables:

The cables shall be coated with fire protection material of 2 mm dry thickness at the strategic locations as follows so as to limit the spread of fire:

i) At fire stops in walls and floors on either side upto 500 mm length.

ii) At fire stop below Electrical Switchgears/ MCCs/ Panels/ Cabins, etc. on one side coating of 500 mm length, i.e., on the cable vault side / cable trench side.

iii) Length of 500 mm on all sides of the junction/crossing of cabling work in open cable routes/ cable trench.

iv) In fire risk areas and where specified at suitable intervals as decided upon side conditions in open cable routes.

v) Where necessary and specified at site intervals along cable routes in cable trenches.

vi) The coating shall be applied evenly on the cables only.

3.03.03 The fire protection coating shall have the following properties/composition:

i) Asbestos free, non-volatile, not eatable by vermin, harmless and non-irritant to skin of human.

ii) Not affecting the current carrying capacity of the cables and the properties of the installed cables.

iii) It shall delay fire damage to cables and prevent flame spreading meeting the requirement of IEEE - 383.

iv) Coating material shall show no signs of cracking and peeling when the coated cable is bent to the radius of minimum 12 times the diameter of the maximum size cable at 180°C.

v) The limiting oxygen index of the material shall not be less than 60% as per ASTMD - 2863.

vi) Life expectancy equivalent to the cable installations.

3.03.04 The various openings in the cable vault, vertical/ horizontal raceways of cables penetrating walls/ floors and the bottom of Electrical switchgears/ MCCs/ distribution boards/ Cabinets/ Panels shall be provided with fire stop systems. Cables passing through the openings at various locations are laid on various tiers of the cable trays/ racks in the bunch formation. Bidder shall visit the site to assess and get acquainted with the type of cable installation where fire stops and fire protection coating are to be provided. In case steel frames are required to be fabricated and fixed in the openings, the fabrication of frame & fixing of the same shall have to be done by the Contractor without any extra cost. The necessary steel section for fabrication of frames shall be supplied by the Contractor without any extra cost. Any civil works required to be done in the openings shall be carried out by the Bidder. Bidder shall also include one set of tools & accessories required for addition or removal of cables after the seal is made.

3.04.00 The bidder shall quote the unit rates for provision of supply, installation, testing & commissioning of the fire proof seals as given in the specification. Bidder is requested to quote the unit rates per square metre (i.e., area) basis of the area of the fire sealing material.

3.05.00 **Type Test On Penetration Seals**

3.05.01 The type tests for fire proof/ penetration seal for floor and wall opening/ fire stop system for bottom of electrical switchgear/ MCC/ panel base are as under:

i) Fire rating test.

ii) Hose Stream test.

iii) Accelerated aging test.

iv) Fire rating test on the penetration seal system built out of accelerated aged components followed by hose stream test.

v) Temp. rise test for cable in the fire stop.

vi) Water absorption test followed by fire rating test.

vii) Flame Resistance test for fire retardant coating material.

viii) Anti-rodent test.

3.05.02 Fire Rating Test

This test shall be carried out to prove the guaranteed power rating duration of the system in respect of stability, integrity and insulation characteristics of the complete system. The penetration seal system as a whole conforming to ASTM 814 and as per BS:476 Part-8 shall be built with the necessary component. The fire test shall be built with the necessary component.

The test specimen of the penetration seal built with 9-10 nos. armoured cables of various sizes passing through the seal shall be fitted to the gas fired furnace and shall form the upper most face of the furnace. The gas fired furnace shall have provision to achieve standard time temperature characteristics for fire tests as mentioned in BS-476 Part-8, according to which the temperature required to be maintained are as under:

Heating time in minutes	**Temperature in the furnace**
30 minutes	821°C
90 minutes	886°C
120 minutes	1029°C
150 minutes	1062°C
180 minutes	1090°C
210 minutes	1113°C
240 minutes	1133°C

The pressure inside the furnace at the time of test shall be more than 2 mm water gauge. The penetration shall be subjected to fire test with surface exposed to controlled fire in the furnace conforming to time / temperature characteristics as mentioned above. During the test, the temperature of both the faces of the penetration seal, i.e. one which is exposed to fire and the other unexposed, shall be measured by calibrated thermocouples after regular interval of 5 minutes. At least 3 thermocouples shall be provided for temperature measurement of each face.

3.05.03 The results at the end of the tests shall be interpreted or failure criteria as under:

i) The system is deemed to have failed to maintain stability if there is a total collapse of the penetration seal.

ii) In case cracks are seen on the face of the penetration seal or cracks through the sealing system through which the flame / or gas can pass,

the system is deemed to have failed to maintain integrity. The development of crack is characterized by ignition cotton wool held near the seal on the unexposed surface at a distance of about 30 mm from the aperture.

iii) In case the mean temperature rise of unexposed surface of seal exceeds 140°C above the initial temperature or temperature of unexposed surface exceeds 180°C, the system shall deemed to have failed in respect of insulation characteristics.

iv) Temperature measurement on the unexposed side of the penetration seal specimen shall be measured by the thermocouple on the surface of penetrating items and on fire stop material in accordance with ATME-814/UL 1479 at a distance of 25 mm from fire stop material and penetration items respectively.

3.05.04 Hose Stream Test:

The intention of the hose stream test is to ascertain whether the penetration seal assembly maintains its stability on application of water jet after withstanding the fire for 1 hour i.e. the guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for carrying out the fire rating test. The penetration seal system shall be subjected to the action of hose stream at the nozzle pressure of 30 psi supplied for a duration of 1.5 sec./ sq.ft. of exposed area. The hose stream shall be applied with 1.1/ 8" dia. nozzle at a perpendicular distance of approximately 17 ft. from the centre of the assembly on a line approximately 270 deg. from the line normal to the centre for the test assembly. The water stream shall be applied within 4 minutes and 30 seconds after completion of fire rating test.

However, this period shall not exceed more than 10 minutes in case of practical difficulties experienced by testing stations. The application of water stream shall be maintained through out the test duration and shall traverse the complete fire stop system.

The fire stop assembly is deemed to have passed the hose stream test successfully if no through projection of water is noticed on the unexposed surface of the seal. Further on completion of hose stream test, the appearance of the penetration seal system shall not alter substantially indicating thereby that the stability of the system ahs been maintained.'

3.05.05 Accelerated aging test

The intention of accelerated aging test is to ascertain whether the artificial aging of the systems and components thereof results into change in the mechanical properties or in the form. In order to simulate aging, artificial aging shall be resorted to.

For the purpose of subjecting the penetrations seal system components to accelerated aging, the system / components shall be stored for 336 hours in air furnace where the temperature of the inside air, shall be maintained at 100 degree centigrade. However, for system components in pliable form, system component shall be stored for 448 hours in air furnace where temp. of air inside the furnace shall be maintained at 75°C. It is assumed that the

changes occurring during test period would roughly correspond to the effect on aging over a period of about 40 years.

After completion of 336 hours / 448 hours, the mechanical properties such as tensile strength element, elongation and hardness of the material (as may be applicable) shall be tested. These results shall be compared with corresponding values before subjecting to accelerated aging test.

The change in the form of system / components shall also be compared with the form before the tests to ascertain whether the system / components thereof have undergone any permanent change.

In case the mechanical properties before and after the accelerated aging do not indicate substantial change, the system shall be deemed to have passed the accelerated aging test. Similarly the variation in the form of the system components at the end of the test shall not indicate permanent deformation which is likely to affect the ceiling properties of the system.

3.05.06 Fire Rating test After Accelerated Aging:

Intention to this test is to ascertain whether the penetration seal built out of components already subjected to accelerated aging still passes the fire rating test for guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for fire rating test mentioned above. The assembly or the penetration seal shall be carried out with the components which were subjected to accelerated aging test based on the test procedure mentioned above. In case there is a problem of co-ordination with the test station, the prototype assembly may be subjected to aging in manufacturer's works under the conditions mentioned above and live fire test should be carried out at manufacturer's works in presence of Owner's representative.

In live fire test, the temperature of fire shall be of the order of 1000 deg.C at the end of 3 hours. The test shall be carried out at atmospheric pressure.

The interpretation of test results for failure shall be similar to those mentioned under fire rating test/live fire test at (1) - (c) above.

3.05.07 Temperature rise test for cable in the fire stop:

This test shall be carried out to ascertain whether due to inadequate dissipation of heat at the location of fire stop, the temperature of cable conductor or outer sheath in contact with the fire stop, rises beyond the acceptable limits due to which whether any derating is required for cables.

Fire stop systems hall be erected with, at least 8-10 armoured cables, specially power cables. While laying the cable through penetration seal, thermocouple shall be placed on the outer surface of cable in contact with the fire stop system. The location shall be selected where there exists possibility of inadequate dissipation of heat from cables to the atmosphere due to fire stop components. Two thermocouples shall also be located on the two surfaces of the fire penetration seal system. Similarly thermocouples shall also be placed on the other surface of cables where there exists contact of free air without any obstruction so as to enable adequate nature cooling.

In case the temperature of outer surface of the cable in contact or inside the fire stop system does not exceed 75 degree centigrade, it is inferred that no derating of cable is required for cable when used in conjunction with the particular fire stop system.

Test shall be repeated with reduced current till the temperature of cable outer surface in contact with fire stop system is limited to 75°C. The rate of the current so guaranteed by the cable manufacturer as free air rating shall be the derating factor.

3.05.08 Water Absorption Test:

The test specimen shall be immersed in fresh clean water at a temp. of 20°C. The test specimen must be separated from the bottom and sides of the soak tank by at least 10 mm and it shall be covered by approximately 25 mm of water. At the end of the 24 hours soak period, the specimen shall be removed from the water and moped up with a damp cloth.

Fire rating test after water absorption is to ascertain whether the penetration seal subjected to water absorption still passes the fire rating test for guaranteed fire rating duration.

The test apparatus for this test shall be similar to the one used for fire rating test at Sr. No.1. In case there is problem of coordination with test stations, the prototype assembly may be subject to water absorption test at manufacturer's works followed by live fire test which should be carried out at manufacturer's works in presence of Owner's representative. In line fire test, the temp. of furnace shall be of the order of 1000°C at the end of 3 hours. The test shall be carried out at atmospheric pressure.

3.05.09 Flame Resistance Test for fire Retardant Coating Material:

Sample strips shall be of ½ " wide, 12" long and approximately 70 mills in thick (without any reinforcement). Each strip shall be held vertically (clamped at the top) in a natural gas burner flame, (blue cone of flame touching bottom edge of sample) for 10 minutes. The flame shall then be removed and observation shall be recorded. In case, any flaming of the samples should cease after the removal of gas burner. White charred length of the sample should not exceed 1 & ½".

3.05.10 Anti-Rodent Test:

Physical tests:

a) This test shall be carried out to ascertain the anti-rodent properties of the components of the Fire proof sealing system.

b) This test shall be carried out at approved test station performing sealing system tests on pharmaceutical products. The complete Fire Proof sealing system shall be subjected to attack of inspect / vermin such as rate for about 20 days.

c) At the end of the test condition of the surface of Fire Proof sealing system the test material shall be compared with the surface condition

before commencement of the test. The fire stop shall be deemed to have passed this test in case no marks of growth are seen on the surface.

3.05.11 Test Certificates

Certified copies of all tests carried out at works and at site shall be furnished in requisite number of copies.

Test reports shall be complete with all details and shall also contain limit valves specified in the relevant standards, wherever applicable, to facilitate review of Test Report/ Certificates.

The fire proof sealing system shall be installed only after receipt of approval of the test reports.

3.05.12 Testing Charges

The bidder has to indicate that unit rates for conducting the type test successfully alongwith the offer, which will be considered for evaluation of tender.

ANNEXURE-B

NOTES & DETAILS
FOR
GROUNDING & LIGHTNING PROTECTION SYSTEM

1.00.00 **GENERAL**

1.01.00 These notes and details shall be read and construed in conjunction with grounding and lightning protection drawings and specification. In case of conflict between these notes and drawings, the latter shall prevail.

1.02.00 The grounding and lightning protection system installation work shall conform to the requirements of the latest editions of the following standards/codes :

a) Indian Electricity Rules, 1956.

b) National Electrical Code, 1985.

c) Code of Practice for Earthing (IS: 3043)

d) Protection of Buildings and Allied Structures Against Lightning (IS: 2309)

e) IEEE 80

2.00.00 **GROUNDING SYSTEM**

2.01.00 **Main Grounding Mat/Grid**

2.01.01 The main ground grid shall be buried in earth at a minimum depth of 1000 mm below finished grade level unless stated otherwise. The diameter of ground grid conductor shall be selected by EPC contractor with supporting calculation.

2.01.02 A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trenches, tunnels, underground pipes, foundations, railway tracks etc. The ground grid conductor shall be re-routed in case it fouls with equipment foundations.

2.01.03 In some cases, it may happen that the construction work of cable trench, foundation and laying of underground pipes are being taken up after the grounding mat has been laid. It may be required to cut a portion of grounding conductor to avoid fouling with cable trench, equipment foundations, underground pipes etc. In this case, the ground conductor shall be properly rerouted and rejoined/reconnected with the main grounding mat during the construction/laying of above underground objects and good electrical continuity of grounding conductor shall be ensured.

2.01.04 Grounding conductors crossing the road may have to be laid at greater depth to suit the site conditions.

2.01.05 Grounding conductor around the building shall be buried in earth at a minimum distance of 1200 mm from the outer boundary of the building.

2.02.00 **Grounding Electrodes**

2.02.01 The ground electrodes shall be 3000 mm long, 40mm dia. mild steel rod. These shall be fabricated and driven into the ground by the side of grounding mat conductors and connected to the ground mat conductors.

2.03.00 **Risers**

2.03.01 All risers/pigtail from the ground grid shall be projected 300 mm above grade level/concrete floor level unless otherwise shown.

2.04.00 **Earthing Conductor**

2.04.01 75x 10 mm galvanised steel flats shall be run as main earthing conductors above ground along building columns, walls, steel structure, etc. for equipment and other structures earthing.

2.04.02 These earthing conductors shall be interconnected between them and to the main ground grid through risers/pigtail. The connection between earthing conductor and riser shall be made above ground.

2.04.03 Earthing conductors along their run on column, wall etc. will be supported by suitable welding/clamping at intervals set exceeding 750 mm.

2.04.04 Earthing conductors shall be embedded in concrete floor of the building without having direct contact with the reinforcement rods.

2.04.05 At the crossing of building walls, floors etc. the earthing conductor shall be passed through galvanised conduit sleeves. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

2.05.00 **Grounding of Equipment and Structures**

2.05.01 All indoor and outdoor electrical equipment and associated non-current carrying metal works, supporting structures, building/ boiler columns, fence, system neutrals, lightning masts/arresters shall be connected to the plant ground system.

2.05.02 Two separate and distinct ground connections shall be provided for grounding electrical equipment frameworks in compliance with I.E. rules.

2.05.03 All Electrical equipment will be furnished with two (2) separate ground pads with tapped holes, bolts and spring washers. The connection between these ground pads and the grounding grid shall be made by short and direct earthing conductors free from kinks and splices.

2.05.04 Miscellaneous devices such as junction boxes, pull boxes, pushbutton stations, lockout switches, cable end boxes, lighting fixtures, receptacles, switches etc. shall be effectively grounded whether specifically shown or not.

2.05.05 The generator neutrals, transformer neutrals, earthing terminals of lightning arresters, coupling capacitor shall be directly connected to rod electrodes through riser which in turn, shall be connected to station grounding mat.

2.05.06 Grounding mat comprising closely spaced conductors shall be provided below the operating handles of isolator and circuit breaker operating box located in outdoor high voltage substation. The operating handles shall be properly bonded with flexible conductors.

2.05.07 Metallic conduits and pipes shall not be used as earth continuity conductor. These shall be grounded at both ends.

2.05.08 a) The cable trays inside the cable trenches shall be grounded thru' one (1) no. M.S. Rod at an interval of ten (10) metres. One end of this rod is connected with riser from grounding mat and the other end which is projected inside the cable trench shall be connected with one (1) 50 x 6 mm G.S. flat which runs horizontally along the cable trench. This earthing conductor shall be securely attached to each tray section of cable tray/trays forming a solidly grounded tray system through 50 x 6 mm G.S. flats.

b) A continuous 50 x 6 mm G.S. flat earthing conductor shall run along the supporting structure of overhead cable trays/cable shafts. This earthing conductor shall be attached to each section of cable tray/trays through 50 x 6 mm G.S. flats.

2.05.09 Fence within the ground grid shall be bonded to the plant ground system at regular interval not exceeding ten (10) metres. Fence gate shall be separately grounded with flexible connection to permit movement.

2.05.10 The street lighting poles, junction boxes mounted on the poles, flood light supporting structures etc. shall be connected to ground grid at minimum two points.

2.05.11 The steel columns, metallic stairs, hand-rail etc. of the building where electrical equipment are located shall be connected to the nearby ground mat by earthing conductor. Electrical continuity shall be ensured by bonding the different sections of handrails and metallic stairs.

2.05.12 The railway tracks within plant area shall be bonded across fish plates and the rail tracks shall be connected to grounding grid at different locations. The rail tracks leaving the plant boundary shall be made electrically discontinuous from the rail tracks inside the plant area by providing suitable arrangements at fish plate joints.

2.05.13 The overhead crane rails shall be grounded at both ends. In addition all joints shall be bonded to provide electrical continuity.

2.05.14 The flexible earthing connection of jumpering wire shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

2.06.00 **Earthing of Cable**

2.06.01 The metallic sheaths, screens and armour of cables shall be earthed at both switchgear/MCC/DB and equipment ends.

2.07.00 **Jointing and Connection**

2.07.01 All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode. The contact surfaces shall be thoroughly cleaned to provide good electrical continuity.

2.07.02 The bending of the large diameter ground conductor where necessary shall be done by gas heating.

2.07.03 The projected portion of riser/pigtail above ground shall be coated with two coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

2.07.04 The connections between the riser/pigtail and earthing conductors (galvanised steel flats) and between the earthing conductors above ground level shall be made by electric arc welding.

2.07.05 The portion of galvanised steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

2.07.06 The earthing connections to equipment grounding pads/terminals and some removable structures shall be bolted type with GI bolts and nuts. The contact surfaces shall be thoroughly cleaned (to free from scale, paint, enamel, grease, rust) before connection to ensure good electrical contact.

2.07.07 Equipment/structures ground connections after properly checked and tested shall be coated with weather resistant paints/cold galvanising paints.

2.08.00 The sizes and materials of ground conductors used in grounding system are listed below :

	Description	**Size**	**Material**
a)	Main Grounding Grid Conductor	36mm dia. min. higher size if required by calculation.	Mild Steel
b)	Riser/Pigtail From Grounding Grid/Mat	to be decided By Bidder	Mild Steel
c)	Electrode	40mm dia. 3000 mm long.	Mild Steel

	Description	Size	Material
d)	Conductor used for connection of various equipment/structures as listed below		
	E.H.V. Substation equipment	75 x 10 mm Flat	Galvanised Steel
	Generator Frame & Gen Neutral	75 x 10 mm Flat	- Do -
	Generator Exciter Frame	75 x 10 mm Flat	- Do -
	GT, ST, UT Frame	75 x 10 mm Flat	- Do -
	GT, ST, UT Neutral	75 x 10 mm Flat	- Do –
	Aux. Power Transformer Frame	50 x 10 mm Flat	- Do -
	11 kV/3.3kV Equipment	75 x 10 mm Flat	- Do -
	415 V PMCC/Swgr	50 x 10 mm Flat	- Do -
	Structures, Bus Duct, Control Panels, Cable trays, etc.	50 x 6 mm Flat	- Do -
	415V Motor Control Centres, Distribution Boards etc.	50 x 10 mm Flat	- Do -
	Motors upto 5.5kW	8 SWG Wire	
	Motors 5.5kW upto 22kW	25 x 4 mm Flat	- Do -
	Motors 23kW upto 55kW	40 x 6 mm Flat	- Do -
	Motors 56kW upto 174kW	50 x 8 mm Flat	- Do –
	Motors 175kW and above	75 x 10mm Flat	- Do -
	Local Panels, Lighting Panels	50 x 6 mm Flat	- Do -
	Miscellaneous Items, viz. Push Button Station, Junction Boxes etc.	8 SWG Wire	

Note: Sizes of GS Flat as indicated above are minimum. However Bidder shall calculate each of them and submit for approval.

3.00.00 **LIGHTNING PROTECTION SYSTEM**

3.01.00 **Air Terminations**

3.01.01 The vertical air terminal rods shall be installed at the roof of buildings (including power house main building), at the top of chimney and cooling towers to protect these objects from lightning strokes.

3.01.02 The vertical air terminal except for chimney shall be made of 20 mm dia galvanised steel rod. The projected length of the rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.

3.01.03 The air terminal rods provided at the top of chimney/stack for lightning protection shall be 20 mm dia lead coated solid copper rod.

3.01.04 The air terminal rod shall be properly fixed on the top of the building/structure to withstand very high wind pressure. In case the air terminal rod is embedded at the top of roof of building: the portion embedded inside the concrete shall not touch the reinforcement bars and shall be duly insulated from them.

3.01.05 All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 75 x 10 mm galvanised steel flats.

3.01.06 The shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 degrees.

3.01.07 Horizontal air termination (i.e. G.S. Flat conductor) shall be so laid that no part of the rood will be more than nine (9) metres from the nearest roof conductor.

3.02.00 **Shielding Masts**

3.02.01 The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of power house main building.

3.02.02 The shielding mast shall be made of galvanised steel pipe and the height of the same shall be decided considering the zones to be protected.

3.02.03 Each shielding mast shall be connected to grounding grid by a down conductor 75 x 10 mm. Galvanised steel flat run along the building column. In addition all power house building columns joints shall be electrically bonded.

3.03.00 **Down Conductors**

3.03.01 The down conductors shall be 75 x 10 mm galvanised steel flats. The sizes of down conductors and horizontal conductor provided for lightning protection of conveyer gallery shall be 25 x 6 mm galvanised steel flats. One end of this shall be connected with air terminal rod/horizontal conductor at the top of roof/structure and other end connected to the nearest 40 mm dia. mild steel rod riser from ground electrode.

3.03.02 Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductor of grounding system above ground level.

3.03.03 The connection between each down conductor and rod electrode shall be made via test link located at approximately 1500 mm above ground level.

3.03.04 The down conductor shall be laid straight and sharp bends shall be avoided as far as practicable. These shall be cleated on outside of the building wall

and column/structure at about 750 mm intervals unless stated otherwise in the drawing.

3.03.05 At all supports for down conductor along the column/wall of the buildings; chimney etc. the portion embedded inside the building concrete should not touch the reinforcement bars.

3.03.06 All exposed metallic parts of the buildings shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.

3.03.07 The down conductors shall be protected at the ground level against mechanical injury by means of non-metallic pipes, viz. PVC pipes filled with bituminous compound.

3.04.00 **Electrodes (for Lightning Protection)**

3.04.01 The electrodes shall be 3000 mm long, 40mm dia. mild steel rod. These shall be driven into the ground.

3.04.02 All the electrodes shall be interconnected by means of one mild steel rod which will be laid under ground at a minimum depth of 1000 mm below finished grade level unless stated otherwise. This ground mat/electrode in turn shall be connected to main grounding grid.

3.05.00 **Riser (for Lightning Protection)**

3.05.01 All risers connected to grounding mat shall be projected 300 mm above grade level unless stated otherwise.

3.06.00 **Jointing & Connection**

3.06.01 All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode.

3.06.02 The projected portion of riser above ground shall be coated with two (2) coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

3.06.03 The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.

3.06.04 All the joints shall be done by arc welding process overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be cleaned properly before jointing.

3.06.05 The portion of galvanised steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

3.06.06 The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.

3.06.07 The air terminal rods and shielding mast shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).

3.06.08 The steel to copper connection shall be brazed type.

3.07.00 **Lightning Protection of 400kV Switchyard & Other areas**

3.07.01 The lightning protection of outdoor switchyards/substation shall be done by lightning masts on the top of steel towers. In addition, shield wires shall be used where required. The shield wire shall be strung across the top of the steel tower and/or powerhouse structure.

3.07.02 The shield wire which shall be brought down up to bottom of steel tower shall be connected to the earthing conductor (50 x 6 mm galvanised steel flat) which in turn connected to the riser (from the main grounding mat/grid).

3.07.03 The lightning protection of inflammable liquid storage tanks wherever required, shall be provided with horizontal conductors strung between tall poles covering the entire zones or with air terminal rods mounted on top of poles/structure. These horizontal conductors/vertical air terminal rods shall be connected to rod electrodes, which in turn shall be connected to station ground mat.

3.07.04 The lightning protection of conveyor gallery shall be provided with horizontal conductors (25 x 6 mm G.S. Flat) run along the length of the conveyor gallery at the top of gallery roof. This conductor shall be connected to riser and grounding electrode at an approximate interval of 30 mm through two down conductions (each 25 x 6 mm G.S. Flats).

3.08.00 The sizes and materials of earthing conductors to be used in lightning protection system are listed below :

	Description		**Size**	**Material**
a)	Vertical Air Termination		20 mm dia Rod (Chimney)	Lead Coated Copper rod.
b)	Vertical Air Termination (Except Chimney)		20 mm dia Rod	Galvanised steel
c)	Horizontal Conductor	i) ii)	75 x 10 mm Flat 25 x 3 mm Flat	- Do - - Do -
d)	Down Conductors	i) ii)	75 x 10 mm Flat 25 x 3 mm Flat	- Do - - Do -
e)	Riser From Electrode/ Grounding Mat		to be decided by Bidder	Mild Steel
f)	Electrode for Lightning Protection		3000 mm long , 40mm dia.	Mild Steel

Note :

In addition to above, all materials as required such as G.I. pipes of appropriate length, diameter and thickness will be provided for lightning masts of Power House building and Switchyard.

1. All the cable tray installation and cabling work will be carried out as per the following drawings and document of respective areas :

   i) Equipment and Cabling Layout.
   i) Grounding Layout.
   ii) Cable Schedule and inter-connection Chart.

   In the above layout drawings, the main routing of cable trays/trenches are shown upto nearest point of any equipment. Local routing of cable trays/cables (from above main routing) upto respective equipment will be decided by the EPC contractor at site.

2.a) Except at panels/enclosure, the conduit ends shall be sealed by suitable sealing compound, having fire withstand capability.

   b) Cables laid on trays and risers shall be clamped at an interval of 1500mm and 900mm for horizontal & vertical cable runs respectively.

   c) All single core power cables shall be laid in trifoil formation and suitably clamped.

3. Based on the drawings and details indicated above in this document, EPC contractor shall estimate and supply all necessary cable tray supports, conduits, clamps, hardwares, etc. to make the installation complete in all respect.

4. Typical arrangement of fixing cable trays in cable trenches/overhead are shown in this document. EPC contractor will supply and install all necessary supporting steel structures for erection of cable trays.

5. Cables shall be laid as follows

   On cable trays
   In duct bank.
   Directly burried (for street lighting only and as specified in the layout drawings)

6. Laying of Cables shall be carried out as per IS:1255. Cabling work shall comprise of the following as/or as stipulated in the specification :-

   On Tray : laying, dressing, clamping of cables on tray, fixing of cable tag including supply of cable clamps, cable tags and fixing hardware. Trifoil clamps shall be provided for single core cables laid in trifoil arrangement.

   Buried : excavation of earth, filling by sand, providing brick partition, laying and dressing of cable, fixing of cable tag, sand covering followed by fixing of precast cover, backfilling by good earth followed by coarse earth including the supply of cable tag, sand, brick, precast cover.

   Shallow trench : laying, dressing, fixing of cable tag, filling with sand and fixing of brick column including supply of sand, brick and cable tag.

   Duct bank : pulling of cable and fixing of cable tag.

7. HT Multicore Power cables of same voltage grade shall be laid in a single row with D gap between cables where D is the largest dia.adjacent of cable and in case of singlecore cable laid in trefoil formation with a distance of four times. The dia. of cable between trefoil centre line and clamped at every 2m. LT Multicore Power cables shall be laid touching in a single row and singlecore cables to be laid in trefoil formation with a distance of four times. The dia.of the cable between trefoil centre lines and clamp every 2m. Control & Instrument cables shall be laid in multiple rows upto a maximum of three rows.
At least 300mm clearance shall be maintained between cables of different voltage grades & services like power, control and instrumentation.
The laying sequence of cable of various voltage levels shall be as follows (from top to bottom) :-

   HT power cables
   LT power cables
   Control cables
   Instrumentation & Communication system cables.

8. For Power cables clamping of adjacent cables on the same tray shall be staggered to avoid fouling of the clamping bolts.

9. Termination work shall be done in accordance with the stipulation of the specification including supply of lugs and glands for control cables.

10. Armour/screen of multi-core cables shall be grounded at both ends. Armour/screen of single core cables shall be grounded only at source end.

11. Indelible identification tags shall be provided for all cables at all terminations just before entering the equipment enclosure, on both side of a wall or floor crossing, on each duct/conduit entry and at every twenty metres in cable tray/trench. Cable trays along a route shall also be systematically numbered and marked to ensure cable laying according to cable schedules. Beside having identification/designation at each end of cable way and branch connection, long length of trays shall have identification at every 10 metres.

12. Whenever cables pass through walls or floors, fire proof penetration seals rated for 90 min. shall be provided.

13. Street lighting cables shall be routed buried and at road crossings lighting cables shall pass through 150mm dia. hume pipes(Class NP-3) Above pipes shall be installed at a min. depth of 1000mm from ground level.

14. RCC trenches, Pull pits & Hand holes in Hazardous area shall be filled up with sand after cable laying.

15. No cable joints are permitted for cable runs less than 500m.

16. Earthing of cable trays shall be provided as per Dwg. no. 13A06-DWG-E-0600.

GROUNDING NOTES

1.0 *These grounding notes and details shall be read and construed in conjunction with grounding drawings and specification.*

2.0 *The grounding installation work shall conform to the requirements of the Indian Electricity Rules and code of Practice for Earthing (IS:3043) as amended up-to-date in India. For the work in other country, the statutury rules and code of practice in vogue there in shall be followed.*

3.0 *The main ground grid shall be buried in earth at a minimum depth of 1000 mm below grade. A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trench/foundation/underground pipe at the crossing.*

4.0 *Ground grid conductors around a building/switchyard fence shall be buried outside the boundary at a minium distance of 1500 mm.*

5.0 *A additional grid of 1500 mm x 1500 mm comprising of closely spaced (300 mmx300 mm) coductor at a depth of 300 mm from finished grade level shall be provided below the operating handle of Isolators and Circuit Breaker operating boxes located in outdoor HV/EHV substation. This grid shall be connected to the main ground grid.*
The ground connection to operating handle shall be made of flexible connection.

6.0 *The ground grid conductor below grade shall be of bare mild steel rod of adequate size. Ground electrode shall be of same diameter of grid conductor and 3000 mm long mild steel rod, driven into the ground and connected to the ground grid conductor.*

7.0 *Riser/pigtail from the ground grid shall also be mild steel rod of same diameter of grid conductor and shall prroject 300 mm above grade/concrete floor level unless otherwise shown.*

8.0 *All ground connections below grade shall be made by electric arc welding with low hydrogen content electrode. Bending of the conductor where necessary shall be done by gas heating.*

9.0 *Above grade, galvanised mild steel flats shall be run as main ground conductors along building steels, walls and cable trays and securely fixed to the same by welding/clamping at intervals not exceeding 1500 mm.*
The ground conductors shall be interconnected between them and to the main ground grid through risers.

* *Exact diameter of ground rod shall be selected by EPC contractor with back-up calculation.*

10. *All electrical equipment and associated non-current carrying metal works, supporting structures, building/boiler columns,fence, system neutrals, lighting masts/arresters shall be connected to the plant ground system.*

11. *Two seperate and distinct ground connections shall be provided for grounding of electrical equipment frameworks.*

12. *Miscellaneous devices such as junction boxes, pull boxes, push-button stations, lockout switches, cable end boxes etc. shall be effectively grounded whether specifically shown or not.*

13. *Ground conductor connections above grade shall be generally made by electric are welding. The connection shall be coated with cold galvanising/weather resistant anti corrosive paints.*

14. *Bolted connection shall be made only for grounding of equipment/ devices and some removable structures. The contact surfaces shall be throughly cleaned before connection to ensure good electrical contact.*

15. *A continuous 75 x 10 mm galvanised M.S flat ground conductor shall be installed along the cable raceway and securely attached to each tray section, forming a solidly grounded tray system.*

16. *A 16 Swg G.I. wire shall be run along the metalic conduit and shall be securely tied with the same at an internal 300 mm.*

    Grounding connection or wire jumpers shall be installed where flexible conduit is used to connect rigid conduit to equipment.

17. *Crane rails shall be grounded at both ends. in addition all joints shall be bonded to provide electrical continuity.*

18. *Fence within the ground grid shall be bonded to the plant ground system at regular interval not exceeding ten(10) meters. Fence gate shall be separately grounded with flexible connection to permit movement.*

19. *For shielding, the ground conductors shall be taken right upto the top along the structure/chimney and connected directly to the lightning masts.*

20. *The poles used for distribution line and / or street light shall be grounded at the bottom.*

21. Ground electrodes shall be provided at connections with generator/ transformer neutrals, lightning arresters and lightning masts.

22. For ground connections, the conductor sizes shall be as listed below :-

	Equipment		Size	Material
a.	EHV Substation equipment	:	75 x 10 mm	Galvanised steel
b.	Generator Frame & Gen. Neutral	:	75 x 10 mm	Galvanised steel
c.	generator Exciter Frame	:	75 x 10 mm	Galvanised steel
d.	GT, ST, UT Frame	:	75 x 10 mm	Galvanised steel
e.	GT, ST, UT Neutral	:	75 x 10 mm	Galvanised steel
f.	Auxiliary Power Transformer Frame	:	50 x 10 mm	Galvanised steel
g.	11kV/3.3kV Equipment	:	75 x 10 mm	Galvanised steel
h.	11kV/3.3kV Switchgear	:	75 x 10 mm	Galvanised steel
i.	415V PMCC/SWGR	:	50 x 10 mm	Galvanised steel
J.	Structures, Bus Duct, Control panels, etc.	:	50 x 6 mm	Galvanised steel
k.	415V Motor Control Centres, Distribution Booards etc.	:	50 x 10 mm	Galvanised steel
l.	Local Panels Lighting Panels, Cable Trays etc.	:	50 x 6 mm	Galvanised steel
m.	Motors :			
	Motors upto 5.5kW	:	8 SWG Wire	
	Motors 5.5kW upto 22kW	:	25 x 4 mm	Galvanised steel
	Motors 23kW upto 55kW	:	40 x 6 mm	Galvanised steel
	Motors 56kW upto 174kW	:	50 x 8 mm	Galvanised steel
	Motors 174kW and above	:	75 x 10 mm	Galvanised steel
n.	Miscellaneous items, viz. Push Button Station, JB etc.	:	8 SWG Wire	

1.0 AIR TERMINATIONS

1.1 Vertical air terminal rods shall be installed on the top of all structured/buildings to be protected from lightning strokes.

1.2 Vertical air terminal except those for chimney shall be 20 mm dia galvanised steel rods. The projected length of the rods including mounting structure, if any, shall be as required to protect the objects, from lightning stroke. Air terminal rods provided on top of chimney/ stack for lightning protection shall be 20 mm dia lead coated solid copper rods.

1.3 Air terminal rods shall be properly fixed on top of buildings/ structures to withstand wind pressure.In case the air terminal rods are embedded in the building roof, the portion embedded in the contrete shall not touch the reinforcement bars and shall be duely insulated from them.

1.4 All vertical air terminal rods shall be electrically connected by means of horizontal conductors (galvanised MS flats) of size 75 x 10 mm.

1.5 The shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 degrees.

1.6 Horizontal air terminations (galvanised MS flats) shall be so laid out that no part of the roof is more than nine (9) metres away from the nearest Horizonal air terminals.

2.0 SHIELDING MASTS

2.1 The shielding mast for lightning protection shall be installed on top of the steel column cap plates of power house main building.

2.2 The shielding masts shall be made of galvanished steel pipe and the heights of the same shall be decided considering the zones to be protected.

2.3 Each shielding mast shall be connected to grounding grid of the station by a 75 x 10 mm. galvanised MS down conductor running along the building column. In addition, all power house building column joints shall be electrically bonded.

3.0 DOWN CONDUCTORS

3.1 The down conductors shall be 75 x 10 mm galvanished MS flats. However, The down conductor of conveyor gallery may be 25 x 3mm galvanised MS flats.

One end of these flats shall be connected to the air terminal rods/ horizontal conductors on top of roof/structure and the other end to the nearest earth terminals.

3.2 Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductors of the grounding system above ground

3.3 The connetion between each down conductor and earth terminal shall be made via test link located at approximately 1500 mm above ground level.

3.4 The down conductors shall be laid straight and sharp bends shall be avoided as far as practicable. These shall be cleated on the outside of the building wall and or columns/structures at intervals of about 750 mm., unless indicated otherwise in the drawings.

3.5 Down conductors along the chimney shell shall be electrically connected with the reinforcement rods by suitable lugs welded (6 mm fillet) to both down conductor and reinforcement at the interval of 30 mm.

3.6 All exposed metallic parts of a building shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.

4.0 EARTH TERMINALS.

4.1 Where ground mat is available, the risers specifically ear-marked for lightning protection shall be considered as Earth Terminal. In such case, one electrode shall be provide close to the each Earth Terminals.

4.2 Where ground mat is not available sparate earth pit as per IS-3043 or approved international standard specifically for lightning protection shall be provided as Earth Terminal.

5.0 JOINTING & CONNECTION

5.1 Number of joints in the lightning conductors shall be kept to a minimum.

5.2 All the joints shall be done by arc welding process. Overlapping of conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be properly cleaned before jointing.

5.3 Those portions of galvanished steel flats, which have been welded at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

5.4 After successful testing the bolted joints of test links shall be wrapped by bitumenons hessian tape followed by 3 mm thick coating of bitumen compound.

5.5 Air terminal rods and shielding masts shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).

5.6 Steel to copper connection shall be brazed type.

6.1 Lightning protection of outdoor switchyards/substations shall be done by lightning masts on top of steel towers. shield wires may also be used wherever required. These shall be strung across the top of the steel towers and/or building/plant structure.

6.2 The shield wire, which shall be brought down to the bottom of the steel towers, shall be connected to the earthing conductor (50 x 6 mm galvanished MS flat), which in turn, shall be connected to the riser from the main grounding mat/grid.

6.3 For lightning protection of conveyor gallery, a horizontal conductor (25 x3 mm galvanised MS flat) running along the entire length of the conveyor gallery shall be provided on top of the gallery roof. This conductor be connected to a earth terminal at approximate intervals of 30M by two down conductors, each 25 x 3 mm galvanised MS flat.

7.0 The sizes and materials of earthing conductors used in lightning protection system are listed below :

	DESCRIPTION		SIZE	MATERIAL
a)	Vertical Air Terminals (Chimney/stack)		20 mm dia rod	Lead coated solid copper rod.
b)	Vertical Air Terminals (Other than chimney)		20 mm dia rod	Galvanised mild steel
c)	Horizontal conductors	i)	75 x 10 mm Flat	Galvanished Mild steel
		ii)	25 x 3 mm Flat	Galvanished Mild steel
d)	Down Conductors	i)	75 x 10 mm Flat	Galvanished Mild steel
		ii)	25 x 3 mm Flat	Galvanished Mild steel
e)	Riser From Electrode/ Grounding Mat		40 mm dia Rod (Min.)	Mild Steel
f)	Electrode for Lightning Protection		40 mm dia Rod(Min.) 3000 mm long	Mild Steel

* Exact diameter of the ground rod shall be selected by EPC contractor with back-up calculation

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SECTION-VII

TECHNICAL SPECIFICATION FOR ILLUMINATION SYSTEM

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SECTION-VII

TECHNICAL SPECIFICATION FOR ILLUMINATION SYSTEM

1.00.00 SCOPE OF WORK

1.01.00 This scope of work shall cover the design, manufacture, assembly, testing at manufacturer's works, supply & delivery, properly packed for transport F.O.R. site of STATION LIGHTING SYSTEM, complete with all materials and accessories for efficient and trouble-free operation.

1.02.00 The scope of work shall also include complete installation, testing, commissioning and putting into successful commercial operation of the Lighting System of all the buildings and facilities included under this Contract inclusive of supply of all labour, tools, implements and supplies.

2.00.00 SCOPE OF SUPPLY

2.01.00 The equipment and materials within the scope of supply shall include but not limited to:

a) Lighting / Welding Transformer.

b) Lighting fixtures with lamps and accessories.

c) Main lighting distribution boards, Lighting panels/boards, Emergency lighting boards, emergency DC lighting panels, street lighting panels etc. All panels shall be provided with energy saving system.

d) Street light poles, flood lighting tower/poles/high masts.

e) Ceiling fans, receptacles, switches, switchboards, portable emergency lights, portable 24V supply module including handset maintenance equipment etc.

f) Separate DB for 1ph, 240 V power supply is required to be indicated suitably for miscellaneous services supplies.

g) Separate DB for 24 V power supply is required to be indicated suitable for 24 V lighting supply.

h) Separate DB with transformers is required to be considered for welding receptacles.

i) Cables, wires, splicing/termination/connection accessories.

j) Conduit and accessories, junction and pull boxes, terminal blocks.

k) Grounding materials and connections.

l) All fittings, supports, brackets, anchors, clamps and connections.

m) Steel for field fabrication of supports and brackets.

2.01.01 Data sheets and technical leaflets on each piece of equipments / devices

3.00.00 SCOPE OF SERVICE

3.01.00 Carrying out of detail engineering including detail design calculations, preparation of lighting layouts showing location of fixtures, cable wires and conduit routing, preparation of cable schedule, and other related drawings as detailed in subsequent clauses and also consider the energy saving system.

3.01.01 Furnishing of all labour, skilled and unskilled, supervisory personnel, erection tools and tackles, testing equipment, implements, supplies, consumables & hardware, and transport for timely and efficient execution of the contract work.

3.01.02 Preparation of AS-BUILT drawings showing field modifications, if any.

4.00.00 GENERAL REQUIREMENTS

4.01.00 Codes and Standards

Major standards, which shall be followed, are listed below. Other applicable Indian standards even if not covered in the listed standard shall be followed.

a) IS-1913

b) IS-1977

c) IS-10322

d) IS-8623

e) IS-6064

f) IS-8828

g) IEC-598

h) IS-13703

i) IS-13947

j) IS-1248

k) IS-2705

l) IS-4160

m) IS-2713

n) IS-800

o) IS-2026

p) IS-2099

q) IS-694

r) IS-1554

s) IS-9537

t) IS-14772

u) IS-5133

5.00.00 **DESIGN CRITERIA**

5.01.00 **Design Basis**

5.01.01 The system provides lighting and electric power supply to Main plant & BOP areas, extension part of 400kV switchyard, peripheral roads inside boundary wall, non service areas, etc. under the scope of this contract. In addition, it also provides lighting to selected areas during plant emergency conditions.

5.01.02 The system will be installed in an adverse industrial environment. Equipment in some areas will be subject to vibration, coal-dust, fly-ash, oil/water vapours as prevalent in a thermal generating plant.

5.01.03 The design shall be such as to provide minimum lighting levels as specified for different areas. The Bidder shall carefully consider these lighting levels and layouts in making the offer and shall clearly indicate if any change is required to achieve the design lighting levels with the equipment offered.

5.01.04 The systems shall be suitable for operation on available power supply having characteristics as given in the annexure.

5.01.05 All fittings of control room / office shall be energy efficient type.

5.01.06 The main plant/auxiliary building/other BOP area shall generally be provided with :

- Main lighting system for full illumination under normal power supply conditions and shall operate from 415V/240V AC power supply tapped from respective MLDB/lighting panels.

- Emergency lighting system for reduced illumination operated by DG supply feeders during failure of main power supply. It shall cover 20% of fixtures in the building and associated area.

- Minimum emergency lighting system for reduced illumination during failure of main power supply with the help of 220V DC batteries/supply feeders. This is applicable for Coal Handling Plant also. Regarding lux level of emergency lighting in CHP area, refer to Annexure-B.

5.01.07 Various lighting panel shall be fed directly from nearest Main Lighting Distribution Board and these MLDB s shall be subsequently fed from respective 415V switchgear/PMCC through 1:1 transformers to reduce fault level. If the fault level can be contained within 9 kA by virtue of cable impedances, use of 1:1 transformer can be dispensed with.

5.02.00 **System Concept**

The lighting system shall comprise following sub-systems:

5.02.01 Normal A.C. Lighting

This will be provided by A.C. lighting fixtures distributed throughout the plant area. These lights will be ON as long as the station A.C. supply is available.

A.C. lighting fixtures will be fed from respective area lighting panels, which in turn will be connected to main lighting distribution board. The main lighting distribution boards (MLDB) shall have 2x100% incomers and bus-coupler and be fed through 2x100% lighting transformers, which forms a part of the MLDB. Normal A.C. supply thus made available by the MLDB is 415V-3ph-4W-50HZ effectively grounded. Both the MLDB & the lighting panels shall be provided with at least 20% spare outlets.

Arrangement shall be made for automatic light control in switchyard, boiler gallery, ESP area, turbine floor (high bay) area as required during day time.

5.02.02 Normal cum Emergency A.C. Lighting

a) On failure of normal A.C. Supply, emergency A.C. lighting will be provided in selected areas of the powerhouse, boiler area, boiler galleries etc for general visibility, safe movements and operation of important auxiliaries.

b) The emergency MLDBs (EMLDB) are similar to the MLDB except that lighting transformers in this case are fed from station A.C. Emergency bus having D.G. System backup. Thus power for A.C. emergency lighting is 415V-3ph-4W, 50HZ, effectively grounded.

These lights will be kept "ON" from normal power supply source and upon its failure will be fed from DG.

c) A.C. emergency lighting fixture will account for 20% of the total lighting fixtures provided in the above mentioned area. In main control room 30% emergency lighting shall be provided.

5.02.03 Emergency D.C. Lighting

a) This will be provided by emergency D.C. lighting fixtures located strategically in critical operating areas and emergency exits to enable safe movement of operating personnel access to important control points when both the normal AC and Emergency lighting system fails. These lighting fixtures will be fed from DC lighting panels which in turn will be fed from 220V DC LDB. The supply to DC lighting panels will be automatically switched ON in case of loss of plant normal &

emergency AC supply. The DC lights will be switched OFF after about 3 minutes following restoration of normal AC or emergency AC supply.

b) Emergency DC Lighting (CHP Area)

100W, 220V DC lighting fixture shall be provided in underground portion of conveyor, each switchgear room, control room, office room, pump house, each drive floor of TPs, staircase of TPs, buildings and local control area. DC lighting fixtures will be fed from 220V DC LDB, which in turn will be fed from CHP DC system.

5.02.04 24V, 1 ph AC maintenance lighting system

Separate DB for 24V power supply shall be provided for 24V maintenance lighting.

5.02.05 Street/Area Lighting

Time switch and photocell will be used for controlling area lights with provision for manual override and also have the provision of latest Energy Saving Systems.

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Same arrangement will also be used for controlling, boiler gallery, ESP area, turbine floor (high bay) area illumination.

5.02.06 Remote Emergency Lighting

This will be provided in auxiliary/off-site buildings except CHP where D.C. supply is not available by self-contained battery / automatic charger/inverter/flood light units. These portable emergency light units will be energized automatically on loss of normal A.C. supply.

5.03.00 **Ratings & Requirements**

5.03.01 All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards.

5.03.02 Switch, fuses, MCCB, miniature circuit breakers (MCB), busbar shall be fully rated for short circuit level at the point of application. MCB shall have back-up HRC fuse if its rating is less than the available short circuit current.

5.03.03 All equipment and accessories shall have proper enclosure to suit the site conditions. Hazardous areas shall have flame-proof enclosure.

5.03.04 All wiring from lighting panels to fixtures and receptacles shall be carried out by PVC wires in G.I. Conduits.

5.03.05 Heavy duty XLPE FRLS cables as pre cable specification will be used for connections :

a) From main lighting board to area lighting panels

b) From street/area lighting panel to street light poles.

c) From Welding DBs to receptacles of 63A and above

5.03.06 The lighting system will be supplied from 415V/415V ± 5%, indoor, dry type lighting transformers. However it shall be so chosen to limit the fault level within 9kA.

5.03.07 Suitable number of Flood Lighting Towers / Lighting Masts with adequate HPSV Flood Light will be provided for necessary outdoor areas as required.

5.03.08 Lighting of all main streets, approach roads to various buildings shall be included.

5.03.09 Each lighting panel shall be provided with adequate number of outgoing miniature circuit breaker for controlling fixtures. 5A, 5 Pin sockets shall be fed from the lighting panel through separate circuits.

5.03.10 All A.C. Normal and Emergency A.C. lighting shall be provided with Energy Saving System.

5.04.00 **Method of Calculation**

5.04.01 Standard Lumen method shall be adopted for interior & exterior lighting in order to determine the number of lighting fixtures for obtaining the desired average level of illumination.

5.04.02 The coefficient of utilization shall be considered to take care of Lumen loss due to :

a) effect of room dimensions.

b) absorption of light in luminaires.

c) absorption of light at various room surfaces, i.e ceiling wall etc.

d) floor cavity, ceiling cavity.

e) mounting height.

5.04.03 Moreover a maintenance factor shall also be considered to account for the fall of illumination due to aging, pollution like dust deposit etc. Maintenance factors to be considered for various areas shall be as follows :

Area	**Maintenance factor**
Control Room	0.75
Switchgear/MCC Room	0.65
General indoor area	0.60
Dusty Area	0.55

Light loss Factor

It is recommended that in interiors with fairly clean atmosphere, for example, offices, air conditioned control rooms etc, a light loss factor of 0.8, in interiors which are prone to accumulate dust faster, for example, most in industrial interior an LLF of 0.7 and in high dirt prone interiors an LLF of 0.6 may be adopted for calculating the no. of luminaires to be installed for a particular service illuminance.

5.04.04 To achieve the recommended luminance relationship, it is necessary to select the reflectance of all finishes of the room surfaces. The recommended reflectance values for industrial interiors and equipment are given below for bidder's guide lines:

(For station / other BOP area except CHP)

Surface	Reflectance Percentage
Ceiling	80-90
Wall	40-60
Desk and Bench tops, machines And equipment	25-45
Floor	not less than 20

CHP Requirement:-

For Dusty area such as conveyor galleries, TPs, crusher house etc.:

Surface	Reflectance Percentage
Ceiling	50
Wall	30
Floor	10

5.04.05 Lux level to be considered for various areas are given in Annexure-C.

5.04.06 Voltage drop at the fixture from the MLDB bus shall not exceed 3%.

5.04.07 Circuit loading of each lighting Panel shall be done in such a way that almost balanced loading in all the phases i.e. R, Y & B is achieved.

5.04.08 At least two sub circuits shall be used for illumination of a particular area.

5.04.09 Sub circuit loading of each lighting panel shall be restricted to 2000 Watts.

6.00.00 SPECIFIC REQUIREMENTS - SUPPLY

6.01.00 Equipment and Material

6.01.01 Equipment and material shall comply with description, rating, type and size as detailed in this specification, drawings and annexures.

6.01.02 Equipment and materials furnished shall be complete and operative in all details.

6.01.03 All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

6.01.04 All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

6.02.00 **Lighting/Welding Transformers & Lighting Fixtures**

6.02.01 Each AC Lighting Distribution Board (MLDB) / Welding DB shall be fed from a transformer. The transformers shall be dry type, indoor type dusty vermin proof having 415V / 415V ± 2 x 2.5% with off load tap-changer on primary side. The vector-group shall be Dyn11. (The secondary side shall be solidly grounded through an additional neutral bushing exclusively used for grounding.)The casing of the transformer shall be grounded at least at two (2) points. The transformer may be located inside the lighting / welding DB itself or by the side of respective DB. Impedance of the transformer shall be so selected such that fault level of lighting/welding system is reduced to 3-5 kA.

6.02.02 If necessary, apart from the main lighting transformers, separate small additional lighting transformers may be used at distance lighting points.

6.02.03 Lighting fixtures shall be designed for minimum glare. The surface finish shall be smooth, unobtrusive and scratch resistant.

6.02.04 Reflector shall be of sheet steel or aluminium, minimum 20 SWG thick, securely fixed by fastening device of captive type.

6.02.05 Fixture shall be suitable for 20 mm conduit entry and 16 SWG G.I. earth wire connection.

6.02.06 High bay fixtures shall have provision for vibration damper to ensure rated lamp life. Cost of each damper shall be separately indicated.

6.02.07 Fixture shall be furnished complete with lamps and integrally/non integrally or separately mounted control gear & accessories as applicable for different types of fixtures. These shall include holders, ballast, capacitor, starter, ignitors, etc.

6.02.08 Fixtures shall be fully wired up to respective terminal blocks, suitable for loop in and loop out connection of PVC wires of following sizes :

a) Lighting fixture : 2.5 mm^2 Copper

b) Flood Light fixture : 2x2.5 mm^2 Copper

6.03.00 **Lamps**

6.03.01 General lighting service (GLS) lamps shall be with clear glass and screwed caps.

6.03.02 All fluorescent lamp shall be bi-pin rotary type. Lamp holder shall be spring loaded, low contact resistance type and shall have resistance to wear. CFL and T5 fluorescent tube with electronic ballast or tri-phosphorous tube

Fluorescent lamp will be used in indoor application having low height like 3 to 5 metres requiring good colour rendering. All control rooms, electrical panel room, auxiliary building, laboratories, office area, etc. will be provided with fluorescent lamp fixtures. The fluorescent lamp will be tubular, cool daylight type of 28W as per annexure.

6.03.03 Mercury/Sodium vapour lamp shall be colour corrected type with screwed cap.

HPSV lamp has the advantage of very high efficiency (lumens/watt) and hence recommended for indoor application with elevation more than 4 meters such as TG Hall, Boiler & ESP platform, Pump House and all outdoor application such as area lighting, roads, boundary wall, etc. Flameproof fixtures will be used for hazardous areas with HPMV lamps. The HPSV/ HPMV lamps will be elliptical of rating 70W/150W/250W/400W as required depending on application. For all indoor application in CHP area such as conveyor galleries / tunnels and floor below 4m, 35W low pressure sodium vapour / 70W HPSV shall be considered.

6.03.04 Lamps shall be suitable for use in position and capable of withstanding small vibrations. Restrictions and special features, if any, shall be clearly indicated in the bid.

6.04.00 **Ballast/Electronic Ballast**

6.04.01 Ballasts shall be heavy duty, low loss, polyester-filled type with copper winding. Ballast shall be free from hum.

6.04.02 Ballast for Mercury/Sodium vapour lamp shall be provided with suitable tapping to set the voltage within range specified.

6.04.03 In multi-lamp fixture, each lamp shall be provided with individual ballast.

6.04.04 Ballast windings shall have maximum operating temperature of 120^{o}C without rated temperature rise marking.

6.04.05 Electronic Ballast shall be suitable for 220 V DC and also 240 V AC.

6.04.06 Electronic Ballast shall be compact, lightweight, high frequency electronic standard ballast for fluorescent lamps.

6.04.07 It shall be Flicker-free warm start, ideal for areas with high switching frequency.

6.04.08 Electronic Ballast shall be of such design that minimum 25% reduction in energy consumption at constant luminous flux compared with conventional gear.

6.04.09 Electronic Ballast shall not cause high harmonic distortion.

6.04.11 Electronic Ballast shall provide constant light independent of mains voltage fluctuation.

6.05.00 **Lighting Panel/Distribution Boards**

6.05.01 Lighting Distribution Boards/panels shall be metal-enclosed, cabinet type, fabricated from CRCA sheet steel minimum 2 mm thick, suitable for either wall/column mounting on brackets or floor mounting on channel sills.

6.05.02 Indoor Lighting Distribution Boards & Lighting Panels shall be dust and vermin-proof, IP-52 or better; outdoor panels shall be weather-proof with canopy, IPW-55 or better. The cubicle-housing transformer shall be minimum IP-42.

6.05.03 Lighting Distribution Boards and Lighting Panels shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements.

6.05.04 Lighting Distribution Boards shall have provision of cable entry from bottom and, panels shall have provision of cable entry from top and bottom, as required, with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminium cable lugs are to be furnished.

6.05.05 Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Distribution Board and Lighting Panel for connection to ground conductor.

6.05.06 Each Lighting Distribution Board shall be complete with designation and caution notice plates fixed on front cover and a directory plate fixed on inside of the front cover. This directory plate shall contain details of the Lighting Panels being fed from the Distribution Board including their designation, location, loading etc.

Each Lighting Panel shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of each circuit.

The plates shall be of anodized aluminium with inscriptions indelibly etched on it.

6.05.07 Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85ºC. Minimum size shall be 25 x 6 mm.

6.05.08 Incoming and outgoing circuits shall be terminated in suitable terminal blocks.

6.06.00 **Board/Panel Equipment**

6.06.01 Each Distribution Board shall consist of one dry type transformer housed in the cubicle, voltmeter with selector switch, C.T. operated ammeter and incoming triple pole MCCB. Outgoing feeder from the Lighting Distribution

Board shall have MCCB. Proper discrimination between outgoing MCCB of Lighting Distribution Board and downstream MCCB of Lighting Panel should be ensured.

6.06.02 Each lighting panel shall have an incoming triple pole MCCB with neutral link and ELCB and a number of outgoing miniature circuit breakers (MCB) as per annexure.

6.06.03 Board/Panel access door shall be interlocked with incoming MCCB such that the door can be opened only when the MCCB is in OFF position. Means shall be provided to defeat this interlock.

6.06.04 All MCCB shall be single throw, air break, heavy duty type having quick-make quick-break contacts. Fuses shall be HRC link type. Contactors shall be air break electromagnetic type. Push buttons shall be push to actuate type.

6.06.05 MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.

6.06.06 Time switch in street lighting panels shall be clock switch type with ON-OFF time setting facility, which shall ensure respective ON-OFF operation in every 24 Hours cycle. Voltmeter/Ammeter shall be of accuracy class 1.0 or better as per IS: 1248. Voltmeter/Ammeter selector switch shall be of reputed make.

6.07.00 **Receptacles**

6.07.01 Receptacles shall be heavy duty, complete with individual plug and switch as detailed in the annexure.

6.07.02 The conduit box of the receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding with 16 SWG G.I. wire. Arrangement shall be provided inside the conduit box for grounding of third pin.

6.07.03 Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.

6.08.00 **Fans & Regulators**

6.08.01 The fans shall have three well balanced blades, and shall be reasonably free from noise. Pedestal fans shall also be provided as per requirement.

6.08.02 Fan motor shall be totally enclosed type with copper winding and class E insulation.

6.08.03 Regulator shall have minimum five steps. Electronic regulator with smooth control is to be provided.

6.09.00 **Switch & Switch Board**

6.09.01 All switch boards/boxes shall be of bent steel construction, fabricated of 14 SWG M.S. sheet with 6 mm thick bakelite cover with brass fixing screws.

6.09.02 Switch boards/boxes located in control room and office areas shall be flush mounted type on brick wall with only the switch knob projecting outside.

6.09.03 Switch boards/boxes shall have conduit knock outs on the sides. Adequate provision shall be made for ventilation of these boxes.

6.09.04 Flush type receptacles where provided shall be so located that only the plug projects outside.

6.09.05 Switches shall have quick-make and quick-break mechanism operated by a suitable external handle complete with position indicator.

6.10.00 **Lighting Poles & Flood Light Tower**

6.10.01 Street Light Poles

a) Street light poles shall be swaged and welded steel pole, complete with fixing brackets, weather-proof junction box and all other accessories.

b) The pole shall be coated with bituminous preservative paint on inside as well as embedded outside surface. Exposed surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in synthetic medium).

6.10.02 **Flood Light Tower**

a) Flood light tower shall be a lattice structure with maintenance platform and approach ladder. All structural members and hardware shall be hot-dip galvanized.

b) Structures shall be designed for an additional load of 1500kg for maintenance crew. Deflection under maximum wind pressure shall not exceed 1 in 360. Structural design shall be as per IS-800.

6.10.03 **Lighting High Masts**

Applicable standards :

The following shall be Reference Standards for loading of the High Mast:

a)	IS-875 (Part-III) 1987	-	Code and practice for design loads for Structures.
b)	BSEN 10025/DIN 17100	-	Grade of M.S. Plates.
c)	BS-5135/AWS	-	Welding
d)	BS.ISO 1461	-	Galvanizing
e)	TR. No. 7200 of ILE	-	UK Specification for Mast and foundation.

Structure :

Lighting High Mast shall be of continuously tapered polygonal cross section, at least 20 sided, hot dip galvanized and presenting a good and pleasuring appearance and shall be based on proven In-Tension design confirming to

the standards referred to above, to give an assured performance, and reliable service. The structure shall be suitable for wind loading as per IS-875 Part-III, 1987. The masts dimensions shall be as per standards.

The Mast shall be of 30M height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless steel wire rope, in built power tool, luminaries, suitable aviation warning light, lightning along with necessary power cables within the mast. The mast shall be delivered only in three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast.

High mast shall be complete with feeder pillar panel for power distribution to lighting fixtures and winch motor. Feeder pillar panel shall be outdoor type stand mounting with dust and vermin proof, IP 55 and constructed of 14 swg sheet steel.

6.11.00 **Maintenance Equipment**

6.11.01 The Contractor shall supply one (1) no. of wheel mounted adjustable aluminium ladder for the maintenance of street lights.

6.11.02 For the maintenance of lighting fixtures within the power house, the contractor shall also supply four (4) nos. free standing adjustable aluminium ladder, adjustable from 5m. to 10m.

6.11.03 For the maintenance of lighting fixtures within the CHP area, the Bidder shall supply two (2) nos. free standing adjustable aluminium ladder, adjustable from 5m. to 10m.

6.12.00 **Special Requirement**

6.12.01 All outdoor illumination fixtures, unless it is fed from photo cell/time switch controlled lighting panel, has to be provided with outdoor type local switches.

6.12.02 In all the air filtration units and air handling units, one marine type lamp (of 100 Watt approx.) shall be supplied and the wiring & fixing of the same has to

6.13.00 **Lighting Cables & Wires**

6.13.01 Lighting Cable shall be heavy duty, 1100 Volt grade, multi-core stranded aluminium conductor, XLPE insulated, extruded PVC inner sheath, single round G.I. wire armoured and overall PVC sheathed with FRLS conforming to IS 1554.

6.13.02 Lighting wires shall be 1100 Volt grade, fire resistance PVC insulated, stranded conductor, single core cable conforming to IS 694, colour coded as below :

RED	for	R-Phase	BLACK	for	Neutral
YELLOW	for	Y-Phase	WHITE	for	+'Ve D.C.

BLUE for B-Phase GREY for -'Ve D.C.

6.13.03 Wire size shall be as follows :

For point wiring beyond lighting panel i.e from lighting Panel to junction box (main run)	:	10 Sq.mm. Aluminium. Stranded conductor
From Junction box to lighting fixture	:	2.5 Sq.mm. Copper Stranded conductor

6.14.00 **Conduits and Accessories**

6.14.01 Conduits shall be rigid steel, hot-dip galvanised, furnished in standard length of 3 metres, threaded at both ends.

6.14.02 Thickness of conduits up to and including 25 mm dia shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 20 mm.

6.14.03 Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.

6.14.04 Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips and coated with PVC.

6.15.00 **Junction Box**

6.15.01 Junction boxes shall be of 16 SWG sheet steel hot-dip galvanised, dust and damp proof, generally conforming to IP-55.

6.15.02 Junction boxes shall be complete with gasketed inspection cover, conduit knock out/threaded hub and terminal blocks.

6.15.03 Junction boxes for outdoor use shall be weatherproof IPW-55 and those for hazardous location shall be flame-proof type.

6.15.04 Junction boxes shall have following indelible markings:

Circuit nos. on top

Circuit nos. with ferrules (inside) as per drawing

DANGER sign in case of 415V circuit

6.16.00 **Terminals**

6.16.01 Multi way terminal blocks of approved type, complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires.

6.16.02 Each terminal shall be suitable for connection up to 2 nos. 10 Sq.mm stranded aluminium conductors without any damage to the conductor or looseness of connectors.

6.17.00 **Portable Emergency Lighting Unit**

The portable emergency lighting unit shall be complete with 6 volt storage battery (rechargeable), inverter, automatic charger, twin 6 watts fluorescents tube lamp and test switch. Contractor shall furnish make, type and catalogue.

6.18.00 **24 V Supply Module**

6.18.01 Each 24V A.C. supply module shall have one (1) no air cooled two winding, 500VA, 1-phase, 50Hz, 240/24V transformer with 6A (240V side) and 16A (24V side) HRC fuse and necessary 240V and 24V terminals for incoming and outgoing connections. The 240V terminals of 24V AC supply module shall be fed from respective lighting panels. A group of 6A, 24V AC receptacles located near Boiler access doors and condenser area shall be wired up from 24V side of each 24V A.C. supply module.

The 24V A.C. supply modules shall be sheet steel enclosed with louvers and shall be suitable for outdoor use. The 24V A.C. supply modules shall be suitable for wall/steel structure/column mounting. Switches shall be mounted at the front on sheet steel enclosure.

6.18.01 Portable 24 V AC supply modules having sheet steel enclosure with louvers as per above shall be supplied. 24V halogen automobiles lamps with reflector along with 1100 V, twin core PVC sheathed, 2.5 mm^2 stranded copper wire of 20 m lengths as handset

Exact requirement will be finalized during detail engineering and accordingly the bidder shall furnish the same.

6.19.00 **Not used.**

6.20.00 **Moulded Case Circuit Breaker (MCCB**)

6.20.01 MCCB shall be heavy duty, triple pole, load break-fault-make type conform to the duty as required. MCCB shall be provided with a common trip bar, so as to ensure opening of all phases even when fault occurs in only one phase.

6.20.02 MCCB shall have positive indication in ON and OFF position with indication on each Module.

6.20.03 The MCCB should be housed in a heat resistant moulded insulated housing Overload and Magnetic release of MCCB shall be suitable for setting at site. The Short Circuit release shall be of minimum of 12x In.

6.20.04 For Fuel Oil / hazardous area, one (1) no. 63Amp MCB shall be provided within a Flame-proof enclosure. The enclosure shall be Flame-proof as per the stipulations of relevant standard. It shall have a degree of protection of IPW-55. The enclosure front access door shall be interlocked with the MCB. It shall have grounding facility on opposite sides complete with designation and caution notice plates fixed on the front cover. It shall meet the requirement of IS 5571 & IS – 5572.The MCB enclosure shall suitable for entry of 4/Cx16 sq.mm XLPE Copper cable. The total unit shall have a valid certification for using in the specified zone from statuory authority preferably of CMRI and/or CE Ex II 2 G EEx-D IIB T4/T5/T6; CE Ex II2 2(1) G EEx-d (ia) IIB T5/T6; CE Ex II2 (1) GD EEx-d (ia)IIB T5/T6 or similar.

6.21.00 **Nameplate**

Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to clearly indicate their functions.

All lighting fixtures, receptacles, fans, junction boxes etc. shall be properly marked up indelibly with corresponding circuit numbers.

6.22.00 **Samples**

Owner reserves the right to call for samples if considered necessary and the same shall be submitted by the Bidder free and without any obligation.

6.23.00 **Street light powered by solar energy**

Solar PV street lighting system is an innovative system that operates using the light energy available from the sun to provide lighting during nighttime. This system is based on the principle of conversion of solar energy into DC electricity.

Solar PV street lighting is a reliable and an efficient stand alone system. It presents a package consists of a solar PV module, a lead acid battery, battery charger regulator & dusk to dawn regulator, electronics control unit complete with high frequency inverter and luminaire.

The energy radiated by sun is converted to DC power by the adjustable solar PV module mounted on the top of the lighting pole. This power is stored in the battery housed in the battery box and powers the street light during the night. The system is automatically switched on at dusk and off at dawn.

Basic system components as per MNES specification are

- Solar PV module (12V, 75Wp)
- A hot deep galvanized epoxy coated light pole with module frame structure
- Luminaries using CFL 11W lamp with high efficiency inverter and dusk to dawn regulator circuit. Along with water proof cabinet.
- A low maintenance 12V, 75AH tubular stationary lead acid battery specially designed for photovoltaic application with suitable battery box.
- A complete set of cables and other installation material.

It shall be featured with bright light, 3/5 non-sun days autonomy, auto on/off and integrated design.

7.00.00 **SPECIFIC REQUIREMENTS - SERVICES**

7.01.00 **Consumables and Hardware**

7.01.01 The Contractor shall furnish all erection materials, hardware and consumables required for the complete installation.

7.01.02 The materials shall include but shall not be limited to the following :

a) Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.

b) Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.

c) Materials : Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.

7.01.03 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.

7.02.00 **Testing Equipment**

7.02.01 The Contractor will provide such checking and testing equipment as test lamp, buzzer, 500-volt meggar, earth meggar, lux-meter etc. and also other testing equipment as required.

7.03.00 **Installation - General**

7.03.01 Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions/ recommendations where the same are available.

7.03.02 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

7.04.00 **Lighting Fixtures**

7.04.01 Continuous rows of fluorescent tubes shall be mounted on a continuous M.S. angle for each row of lights.

7.04.02 In turbine hall, fixtures shall be mounted to maintain sufficient clearance from the overhead traveling crane trolley.

7.04.03 In boiler galleries, mounting height of fixtures shall be about 2500 mm from platforms except shown otherwise.

Bracket for fixture mounting shall be fabricated at site from 40 mm conduits with a reducing socket to suit the fixtures and clamped on to the handrails. The fixing shall be strong enough to withstand vibration and high wind velocity.

If a roof over platform is available, the fixture can be pendant mounted.

7.04.04 Floodlights shall be mounted on steel base facing the tentative direction shown on drawings. Fixing holes shall be provided with slot to turn the fixture

about 5 Deg on both sides. Bolts shall be finally tightened with spring washer.

The Contractor shall supply and install the steel base for fixing the flood light on the flood light towers.

Terminal connection to the floodlight shall be made through PVC coated flexible metallic conduits.

7.04.05 Fixtures shall be mounted on sub-station structures with suitable clamps. No cutting or drilling of sub-station structures is permitted.

7.04.06 The fixtures after erection shall be marked up indelibly with corresponding circuit number for easy identification of lamp circuit.

7.05.00 **Receptacles**

Receptacles shall be installed at locations shown in approved drawings. As a minimum the following shall be provided –

Atleast one 6/16A, 240V AC universal socket outlet with switch shall be provided in office, cabins, etc.

63A, 3 phase, 4 wire, 5 pin Receptacle shall be provided at the following locations as a minimum –

a) Two (2) nos. at each floor of TG building
b) Three (3) nos. in each Boiler platform
c) One (1) each in pump houses and switchgear rooms
d) One (1) no. in each ESP, Transformer yard, Cooling Tower, Battery room.
e) Two (2) nos. in each floor of Junction Tower, Transfer Tower, Screen house, Bunker floor, Hopper area, CHP switchgear room. Receptacles in these area will be flame proof type.
f) In conveyor gallery Receptacle shall be provided at interval of 50m, atleast one if length is less than 50m.

Each circuit of welding DB shall feed a maximum of two (2) nos. welding receptacles.

7.06.00 **MLDB, EMLDB DCELDB and Lighting Panel**

7.06.01 MLDB, EMLDB DCELDB and Lighting panels shall be erected at the locations indicated in approved drawings.

7.07.00 **Street Lighting Poles**

Erection of Street Lighting poles together with all its accessories including civil foundation work, installing lighting fixture, wiring and cabling work are included within scope of contractor.

7.08.00 **Conduit System**

7.08.01 In case of unarmoured cable, all conduits shall originate from the respective lighting panel and terminate in lighting fixtures, receptacles etc.

7.08.02 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls as far as practicable. Unnecessary bends and crossings shall be avoided to present a neat appearance.

7.08.03 Conduit supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

7.08.04 Conduits shall be clamped on to approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be fixed to the building steel by welding and to concrete or brick work by grouting as shown on drawings.

Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.

7.08.05 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

7.08.06 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less than 40 mm.

7.08.07 Where conduits are run on cable trays they shall be clamped to supporting steel at an interval of 600 mm.

7.08.08 For directly embedding in soil, the conduits shall be coated with an asphalt - base compound. Concrete pier or anchor shall be provided where necessary to support the conduit rigidly and to hold it in place.

7.08.09 Conduits shall be installed in such a way as to ensure against trouble from trapped condensation.

7.08.10 Running threads shall be avoided as far as practicable. Where it is unavoidable, check nuts shall be used.

7.08.11 Conduits shall be kept, wherever possible, at least 300 mm away from hot pipes, heating device etc. when it is evident that such proximity may impair the service life of cables.

7.08.12 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.

7.08.13 For long run, junction/pull boxes shall be provided at suitable intervals to facilitate wiring.

7.08.14 Conduits shall be securely fastened to junction box or cabinets, each with a locknut and insulated bushing inside the box and locknut outside.

7.08.15 Conduit lengths shall be joined by screwed couplers. Couplers shall be clearly cut.

7.08.16 Conduit joints and connections shall be made thoroughly water-tight and rust-proof by application of a thread compound which will not insulate the joints.

White lead is suitable for application on embedded conduit and red lead for exposed conduit.

7.08.17 The Battery Room installation shall be made with acid fume proof conduits.

7.08.18 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend.

7.08.19 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded.

7.08.20 Lighting fixture shall not be suspended directly from junction box in the main conduit run.

7.08.21 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduits ends shall be plugged or capped to prevent entry of foreign material.

7.08.22 After installation the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

7.08.23 In control rooms and office areas provided with false ceiling conduct run shall be concealed type, embedded in the walls.

7.09.00 **Wiring**

7.09.01 Wiring shall be generally carried out by PVC wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.

7.09.02 Wire shall not be pulled through more than two equivalent 90º bends in a single conduit run.

7.09.03 Wiring shall be spliced only at junction boxes with approved type connections or terminal strips. Maximum two wires can be connected to each way of the terminal block. Splicing of only one phase shall be done in a junction box.

7.09.04 For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.

7.09.05 For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/ junction box.

7.09.06 A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers shall be run through different conduits and Junction boxes.

7.09.07 Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.

7.09.08 Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in form of switch or fuse.

7.10.00 **Cabling**

7.10.01 In outdoor areas, main runs from lighting panels shall be by means of XLPE cables, directly buried in ground or laid in trenches for the underground portion and through conduit for the over ground portion.

7.10.02 Buried cables shall be laid and covered with sand/ riddled earth, and protected from damage by bricks at sides and pre cast concrete stab at top. Buried cables shall have cable markers at 50M interval and projecting 150 mm above ground. At cable bends and joints markers shall be provided.

7.10.03 When buried cables cross road/railway track, additional protection to be provided in form of hume / G.I. pipe.

7.11.00 **Grounding**

7.11.01 All lighting panels, junction boxes, receptacles, fixtures, conduit etc. shall be grounded in compliance with the provision of I.E. Rules.

7.11.02 Ground connections shall be made from nearest available station ground grid. All connections to ground grid shall be done by arc welding.

7.11.03 Panels/Boards shall be directly connected to ground grid by two nos. 35 x 6 mm G.I. flats (for panels) / two nos. 50x6 mm G.I. flats (for distribution boards).

7.11.04 All junction boxes, receptacles, lighting fixtures etc. shall be grounded with 16 SWG G.I. wire.

7.11.05 Each street lighting Pole shall be grounded at two points by two nos. 50x6 mm G.I flat risers from two (2) nos. earthing spike 40 mm dia & 3m long directly driven into ground at a depth of 1m from ground level. The junction box at each lighting pole is grounded at two (2) points from two (2) nos. earthing terminals by 16 SWG GI wire. One 16 SWG G.I wire shall be taken up to the junction box from lighting fixtures and connected to grounding point.

7.12.00 **Foundation & Civil Works**

7.12.01 Equipment foundations, panel foundations and all other civil work will be provided by the Contractor.

7.13.00 **Excavation and Back Filling**

7.13.01 The Contractor shall perform all excavation and backfilling as required for buried cable and ground connections.

7.13.02 Excavation shall be performed up to the required depth. Such sheeting and shorting shall be done as may be necessary for protection of the work.

7.13.03 The Contractor shall make use of his own arrangements for pumping out any water that may be accumulated in the excavation.

7.13.04 All excavation shall be backfilled to the original level with good consolidation.

7.14.00 **Steel Fabrication**

7.14.01 All supports, hangers & brackets shall be fabricated by the Contractor. Necessary steel shall be supplied by the Contractor.

7.14.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge.

7.14.03 Every effort shall be made to minimize the wastage of steel as far as practicable during fabrication. The wastage in no case shall exceed 3% of the total quantity of steel fabricated.

7.15.00 **Painting**

7.15.01 Street light poles shall be given two coats of aluminium paints after installation.

7.15.02 All steel fabrication shall be given two coats of red oxide primer. Finish paint shall be as mentioned in clause no.1.16.00 of Section-I, Volume V-A..

7.15.03 All equipment shall be given touch-up paint as required after installation.

7.16.00 **Inspection & Testing**

7.16.01 On completion of erection works, the Contractor shall request the Engineer for inspection and tests with minimum fourteen (14) days advance notice.

7.16.02 The Engineer shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor.

7.16.03 The installation shall be then tested and commissioned in presence of the Engineer and put on trial run for stipulated contract period.

7.16.04 All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Contractor without any extra cost.

8.00.00 **TESTS**

8.01.00 **Shop Tests**

8.01.01 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works.

8.01.02 Tests on lighting Distribution Boards/Panels shall include :

a) Wiring continuity tests.

b) High voltage and insulation tests.

c) Operational tests.

8.02.00 **Site Tests**

8.02.01 Contractor shall thoroughly test and megger all cables, wires and equipment to prove that the same are free from ground and short circuit.

8.02.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.

8.02.03 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.

8.02.04 Illumination in different areas are as per designed lux level should be established.

9.00.00 **DRAWINGS, DATA & MANUALS**

9.01.00 Drawings, data and manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in the General Condition of Contract and/or elsewhere in this specification for approval and subsequent distribution after the issue of Letter of Intent.

9.02.00 **To be submitted with the Bid**

9.02.01 Make, type and catalogue number of lighting fixtures, lamps and accessories along with technical leaflets, data sheets, polar curves etc.

9.02.02 Typical outline drawings, showing constructional features, cable/ conduit entry, fixing arrangements etc of :

a) Lighting Distribution Board & Panel/receptacles/junction boxes.

b) Street light pole.

9.02.03 Technical leaflets and data sheet on each piece of equipment / device such as MCB, switch fuse, MCCB, receptacle etc.

9.02.04 Type test certificates on lighting fixtures and lighting panels, transformer, ballast, power cables.

9.03.00 **To be submitted after Award of Contract**

9.03.01 All relevant drawings and data pertaining to the lighting system like GTP, GA drawing, BOM, lighting layout drawings showing disposition of fixtures,

panels, conduit/wire routing, schematic drawing, QAP, etc. shall be submitted by the Bidder for the approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

9.03.02 AS-BUILT lighting layout and erection drawings, properly incorporating the changes/alterations/field modifications, if any, as carried out at field along with circuit distribution schemes of all lighting panels, conduit and cable routing and as acceptable to the Owner.

ANNEXURE-A

AVAILABLE POWER SUPPLY

1.0 **System Voltage**

Lighting equipment and accessories shall be designed for satisfactory operation from the following power supply sources:

1.1	A.C. Supply	:	415 Volt, 3 phase, 50 Hz, 4 wire effectively grounded system.
			Fault Level 50 KA r.m.s. symmetrical.
1.2	D.C. Supply	:	220 V, 2 wire, ungrounded system.
			Fault Level 25 * KA

2.0 **Permissible Variation**

Equipment and accessories shall be suitable for operation over the entire range of voltage/frequency variations as listed below:

2.1	A.C. Supply	:	Voltage $\pm$ 10%
			Frequency +3% to -5%
			Combined Voltage + Frequency 10% (absolute sum)
	D.C. Supply	:	Voltage 187 to 242 Volt.

* Indicative only; actual value will be decided by the Bidder after substantiating the same by calculation.

ANNEXURE-B

TYPES OF LIGHTING EQUIPMENT

1.0 LIGHTING FIXTURES & LAMPS

Each lighting fixture shall be furnished complete with associated lamp, holder and control gear fully wired up. Control should include copper ballast, electronic choke, capacitor starter, electronic-igniter (separate type), fuse connector block etc.

Well glass fittings for HPSV lamps higher wattage (250/400 W) floodlight luminaire, the control gear will be separate/non-integral type whereas for high bay, streetlight and mini flood light fixture, the control gear shall be integral type.

SL. NO.	FIXTURE TYPE	REFERENCE FIXTURE NO.	DESCRIPTION	AREA OF USE
1.1	SA	GE GET CI 1X28 C/S HF + Reflector 1X28 (ALM) / eqv.	Surface / pendant mounted with Al reflector commercial / decorative type luminaire suitable for 1 x 28W T5 FL	Swgr room / MCC room / Workshop / Maint. Shop / Office / Toilet / Corridor / Pantry / Stores
1.2	SB	GE GET CI 1X28 C/S HF / eqv.	Surface / pendant mounted without reflector commercial / decorative type luminaire suitable for 1 x 28W T5 FL	Swgr room / MCC room / Workshop / Maint. Shop / Office / Toilet / Corridor / Stairs / Pantry / Stores
1.3	DA	GE GET CI 2X28 C/S HF + Reflector 2X28 (ALM) / eqv.	Surface / pendant mounted with Al reflector commercial / decorative type luminaire suitable for 2 x 28W T5 FL	Swgr room / MCC room / Workshop / Maint. Shop / Office / Toilet / Corridor / Pantry / Stores
1.4	DB	GE GET CI 2X28 C/S HF / eqv.	Surface / pendant mounted without reflector commercial / decorative type luminaire suitable for 2 x 28W T5 FL	Swgr room / MCC room / Workshop / Maint. Shop / Office / Toilet / Corridor / Stairs / Pantry / Stores
1.5	DC	Philips TCS 150 2XTL5-28W MIEBT 228 / eqv.	Decorative, surface / pendant mounted mirror optics luminaire housing made up of CRCA sheet steel, powder coated white, accommodating all electrical accessories pre-wired up to a terminal block suitable for 2 x 28W TL5.	Office rooms / Corridor / Conference Room / Engineer's Room
1.6	DD	Philips TMS 669 M 2XTL5-28W HF D6 / eqv.	Decorative, recess mounted mirror optics luminaire, housing made up of CRCA sheet steel, powder coated white,	False Ceiling areas (Control Room / Electronic Eqpt. Room / Office / Conference room /

SL. NO.	FIXTURE TYPE	REFERENCE FIXTURE NO.	DESCRIPTION	AREA OF USE
			accommodating all electrical accessories pre-wired up to a terminal block suitable for 2 x 28W TL5.	Engineer's Room / Corridor)
1.7	DE	GE MAR228FTL HF / eqv.	Indoor, industrial, corrosion resistant, with diffuser and reflector for lamp, ceiling or suspension mounting luminaire suitable for 2 x 28W T5 FTL.	Battery Room / Chemical Plant / Area with corrosive atmosphere
1.8	MA	Philips HPK250 1XSON250W E / eqv.	Medium and High bay non integral luminaire with aluminium anodized reflector and toughened glass cover suitable for 1 x 250W HPSV lamp	General Indoor equipment area / Pump House / Workshop
1.9	MB	Philips HPK225 1XSON150W E / eqv.	Medium and High bay integral luminaire with aluminium anodized reflector and toughened glass cover suitable for 1 x 150W HPSV lamp	General Indoor equipment area / Pump House / Workshop
1.10	MC / MD	Philips HPK225 1XSON250W /400W E / eqv.	Medium and High bay integral luminaire with aluminium anodized reflector and toughened glass cover suitable for 1 x 250W/400W HPSV lamp	General Indoor equipment area / TG Hall / Pump House
1.11	LA / LB	Philips HPK 150 1XSON-I 70W / eqv.	Integral, higher ingress protection, pressure die-cast Aluminium housing, well glass, luminaire with built in control gear suitable for 1 x 70W HPSV lamp	Boiler Platform / ESP Platform / Dust & Vapour laden areas
1.12	JA/JB	Bajaj BJFW-125MV / eqv.	Flamefroof, weatherproof, non-integral wellglass luminaire for indoor / outdoor applications suitable for 1 x 125W MV lamp	Fuel Oil Pump House / Area with explosive atmosphere
1.13	IA	Philips NXC101 1xA60-60W-CL B22 GR/ eqv.	Weatherproof bulkhead luminaire suitable for 1 x 60W GLS lamp.	DC emergency lighting / staircase / exit point
1.14	NA	Philips TRC033 2XTL-D36W IC / eqv.	Road lighting luminaire, Aluminium steel housing, gear tray cum reflector	Building exterior lighting / Outdoor area lighting /

SL. NO.	FIXTURE TYPE	REFERENCE FIXTURE NO.	DESCRIPTION	AREA OF USE
			made of CRCA sheet, with acrylic cover suitable for 2X36W TL-D.	Outdoor eqpt. Area
1.15	TA	Philips SGP 325 1XSON-T 150W FG / eqv.	Street light luminaire with pressure die cast aluminium housing, POT optics reflector and heat resistant toughened flat glass cover (IP 65) with 1 x 150W HPSV lamp - pole mounted	Street lighting / boundary lighting
1.16	TB	Philips SGP 325 1XSON-T 250W FG / eqv.	Street light luminaire with pressure die cast aluminium housing, POT optics reflector and heat resistant toughened flat glass cover (IP 65) with 1 x 250W HPSV lamp - pole mounted	Street lighting / boundary lighting
1.17	CA	Bajaj BJC-111 / eqv.	Surface mounting decorative luminaire with 1 x 11W CFL	Toilet / Wash basin / staircase
1.18	CB	Philips FCS 100 1XPL-C/2P 18W I 240V / eqv.	Surface mounting decorative downlight luminaire, electrochemical brightened reflector with 1 x 18W PL-C	Lobby / Staircase
1.19	CC	Philips FBH 145 M 1XPL-C/2P 18W / 220V / eqv.	Recess, decorative vertical mounting downlighter, high efficiency optics and option of multiple attachment suitable for 1X 13W/18W PL-C	Control Room / Electronic Eqpt. Room for DC emergency light
1.20	CD	Philips FBH 145 M 2XPL-C/4P 18W HF 240V LH / eqv.	Recess, decorative vertical mounting downlighter, high efficiency optics and option of multiple attachment suitable for 2X 18W PL-C	Control Room / Electronic Eqpt. Room / Conference room / Office / Engineer's Room as UPS emergency light
1.21	PA	Philips SWF231 1XSON-T 150W A / eqv.	Compact, sturdy, general purpose with integral gear floodlight luminaire suitable for with 1 x 150W HPSV lamp	Area lighting / Yard lighting / Floodlighting purpose
1.22	PB	Philips SWF331 1XSON-T 250W	Compact, sturdy, general purpose with integral	Area lighting / Yard lighting /

SL. NO.	FIXTURE TYPE	REFERENCE FIXTURE NO.	DESCRIPTION	AREA OF USE
		A / eqv.	gear floodlight luminaire suitable for with 1 x 250W HPSV lamp	Floodlighting purpose
1.23	PC	Philips RVP302 2XSON-T 250W / eqv.	Compact, sturdy non integral, corrosion resistant with pre anodized aluminium reflector, floodlight luminaire suitable for with 2 x 250W HPSV lamp	Area lighting / Yard lighting / Floodlighting purpose
1.24	PD	Philips RVP302 2XSON-T 400W / eqv.	Compact, sturdy non integral, corrosion resistant with pre anodized aluminium reflector, floodlight luminaire suitable for with 2 x 400W HPSV lamp	Area lighting / Yard lighting / Floodlighting purpose
1.25	BA	Philips SWF231 1XMHN-TD 150W A / eqv.	Compact, sturdy, general purpose with integral gear floodlight luminaire suitable for with 1 x 150W metal halide lamp	Area lighting / Yard lighting / Floodlighting purpose
1.26	BB	Philips SWF331 1XMHN-TD 250W A / eqv.	Compact, sturdy, general purpose with integral gear floodlight luminaire suitable for with 1 x 250W metal halide lamp	Area lighting / Yard lighting / Floodlighting purpose
1.27	BC	Philips RVP302 2XMHN-TD 250W / eqv.	Compact, sturdy non integral, corrosion resistant with pre anodized aluminium reflector, floodlight luminaire suitable for with 2 x 250W metal halide lamp	Area lighting / Yard lighting / Floodlighting purpose
1.28	BD	Philips RVP302 2XMHN-TD 400W / eqv.	Compact, sturdy non integral, corrosion resistant with pre anodized aluminium reflector, floodlight luminaire suitable for with 2 x 400W metal halide lamp	Area lighting / Yard lighting / Floodlighting purpose
1.29	EX	Philips (Exit Lamp) / eqv.	Escape lighting luminaire with “EXIT” sign fitted with 1x20 FLT. Each luminaire shall be self contained 6 volt battery, battery charger unit.	Control Room / Electronic Eqpt. Room / Conference room / Office / Engineer's Room as UPS

SL. NO.	FIXTURE TYPE	REFERENCE FIXTURE NO.	DESCRIPTION	AREA OF USE
			Normally the luminaire shall be ON continuously through 240V AC supply. When AC supply goes OFF the in built battery & inverter system automatically takes on to ignite luminaire for duration of two & half (2½) hours. The battery shall be maintenance free and shall be trickle charged when 240 V AC mains supply is available.	
1.30	FA	GE Evolve™ LED Outdoor Family IBERIA / eqv..	Die-cast aluminium housing, decorative luminaire using LED technology with symmetric and asymmetric light distribution, IP 65 rated for optical assembly with high brightness LED-pole mounted.	Street lighting / boundary lighting
1.31	Ceiling/Column /wall mounted	Bajaj BJDB 100 with 1X100W. GLS/eqv	Bulkhead luminaire with wire guard, die cast Al alloy body, heat resistant prismatic glass cover with specially designed weather proof gasket.	Emergency light-ing in CHP area

Note 1: The supply also includes associated junction boxes, brackets, supports, hangers, and wires wherever applicable.

2.0 LIGHTING PANEL

2.1	LP-1	415 V A.C. Indoor type Lighting Panel with 415 V, 100A, 3 ph, 4 wire bus, one (1) no. 100A TP & N switch/MCCB as incomer along with ELCB, 24 nos. 20A, 240 V, 1 pole MCBs as outgoing feeders.
2.2	LP-2	415 V A.C. Indoor type Lighting Panel with 415 V, 100A, 3 ph, 4 wire bus, one (1) no. 100A TP & N switch/MCCB as incomer along with ELCB, 18 nos. 20A, 240 V, 1 pole MCBs as outgoing feeders.
2.3	LP-3	415 V A.C. Indoor Lighting panel with 415 V, 3ph, 4W bus & one 63A TP & N Switch/MCCB as incomer with ELCB and 12 nos 20A , 240V 1 pole MCBs as outgoing feeder.
2.4	LP-4	415V A.C. Indoor type Lighting Panel with 415V, 63A, 3 ph, 4 wire bus, one (1) no. 32 A TP & N switch/MCCB as incomer with ELCB, 6 nos. 20A, 240V, 1 pole MCBs as outgoing feeders.

2.5	SLP	415 V A.C. Outdoor type Panel with 415 V, 100A, 3 ph, 4 wire bus, one 100A TP & N switch/MCCB as incomer, 18 nos. 20A, 240V, 1 pole MCBs as outgoing feeders. The lighting panel shall be provided with 63A contactor, frequency compensated timer switch, photo-cell switch push- buttons for automatic control of street/area lighting with provision for manual override.
2.6	DCLP	Indoor type emergency lighting panel with 240V bus, one no Fuse switch as incomer and 6 nos 16A two pole MCB as outgoing feeders.
2.7	FLP	Outdoor, lockable type Isolating switch of 415V, 63A, 3 ph, 4 wire TP & N. with 2 mm sheet steel/cast iron cubicle.
3.0	**RECEPTACLE**	
3.1	RA	6A, 240 V, 2 pole, 3 pin with third pin earthed, suitable for flush mounting in office areas and control room. The switch shall be also flush mounted piano type.
3.2	RB	16A, 240V, 2 pole, 3 pin with third pin earthed, wall/ column mounted, metal clad gasketed construction, 20mm conduit entry, screwed metal cover tied to it by a metal chain, weatherproof suitable for indoor/outdoor installation.
3.3	RC	63A, 415 V, 3 phase, 4 pin interlocked plug and switch with earthing contact, wall/column mounted, metal clad gasketed construction, weatherproof, suitable for loop-in/loop-out connection of 4/C-35 Sq.mm XLPE cable. These shall be fed from Welding DB.
3.4	RD	125 A, 415 V, 3 phase 5 pin interlocked plug & switch with fifth pin earthed, wall/column mounted metal clad gasketed construction, weatherproof, suitable for loop in and loop out connection of 3-1/2C -95 Sq.mm XLPE cable. These shall be fed from A.C-Distribution Board/Station MCC.
4.0	**CEILING FANS**	
4.1	FA	1200 mm sweep ceiling fan with regulator, down rod and canopy.
4.2	FB	1400 mm sweep ceiling fan with regulator, down rod and canopy.
5.0	**LIGHTING POLES**	
5.1	TA/TB	Single arm/double arm swaged and welded steel pole with junction box and all accessories.
6.0	**SWITCHBOARD**	
6.1	S-1	Switch board with 1-6A switch.
6.2	S-2	Switch board with 3-6A switch and 1-6A receptacle.
6.3	S-3	Switch board with 6-6A switch and 1-6A receptacle.
7.0	**MISCELLANEOUS ITEMS**	
7.1	M1	10 m high car wheel mounted aluminium ladder.
7.2	M2	Adjustable free-standing aluminium ladder height adjustable from 5 m to 10 m.+
7.3	M3	Portable Emergency light set complete with one 20W tube light, battery, battery charger and all other accessories.
7.4	M4	24 Volt Supply Module with all accessories.

ANNEXURE-C

ILLUMINATION LEVEL & AREA WISE LIGHT DISTRIBUTION

Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
1.0	**Turbine Generator Building :**			
1.1	General Auxiliary Equipment Areas	100	Industrial Well Glass	70W/150W HPSV/125 W HPMV Lamp
1.2	Cable Spreader Room	70	Industrial type fluorescent lamp with vitreous enamel reflectors	Fluorescent tube (T5) with electronic ballast.
1.3	Switchgear Room	200	Industrial type fluorescent lamp with vitreous enamel reflectors	Fluorescent tube (T5) with electronic ballast.
1.4	TG Building Operating Floor	200	Industrial Integral high bay	250 W/400W HPSV / HPMV lamp
1.5	Main Control Rooms	400	Decorative recessed mounted with mirror optics aluminum anodized reflector	2 x 28W FTL
1.6	Battery Rooms	200	Industrial Corrosion proof luminarie.	2 x 28W FTL.
1.7	Unloading and Maintenance bay	250	Industrial integral high bay	250 W / 400W HPSV /HPMV lamp
2.0	**Boiler Area :**			
2.1	Boiler area and platforms	100	Dust proof / dust tight integral well glass luminaire	70 W HPSV/ 125W HPMV lamp
2.2	Coal Bunker and Mill bay area	100	Dust proof / dust tight integral well glass luminaire	1 x 80 W /125 W HPMV lamp
2.3	ESP areas and Platforms	100	Dust proof / dust tight integral well glass luminaire	70 W HPSV/ 125W HPMV lamp
2.4	ESP Control Room	400	Decorative recessed mounted with mirror optics aluminum anodized reflector	2 x 28 W FTL.
3,0	**Transformer Yard :**			
3.1	General	20	General purpose flood light	250 W/400 W HPSV lamp
3.2	Near equipment	50	Dust proof / dust tight integral well glass	1 x 70 W HPSV lamp
4.0	**Laboratory**			

Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
4.1	General	100	Decorative recess / surface mounted/ Suspended type mirror optics	Fluorescent tube (T5) with electronic ballast.
4.2	Analysis Area	300	Industrial Corrosion proof luminarie.	2 x 28W FTL.
5.0	**Various Off-site Buildings :**			
5.1	Equipment Room / Switchgear Rooms	200	Industrial type fluores-cent lamp with vitreous enamel reflectors up to mounting height of 3.5 M or Industrial medium bay integral luminaire for mounting heights between 3.5 to 8 M.	fluorescent tube (T5) with electronic ballast
5.2	Pump Houses/ DG room / Compressor room	200	Industrial well glass / Industrial Medium bay integral luminaire	70 W HPSV/ 150W HPSV lamp
5.3	DM Plant, Pre-Treatment	150	Industrial trough type fluorescent/ Industrial Medium bay integral luminaire	2 x 28W FTL. / 125W HPMV / 150W HPSV lamp
5.4	Workshop	150	Industrial trough type fluorescent/ Industrial Medium bay integral luminaire	2 x 28W FTL. / 125W HPMV / 150W HPSV lamp
6.0	**Cooling Water Pump House Area :**			
6.1	Cooling Tower Area	30	Industrial well glass	70 W HPSV/ 125W HPMV lamp
6.2	CW PH	200	Industrial medium bay integral luminaire for mounting heights between 3.5 to 8 M	70 /150 W HPSV or 150 / 250 W HPMV lamp
7.0	**Road & Yard Lighting:**			
7.1	Main Roads	20	Integral type street Lighting luminaire with aluminium reflector	150 /250W HPSV lamp
7.2	Secondary Roads	10	-do-	-do-
7.3	Perimeter (Compound) Lighting	10	-do-	-do-
8.0	**Service Building, Canteen, etc.**			
8.1	Main Office /Staff Room	300	Decorative recess mounted mirror optics aluminum anodized reflector	2 x 28W FTL
8.2	Non-Office /Service	300	Decorative recess /	Fluorescent tube

Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
	Areas		surface mounted/ Suspended type mirror optics	(T5) with electronic ballast.
9.0	**General :**			
9.1	Corridors, Walkways, Staircase, Lockers etc.	70	Industrial type fluorescent lamp with vitreous enamel reflectors	Fluorescent tube (T5) with electronic ballast.
9.2	Toilets, Wash Rooms, etc.	70	Commercial channel mounted box type	Fluorescent tube (T5) with electronic ballast.
10.0	**400kV SWYD (as applicable)**			
10.1	Control Room	400	Decorative recessed mounted with mirror optics aluminum anodized reflector	2 x 28W FTL
10.2	Switchgear/Electrical Equipment room	200	Industrial type fluores-cent lamp with vitreous enamel reflectors up to mounting height of 3.5 M or Industrial medium bay integral luminaire for mounting heights between 3.5 to 8 M.	fluorescent tube (T5) with electronic ballast
10.3	Battery Room	200	Industrial Corrosion proof luminarie.	2 x 28W FTL.
10.4	Outdoor Operating Area	50	General purpose flood light	250 W/400 W HPSV lamp
10.5	General Outdoor Area	20	General purpose flood light	250 W/400 W HPSV lamp
11.0	**CHP Area**			
11.1	Transfer Point, Conveyor gallery, pent house, tunnel, Crusher house & Wagon Tippler	100	Dust proof / dust tight integral well glass	70 W HPSV/125 W HPMV lamp
11.2	Coal Stack yard/ Open area/ Marshalling yard	10	General purpose flood light & Integral type street Lighting luminaire with aluminium reflector	150 W/250 W/400 W HPSV lamp
12.0	Fuel Oil Tank	20	Industrial medium bay integral luminaire/ General purpose flood	250 W/400 W HPSV lamp

Sr. No.	Area/Structure	Average Illumination Level in Lux.	Type of Fixture / Luminaire	Type of Lamp
			light	
13.0	DC Emergency area Main Control room	50	Downlight luminaire, recessed type with cylindrical reflector	Incandescent lamp
14.0	DC Emergency other area	20	Industrial bulkhead luminaire	Incandescent lamp

* Medium bay fixtures shall be used where the room height is 8 M. Otherwise high bay fixtures are to be used.

Lux level for A.C. Emergency lighting in control room shall be 50 and for other areas 20 lux.

Lux level for main road lighting shall be 20 and for secondary road shall be 10 lux.

Lux level for D.C. Emergency lighting in main control room shall be 50 and for other areas 20 lux.

Area Wise Distribution of Lighting System

Sl.No.	Area	Normal AC	Emergency AC	Emergency DC	Portable DC
1.0	TG Building general	80%	20%	Yes	
2.0	Boiler platform	80%	20%	Yes	
3.0	DG / Compressor Room	80%	20%		Yes
4.0	ESP Control Room	80%	20%		Yes
5.0	Main Control Room	70%	30%	Yes	
6.0	Switchyard Control Room	100%			Yes
7.0	Battery Room	80%	20%		
8.0	Cable Spreader	80%	20%	Yes	
9.0	Pump house, Water Treatment Plant, Ash Handling Plant, Chemical house	100%			Yes
10.0	Cooling Tower, Transformer yard, Store, Switchyard, Area/Street lighting	100%			
11.0	Coal Handling Plant	100%		Yes	

ANNEXURE-D

RATINGS AND REQUIREMENTS
OF
LIGHTING / WELDINGTRANSFORMER

Type	:	Cast Resin Dry Type
KVA rating	:	to be finalized during detail engineering
Voltage rating	:	415 V/415 V
Cooling	:	AN
P.U. Impedance	:	0.045 ± 10%
Voltage control	:	Off load tap switch/link with change of ± 5% in step of 2.5% tapping full capacity.
Vector Group	:	Dyn11
Class of Insulation	:	F (155°C)
Maximum Temperature rise over 50°C. ambient in winding by resistance	:	90°C
Neutral	:	Solidly grounded.

The secondary neutral of the transformer shall be brought out for getting a grounded 4wire supply. Each transformer shall be routine tested and one transformer shall be type tested in accordance with relevant standard.

The transformer shall be liable for rejection if the tolerance on the quoted values of losses, impedance, temperature rise, etc. exceeds the specified values of relevant standard.

The transformer shall be mounted inside sheet steel enclosure, which shall be an integral part of Lighting Distribution Board.

ANNEXURE-E

FITTINGS AND ACCESSORIES OF LIGHTING / WELDING TRANSFORMER

Each transformer shall be equipped with fittings and accessories as listed below :

1. 150 mm dia. winding temperature indicator with maximum reading pointer and electrically separate sets of contacts for trip and alarm

2. Handling and lifting lugs both for enclosure and core-coil assembly.

3. Jacking pad for core-coil assembly.

4. Inspection cover for cable and box.

5. Door handle operated safety limit switch with 1NO + 1NC contact.

6. Ground bus.

7. IP-55 junction box.

8. Rating and terminal marking plates.

Note

All indication, alarm, trip contacts provided shall be rated for 2.0A at 220 V D.C. and 5A at 240 V A.C.

REFERENCES:

- IS–732: Code of practice for Elecrtical Wiring Installation.
- IS13408: Code of practice for the Selection, Installation and Maintenance of Electrical Apparatus for use in Ponentially Explosive Atmospheres (other than Mining Applications or Explosives Processing and Manufacture).
- National Building Code (NBC).
- National Electrical Code (NEC).
- Indian Electricity Rules.

NOTES & DETAILS:

1. The electrical installation work shall meet the requirements of Indian Electricity Rules, relevatn IS codes of practice and safety codes, as amended upto date. In addition, other rules or regulations as applicable to the work shall be followed.

2. These lighting notes and details shall be read and construed in conjunction with the Illumination Layout and drawings.

3. Except specifically approved by site office, installation of exposed conduits, mounting of lighting fixtures etc. shall be taken up only after all other services such as Piping, Air Ducting, Cable Tray/Busduct Hanger, Structural Bracings etc. in a particular area have been installed.

4. Unless otherwise shown, the mounting heights of lighting fixtures and accessories shall be generally as follows :

a)	i)	Low–Bay Lighting Fixtures in general indoor Areas of Industrial plants.	:	3500 mm from bottom to finished floor.
	ii)	Medium Bay Type Fixtures.	:	3500 to less than 8000 mm from bottom to finished floor.
	iii)	High Bay Type Fixtures	:	8000 mm and above from Bottom to finished floor.
	iv)	General indoor lightign for residential, commerical area	:	2700 mm from Bottom to finished floor.
b)		Lights over door Openings	:	300 mm bottom of fixture above top of opening.
c)		In Boiler Platform/ Platform around reactor column, reformer, cracker etc.	:	Pendant below Boiler platforms or with brackets from handrail 2000mm above platform.

d) Receptacles –

i)	In control room/office	:	450 mm from finished floor to centre
ii)	Elsewhere	:	900 mm from finished floor to centre
e)	Local Switches	:	1500 mm from finished floor to centre
f)	Lighting Panels	:	1800 mm from finished floor to top
g)	Ceiling Fans	:	200 mm above lighting fixtures

5. Unless otherwise noted, all lighting fixtures shall be fed from respective lighting panels. Normal AC lighting panels will be fed from Main lighting distribution boards (MLDB). Emergency AC lighting panels will be fed from Emergency Main lighting distribution boards (EMLDB). DC Emrgency lighting distribution boards (DCELDB) will be fed from MLDB and Main DC distribution boards.

6. All outdoor lighting poles/towers shall be provided with fuse/MCBs at their base while receiving incoming cable.

7. Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in the from of switch or fuse.

8. All exposed conduit runs in battery room, chemical feed station area, water treatment building etc. shall be suitably painted with electrolytic/chemical proof paints.

9. The entire metallic conduit system whether embedded or exposed, shall be electrically continuous and thoroughly grounded.

10. Lighting fixtures shall not be suspended directly from junction box in the main conduit run.

11. Separate conduit shall be used for wiring lighting circuits of different lighting distribution system such as normal AC lighting/emergency AC lighting/emergency DC lighting/low voltage lighting.

12. A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers and different batteries (D.C. Source) shall not be run through same conduit and junction boxes.

13. Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.

14. Wires/cable shall be spliced only at junction boxes with ring–tongue lugs or approved equal.

15. For cable/wire numbering, PVC sleeve with cable/wire Tag number of different colour code shall be used.

16. For roads/outdoor areas, main runs from street/area lighting panels shall be by means of AYWY/AYFY/A2XFY cables, directly buried in ground with proper protection as per details shown or through duct bank.

17. When buried cables cross road/railway track, additional protection to be provided in from of Hume/G.I. Pipe/HDPE pipes. GI pipes/Hume pipes shall not be used for single core cable run.

18. All wiring in hazardous areas shall be carried out either with armoured cables or cables drawn in screwed solid or sameless conduit.

19. For classified hazardous area (othe than mines) havining flammable gases and vapors only, all the items and accessories of illumination system shall have enclosure as provided for the hazardous area classification (Zone 0, Zone 1 and Zone 2) as per code of standard IS-5571 and 5572.

    Lamps containing free matallic sodium (e.g. low pressure sodium vapour lamps) are not permitted for use in hazardous areas.

20. In underground mines, the lighting system shall have a mid or neutral point connected with earth and the voltage shall not exceed 125 volts between phases.

    On the surface of a mine or in an open cast mine, the voltage may be rised to 250 volts, if the neutral fo mid point of the system is connected with earth and voltage between the phases does not exceed 250 volts.

    Where portable hand-lamps are used in under ground working of mine, the voltage shall not be exceed 30 volts.

21. Number of receptacles in an area shall be decided based on utility of this area. However, unless otherwise noted, number of receptacles shall generally be selected based on following guidelines:

    a) For Residental Building, 6A and 16/6A single-phase receptacles shall be considered as per NBC.

    b) For general area (e.g. Electrical room, Pump room, Contro room) of Plant Building. 16/6A receptacle shall be considered.

    c) One (1) number 63A three-phase receptacle shall be provided at each generator busduct area, at each generator-transformer area, station-transformer area, transformer area at switchyard, bioler area, major pump rooms.

d) 63A three phase receptacle shall be provided at each turbine bay, at eachboiler area, etc. for use of welding machine.

e) Inindustrial plants, 63A three–phase receptacles shall be dicided based on the application requirement.

f) 24v singel–phase receptacle shall be used in boiler platform area and vessels platforms (e.g. reactor, reformers etc.) hazardous classified area. The number shall be decided based on application and area.

22. Unless otherwise noted, the minimum size of cables, wires, conduits, junction boxes shall be as below :

A) CABLES

i)	From main lighting distritbution Boards to 400 V normal AC lighting panels	:	1x3–1/2C, 95 Sq.mm AL PVC/XLPE
ii)	From Emergency main lighting distritbution Boards (EMLDB) to 400v Emergency AC lighting panels.	:	1x3–1/2C, 95 Sq.mm AL PVC/XLPE
iii)	From Main Lighting Distribution Boards (MLDB) to 400V AC/220V DC Emergency Lighting Distribution Boards (DCELDB)	:	1x3–1/2C, 95 Sq.mm AL PVC/XLPE
iv)	From Main Lighting Distribution Boards (MLDB) to 400V AC/220V DC Emergency Lighting Distribution Boards (DCELDB)	:	1x3–1/2C, 95 Sq.mm AL PVC/XLPE
v)	From PMCC/MCC/DB to 100A 3 phase receptacles	:	1x3–1/2C, 95 Sq.mm AL PVC/XLPE
vi)	From PMCC/MCC/DB to 63A 3 phase receptacles	:	1x4C, 35 Sq.mm AL PVC/XLPE
vii)	From SLP (Street Lighting Panel) to tower junction box	:	1x4C, 16 Sq.mm AL PVC/XLPE
viii)	From SLP to light pole junction box (for single phase)	:	1x2C, 16 Sq.mm AL PVC/XLPE
ix)	From SLP to light pole junction box (for three phase)	:	1x4C, 16 Sq.mm AL PVC/XLPE

B. WIRES

Wires shall generally be PVC insulated650V grade. Each wire shall be of following sizes:

i)	From lighting panels (LPs) to Junction Boxes	:	10sqmm AL (stranded) or 6 sqmm Cu (stranded)
ii)	From junction boxes (JBs) to lighting fixtures	:	2.5sqmm Cu
iii)	From junction boxes to flood light fixtures	:	2.5sqmm Cu
iv)	From lighting panels to 24V AC supply modules (complete with 230/24V built–in transformer & 24V receptacle)	:	10sqmm AL (stranded) or 6 sqmm Cu (stranded)
v)	Point wiring of light/celling fan/exhaust fan/call bell	:	1.5sqmm Cu (stranded)
vi)	230V, 6A receptacle	:	1.5sqmm Cu (stranded)
vii)	From LP to 230V, 16/6A 1st receptacles	:	4sqmm Cu (stranded)
viii)	From 230V, 16/6A 1st receptacle to 230V 16/6A second receptacle	:	2.5sqmm Cu (stranded)
ix)	From LP to 230V, 20/6A receptacles	:	4sqmm Cu (stranded)
x)	230V window/split AC starter unit upto 2 Ton capacity	:	4sqmm Cu (stranded)
xi)	Circuit wiring from LP to switchboard	:	2.5sqmm Cu (stranded)
xii)	From street light panel to lighting pole JB (if conduit used)	:	16sqmm AL (stranded) or 6 sqmm Cu (stranded)
xiii)	From street light pole junction box to street light fixture	:	2.5sqmm Cu (stranded)

C. CONDUITS

a) Unless otherwise noted, in residential and commerical building, PVC conduit shall generally be used for concealed conduiting purpose both in masonry wall as well as in concrete portion. Two numbers 18 SWG GI fish wires shall be drawn inside each conduit while embedding in concrete portion. At both ends of each conduit a minimum 400mm length of fish wiers shall be ketp by cooling, for pulling of wires. All exposed conduits above false celling shall be Galvanised Iron (GI) or Enameled Iron (EI).

b) In plant area GI conduit shall be used at surface. Unless otherwise noted, in Non–Plant building rigid PVC conduit shall be used at surface.

c) Conduits shall generally be Galvanised Iron (GI)/ Enameled Iron (EI)/PVC of following minimun sizes:

	Wire Size	Conduit. Size					
		20MM	25MM	32MM	40MM	50MM	
i)	10 Sq.mm AL	–	2	5	7	8	Maximum no. of wires admissable for conduit
ii)	6 Sq.mm Cu	2	3	7	–	–	
iii)	4 Sq.mm Cu	3	5	10	–	–	
iv)	2.5 Sq.mm CU	4	6	10	–	–	
v)	2.5 Sq.mm CU	4	6	10	–	–	

D. JUNCTION BOXES

	Conduit Size (MM)	Junction Box Size (MM)			
		4–WAY	3–WAY	STRAIGHT THROUGH	90°
i)	20 / 25	150x150x100	150x100x100	88 ø	88 ø
ii)	32 / 40	254x200x127	254x200x127	150x150x100	–
iii)	50	254x200x127	254x200x127	254x200x127	–

23. All lighting panels/distribution boards, junction boxes, receptacles fixtures, conduits, etc. shal be grounded in compliance with the provision of I.E. rules and as detailed below :

i)	LIghting Panels	:	35 x 6 mm G.S. Flat
ii)	Distribution Boards	:	50 x 6 mm G.S. Flat
iii)	Power receptacles Junction Boxes etc.	:	12 SWG G.I. Wire
iv)	Lighting fixtures, switches conduits, etc.	:	16 SWG G.I. Wire
v)	Street Light Poles and Towers for floodlighting	:	25 x 3 mm G.S. Flat

24. A continious ground conductor of 16 SWG GI.wire shall run along each exposed metallic conduit run and bonded to it every 600mm.

25. For a run of conduit partly or wholly embedded, PVC insulated stranded copper conductor wire, as ground conductor shall run through the conduit.

26. Typical details of lighting fixtures, other lightign system components and their mounting arrangement as shown herein are for general guidance only. The type no. of some make has been referred in the various drawings only to indicate desired appearance and construction features of the fixture. The contactor has to design the same fulfilling the requirement of the specification.

VOLUME: V-A

SECTION-VII

TECHNICAL SPECIFICATION
FOR
415V PMCC/MCC, 415V ACDB AND 220V DCDB

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SECTION-VII

TECHNICAL SPECIFICATION FOR 415V PMCC/MCC, 415V ACDB AND 220V DCDB

1.00.00 SCOPE OF SUPPLY

1.01.01 Requisite nos. of following equipment shall be furnished with all accessories :-

a. Power cum Motor Control Centre (PMCC)
b. Motor Control Centres (MCC)
b. A.C. Distribution Board (DB)
c. D.C. Distribution Board (DB)
d. D.C. Starters
e. Lockout Switches
f. A.C./D.C. fuse boards

1.01.02 The base channel frame with hardware and lifting angles.

1.01.03 One set of special tools and tackles.

1.01.04 Set of accessories as listed below :

a) Breaker lifting and handling trolley.

b) Test cabinet with coupling cables for testing the breaker in drawout position.

c) Racking in/out handle for breakers.

1.01.05 12kV rubber mats shall be provided both at front and rear of LT Switchgear.

1.01.06 Mandatory Spare parts.

1.01.07 All relevant drawings, data and instruction manuals.

2.00.00 CODES AND STANDARDS

2.01.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

2.01.02 Equipment and material conforming to any other international standard which ensures equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.01.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 **DESIGN CRITERIA**

3.01.00 The PMCCs/MCCs/DBs will be used to provide power, control and protection for 415/240V A.C. and 220V D.C. auxiliary services (Motors & Feeders) of generating units.

3.02.00 Duty involves direct-on-line starting of large squirrel cage motors below 175kW. The starting current varies from 6 to 8 times rated current at very low power factor.

3.03.00 The equipment will be located in a hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.04.00 For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values stipulated in relevant standards and/or this specification.

3.05.00 Equipment ratings and quantities are detailed in the enclosed drawings and annexure. Equipment shall be furnished in strict compliance with the same.

3.06.00 All equipment and components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents without any damage or deterioration of the materials.

3.07.00 The PMCCs/ MCCs / DBs shall have two incomers and one bus-coupler. In addition to electrical interlocks, mechanical castle key interlock shall be provided between the two incomers and the bus-coupler so that any two of the three may be closed at a time.

3.08.00 Busbars of PMCCs shall be sized to carry continuously the associated transformer secondary current plus a 20% margin.

Busbars of MCC/DBs shall be sized to carry continuously the total running load of MCC/DB plus a 20% margin.

3.09.00 In cubicle of incomers & bus section breakers/MCCBs shall be identical to the associated busbar rating.

3.10.00 For continuous operation at specified ratings, the temperature rise of various equipment/components shall be limited to the permissible values specified in relevant standards and/or this specification.

3.11.00 Circuit breakers shall not produce any harmful over voltage during switching off of induction motors. If required, surge protective devices shall be included in the scope of supply to limit over voltages.

3.12.00 Incomers, Bus-couplers & outgoing feeders rated upto & including 630A shall be MCCB controlled. Above 630A all incomers, Bus-couplers & outgoing Feeders shall be ACB controlled. For critical loads ACB controlled feeders shall be provided which will be decided during detail engineering.

3.13.00 All motor rated 110kW & above, below 175kW shall be ACB controlled. Motor rated upto 110kW shall be contactor operated.

3.14.00 MCC & PMCC shall have sufficient number of spare modules (at least 20% of various sizes used with a minimum of 1 no. for each rating and type).

3.15.00 Outgoing feeders of PMCC shall be limited to minimum number of different sizes so that max. standardization is achieved from MCCB & contactor size point of view.

3.16.00 Incomers & bus section breakers of PMCCs/MCCs shall have provisions for remote operation from control room.

3.17.00 All breaker operated motor feeder shall be supplied from PMCC.

3.18.00 One no. Normal/Emergency switchgear to cater power supply to important emergency load / motors for safe shut-down of unit including 220V battery chargers shall be provided for each unit. The main incoming supply shall be from 415V unit service switchgear. When main incoming supply fails, reserve incoming supply shall be switched ON automatically from 415V station service switchgear. In case of total failure of AC supply of the power station, the supply from DG shall be switched ON automatically.

3.19.00 Each switchgear shall be provided with two bus sections, two incomer and a bus coupler rated for 100% of the loads connected to the switchgear.

3.20.00 For each auxiliary or load, one feeder shall be provided except for the following cases:

One feeder for a maximum 2 nos. isolator motor operating mechanism.

3.21.00 The switchgears shall be provided with suitable number and type of outgoing feeders for the respective auxiliary loads of the system/area, power supply feeders to various panels, lighting transformer, space heating panels, control cabinets and all other loads encountered in the plant. In addition, following feeders shall be provided in each bus section of each switchgear.

a) Bus VT module: One (1) no.

b) Switchgear test supply module: One (1) no.

c) 240V, 1 phase essential supply module with five nos. 1 phase outlets: One (1) no.
Necessary 415V/240V dry type transformer shall be provided.

d) Alarm module for common alarm for outgoing feeder fault: One (1) no.

e) DC supply alarm module for incomer, bus coupler fault: One (1) no.

3.22.00 Each feeder shall be provided with two nos. interposing relays for start & stop. These interposing relays shall be located in separate IPR panel described under C&I specification.

4.00.00 **SPECIFIC REQUIREMENTS**

4.01.00 **Construction**

4.01.01 PMCC / MCC / DB shall be indoor, metal-clad, air insulated and floor mounting type. All MCCs shall be fully draw out type and DBs shall be fixed type. ACB modules of PMCCs/MCCs shall be fully drawout type. MCCB / Switch Fuse modules shall also be fully drawout type. The design and construction shall be such as to allow extension at either end.

4.01.02 All PMCC/MCC shall be of double front construction.

4.01.03 PMCC /MCC/DB enclosure shall be dust and splash proof, conforming to a degree of protection IP-54. All switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness 2.0mm. Frames shall be enclosed in cold rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot/cold rolled sheet steel and 4.0 mm for non-magnetic material.

4.01.04 PMCC / MCC / DB assembly shall comprise a continuous line up of dead front, free-standing vertical sections, housing the control modules in multi tier formation.

4.01.05 The design shall be fully compartmentalized with metal/insulating partitions between compartments. The working height shall be limited within 750 mm to 1800 mm from floor level.

4.01.06 Each control module shall be housed in a separate compartment, complete with an individual front access door having sufficient opening with concealed type hinges. Each vertical section shall have a removal back cover. All doors and covers shall be gasketed.

4.01.07 All push buttons, lamps, indicating instruments shall be flush / semi-flush mounted on respective module compartment.

4.01.08 A full height vertical cable chamber with cable supports shall be provided in each section to facilitate unit wiring. The chamber shall be liberally sized to accommodate all cables and shall have removable cover at the front for access.

4.01.09 A horizontal wireway, extending the entire length, shall be provided at the top of each PMCC / MCC / DB for inter panel wiring.

4.01.10 The width of the cable alley shall not be less than 250 mm.

4.02.00 **Bus and Bus Taps**

4.02.01 All PMCCs/MCCs/DBs shall be provided with three phase & neutral bus bars . All DCDBs shall be provided with two busbars. All busbar compartments shall be completely enclosed.

4.02.02 The main buses and connections shall be of high conductivity Aluminium / Aluminium alloy, sized for specified current ratings with maximum temperature limited to 85°c (i.e., 35°C rise over 50°C ambient).

4.02.03 Vertical busbars shall be designed for minimum current rating of 200A. Separate vertical busbars shall be provided for each vertical panel.

4.02.04 All bus connections shall be silver plated. Adequate contact pressure shall be ensured by means of two-bolt connection with plain and spring washers and locknuts.

Bimetallic connector shall be furnished for connection between dissimilar metals.

4.02.05 Busbars and connections shall be fully insulated for working voltage with adequate phase/ground clearances. Insulating sleeves for busbars and shrouds for joints and tap-off points shall be provided.

Bus insulators shall be flame retardant, non-hygroscopic track-resistant type with high creepage surface.

4.02.06 Busbars shall be supported and braced to withstand the stresses due to maximum short circuit current and also to take care of any thermal expansion.

4.02.07 Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear when viewed from the front of the assembly.

4.03.00 **Control Modules**

4.03.01 Draw-out type control module shall have self-aligning power/control disconnects. All disconnects shall be silver plated to ensure good contacts.

4.03.02 The design shall be such as to permit easy withdrawal/reinsertion of the unit with guide rails to ensure correct alignment.

4.03.03 Control Module shall house the control components for a circuit such as switch fuse / MCCB, contactors, relays, push buttons, lamps etc. as per requirement of the control circuit.

4.03.04 The equipment layout shall provide sufficient working space in between the components and subject to Owner's approval.

4.03.05 Various module/compartment sizes shall be multiple of one basic unit to facilitate modifications at site. Suitable provision for this purpose should also be incorporated in the vertical bus bars.

4.03.06 Draw-out type control modules of same size and type shall be electrically and physically interchangeable.

4.04.00 **Air Circuit Breaker**

4.04.01 Circuit breaker shall be provided on the incomer having minimum interrupting capacity equal to the 50kA(r.m.s) fault level.

4.04.02 Circuit breaker shall be three pole, single throw, air-break type with independent manual spring closing, trip-free mechanism and shunt trip. However Incomer breaker shall be four pole type.

4.04.03 Circuit breaker shall be draw-out type, having service, test & isolated position with positive indication for each position.

4.04.04 Circuit breakers of identical rating shall be physically and electrically interchangeable.

4.04.05 Each breaker shall be provided with microprocessor based protection unit having three overload protection with adjustable current and time, three short circuit protection with adjustable current and time and three instantaneous short circuit protection. The operating characteristic shall be suitable for co-ordination with down-stream fuses.

4.04.06 Circuit breakers shall be provided with motor wound spring charging mechanism. Spring charging shall take place automatically after each breaker closing operation. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to the motor. In addition, facility for manual charging of spring shall be provided.

4.04.07 Mechanical safety interlock shall be provided to prevent the circuit breaker from being racked in or out of the service position when the breaker is closed. It shall not be possible to open the circuit breaker door cubicle unless the breaker is in 'OFF' position.

4.04.08 Automatic safety shutters shall be provided to cover up the stationary disconnects when the breaker is withdrawn.

4.04.09 Each breaker shall be provided with an emergency manual trip, mechanical ON-OFF indicator, an operation counter and spring mechanism charge/discharge indicator, and electrical anti-pumping feature.

4.04.10 In addition to the auxiliary contacts required for normal breaker operation and indication, each breaker shall be provided with the following for interlocking purpose :-

a. Position/Cell switch with 4 NO + 4 NC contacts.

b. Auxiliary switch, with minimum 6NO + 6NC contacts,

4.04.11 Spring charge limit switch shall be provided for breakers with motor wound spring charging mechanism. These limit switches shall be provided with minimum 2NO + 2NC contact.

4.04.12 Limit/auxiliary switches shall be convertible type, that is, suitable for changing N.O. contact to N.C. and vice-versa.

4.04.13 Each breakers operated feeder shall be provided with protective devices as specified in Annexure–B.

4.05.00 **Switches**

4.05.01 Switches shall be triple pole, air break, AC23 motor duty for motor feeders and AC22 heavy duty for other feeders.

Motors duty switches shall be capable of safely making and breaking the locked rotor current of the associated motor circuit.

4.05.02 The switch shall have a quick-make, quick-break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON and OFF position.

4.05.03 The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing this interlock at any time.

4.05.04 Switches shall be capable of withstanding the let-through fault current of back-up fuses or circuit breakers.

4.05.05 Wherever two incoming switches and one bus-section switch are provided for an assembly, these shall be mechanically/key interlocked to ensure that only two out of the three can be closed at time.

Wherever two incoming switches are provided for an assembly, these shall be mechanically/key interlocked to ensure that one of the two can be closed at time.

4.05.06 All incoming and outgoing feeders shall be provided with bolted disconnect link for isolation of neutral if necessary.

4.06.00 **Fuses**

4.06.01 Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the short circuit current of the LT system. Fuses shall be mounted on insulated fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of base. In such cases, one set of insulated fuse pulling handles shall be supplied with each board.

4.06.02 Fuses shall be furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element.

Visible indication shall be provided on blowing of the fuse.

4.06.03 Motor fuse characteristics and ratings shall be chosen to ride over starting period without blowing. The fuse on incoming feeder wherever provided, shall be chosen to provide discrimination with motor/feeder fuses.

4.07.00 **Moulded Case Circuit Breaker (MCCB)**

4.07.01 The MCCBs shall be of drawout type with trip-free operating mechanism of quick make & quick break type. Each MCCB shall be equipped with thermal release for thermal overload and magnetic release for short circuit protection on each pole.

4.07.02 MCCBs / MPCBs shall be suitable for manual closing and opening and also automatic trip on overload and short circuit. MCCB shall have intermediate position to indicate trip condition.

4.07.03 The MCCBs shall be provided with mechanical ON-OFF indicator at the front panel. The MCCB handles, after the breaker tripped due to faults, shall occupy a mean position indicating trip condition.

4.07.04 The compartment door shall be interlocked mechanically with the MCCB such that the door cannot be opened unless the MCCB is in OFF position. Means shall be provided for releasing this interlock at any time.

4.07.05 All feeders of PMCC / MCC rated up to & including 630 Amp shall be provided with MCCB. Air circuit breaker shall be provided for feeders rated above 630 Amp. For critical loads ACB controlled feeders shall be provided which will be decided during detailed engineering.

4.07.06 Motors rating above 110 KW will be operated by Air circuit breaker and protected by consolidated numerical motor protection relay.

4.08.00 **A.C. Starter**

4.08.01 Contactors

a. The contactors shall be three pole, air break type designed for duty class III - Category AC3 (for unidirectional motor) with non-bouncing silver/ silver alloy contacts. Contacts for reversible motors will be of AC4 duty.

b. Each contactor shall be provided with minimum two (2) normally open and two (2) normally closed auxiliary contacts rated 10 A at 240V A.C.

c. Reversing contacts shall be electrically and mechanically interlocked.

d. Contactors with delayed dropout feature shall be provided for some essential auxiliaries. These contactors shall not dropout on power failure if the voltage is restored within 3 seconds.

4.08.02 **Protection**

a. Thermal overload relays shall be three element, positive acting, ambient temperature compensated with adjustable settings.

b. Single phase preventor relay shall be provided, preferably as an inbuilt feature of thermal overload relay.

c. Relays shall be manual reset type with two changeover potential-free contacts. Resetting of relays shall be possible with compartment door closed. Colour of the resetting button shall be BLACK.

d. Relays may be direct acting or C.T. operated, depending on current rating. C.T.s shall be included in the scope of supply.

e. Motor starters shall have type '2' co-ordination according to IEC 947-4.

f. Earth fault relays with adjustable settings and time delays fed from core balance CT shall be provided.

g. Numerical / Digital Motor protection relay with short circuit, over load, earth fault, locked rotor and unbalance (NPS) load protection functions shall be provided for motor rated above 90 kW.

4.09.00 **Control Transformer**

4.09.01 LT Switchboard control supply

The Bidder shall provide one (1) no. adequately rated 415V/110V Control Transformer in each bus section with necessary taps and auto changeover facility for providing control power supply to various modules of the board, except motor feeders. Each motor feeder shall be provided with 415/110V control transformer of adequate capacity (min. 75VA) for control supply to such module. The sizing of control transformer shall be carried out by the Bidder considering the actual load of power contactors, auxiliary contactors, indicating lamps and other equipment in the module circuit. An additional load of 15watts shall be considered for each module for remote auxiliary relays and lamps to be connected in the control circuit of modules. Bidder shall also ensure that control transformer are adequately designed for meeting the momentary loading requirements and the voltage drop during this condition shall not be more than 5%. Each transformer shall be sized for catering to control supply of both bus sections.

4.09.02 LT Switchboard space heater supply

The Bidder shall provide one (1) no. adequately rated 415V/240V Control Transformer in each bus section with necessary taps and auto changeover facility for providing power supply to panel space heater, Motor space heater of motor rated 30 KW & above, Panel Illumination & Socket. The supply of these two (2) nos. control transformer are tapped from incoming supply of 415V PMCC/MCC before the incoming breaker. Incoming circuit to the space heater auxiliary bus shall be through isolating switch HRC fuse and neutral link of suitable rating. The supply of different modules shall be tapped individually from the auxiliary bus bars. Control supply healthy indication shall be provided. Each transformer shall be sized for catering to space heater supply of both bus sections.

4.10.00 **D.C. Starters**

4.10.01 D.C. Starter for emergency oil pump shall be fixed resistance type, designed to provide fast acceleration during starting.

4.10.02 DC starters shall be complete with switch-fuse units, contactors, resistors, relays, meters, push-buttons, lamps, etc.

4.10.03 Starters shall be furnished in totally enclosed floor-mounting, sheet steel cubicles complete with a hinged front access door. Minimum thickness of sheet steel shall be 2mm.

4.10.04 The cubicle enclosure shall provide dust and humidity protection, the degree of protection being not less than IP-54.

The resistor enclosure shall be provided with ventilating louvers and wire mesh guard and shall have a degree of protection IP-23.

4.10.05 Cubicle space heater shall be provided to maintain internal temperature above dew point. Heater shall be furnished with switch-fuse unit and thermostat control.

4.11.00 **Relays**

4.11.01 All incoming and bus-coupler circuits and circuit breaker operated outgoing feeders shall be provided with numerical relays. Breaker operated motor feeders shall be provided with numerical motor protection relay.

4.11.02 The numerical relays shall have provisions for interfacing with Plant DDCMIS / PLC.

4.11.03 Relays shall be of drawout design with built-in testing facilities. Small auxiliary relays may be in non-drawout execution.

4.11.04 All protective relays, auxiliary relays, and timers shall be provided with hand reset operation indicator (flag).

4.11.05 Relays shall be rated for operation on 110V secondary voltage and 5 A or 1 A. Number and rating of relay contacts shall suit the job requirements.

4.12.00 **Control and Indication**

4.12.01 Circuit breakers shall be wired up for local and remote operation. Each breaker cubicle shall be equipped with the following :

i) One (1) TEST-NORMAL-TRIAL selector switch with pistol grip handle and key interlock for breakers with motor wound spring charging mechanism.

ii) On-Off control switches shall have three positions (T-N-C) and shall be spring return to 'Neutral' from close and trip positions. They shall have two contacts closing in close position and two contacts closing in trip positions, and shall have Pistol Grip handles. Lost motion feature shall be provided wherever required.

iii) Following indicating lamps on the front of the compartment:

Breaker open	-	GREEN
Breaker closed	-	RED
Breaker tripped	-	AMBER
Spring charged	-	WHITE
Trip Ckt. Healthy	-	BLUE

Motor Space heater ‘ON’ for motor circuit - YELLOW

4.12.02 Push button shall be heavy duty, oil tight, push to actuate type with integral escutcheon plate marked with its function.

4.12.03 Each push button shall have minimum two (2) nos. normally open and two (2) nos. normally closed contacts rated 10 A at 240 V.

4.12.04 One (1) NORMAL-TRIAL selector switch shall be provided for all motor feeders.

4.12.05 Selectors switches shall be stay-put, rotary type with escutcheon plates marked to indicate the function and positions, and shall be lockable in each position. Selector switch contacts shall be rated for 10A at 240 V A.C.

4.12.06 Selector switches shall be provided with minimum three (3) contact blocks of 1 NO + 1 NC each.

The exact requirements of contacts shall be decided by the Tenderers taking into account the scheme requirement and spares.

4.12.07 Lamps shall be clustered LED type with series resistor and coloured lens. Lens and lamps shall be replaceable from the front. Lamps shall be located just above the associated push button/control switch

4.12.08 The general scheme of connections for control, interlock and protection is shown in the enclosed drawings. Detailed requirements of individual circuits will be intimated later to the successful bidder, who shall develop and furnish the schemes accordingly.

4.13.00 **Meters**

4.13.01 All indicating instruments (96 x 96 mm) shall be switchboard type, with 250` scale, anti-glare glass and accuracy class of ± 2% full scale. Each meter shall have zero adjuster on the front.

4.13.02 Motor ammeter shall be suitable to indicate starting current (6 to 8 times full load current) for DOL starting of motor.

Motor ammeter shall be provided for motor rated 30 kW and above and for critical drives, to be finalized during detail engineering.

4.13.03 All incomers, tie feeders, circuit breaker operated motor feeders shall be provided with 3-phase multifunction meter with pulse output and communication port for interfacing with Plant DDCMIS / PLC.

4.13.04 Meter selector switches shall be maintained contact, stay-put type, with knob handle. Ammeter and voltmeter selector switches shall be four position type. Ammeter selector switches shall have made before break contacts, to prevent open circuiting of CT secondary.

4.14.00 **Current Transformer**

4.14.01 Current Transformer, shall be cast resin type rated 10 VA. All secondary connections shall be bought out to terminal blocks where wye or delta connection will be made.

4.14.02 Accuracy class of the current transformers shall be:

a) Class PS for REF

b) Class 5P20 for other relaying.

c) Class 1.0 ISF < 5 for metering.

d) Class 0.5 ISF < 5 for metering (Incomer & Bus coupler of PMCC)

Other CT particulars like ratio, burden, knee point, excitation current & secondary resistance shall be decided by the bidder.

4.14.03 CT secondary shall be rated for 1A for metering & either 5A or 1A for protection.

4.15.00 **Voltage Transformer**

4.15.01 Voltage transformers shall be cast-resin, drawout type and shall have an accuracy class of 1.0. Voltage transformer mounted on breaker carriage is not acceptable. For Incomer and bus coupler of PMCC accuracy class of voltage transformer shall be 0.5.

4.15.02 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw out position.

4.15.03 Secondary winding MCBs, sized to prevent overload shall be installed in all ungrounded secondary leads. MCBs shall be suitably located to permit easy replacement while the switchgear/PMCC is energized.

4.15.04 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided.

4.16.00 **Transducers**

4.16.01 Transducer for conversion of AC electrical quantities such as voltage, current, KW etc. shall be supplied as required for remote connection to Plant DDCMIS / PLC. All transducers shall be dual output type.

4.16.02 The transducers for indicating type instruments shall be of very low burden type having 4-20 mA DC linear, galvanically isolated output, compatible with secondary instruments and Plant DDCMIS system.

4.17.00 **Secondary Wiring**

4.17.01 The PMCC/MCC/DB shall be fully wired at the factory to ensure proper functioning of control, protection and interlocking schemes.

4.17.02 Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, push buttons and other devices shall be wired upto terminal blocks.

4.17.03 Wiring shall be done with flexible, 1100V grade, fire resistance PVC insulated switchboard wires with stranded Copper conductors of 2.5 mm^2 for control & current circuits and 1.5 mm^2 for voltage circuits.

4.17.04 Each wire shall be identified, at both ends, with permanent markers bearing wire numbers as per Contractor's wiring diagrams.

4.17.05 Wire terminations shall be made with crimping type connector with insulating sleeves. Wires shall not be spliced between terminals. Separate colour code shall be used for AC & DC circuit wiring for easy identification.

4.18.00 **Terminal Blocks**

4.18.01 Terminal blocks shall be 1100V grade box-clamp type with marking strips similar to ELMEX 10 mm^2 or equal. Terminals for C.T. secondary leads shall have provision for shorting.

4.18.02 Terminal blocks used for interface with DDCMIS / PLC via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.

4.18.03 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

4.18.04 Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

4.19.00 **Cable Terminations**

4.19.01 PMCC shall be designed for cable entry from bottom. MCC/DB shall be designed for cable entry both from top and bottom. Actual configuration shall be intimated later sufficient space shall be provided for ease of termination and connection.

4.19.02 Power cables shall be 1100V, Copper/Aluminum conductor, XLPE insulated, armoured, FRLSH PVC overall sheathed.

Control cables shall be 1100V, PVC insulated, armoured, PVC overall sheathed with 2.5 mm^2 stranded Copper conductor.

4.19.03 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates, cable supports, crimp type tinned Copper/Aluminium lugs, brass compression glands with tapered washer (Power Cables only) and Terminal blocks.

4.19.04 Sufficient space shall be provided between the lower most power cable termination and gland plate for easy cable connection.

4.20.00 **Bus Duct Connection**

4.20.01 Bus duct connections shall be furnished along with transition panel, if required. Unless mentioned otherwise bus duct connections shall generally be from the top.

4.20.02 All connecting bus work shall have the same continuous current rating as associated PMCC bus and shall be fully braced for the LT system short circuit current.

4.20.03 All provisions such as matching flange and other accessories shall be furnished for connection to bus duct.

4.21.00 **Ground Bus**

4.21.01 A Cu / Al ground bus rated to carry the maximum fault current, shall extend full length of the MCC/DB.

4.21.02 The ground bus shall be provided with two-bolt drilling with G.I. bolts & nuts at each end to receive 50 x 6 mm G.I. flats.

4.21.03 All stationary structures shall be directly connected to the ground bus for effective grounding.

4.21.04 The frame of draw out module shall be grounded at all times except when the power disconnects are separated by a safe distance.

4.21.05 All hinged doors shall be earthed through flexible copper braid wire.

4.22.00 **Nameplate**

4.22.01 Nameplate of approved design shall be provided for each control compartment and also at the top of each PMCC / MCC / DB.

4.22.02 The material of the name plate shall be anodized aluminium / lamicoid or approved equal, 3 mm thick, with white letter on black background. Name plates shall be minimum 20 x 75 mm for instrument / devices and 40 x 150 mm for panels.

4.22.03 Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.

4.23.00 **Space Heater**

4.23.01 Panel and motor space heater shall be fed from separate AC auxiliary busbars running throughout the switchboard. The space heater bus shall be fed from control transformer described earlier. Suitable terminals shall also be provided to facilitate energisation of the control transformer from outside during long shutdown of the board.

4.23.02 Each vertical section of the PMCC / MCC / DB shall be furnished with thermostat controlled space heater and 5A, 5 pin plug socket.

4.23.03 In addition, motor feeders 30 KW and above shall be wired up for feeding motor space heater through starter auxiliary ‘OFF’ contacts.

4.23.04 Cubicle heater, Motor heater and plug socket circuit shall be provided with individual MCB/switch fuse units.

4.24.00 **A.C./D.C. Power Supplies**

4.24.01 Necessary 415V AC and 220V DC power supplies as required for control and service shall be arranged by the contractor. Single feeder shall be arranged for A.C. supply and duplicate feeder shall be arranged for D.C. supply.

4.24.02 Isolating switch fuse units shall be provided at each switchgear for the incoming supplies, 4-pole, single throw for A.C. and 2-pole, double throw for D.C. Molded case circuit breaker (MCCB) shall also be accepted as an alternative.

4.24.03 Bus-wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles. Isolating switch fuse units / MCCB shall be provided at each cubicle for A.C/D.C. supplies.

4.24.04 A.C. load shall be so distributed as to present a balanced loading on three-phase supply system.

4.25.00 **Tropical Protection**

All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.

Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

4.26.00 **Painting**

4.26.01 All steel surfaces shall be sand blasted, grounded and pickled as required to produce a smooth, clean surface free of scale, grease & rust.

4.26.02 After cleaning, the surfaces shall be given a phosphate coating followed by two coats of high quality primer and stoved after each coat.

4.26.03 For paint shade of finish coat, refer clause no.1.16.00 of Section E1, Volume V-A.

4.26.04 Sufficient quantity of touch-up paint shall be furnished for application at site.

4.26.05 Caution notice plate shall be affixed at the back of each vertical panel.

5.00.00 **TESTS**

5.01.00 All equipment shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards.

5.02.00 **Routine Test**

The tests shall include but not necessarily be limited to the following :-

a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.

b. All wiring and current carrying part shall be given appropriate High Voltage Test.

c. Primary current & voltages shall be applied to all instrument transformers.

d. Routine test shall be carried out on all equipment such as circuit breakers, switch - fuse, contactors, relays, meters etc.

5.03.00 **Type Tests**

The type test certificates for the following tests carried out on an identical & similar type of switchgear shall be furnished. The date of tests shall be within the last five years.

a. Temperature rise Test

b. Short time current test on main circuit and earth circuit.

c. Verification of making and breaking capacity.

Type test certificates of any equipment shall be furnished if so designed by the purchaser/ owner. Otherwise the equipment shall have to be type tested free of charge, to prove the design. Type test performed before five (5) years are not acceptable.

6.00.00 **DRAWINGS, DATA & MANUALS**

6.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

6.02.00 **To be submitted with the bid** :-

a. General arrangement drawing showing constructional features, space required in front for withdrawals, power & control cable entry points etc.

b. Typical foundation plan

c. Typical control schematic

d. Bill of materials

e. Type test reports on circuit breaker

f. Technical leaflets on :-
   i) Circuit breaker
   ii) Switch-fuse units
   iii) Contactors
   iv) Relays, meters, push buttons, selector switches etc.
   v) Glands/terminals blocks

6.03.00 **To be submitted for Owner / Purchaser's Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

RATINGS AND REQUIREMENTS

1.0	General			
	Type	:	ACB Modules - Drawout type MCCB Modules – Drawout type	
	Service	:	Indoor	
	Enclosure	:	IP52	
2.0	System		AC	DC
	Voltage	:	415V ± 10%	220V (187-242V)
	Phase	:	3-phase, 4-wire	2- wire
	Frequency	:	50 Hz +3% to - 5%	
	Combined voltage and Frequency variation	:	10% (absolute sum)	
	System grounding	:	Solidly grounded	Ungrounded
3.0	Rating			
	Rated current	:	To be decided by the tenderers.	
	Design Ambient Temperature	:	50ºC	
	Short Circuit Current Symm.	:	50 KA	25* KA
	* Indicative only, the actual value will be decided by the tenderers.			
	S/C Withstand Time	:	---------- 1 second ----------	
	High voltage test for 1 minute	:	2.5 kV	1.5 kV
4.0	Duty			
	Circuit Breaker	:	0-3'-CO-3'-0	
	Contactor (AC)	:	Class III - Category AC3 for unidirectional drives and AC4 for bi-directional / inching duty drives	
	Contactor (DC)	:	Class I – category DC2	
	MCCB / Switch Duty for		AC	DC
	Motor Feeder	:	AC23	DC22

	Other Feeder	:	AC22 DC22
5.0	A.C. / D.C. Power Supply		
	Control Voltage for Circuit breaker	:	220V DC +10% to -15%
	Control voltage for MCCB modules	:	110V AC ± 10%, 1Ph, 50Hz +3% to - 5%
	Service voltage	:	240V AC ± 10%, 1Ph, 50Hz +3% to - 5%

ANNEXURE-B

PROTECTIONS

1.0 All Protective relays shall be numerical type having communication facility with Plant DDCMIS system / PLC.

2.0 The minimum protections to be provided for different types of circuits are listed below:

a.	Incoming Feeder & Bus-coupler with ACB :	3 -	inverse time O/C relays (51) for phase fault.
		1 -	Inverse time O/C relay (51N) for Earth fault.
		3 -	Under Voltage (27), Range : 40-80% with timer
b.	Motor Feeder with ACB: (above 110 kW)	1 -	Composite Motor protection relay (99) for protection against
		-	Thermal overload
		-	Phase faults
		-	Unbalance (negative sequence)
		-	Locked rotor
		-	Excessive Start-up time and Start-Stop.
		-	Earth fault
c.	Outgoing Feeder with ACB :	3 -	Inverse time O/C relays (51) for phase fault.
		1 -	Inverse time O/C relay (51N) for Earth fault.

3.0 Apart from protection relays, each electrically operated breaker shall be provided with anti-pumping (94), trip annunciation (30), lockout (86) and trip circuit supervision (74) relays. Lockout relay shall be hand reset type.

4.0 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided..

5.0 For Auto-bus change-over as well as live bus change-over through synchronization refer enclosed Control Schematic drawings.

6.0 Each incomer shall be provided with three (3) nos. Bus Energised indicating lamps – Red/Yellow/Blue for each phase.

ANNEXURE-C

FITTINGS & ACCESSORIES

Each switchboard shall be furnished complete with fittings and accessories as listed below: -

1. Operating mechanism complete with all accessories, fittings and tripping coil and closing coil, pole discrepancy feature etc. as required.
2. Base frame and anchor bolts and nuts.
3. Auxiliary contacts and relays.
4. LOCAL/REMOTE Selector switch, TRIP/CLOSE Push Buttons.
5. Manual tripping devices with protective flap.
6. Mechanical ON-OFF indicator.
7. Operation counters.
8. Set of switch fuse units/MCCB for A.C. and D.C. supply.
9. Space heater with thermostat and ON-OFF switch.
10. Cubicle illumination lamp with ON-OFF switch.
11. 3 Pin 5A Socket with ON-OFF Switch.
12. Terminal blocks and internal wiring - lot as required.
13. Other standard accessories which are not specifically mentioned but supplied with breakers of similar type and rating for efficient and trouble-free operation.

14. Bimetallic terminal connectors.

ANNEXURE-D

BUS TRANSFER SCHEME FOR PMCC

1.0 The manual bus transfer shall be arranged in such a way that any of the following modes of operation is possible.

1.1 **Manual Bus Transfer**

a) Without voltage interruption

This means by allowing momentary parallel operation of two sources.

b) With voltage interruption

i) Slow Transfer

ii) Fast Transfer

NOTE : For CHP/AHP system 'Manual bus transfer without voltage interruption' and 'dead bus transfer with voltage interruption' shall be provided.

Synchronization of Incomer & Bus coupler for each of the 415V PMCC shall be implemented through PLC in CHP electrical cum control room building. Synchronization check relay, guard relay and auxiliary relay shall be provided in each PMCC. Synchroscope along with cut off switch, double voltmeter, double frequency meter shall be provided in the Main CHP electrical building cum control room. Separate synchronization switch and trip selector switch for each of the PMCC shall also be provided in the CHP electrical building cum control room.

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SECTION-VIII

TECHNICAL SPECIFICATION
FOR
LOCAL CONTROL BOARDS/PANELS,
LOCAL ISOLATING SWITCH UNITS
AND LOCAL PUSH BUTTON STATIONS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE OF SUPPLY
2.00.00	CODES AND STANDARDS
3.00.00	DESIGN CRITERIA
4.00.00	SPECIFIC REQUIREMENTS
5.00.00	TESTS
6.00.00	DRAWINGS, DATA AND MANUALS

ATTACHMENTS

ANNEXURE-ARATINGS AND REQUIREMENTS	
ANNEXURE-B	A.C/D.C POWER SUPPLY
ANNEXURE-C	FUNCTIONAL REQUIREMENTS OF ANNUNCIATOR
ANNEXURE-D	AREA WISE INDICATIVE LIST OF LOCAL CONTROL BOARDS/PANELS
ANNEXURE-E	LOCAL CONTROL PANEL / LOCAL STARTER PANEL FOR COAL HANDLING PLANT

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SECTION-VIII

TECHNICAL SPECIFICATION FOR LOCAL CONTROL BOARDS/PANELS, LOCAL ISOLATING SWITCH UNITS AND LOCAL PUSH BUTTON STATIONS

1.00.00 SCOPE OF SUPPLY

1.01.00 The following equipment shall be furnished with all accessories:

a) Complete set of Local Control Boards/Panels, an indicative list of which is given in Annexure-C

b) Local Push Button Stations: As required

c) Local Isolating Switch Units: As required

1.02.00 Furnishing, Mounting, and wiring of all equipments, devices and accessories

1.03.00 Floor Channel sill, vibration damping pad, and kick plates for all floor-mounted control boards/panels, complete with holding down bolts and nuts.

1.04.00 Mounting hardware for all control boards/panels, Local Push Button Stations, and Local Isolating Switch Units.

2.00.00 CODES AND STANDARDS

2.01.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

2.02.00 Equipment and material conforming to any other international standards, which ensure equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.03.00 The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 DESIGN CRITERIA

3.01.00 The Local Control Boards/Panels will be used for controlling incomers/ bus-section/electrically operated radial breaker feeders of the associated PMCC/MCC. Necessary indications, meters, annunciations and mimic representation shall also be provided on these control boards/panels.

Local control of all drives shall be done from Process Control Boards/Panels, as described in respective sections of mechanical specification.

The Local Control Boards/Panels shall have to be duly matched with the Process Control Boards/Panels.

3.02.00 Local Push Button (L.P.B.) stations will be used for controlling drives from local as required.

3.03.00 Local Isolating Switch (L.I.S) Units will be used for local isolation of power supply to various machines as required.

3.04.00 All equipment except L.I.S. Units and L.P.B stations, will be located in a clean but hot, humid, and tropical atmosphere. The L.I.S. Units and L.P.B. stations will be generally installed in a hot, humid, and tropical atmosphere, heavily polluted at places with fly ash and/or coal dust, and shall be suitable for outdoor service with degree of protection specified elsewhere in this specification.

3.05.00 All Control Boards/Panels, L.I.S. Units, and L.P.B. stations shall be liberally sized so as to provide spacious layout of equipment and devices with sufficient working space in between.

3.06.00 Adequate space/terminals shall be kept in the boards/panels for installing additional equipment in future.

3.07.00 For continuous operation at specified ratings, temperature rise of the various components/equipment shall be limited to the permissible values stipulated in the relevant standards and/or this specification.

3.08.00 All equipment/components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the system short circuit current without any damage or deterioration of material.

3.09.00 Design, material selection, and workmanship shall be such as to present a neat appearance outside and inside with no welds, rivets, screws, or bolt heads apparent from the exterior surface of the boards/panels. All instrument cut-outs, mounting studs, and support brackets shall be accurately located.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 Construction

4.01.01 Local Control Boards/Panels

a) Local Control Boards may consist of a number of vertical panels mounted side-by-side, in each case, they shall be bolted together to form a compact unit. Where two panels meet, the joints shall be smooth, close-fitting, and unobtrusive.

b) The control boards/panels shall be totally enclosed type, conforming to degree of protection IP-54 or better.

c) Generally, the local control boards/panels shall be free-standing, floor-mounted, dead-front assemblies. In some cases, however, wall-mounted type control boards/panels may also be accepted.

d) Floor-mounted control boards/panels shall be assembled on channel/ angle base plates with anti-vibration mountings and stainless steel kick-plates.

e) All switchboard/panels frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness 2.0mm. Frames shall be enclosed in cold rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot/cold rolled sheet steel and 4.0 mm for non-magnetic material.

The boards/panels shall have sufficient structural reinforcement to ensure a plane surface, to limit vibration, and to provide rigidity during shipment and installation.

f) All floor-mounted panels shall have rear door.

g) Doors shall have concealed type hinges and padlocking arrangement. Doors shall be grounded by flexible copper braid.

h) All doors and removable covers shall be provided with neoprene rubber gaskets all round and latches sufficiently strong to hold them in alignment when closed.

i) Working height of the panels shall be limited between 550 mm and 1800 mm above floor level.

4.01.02 Local Push Button Stations

a) L.P.B. Stations shall be furnished in sheet steel enclosure of dust and vermin-proof, weather-proof, gasketted construction, suitable for outdoor use without canopy, and conforming to degree of protection IP-55 or better for indoor and IP-65 for outdoor.

b) L.P.B. Stations shall be suitable for column/structure/wall mounting and shall be complete with push-buttons, terminal blocks, anodised aluminum inscription plate, two (2) nos. earthing terminals, removable gland plate along with crimp type tinned copper lugs and compression type glands for cable/conduit entry from top and bottom. The earthing terminals shall be suitable for connection to one (1) no. 8 SWG G.I. wire.

c) L.P.B. Stations shall be of the following basic type and equipped with:

Type-A	:	One (1) START push-button and one (1) STOP push-button.
Type-B	:	One (1) OPEN push-button, one(1) CLOSE push-button, and one(1) STOP push-button.

Type-C	:	Flame proof type as per IS-2148. one (1) START push-button and one(1) STOP push-button.
Type-D	:	One (1) STOP Lock-out switch.
Type-E	:	One (1) STOP Emergency PB.

Belt sway bridging Push Button shall be provided in the Local Push Button Station for all conveyor Drives.

Emergency Stop push button shall be provided in the Local Push Button Station for all HT motors.

Any other type of L.P.B. Station, if required, shall be subject to approval of the Purchaser.

d) OPEN, CLOSE, and START push-buttons shall be spring return to normal type. STOP push-buttons shall have mushroom head actuator with press-to-latch and key-to-release feature.

e) OPEN/START push buttons shall be GREEN, STOP push buttons shall be RED, and CLOSE buttons may be YELLOW.

f) All push-buttons shall have a minimum of two (2) Normally-Open and two (2) Normally-Closed electrically separate contacts, rated minimum 10 A at operating voltage.

g) Wiring shall be done with 1100V grade fire resistance PVC insulated stranded copper conductor of not less than 2.5 Sq.mm cross section. Each wire shall be identified at both ends by ferrules with wire designation.

h) Terminals shall have provision for connecting at least two (2) nos. 2.5 sq.mm. Copper cable and shall be rated for carrying continuously minimum 10 A at 240V A.C. and 2 A at 220V D.C.

4.01.03 Local Isolating Switch Units

a) L.I.S. Units shall be furnished in sheet steel enclosure of dust and vermin-proof, weather-proof, gasketted construction, suitable for outdoor use without canopy, and conforming to degree of protection IP-55 or better.

b) L.I.S. Units shall be suitable for column/structure/wall mounting and shall be complete with load-break switch, terminal blocks, anodised aluminum inscription plate, two (2) nos. earthing pads, removable gland plate along with crimp type tinned copper lugs and compression type glands for cable/conduit entry from top and bottom. The earthing pads shall be suitable for connection to 25 x 3 mm G.S. flat

c) Load-break switches shall be four-pole, air break, heavy-duty type. Duty class of load-break switches shall be AC-23 for motor feeders. Motor feeder switches shall be capable of safely breaking the locked rotor current of the associated motor circuit.

d) Terminals shall be clip-on type, 10 sq.mm. minimum.

4.02.00 **Equipment Mounting**

4.02.01 All equipment shall be so mounted that removal and replacement may be accomplished individually without interruption of services to others. No equipment shall be mounted on panel door.

4.02.02 All equipment mounted inside the panels shall be so located that their terminals and adjustments are readily accessible for inspection or maintenance.

4.02.03 For Local Control Boards/Panels control components such as push buttons, indicating lamps, selector switches, indicating meters etc. shall be flush mounted on the front face of the board/panel while switch fuses, supervision relays (AC/DC) etc. shall be mounted inside.

4.03.00 **Name Plate**

4.03.01 Nameplates shall be furnished for each panel and for each instrument or device mounted on the panel. Each LPB Station shall also be provided with a nameplate.

4.03.02 The material of the nameplate shall be lamicoid or approved equal, 3 mm thick, with white letters on black background.

4.03.03 The nameplates shall be held by self tapping screws. The size of nameplate shall be approx. 20 mm x 75 mm for equipment and 40 mm x 150 mm for the panels. The size of the nameplate shall suit the overall dimensions of LPB station/L.I.S Unit.

4.03.04 Nameplates for panels shall be provided both on the front and on the rear and shall be according to final device/designation list.

4.03.05 Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices.

4.03.06 Instruments and devices mounted on the face of the panels shall also be identified on the rear with the instrument or device number. The number may be painted on or adjacent to the instrument or device case.

4.04.00 **Mimic Diagram**

4.04.01 Mimic diagram of electrical connections shall be furnished on the front face of all electrical control panels.

4.04.02 Mimic buses shall be at least 3 mm thick and 10 mm in width, made of suitably treated metal strips or approved equivalent and colour coded to denote different voltages.

4.04.03 The mimic representation, colour and size of diagram are subject to the approval of the Purchaser.

4.05.00 **Illumination, Space Heating and Receptacles**

4.05.01 Each panel shall be provided with interior fluorescent tube with door switch, space heater with thermostat and 5A, 5-pin receptacle with plug. Fifth pin of the socket shall be effectively grounded through the metallic structure.

4.05.02 Tube, heater and receptacle circuits shall be suitable for available A.C. supply and furnished with individual ON-OFF switch.

4.05.03 The lamp shall be located at the ceiling and guarded with protective cage. Space heater shall be located near the floor so as not to pose any hazard to service personnel.

4.06.00 **AC/DC Power Supply**

4.06.01 Necessary A.C. and D.C. supplies as required for control and service shall be arranged by the contractor. Single feeder shall be arranged for A.C supply and duplicate feeders shall be arranged for D.C supply.

4.06.02 Isolating switch fuse units shall be provided for the incoming AC/DC power supplies and bus wires shall be run for power distribution to different panels. D.C. supply isolating switches shall be double pole, double throw with off and A.C. supply isolating switches shall be 4-pole, double throw type.

4.06.03 Fuse and link shall be provided for individual circuits for protection and also for isolation from bus wire without disturbing other circuits.

4.06.04 The fuse requirements in each panel shall be grouped in easily accessible fuse blocks or distribution panel. The grouping shall be done in a neat and orderly fashion.

4.06.05 Alarm relays with reverse flag shall be provided to annunciate failure of main incoming A.C. and D.C. power supplies and annunciation D.C. supply in each panel. Lamp indications shall be provided individually for main D.C. supply-1 fail, main D.C. supply-2 fail, and panel annunciation D.C. supply fail. A common A.C. electric bell shall be provided to give an audible alarm in case of failure of D.C. supply-1/D.C. supply-2/annunciation D.C. supply in any panel. A common push-button shall also be provided for cancellation of lamp indications and audible alarm.

4.06.06 Separate circuits shall be provided for (a) indication and alarm (b) tripping, and (c) control.

4.06.07 For lighting, auxiliary supply and space heating A.C. supply shall be used. D.C. supply shall be used for providing control supply to annunciator.

4.06.08 Bus wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles of a VDB. Isolating switch fuse units shall be provided at each cubicle for A.C/D.C supplies.

4.07.00 **Wiring**

4.07.01 The panels shall be fully wired up at the factory to ensure proper functioning of control, protection and metering schemes.

4.07.02 All spare contacts of relays and switches shall be wired up to terminal blocks.

4.07.03 Wiring shall be done with 1100V grade fire resistance PVC insulated stranded copper conductor of not less than 2.5 Sq.mm cross section for current control circuits and voltage circuits.

4.07.04 Each wire shall be ferruled by plastic tube with indelliable ink print at both end having terminal Block No., terminal numbers, destination number as per approved wiring drawing.

4.07.05 All wire termination shall be made with insulated sleeve solderless crimping type tinned copper lugs. Wires shall not be tapped or spliced between terminals.

4.07.06 Wiring shall be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on the termination.

4.07.07 Colour codes shall be used for wiring as per latest revision of IS: 375.

4.08.00 **Terminal Block**

4.08.01 Multi-way terminal blocks complete with necessary binding screws and washers for wire connections and marking strip for circuit identification shall be furnished for terminating the panel wiring and outgoing cables. Terminals shall be box-clamp type, 10 sq.mm. minimum. Terminals for C.T. secondary leads shall have provision of shorting and grounding.

4.08.02 Not more than two wires shall be connected to one terminal. If necessary, a number of terminals shall be jumpered together to provide wiring points.

4.08.03 Each terminal shall be identified with designation as per approved schematic. At least 20% of the total number of active terminals shall be furnished as spare in each panel.

4.08.04 The wiring and terminals shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

4.08.05 The terminal blocks shall be located to allow easy access and also to suit floor openings for cable entry.

4.08.06 The terminal blocks within the panels shall be mounted on vertical support brackets. The support brackets shall be tack welded to the interior sheet steel mounting plates of the cabinet. Support brackets shall not be welded directly to the walls of the enclosure. The terminal blocks shall be attached to the support brackets with round head machine screws.

4.08.07 Terminal blocks shall generally be mounted vertically with adequate spacing (not less than 100 mm) between adjacent rows.

4.08.08 The bottom of the terminal block shall be at least 200 mm above the incoming cable gland plate.

4.09.00 **Cable Entry**

4.09.01 The Control Boards/Panels shall have provisions of cable entry from the bottom. Bottom plate shall be provided to make entry dust-tight. L.P.B. stations and Local Isolating Switch Units shall have provision for cable/ conduit entry from both top and bottom. Suitable cable gland-plates shall be provided.

4.10.00 **Grounding**

4.10.01 50 x 6 mm GI ground bus shall be provided in each control panel extending along the entire length of the assembly.

4.10.02 The ground bus shall have two-bolt drilling with GI bolts and nuts at each end and shall be suitable for connection to 50 x 6 mm G.S. flat.

4.10.03 The ground bus shall be bolted to the panel structures and shall effectively ground the entire assembly. The cases of meters, relays and switching devices shall be grounded through the steel structure.

4.10.04 Whenever a circuit is grounded, a single wire from the circuit shall be run independently to the ground bus and connected to it.

4.11.00 **Painting**

4.11.01 For paint shade finish, refer Section-X of Volume: II-A : Lead Specification.

4.11.02 Caution Notice plate shall be affixed at the back of each vertical panel.

4.12.00 **Switches**

4.12.01 Switches shall be dust protected, heavy duty, switchboard type, complete with escutcheon plate. Contacts shall be silver surfaced and rated minimum 10A at operating voltage.

4.12.02 415V Breaker control switches shall be 3-position (TRIP/NORMAL/-CLOSE), 120^{o}, spring return to neutral with lost motion device, non-lockable, sequence device, pistol grip handle. RED/AMBER/GREEN (circuit breaker CLOSED/ TRIPPED-OR-TRIP CIRCUIT UNHEALTHY/OPEN) indicating lamps shall be provided with each breaker control switch.

4.12.03 Contact details and type of handle required for other types of switches are given below :

Sl. No.	Application	Switch description
a)	Synchronizing Selector switch	180^{o}, 4-position (INCOMER-1/ BUS-SECTION / INCOMER-2/OFF), stay put type, pistol grip handle. OR

		120°, 3-position (INCOMER/TIE/ OFF) stayput type, pistol grip handle.
b)	Trip Selector Switch	120°, 3-position (INCOMER-1/ BUS-SECTION OR TIE/ INCOMER-2), stayput type, pistol grip handle.
c)	Meter Selector Switch	4-position (OFF/R/Y/B for ammeter selector switch and OFF/RY/YB/RB for voltmeter selector switch), maintained contact, stay-put type, knob handle. Ammeter selector switches shall have make-before- break contacts.
d)	Auto-Manual Selector switch	120°, 2-position (AUTO/ MANUAL), stayput type, non-lockable, spade handle.
e)	On-off Switch/Local-Remote Selector Switch	90°, 2-position (ON/OF OR LOCAL/ REMOTE), stayput type, non-lockable, spade handle

4.12.04 Any other type of switch, if required, shall be subjected to approval of purchaser.

4.12.05 Tenderer shall decide the number of switch contacts taking into account the scheme requirements and spares.

4.13.00 **Fuses**

4.13.01 Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the system short circuit current.

4.13.02 Fuses shall be furnished complete with fuse boxes and fittings of such design as to permit easy and safe replacement of fuse element. Visible indication shall be provided on blowing of the fuse.

4.13.03 Motor fuse characteristics and ratings shall be chosen to ride over motor starting period without blowing. The fuse on incoming feeder, wherever provided, shall be chosen to provide discrimination with motor/feeder fuses.

4.14.00 **Contactors**

4.14.01 Contactors shall be three pole, air break type, with non-bouncing silver/silver alloy contacts. Contactor duty shall be class III - category AC3 for unidirectional drives and AC4 for bi-directional and inching drives/class I - category DC2.

4.14.02 Each contactor shall be provided with minimum two (2) N/O and two (2) N/C auxiliary contacts rated 10 A at operating voltage. The exact requirement of

contacts shall be decided by the Tenderers taking into account the scheme requirements and spares.

4.14.03 Contactor starters shall comply with the requirements of IS-8544 (Part - 1) in respect of co-ordination of the characteristics of contactor, overload relay, and fuse. The type of co-ordination shall be Type-C as per IS-8544.

4.15.00 **Thermal Overload**

4.15.01 Thermal overload relays shall be three elements, positive acting, ambient temperature compensated with adjustable settings.

4.15.02 Single phasing preventor shall be provided as an inbuilt feature of the thermal overload relay.

4.15.03 Overload relays shall be manual reset type with change over contacts. Resetting of relays shall be possible with compartment door closed. Colour of resetting button shall be BLACK.

4.15.04 Relays for fan motors having long starting time shall be saturable core C.T. operated.

4.16.00 **Current Transformers**

4.16.01 Current transformers shall be cast-resin type. All secondary connections shall be bought out to terminal blocks where wye or delta connection will be made.

4.16.02 Accuracy class of the current transformers shall be:

a) Class PS for differential.

b) Class 5P20 for other relaying.

c) Class 1.0 ISF < 5 for metering.

Other CT particulars like ratio, burden, knee point, excitation current & secondary resistance shall be decided by the tenderers.

4.16.03 Drives requiring current monitoring shall be provided with current transducers with calibration for full-scale reading. The output shall be 4-20 mA D.C; 4-18mA of which shall correspond to the normal range and 18-20 mA shall correspond to the suppressed range.

4.17.00 **Voltage Transformers**

4.17.01 Voltage transformers shall be cast-resin, drawout type and shall have an accuracy class of 1.0.

4.17.02 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw out position.

4.17.03 Secondary winding MCBs, sized to prevent overload shall be installed in all ungrounded secondary leads. MCBs shall be suitably located to permit easy replacement while the switchgear/PMCC is energized.

4.17.04 Both primary side & secondary side fuse failure / voltage loss monitoring system of VT shall be provided.

4.18.00 **Push Button**

4.18.01 All push buttons shall be oil tight, heavy duty, push to actuate type, with coloured button and inscription plate marked with its function. The colour of "ON" and "OFF" push buttons shall be RED and GREEN respectively. RESET push buttons shall be coloured black.

4.18.02 Each push button shall have minimum 2 NO. + 2 NO. contacts, rated 10A at 240V AC and 2A at 220V DC.

4.18.03 Push buttons shall be shrouded type except for emergency trip button, which shall be mushroom type for easy identification.

4.19.00 **Lamps**

4.19.01 Lamps shall be LED type.

4.19.02 LED lamp shall be made in accordance with InP Technology (Aluminium Indium Gallium Phosphide Technology). The body shall be made of Poly Carbonate Unbreakable Lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All Push Button lamp shall be as per LED indicating lamp.

4.20.00 **Operating Range**

All instruments shall be generally suitable for operation on 1A or 5A C.T. secondary circuit and/or 110V V.T. secondary circuit.

4.21.00 **Meters**

4.21.01 All indicating instruments shall be switchboard type, back connected, suitable for flush mounting, 96 x 96 mm with 240 Deg. scale, antiglare glass and accuracy class of 0.5. The dials shall be made of such material as to ensure freedom from warping, fading, and discolouring during the lifetime of the instruments.

4.21.02 All indicating instruments shall be enclosed in dust-tight cases suitable for tropical use.

4.21.03 Meters shall have provision for zero-adjustment from front of the panel.

4.21.04 Meters shall be compensated for temperature errors and factory calibrated to read the primary quantities directly without using a multiplying factor.

4.21.05 D.C. ammeters, wherever required, shall be provided with external shunt if the current exceeds 5A. The rated voltage drop for the shunts shall be 75mV.

4.22.00 **Annunciator System**

4.22.01 Each control panel shall be provided with an annunciator window board. The annunciator boards shall be back-connected and suitable for semi-flush mounting.

4.22.02 The annunciator system shall be solid state type with optical isolation for input signals. The functional requirements shall be as per Annexure-C.

4.22.03 Each annunciator group shall be independent, complete with its own power supply, acknowledge-reset-test buttons and other necessary accessories. Hooter for audible alarm shall be common for each control panel assembly.

4.22.04 Each annunciator group shall be provided with a common alarm relay for group alarm annunciation in remote control room. The common alarm relay will operate on actuation of any alarm point of the group.

4.22.05 The annunciator shall be non-integral type with hardware box mounted separately for easy access and maintenance.

4.22.06 Audible alarms with different tones shall be used for trip, non-trip and ring back functions.

4.22.07 The window size shall be such as to accommodate minimum three (3) lines of twelve (12) characters each. Each character shall be minimum 4.75 mm high.

4.22.08 The annunciator system shall be suitable for operation from both NO and NC type initiating contacts.

4.22.09 At least 10% spare channels and window facia shall be provided in each annunciator group.

4.23.00 **Relays**

4.23.01 Auxiliary relays shall be furnished in fixed, dust-tight, casings and mounted inside the panel.

4.23.02 The relays shall have adequate numbers of contacts to suit scheme requirements. Besides, each relay shall have spare contacts for future use.

4.23.03 Contacts shall be silver-surfaced, bounce-free, and capable of repeated operation without deterioration.

4.24.00 **Auxiliary Devices**

4.24.01 The Contractor shall furnish, install, and wire-up all auxiliary devices such as timing / switching / lockout / auxiliary relays/auxiliary contactors, etc. as required for the proper functioning of the approved schemes.

4.24.02 The Contractor shall number the various types of relays and contactors as per the numbers appearing in the approved Schematic/Wiring appearing in the approved Schematic/Wiring diagrams.

5.00.00 **TESTS**

5.01.00 All Control Boards/Panels, L.I.S. Units and L.P.B. Stations shall be completely assembled, wired, adjusted and tested at the factory prior to shipment to ensure accuracy of wiring, correctness of control scheme and proper functioning of all components.

5.02.00 **Routine Tests**

5.02.01 The tests shall include wiring continuity tests, high voltage tests, interlock & sequential operation test, insulation measurement test both before and after high voltage test, and functional tests to ensure accuracy of wiring operation of the control/ protection/metering schemes and individual equipment. Detailed test report including procedure and drawing shall be furnished.

5.02.02 All switches, meters, relays and other devices shall be tested and calibrated in accordance with relevant IS standards.

5.03.00 Type test certificate on any equipment, if so desired shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

6.00.00 **DRAWINGS, DATA & MANUALS**

6.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

6.02.00 **To be submitted with the Bid**

6.02.01 General Arrangement drawings and cross-section of each equipment showing constructional features, cable entry points etc.

6.02.02 Typical foundation plan.

6.02.03 Bill of Materials.

6.02.04 Technical leaflet and Catalogues of:

a) Local Control Boards and Local Starter-cum-Control panels

b) Local Isolating switch units

c) Local Push Button Stations

d) Switches and Lamps

e) Meters, relays, push buttons

f) Switch fuse units

g) Annunciator System

h) Auxiliary Devices

i) Terminal Blocks/glands.

j) Temperature Scanner

6.02.00 **To be submitted for Owner / Purchaser's Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

RATINGS & REQUIREMENTS

1.0	Local Control Board		
1.1	General		
	Type	:	Fixed type
	Service	:	Indoor
	Enclosure	:	IP-54
1.2	System		
	Voltage	:	415 Volt ± 10%
	Phase	:	3
	Frequency	:	50 Hz +3% to -5%
	System	:	Solidly grounded
1.3	Rated Current at 50°C		
	Bus bar	:	To be decided by the Tenderers
	Switches	:	To be decided by the Tenderers
1.4	Short Circuit Rating		
	Interrupting	:	50 kA
	Short time for 1 Second	:	50 kA
1.5	Insulation Level	:	2.5 kV for 1 min.

ANNEXURE-B

A.C./D.C. POWER SUPPLY

1.0 **System Voltages**

All systems shall be designed for satisfactory operation from the following power supply :-

A.C. Supply	:	240 Volt, 1 Phase, 50 Hz, 2 wire, effectively grounded system.
		Fault level 50 kA rms Symmetrical.
D.C. Supply	:	220V, 2 Wire, ungrounded.
		Fault level 25* kA

* Indicative only actual value will be decided by the Bidder, after substantiating the same by calculation.

2.0 **Permissible Variation**

Equipment and accessories shall be suitable for operation over the entire range of voltage/frequency variation as listed below :

A.C. Supply:

Voltage	:	± 10%
Frequency	:	+3% to -5%
Combined Volt & Freq.	:	10% (absolute sum)

D.C. Supply:

Voltage	:	187 to 242
Service Voltage for Control Panels/ Distribution Boards	:	240V ± 10%, 1ph, 50Hz +3% to -5%

ANNEXURE-C

FUNCTIONAL REQUIREMENTS OF ANNUNCIATOR

TYPE

The annunciation system shall be manually reset type with ring back facility, suitable for operation from 220V DC ungrounded supply.

FUNCTION

The sequence of operation shall be similar to ISA-2A with fast/slow blinking as detailed below:

Field Condition	Visual Display	Audible Alarm	Ringback Alarm
Normal	Off	Silent	Silent
Abnormal	Fast blinking	On	Silent
Acknowledge	Steady On	Silent	Silent
Return to normal	Slow blinking	Silent	On
Reset	Off	Silent	Silent
Normal Before Acknowledge	Slow blinking	On	On
Acknowledge	Steady On	Silent	On
Reset	Off	Silent	Silent
Test	Fast blinking	On	On

ANNEXURE-D

AREA WISE INDICATIVE LIST OF LOCAL CONTROL BOARDS

Sl. No.	Description
1.	C.W. System Electrical Control Board
2.	Electrical Control Board for MCC/PMCC located in Ash-Slurry and Ash-Water Building.
3.	Electrical Control Boards for ESP PCC/PMCC
4.	Electrical Control Board for Fuel Oil Pressurizing system
5.	Electrical Control Board for Fuel Oil Unloading and Forwarding MCC
6.	Electrical Control Boards for Raw water MCC
7.	Electrical Control Boards for Hydrogen generation plant

Note: The above list is indicative only. The above boards shall be hooked-up to respective system PLCs. In addition to the above Electrical Control Boards, necessary local panels/remote panel shall be provided for respective system/equipment/drive, e.g., BFP, Hydrogen-seal Oil system for Generator, ESP, etc. as described in respective sections of mechanical specification.

ANNEXURE-E

LOCAL CONTROL PANEL / LOCAL STARTER PANEL FOR COAL HANDLING PLANT

1.00.00 **DESIGN CRITERIA**

1.01.00 **Stacker/Reclaimer MCC & Control Desk**

The power supply from 3.3 kV CHP switchgear shall be achieved through one (1) number land mounted load break isolator, one (1) number fuse cum junction box located near centre or travel, one (1) number machine mounted load break isolator, line P.T with voltmeter on 3.3 kV side, L.T Air Circuit Breaker, Ammeter with selector switch, Voltmeter with selector switch etc.

Power CRD shall be connected to isolator panel mounted on the machine. H.T. fuses for the primary side of the transformer shall be housed inside the isolator panel on machine. Fuses shall be provided with the striker pin mechanism. Specification of Load break isolator is governed by HT Switchgear Specification

1.01.01

a) One number Stacker-Reclaimer MCC shall be provided on the mobile Stacker-Reclaimer. This MCC shall receive power at 433V, 50 Hz, from the output of a 3.3 kV/433V, dry type cast resin power transformer located on the mobile machine, through suitable cables.

b) Power shall be received at the panel by means of ACB unit. The ACB shall be series trip type with short circuit and ground fault releases having adjustable settings. Necessary CT ammeter, ammeter selector switch; voltmeter; voltmeter selector switch; R/Y/B indication lamps shall be available on the MCC. Power supply for indication of breaker including load break isolator shall be derived from the UPS of PLC. The specification requirement of MCC is guided by respective 415V PMCC/MCC specification.

c) Stacker/Reclaimer is PLC controlled. Under manual local operation it shall only be possible to run individual equipment by passing all process interlock. Under manual remote operation it shall be possible to run the entire system through PLC with process and safety interlock in place. The selector switch, remote/local shall be housed in control desk.

d) Specification requirement of PLC has been detailed under main PLC specification with the exception of 100% hot standby mode and redundancy.

e) Control desk shall accommodate annunciation windows, selector switches, ammeter, voltmeter and indicating lamps for incomer, ammeter for outgoing motor feeder rated 30 kW and above.

f) Panel door shall be interlocked with the incoming switch such that the panel door can not be opened when the switch is `ON'. However, necessary door interlock defeat feature shall also be provided for

testing purpose. Rating of components shall conform to the rating indicated in the enclosed component selection chart.

g) Audio visual annunciation system shall have at least but not limited to the following annunciation points complete with Accept/Test Preset P.B.:

i) Transformer winding temperature high.
ii) 415 V Incomer breaker tripped
iii) Boom Conveyor zero speed switch operated
iv) Boom Conveyor belt sway operated
v) Boom Conveyor pull cord switch operated
vi) Boom Conveyor brake not released.
vii) Boom Conveyor Motor overload/SPPR fault
viii) Back up limit switch operated.
ix) Wind velocity high.
x) Wind velocity very high.
xi) Slew limit switch operated.
xii) Slew drive fault.
xiii) Slew motor overload.
xiv) Slew drive lubrication system fault.
xv) Hydraulic oil temperature high.
xvi) Oil level low in hydraulic tank.
xvii) Hydraulic system filter clogged.
xviii) Bucket wheel brake not released.
xix) Bucket wheel zero speed switch fault.
xx) Bucket wheel motor overload/SPPR fault.
xxi) Power CRD motor overload.
xxii) Power CRD over tension switch operated.
xxiii) Control CRD motor overload.
xxiv) Control CRD over tension switch operated.
xxv) Travel drive brake not released.
xxvi) Travel drive motor overload/SPPR fault.
xxvii) Travel limit switch operated.
xxviii) Rail clamp not released.
xxix) DS motor overload/SPPR fault (to be provided for each motor).
xxx) HT load brake switch operated.

Annunciation system shall be similar to that of main Control Panel with 20% spare windows.

h) Separate cable reeling drum shall be provided for power & control cable. Combined trailing cable shall have 24C X 2.5 mm^2 (cu) control cable and 8 pair 1.5 mm^2 (cu) screened cable for signal and communication.

1.02.00 ON/OFF operation of Wagon tipplers shall be achieved from the respective Wagon tippler Control desk through PLC based logic. Control desk shall be provided in each Wagon tippler Control room for Control, Operation, Indication & Annunciation of Wagon Tippler equipment. Control desk shall interface with PLC for the entire operation and shall accommodate annunciation windows, ammeter, voltmeter, selector switches and indicating lamps for incomer, ammeter for outgoing motor feeder rated 30 kW and above. Other features as described above for the control desk of Stacker Reclaimer shall also be considered for Wagon Tippler.

1.03.00 MCC/DB/Local Starter Panel for Dust Suppression, Dust Extraction, Sump Pump, Coal Sampler, Bunker Level and other Panels

1.03.01 The Local Starter Panel shall be fixed type with compartmentalized execution. One (1) number 415 V ± 10% 3 phase 4 wire 50 Hz +3% to -5% power supply feeder shall be provided for each panel. Power shall be received through an incoming SFU having R/Y/B indication lamps, voltmeter with selector switch, ammeter with selector switch. Individual motor feeder shall have their switch fuse, power contactor, overload relay-cum-single phasing preventor (hand reset type), stop/ start push button, auto/manual selector switch, Red/Green/ Trip indication lamp, auxiliary relays, timers, etc. The stop push button shall be lockable type. Necessary interlock, annunciation, 415/240 V Transformers for control supply, space heating as applicable to meet system requirement shall also be provided and in no case derive any power supply from its main feeder. Separate feeders shall also be provided for brakes and rail clamp as applicable. Facility shall be provided for resetting the motor overload relay from outside without opening the panel door. Panel door shall be interlocked with the incoming Switch such that the door can not be opened when Switch is ON.

Specification requirement of the above including module selection chart will be governed by 415 V MCC/PMCC Specification.

1.03.02 Interlock, control, indication, annunciation etc. shall be achieved by relay logic

1.03.03 Isolation of individual circuit in the MCC/DB/Local Starter Panel shall be provided through individual Fuse.

1.03.04 Control features as described under relevant mechanical section shall be considered for interlocking and preparation of control schematic.

1.03.05 Thermostatically control space heater shall be provided.

1.03.06 Necessary door interlock defeat feature shall also be provided for testing purpose. Wherever necessary, the panels shall be designed for outdoor and of weather proof/rain protection type. Ratings of components shall be as per module selection chart indicated under 415 V PCC/PMCC/MCC Specification.

1.03.07 **Travelling Tripper DB cum Control Panel**

In addition to indication to be provided for drives, following indications shall also be provided in local panel:

i) Brakes applied
ii) Rail clamps applied
iii) Flap Gate position
iv) Travel driver over speed
v) Travelling tripper – Forward/Reverse
vi) Cable Reeling Drum on

Travelling tripper position on bunker shall be provided in the PLC.

Control features as described under relevant mechanical portion shall be considered for interlocking and preparation of control schematic.

Cable reeling drum shall be provided for power & control cable. Apart from meeting the requirements in respect of control , indication & annunciation and telecommunication following spare cores shall be provided:

i) 4 pair core (Sheilded) for communication.
ii) 4 Core for control.

1.03.08 **Sump Pump Control Panel**

Sump Pump Control Panel shall be provided with level controller, necessary contacts to start pumps in auto mode when level reaches high. Further, very high level shall cause hooter to blare and the same shall stop after sometime delay. In manual mode it shall be possible to start individual pump. However, in manual mode and auto mode of operation, pump shall be tripped when level in the sump pit reaches low. Sump pumps shall be able to operate from PLC, the level switches shall be wired to PLC.

In addition to other indicating lamps level high indication lamp shall also be provided in local panel.

1.03.09 **Miscellaneous Control Panels**

Miscellaneous control panel i.e. dust suppression panel, ventilation panel, etc. shall have individual starter feeder for individual drive. Other features as specified above shall also be provided. Equipment such as Vibrating Grizzle feeders, Magnetic separators, Metal detectors, Dust suppression, Ventilation, Dust extraction, Coal Sampler, Bunker Level, Hoists etc. shall have individual starter-cum-control panels to suit individual requirements. The panels shall include all necessary feeders, start stop PB, indicating lamp, annunciation system, 415/240V control transformers for control supply and space heating as applicable to meet system requirement. For Magnetic Separators, separate panels shall be provided. One panel shall accommodate transformer & rectifier and the other panel shall accommodate incomer and other controlling items.

The requirement of 4-20 mA signals for Belt Weigher and bunker level indicator have been spell out in Mechanical Specification and accordingly the same shall be provided.

2.00.00 SPECIFIC DESIGN REQUIREMENT

2.01.00 Construction

a) Stacker/Reclaimer/ Wagon Tippler Control Desk

Ammeters and annunciation facia shall be mounted on the vertical portion of the panel and all push button; selector switches; indication lamps etc. shall be mounted on the desk portion. The front desk shall be with top inclined downward towards front. A removable type front door shall be provided on the desk portion along with a lockable and lift-off rear door for the panel portion of the desk-cum-panel.

Travelling Tripper/Magnetic Separator/Metal Detector/Dust Extraction/ Dust Suppression/Ventilation/Coal Sampler/Bunker Level indication, Hoist/MCC/DB/Starter-Cum-Control Panel, Misc. Control Stations, Push Button Stations & Local Information Boards.

These panels/stations shall be furnished in sheet steel enclosures suitable for wall/column/floor mounting.

2.02.00 General

a) Design, material selection and workmanship shall be such as to present a neat appearance outside and inside with no marks of welds, rivets, screws or bolt heads apparent from the exterior surface of the frames.

b) Panels shall be of folded sheet steel construction, assembled on channel/angle base plates. Anti-vibration mountings shall be provided for moving equipment.

c) All switchboard/panel frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness 2.0mm. Frames shall be enclosed in cold rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot/cold rolled sheet steel and 4.0 mm for non-magnetic material. The panels shall have sufficient structural reinforcement to ensure a plain surface, limit vibration and provide rigidity during despatch and installation. Vertical panels shall be freestanding type.

d) Sufficient inter-component spacing shall be available for easy maintenance, replacement, ventilation etc. of the components. A minimum spacing of 50mm is recommended for the same.

e) All doors, covers etc. shall be properly gasketted to make the panel effectively vermin and dust proof. Door hinges shall be concealed

type. Special dust protection measures shall be taken for panels located in dusty area.

f) All hardware for the complete installation of the equipment including foundation and fixing bolts, nuts, washers etc. shall be supplied to suit the requirement. All bolts, nuts etc. exposed to external atmosphere shall be cadmium plated or zinc passivated.

g) The panels shall be liberally sized so as to provide spacious layout of equipment and devices with sufficient working space in between.

h) Shock absorbers shall be provided for panels mounted on mobile machines.

i) Maximum and minimum height of the operating devices on all panels except Local Control Stations shall be restricted to 1800 mm and 750 mm respectively from the floor level.

VOLUME: V-A

SECTION-II

TECHNICAL SPECIFICATION
FOR
A.C. & D.C. MOTORS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	CODES & STANDARDS
3.00.00	SERVICE CONDITIONS
4.00.00	TYPE AND RATING
5.00.00	PERFORMANCE
6.00.00	SPECIFIC REQUIREMENTS
7.00.00	ACCESSORIES
8.00.00	TESTS
9.00.00	DRAWINGS, DATA & MANUALS

ATTACHMENT

ANNEXURE-A	DESIGN DATA

VOLUME: V-A

SECTION-II

TECHNICAL SPECIFICATION FOR A.C. & D.C. MOTORS

1.00.00 **SCOPE**

1.01.00 This section covers the general requirements of the drive motors for power station auxiliary equipment.

1.02.00 Motors shall be furnished in accordance with both this general specification and the accompanying driven equipment specification.

1.03.00 In case of any discrepancy, the driven equipment specification shall govern.

2.00.00 **CODES & STANDARDS**

2.01.00 All motors shall conform to the latest applicable IS, IEC and CBIP Standards/ Publications except when otherwise stated herein or in the driven equipment specification.

2.02.00 Major standards, which shall be followed, are listed below other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed:

i) IS-325

ii) IS-12615

iii) IEC-60034

3.00.00 **SERVICE CONDITIONS**

3.01.00 The motors will be installed in hot, humid and tropical atmosphere highly polluted at places with coal dust and/or fly ash.

3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the annexure to this specification.

3.03.00 For motor installed outdoor and exposed to direct sunrays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 **TYPE AND RATING**

4.01.00 **A.C. Motors**

4.01.01 Motors shall be general purpose, constant speed, squirrel cage, three/single phase, induction type.

4.01.02 All motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity.

4.01.03 LT motor & HT motor name-plate rating at 50°C shall have at least 15% margin and 10% margin respectively over the input power requirement of the driven equipment at rated duty point unless stated otherwise in driven equipment specification.

4.01.04 The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service.

4.01.05 Motors efficiency class shall be **IE3** as per latest version of IEC-60034.

4.02.00 **D.C. Motors**

4.02.01 D.C. motor provided for emergency service shall be shunt/compound wound type.

4.02.02 Motor shall be sized for operation with fixed resistance starter for maximum reliability.

Starter panel complete with all accessories shall be included in the scope of supply.

5.00.00 **PERFORMANCE**

5.01.00 **Running Requirements**

5.01.01 Motor shall run continuously at rated output over the entire range of voltage and frequency variations as given in the annexure.

5.01.02 The motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.

5.01.03 The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

5.02.00 **Starting Requirements**

Motor shall be designed for direct online starting at full voltage. Breakaway starting current as percentage of full load current for various motor rating shall not exceed the given below-

Motors up to 1500kW	-	600% subject to IS tolerance of plus 20%.
Motors above 1500kW	-	450% not subject to any positive tolerance.

5.02.01 The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

5.02.02 Motor shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminals except mill motor. Mill motor shall start with rated load and accelerate to full speed at 85% of the rated voltage at the motor terminals.

5.02.03 a) Two hot starts in succession with motor initially at normal running temperature.

b) Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with shaft rotating at 125% rated speed in reverse direction.

5.02.04 The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage.

5.03.00 **Stress During Bus Transfer**

5.03.01 The motor may be subjected to sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.

5.03.02 The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.

5.04.00 **Locked Rotor Withstand Time**

5.04.01 The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time by at least 3 seconds for motors up to 20 seconds starting time and by 5 seconds for motor with more than 20 seconds starting time.

5.04.02 Starting time mentioned above is at minimum permissible voltage of 80% rated voltage.

5.04.03 Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

6.00.00 **SPECIFIC REQUIREMENTS**

6.01.00 **Enclosure**

6.01.01 All motor enclosures for outdoor, semi-outdoor & indoor application shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be of weather-proof construction with canopy.

6.01.02 For hazardous area approved type of increased safety enclosure shall be furnished.

6.02.00 **Cooling**

6.02.01 The motor shall be self ventilated type, either totally enclosed fan cooled IC 411(TEFC), totally enclosed tube ventilated IC 511(TETV) or closed air circuit air- cooled IC 611(CACA).

6.02.02 For large capacity motors not available with above type of cooling may be accepted with IC 81W or IC 91W, closed air circuit water cooled (CACW) subject to the approval of the owner.

6.03.00 **Winding and Insulation**

6.03.01 All insulated winding shall be of copper.

6.03.02 All motors shall have class F insulation but limited to class B temperature rise.

6.03.03 Windings shall be impregnated to make them non-hygroscopic and oil resistant.

6.04.00 **Tropical Protection**

6.04.01 All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

6.04.02 All fittings and hardwares shall be corrosion resistant.

6.05.00 **Bearings**

6.05.01 Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be rated for minimum service life of 40,000Hrs.

6.05.02 Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred.

6.05.03 Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.

6.05.04 Sleeve bearings shall be split type, ring oiled, with permanently aligned, close running shaft sleeves.

6.05.05 Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with drains to guard against over lubrication. LT motors 15kW and above shall be provided with external greasing arrangement.

6.05.06 Oiled bearing shall have an integral self cooled oil reservoir with oil ring inspection ports, oil sight glass with oil level marked for standstill and running conditions and oil fill and drain plugs.

6.05.07 Forced lubricated or water cooled bearing shall not be used without prior approval of Owner.

6.05.08 Lubricant shall not deteriorate under all service conditions. The lubricant shall be limited to normally available types with IOC equivalent.

6.05.09 Bearings shall be insulated as required to prevent shaft current and resultant bearing damage.

6.06.00 **Noise & Vibration**

6.06.01 All HT motors shall be provided with vibration pads for mounting of vibration detectors. Vibration monitoring devices shall be provided on DE and NDE side in x&y direction with remote DCS monitoring, alarm and tripping.

6.06.02 The maximum double amplitude vibrations for HT motors upto 1500 rpm shall be 25 microns and 15 microns upto 3000 rpm. For 415V motors, maximum double amplitude vibrations upto 1500 rpm shall be 40 microns and 15 microns upto 3000 rpm.

6.06.03 The noise level shall not exceed 85db (A) at 1.5 meters from the motor.

6.07.00 **Motor Terminal Box**

6.07.01 Motor terminal box shall be detachable type and located in accordance with Indian Standards clearing the motor base- plate/ foundation

6.07.02 Terminal box shall be capable of being turned 360 Deg. in steps of 180 Deg. for HT motors and 90 Deg. for LT motors unless otherwise approved.

6.07.03 The terminal box shall be split type with removable cover with access to connections and shall have the same degree of protection as motor.

6.07.04 The terminal box shall have sufficient space inside for termination/connection of XLPE insulated armoured aluminium cables.

6.07.05 Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.

6.07.06 The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.

6.07.07 The terminal box shall be capable of withstanding maximum system fault current for a duration of 0.25 sec.

6.07.08 For 11000V and 3300V motor, the terminal box shall be phase-segregated type. The neutral leads shall be brought out in a separate terminal box (not necessarily phase segregated type) with shorting links for star connection.

6.07.09 Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used.

6.07.10 The gland plate for single core cable shall be non-magnetic type.

6.07.11 Minimum clearances to be provided between phase to phase and phase to earth shall be as under-

Voltage Rating of Motor		Minimum Ph-Ph & Ph-Earth clearance
0.415 kV	:	25 mm
3.3 kV	:	65 mm
11.0 kV	:	140 mm

Note: In case it is not possible to maintain these clearances, the live parts shall be totally insulated from earth and other Phases. Adequate clearances shall be provided for cable connections.

6.08.00 **Grounding**

6.08.01 The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

6.08.02 The grounding connection shall be suitable for accommodation of ground conductors as follows:

Rating			Conductor Size
Above	Up to		
-------	5.5 kW	:	8 SWG GI Wires.
5.5 kW	22 kW	:	25mm X 4mm GS Flat.
23 kW	55 kW	:	40mm X 6mm GS Flat.
56kW	174kW	:	50mm X 8mm GS Flat.
175kW	ABOVE	:	75mm X 10mm GS Flat.

6.08.03 The cable terminal box shall have a separate grounding pad.

6.09.00 **Minimum Cable Size for LT & HT Motors shall as be as follows-**

a) For 415V, 3-Ph, LT Motors-

Rating			Cable Size
Above	Up to		
-------	5.5 kW	:	1R X 3C X 6 Sq.mm
5.5 kW	11 kW	:	1R X 3C X 10 Sq.mm
11 kW	22 kW	:	1R X 3C X 35 Sq.mm
22 kW	37.5 kW	:	1R X 3C X 70 Sq.mm.
37.5kW	55 kW	:	1R X 3C X 150 Sq.mm
55 kW	75 kW	:	1R X 3C X 300 Sq.mm
75 kW	110kW	:	2R X 3C X 150 Sq.mm
110 kW	175kW	:	2R X 3C X 300 Sq.mm

b) For 3.3kV & 11kV, 3-Ph, HT Motors-

Rating			Cable Size
Above	Up to		

175 kW	1000 kW	:	1R X 3C X 240 Sq.mm
1000 kW	2000 kW	:	2R X 3C X 240 Sq.mm
2000 kW	4500 kW	:	2R X 3C X 300 Sq.mm
4501 kW	10,000 kW	:	9R X 1C X 1000 Sq.mm.

Note: During detail engineering if higher cable size is required same shall be provided.

6.10.00 **Rating Plate**

In addition to the minimum information required by IS, the following information shall be shown on motor rating plate :

a) Temperature rise in Deg.C under rated condition and method of measurement.

b) Degree of protection.

c) Bearing identification no. and recommended lubricant.

d) Location of insulated bearings.

7.00.00 **ACCESSORIES**

7.01.00 **General**

Accessories shall be furnished, as listed below, or if otherwise required by driven equipment specification or application.

7.02.00 **Space Heater**

7.02.01 Motor of rating 30 kW and above shall be provided with space heaters, suitably located for easy removal or replacement.

7.02.02 The space heater shall be rated 240 V, 1 Phase, 50Hz and sized to maintain the motor internal temperature above dew point when the motor is idle.

7.02.03 Minimum Cable Size for space heater shall be as listed-

i) For LT motors: 2.5 sq.mm, 2-Core copper cable complying with IS-1554(Part-1).

ii) For HT motors: 6 sq.mm, 2 Core aluminium cable complying with IS-1554(Part-1).

7.03.00 **Temperature Detectors**

7.03.01 All 11000V and 3300V motors shall be provided with twelve (12) nos. simplex type winding temperature detectors, four (4) nos. per phase.

7.03.02 11000V and 3300V motor bearing shall be provided with duplex type temperature detectors.

7.03.03 The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0°C.

7.03.04 Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DDCMIS connectivity.

7.03.05 0.5 sq.mm annealed tinned copper conductor complying with IS-1554(Part-1). shall be used for RTD/BTD wiring.

7.04.00 **Indicator/Switch**

7.04.01 Dial type local indicator with alarm contacts shall be provided for the following:

a) 11000 V and 3300V motor bearing temperature.

b) Hot and cold air temperature of the closed air circuit for CACA and CACW motor.

7.04.02 Flow switches shall be provided for monitoring cooling water flow of CACW motor and oil flow of forced lubrication bearing, if used. CACW motor shall be provided with water leakage detector with remote alarm and tripping.

7.04.03 Alarm switch contact rating shall be minimum 2.0 A at 220V D.C. and 10A at 240V A.C.

7.05.00 **Current Transformer for Differential Protection**

7.05.01 Motor 1000 kW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure.

7.05.02 The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later.

7.06.00 **Accessory Terminal Box**

7.06.01 All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from and independent of motor (power) terminal box.

7.06.02 Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit owner’s cable connections.

7.07.00 **Drain Plug**

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

7.08.00 **Lifting Provisions**

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

7.09.00 **Dowel Pins**

The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment.

7.10.00 **Painting**

For paint shade finish, refer Section-X of Volume: II-A : Lead Specification.

8.00.00 **TESTS**

Routine and Type Tests are to be conducted in presence of customer's representative as per IS:325 and in addition,any special test called for in the driven equipment specification shall be performed and required copies of test certificates are to be furnished for approval. In addition, following tests shall have to be carried out on the motors in presence of OWNER's representative on 3.3kV/11kV motors.

a. Impulse test by 1.2 / 50 micro sec. On sample coil of Stator winding insulation as type test as per IEC-60034, part -15 test voltages as under :

Voltage rating of motor	Impulse Test Voltage
3.3 kV	18 kV peak
11 kV	49 kV peak

b. Tan delta, charging current and dielectric loss measurements on each phase of motor stator winding as routine test.

c. Polarization Index Test as per IS: 7816 as routine test

d. Test for suitability of IPW– 55(Weather proof) as per IS 4691 as type test. Type test certificate for first numeral shall be acceptable in lieu to test, provided the test motor is identical to motor being supplied. Second numeral test shall be carried out on one motor of each type and rating.

e. Fault Withstand Test for main terminal box as type test. Type test certificate shall be acceptable, if the test is conducted on exactly identical terminal box.

f. Test for noise level as routine test.

g. Test for vibration as routine test.

h. Tan delta measurement on coils.

i. Surge withstand test for inter turn insulation.

j. Test to diagnose rotor bar failure during manufacture.

k. Over speed test as routine test.

l. Temperature rise test.

Temperature rise under normal condition above ambient temperature shall be limited to-

Specified Design Ambient temperature	Thermometer Method	Resistance Method
50 deg.C	60 deg.C	70 deg.C
45 deg.C	65 deg.C	75 deg.C
40 deg.C	70 deg.C	80 deg.C

Tests indicated at (h), (i), (j) shall be carried out during manufacture of the coils and shall be furnished for verification.

9.00.00 **DRAWINGS, DATA & MANUALS**

9.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.02.00 **To be Submitted with the bid**

a) List of the motors

b) Individual motor data sheet as per format of the proposal data sheets.

c) Scheme & write-up on forced lubrication system, if any

d) Type test report

9.03.00 **To be submitted for Owner / Purchaser's Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply		Description	Consumer
H.V. Supply		11000 V, 3Ø, 3W, 50 Hz, Non-effectively earthed Fault level 44 kA symm. for 1 sec.	Motors 1500 kW & above
M.V. Supply		3300 V, 3Ø, 3W, 50 Hz, Non-effectively earthed Fault level 40 kA symm. for 1 sec.	Motors 175 kW and Up to less than 1500 kW.
L.V. Supply	(i)	415V, 3Ø, 3W, 50 Hz effectively earthed Fault level 50 kA symm. for 1 sec.	Motors above 0.2kW and below 175kW.
	(ii)	240V AC/415V AC 240V, 1Ø, 2W, 50 Hz effectively earthed	Motors upto 0.2kW. Lighting, Space heating , A.C supply for Control & protective devices.
D.C. Supply		220V, 2W, unearthed Fault level 25* kA. for 1 sec.	D.C. alarm, control & protective devices

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

Note-

- 415V or 3.3 kV may be adopted by the bidder for the drives in the range of 160-210 kW.
- 3.3 kV AC supply for CHP conveyor motors of rating above 160 kW is to be used.
- The voltage rating of the drives indicated above is for basic guideline. Minor variations can be accepted on case to case basis based on techno-economic considerations of the various sub-systems.
- Voltage rating for special purpose motors viz, VFD and screw compressors, shall be as per manufacturer's standard. All the motors ratings on Stacker/ reclaimer shall be 415V ac supply only.

2.0 RANGE OF VARIATION

A.C. Supply :

Voltage	:	± 10%
Frequency	:	+3% to -5%
Combined Volt + frequency	:	10% (absolute sum)

During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

D.C. Supply :

Voltage	:	187 to 242 Volt

VOLUME: V-A

SECTION-III

TECHNICAL SPECIFICATION
FOR
ELECTRIC MOTOR ACTUATORS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	SCOPE
2.00.00	STANDARDS
3.00.00	SERVICE CONDITIONS
4.00.00	RATING
5.00.00	PERFORMANCE
6.00.00	SPECIFIC REQUIREMENT
7.00.00	ACCESSORIES
8.00.00	TEST
9.00.00	DRAWINGS, DATA & MANUALS

ATTACHMENT

ANNEXURE-A	DESIGN DATA

VOLUME: V-A

SECTION-III

TECHNICAL SPECIFICATION FOR ELECTRIC MOTOR ACTUATORS

1.00.00 **SCOPE**

1.01.00 This Section covers the general requirements of Electric Motor Actuators for valves/dampers.

1.02.00 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification. All the electrical actuators shall be INTEGRAL type only.

2.00.00 **STANDARDS**

2.01.00 All electrical equipment shall conform to the latest applicable IS, ANSI and NEMA Standards, except when stated otherwise herein or in driven equipment specification.

2.02.00 Major standards, which shall be followed, are listed below. Other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed

i) IS-9334

ii) IS-325

3.00.00 **SERVICE CONDITIONS**

3.01.00 The actuator shall be suitable for operation in hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the general specification.

3.03.00 For actuator motor installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 **RATING**

4.01.00 For isolating service, the actuator shall be rated for three successive open-close operation of the valve/damper or 15 minutes, whichever is longer.

4.02.00 For regulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.

5.00.00 **PERFORMANCE**

The actuator shall meet the following performance requirements:

5.01.00 Open and close the valve completely and make leak-tight valve closure without jamming.

5.02.00 Attain full speed operation before valve load is encountered and imparts an unseating blow to start the valve in motion (hammer blow effect).

5.03.00 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

5.04.00 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.

5.05.00 The entire mechanism shall withstand shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

6.00.00 **SPECIFIC REQUIREMENT**

6.01.00 **Construction**

6.01.01 The actuator shall essentially comprise the drive motor, torque/ limit switches, gear train, clutch, hand wheel, position indicator/ transmitter, in-built thermostat for over load protection, space heater and internal wiring.

6.01.02 The actuator enclosure shall be totally enclosed, dust tight, weather-proof suitable for outdoor use without necessity of any canopy. Degree of protection of enclosure for motor actuator shall be IP-65.

6.01.03 All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

6.01.04 The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

6.02.00 **Motor**

6.02.01 The drive motor shall be three phase, squirrel cage, induction machine with minimum class B insulation and IPW-55 enclosure, designed for high torque and reversing service. Canopy shall be provided for outdoor service.

6.02.02 The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current.

6.02.03 The motor shall be capable of starting at 85 percent of rated voltage and running at 80 percent of rated voltage at rated torque and 85 percent rated voltage at 33 percent excess rated torque for a period of 5 minutes each.

6.02.04 Motor leads shall be terminated in the limit switch compartment.

6.02.05 Motor actuators for valves/dampers shall be with integral starter with 3phase/3wire, 415V AC and operable from remote.

6.02.06 Earthing terminals shall be provided on either side of the motor.

6.03.00 **Limit Switches**

Each actuator shall be provided with following limit switches: -

6.03.01 2 torque limit switches, one for each direction of travel, self-locking, adjustable torque type.

6.03.02 4 end-of-travel limit switches, two for each direction of travel.

6.03.03 2 position limit switches, one for each direction of travel, each adjustable at any position from fully open to fully closed positions of the valve/damper.

6.03.04 Each limit switch shall have 2 NO + 2 NC potential free contacts. Contact rating shall be 5A at 240V A.C. or 0.5A at 220V D.C.

6.04.00 **Hand Wheel**

Each actuator shall be provided with a hand wheel for emergency manual operation. The hand wheel shall declutch automatically when the motor is energized.

6.05.00 **Position Indicator/Transmitter**

The actuator shall have:

6.05.01 One (1) built-in local position indicator for 0-100% travel.

6.05.02 One (1) position transmitter, 4-20 mA current signal as position feedback, for remote indicator.

6.06.00 **Space Heater**

A space heater shall be included in the limit switch compartment suitable for 240V, 1 phase, 50 Hz supply.

6.07.00 **Wiring**

All electrical devices shall be wired up to and terminated in a terminal box. All wiring shall be done with 1100V grade fire resistance PVC insulated stranded copper conductor of not less than 2.5 Sq.mm cross section. All wiring shall be identified at both ends with ferrules. All the electrical actuators shall have uniform wiring.

6.08.00 **Terminal Box**

The terminal box shall be weather proof, with removable front cover and cable glands for cable connection. The terminal shall be suitable for connection of 2.5 Sq.mm copper conductor.

7.00.00 **ACCESSORIES**

As required for the driven equipment, the actuator shall be furnished with starting equipment mounted on the actuator. This shall include:

7.01.00 One (1) triple pole MCCB

7.02.00 One (1) reversing starter with mechanically interlocked contactors, 3 thermal overload relays, 2 NO + 2 NC auxiliary contacts for each contactor.

7.03.00 One (1) remote-local selector switch.

7.04.00 CLOSE-STOP-OPEN oil tight push buttons with indication lights.

7.05.00 415/240 V control transformer with primary & secondary fuses.

8.00.00 **TEST**

The actuator and all components thereof shall be subject to tests as per relevant Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

9.00.00 **DRAWINGS, DATA & MANUALS**

9.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.02.00 **To be submitted with Bid**

Data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque limit switch contact development and manufacturer's catalogues. Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.03.00 **To be submitted for Owner / Purchaser’s Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner’s consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply		Description	Consumer
L.V. Supply	(i)	415V, 3Ø, 3W, 50 Hz Effectively earthed	Motors above 0.2kW upto less than 175kW.
		Fault level 50 kA symm. for 1 sec.	
	(ii)	240V AC/415V AC	Motors upto 0.2kW.
		240V, 1Ø, 2W, 50 Hz effectively earthed	Lighting, Space heating , A.C supply for Control & protective devices.
D.C. Supply		220V, 2W, unearthed	D.C. alarm, control & protective devices
		Fault level 25* kA. for 1 sec.	

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

2.0 RANGE OF VARIATION

A.C. Supply :

Voltage	:	± 10%
Frequency	:	+3% to -5%.
Combined Volt + frequency	:	10% (absolute sum)

During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

D.C. Supply :

Voltage	:	187 to 242

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
		SHEET 1 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
BHEL			**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :			
	SHEET 2 OF 2		SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

NOTES:

1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

ANNEXURE-I

SUB-VENDOR LIST

The list of approved make of the LT Motors are as mentioned below:

S.No.	LIST OF LT MOTORS
1.	BHARAT BIJLEE LTD.
2.	CROMPTON GREAVES
3.	ASEA BROWN BOVERI
4.	KIRLOSKAR ELECTRIC CO LTD.
5.	NGEF
6.	SIEMENS
7.	MARATHON
8.	GE-POWER
9.	RAJINDRA ELECT INDUSTRIES
10.	LAXMI HYDRAULICS PVT. LTD

However, the final list of makes for the LT Motors is subjected to BHEL/Customer approval, during contract stage, without any commercial implications.

SUB-SECTION - IIC

STANDARD TECHNICAL SPECIFICATION (C &I)

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.:	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE :
		SHEET 1	OF 5

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a) IS-6005 : 1998 : Code of practice for phosphating of iron and steel.
b) IS-5 : 2007 : Colors for ready mixed paints and enamels.
c) IS-1248:2003 : Direct Acting Indicating Analog Elec Measuring Instruments.
d) IS/IEC 60947:Part 1:2004 : Low Voltage switchgear & control gear: Part-I (General Rules)
e) IS-8828:1996 : Circuit breaker for household and similar installations.
f) IS-13947 (Part-I):1993 : Low Voltage switchgear & control gear : Part-I (General Rules)
g) ISA-18.1:1979 : Annunciator Sequences and Specification
h) NFPA-496:2003 : Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.5 mm for load bearing sections (Mounted with instruments)
1.6 mm for doors and Not less than 2.0 mm for others
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm.The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

3.1.7 The class of protection shall be in accordance with IP-55 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).

3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function.
The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm2 size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm2 to 2.5mm2 external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The panel shall have ten (20) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 50 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm2 size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type.

Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Shee No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrossion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Local Panels : Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels : Data sheet no. PES-145A-DS2-0

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

			DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER			
	CONSTRUCTION		☐ FOLDED ■ WELDED (CRCA) (As per requirement)	
	ENCLOSURE SHEET THICKNESS	FRONT	▌2.0 mm	
		OTHER	▌2.0 mm	
		DOOR	▌2.0 mm	
TECHNICAL	INPUT POWER SUPPLY		☐ 240V 50 Hz AC ☐ 220V DC ■ 415V 3 PHASE	
	NO. OF FEEDERS		☐ ONE ▌ TWO	
	CONTROL SUPPLY		☐ 110V AC ☐ 220V AC ☐ 220V DC ■ During detailed engg. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		AS REQUIRED	
	PAINT TYPE		☐ EPOXY ENAMEL ■ EPOXY POWDER COATED	
	PANEL COLOUR (EXTERNAL)		■ Exterior- Opaline green shade 275 of IS: 5 or equivalent international code ■ Interior- Brilliant White (To be finalized during detailed engineering.)	
	FINISH		■ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	PANEL COLOUR (INTERNAL)		■ BRILLIANT WHITE ☐ CREAM ☐ OFF WHITE	
	FINISH		☐ MATT ☐ GLOSSY ■ SEMI GLOSSY	
	CLASS OF PROTECTION		■ IP-42 ☐ IP-65	
	CONTROL HARDWARE		■ RELAY BASED	
	FOUNDATION ARRANGEMENT		■ FOUNDATION BOLTS ☐ ANCHOR FASTENERS	
	WEIGHT OF PANEL (Kg.)		BIDDER TO SPECIFY	
	PANEL TYPE		☐ PRESSURISED ■ UNPRESSURISED As per Requirement	
	CABLE GLAND		☐ SINGLE COMPRESSION ■ DOUBLE COMPRESSION	
	AMMETER (TYPE OF INPUT)		☐ 1 Amp CT ☐ 4-20 mA As per Requirement	

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER			
	CONSTRUCTION			
	ENCLOSURE SHEET THICKNESS	FRONT		
		OTHER		
		DOOR		
TECHNICAL	INPUT POWER SUPPLY			
	NO. OF FEEDERS			
	CONTROL SUPPLY			
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)			
	PAINT TYPE			
	PANEL COLOUR (EXTERNAL)			
	FINISH			
	PANEL COLOUR (INTERNAL)			
	FINISH			
	CLASS OF PROTECTION			
	CONTROL HARDWARE			
	FOUNDATION ARRANGEMENT			
	WEIGHT OF PANEL (Kg.)			
	PANEL TYPE			
	CABLE GLAND			
	AAMETER (TYPE OF INPUT)			

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

	5x800 MW TSGENCO YADADRI TPS **CONTROL & INSTRUMENTATION** Technical specification for **NATURAL DRAFT COOLING TOWER**	SPEC NO.: **PE-TS-417-145-IXXX** VOLUME SECTION REV. NO. 00 | DATE : 20.07.2017 SHEET OF

QAP FOR
LOCAL CONTROL PANEL

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	1 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
	INCOMING											
1.0	Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	IS:1079 IS:513	IS:1079 IS:513	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	IS:1079 IS:513	IS:1079 IS:513	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	IS:2062	IS:2062	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	IS:2062	IS:2062	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	

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1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	2 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
		3. Conductor a) Resistance b) Size c) Sheet colour	 MA MA MA	 Electrical Measurement Visual	 100% 100% 100%	 BHEL Spec. and IS:1554 or IS:694	 BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant IS	Relevant IS	Log Book	2	---	---	
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	+ for relay & contactors only
		4. I.R.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	@ for all components except relays & contactors.
		5. H.V.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	
		6. Calibration	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	1	
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
	IN PROCESS											
6.0	Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---	
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
	ASSEMBLY											
8.0	Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
	FINAL											
12.	Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

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KKS NO. PHILOSOPHY

KKS NUMBERING PHILOSOPHY

For identifying (tagging) an instrument / equipment in Power plant KKS numbering scheme is used. The purpose is to assign a unique number to every equipment in the power plant. For C&I equipment unique number are to be provided up to the signal level so that a unique number Input / Output exist in DCS for every signal.

Normally KKS number is a 10 digit alpha-numeric code and is typically split into the following:

X	X	X	A	A	Y	Y	B	B	B

First three digits indicate the Sub-System. The Code for the major system are given as per **Annexure-**1.

Fourth and Fifth digits are the **Numerical Keys at System Code Level** and used to distinguish between main systems having same Alpha Codes.

Sixth and Seventh digits are the **Equipment** / **Apparatus** / **Measuring Circuit Code**. The code of various Equipment / Apparatus / Measuring Circuit is shown in **Annexure-2**

Eight, Nine and tenth digits are the **Numerical Keys at Equipment** / **Apparatus** / **Measuring Circuit Code** and used to distinguish between various instruments in the same sub-group. Numerical keys at System / Equipment / Apparatus / Measuring Circuit is shown in **Annexure-3**.

ANNEXURE-1

List of System / Sub-System Codes used in Power Plant:

1) Mill Reject Handling System: EUA

ANNEXURE-2

Standard Equipment Codes:

AA	Valves including drives, also hand operated
AB	Seclusions, Lock, Gates, Doors
AC	Heat Exchanger
AE	Turning, Driving, Lifting equipment
AF	Continuous conveyors, Feeders
AG	Generator Units
AH	Heating and Cooling Units
AK	Pressing and Packaging equipment
AM	Mixer, Stirrer
AN	Blower, Air Pumps / Fans, Compressor Units
AP	Pump Units
AT	Purification, Drying, Filter
AV	Combustion Equipment e.g. grates

Standard Apparatus Codes:

BB	Vessels and Tank
BF	Foundation
BG	Boiler Heating Surfaces
BN	Injector, Ejector
BP	Flow and throughput limitation equipment (Orifice)
BQ	Holders, Carrying Equipment, Support
BR	Piping, Ducts, Chutes, Compensator
BS	Sound Absorber
BU	Insulations, Sheatings

Standard Measuring Circuits Codes:

CD	Density
CE	Electrical Quantities
CF	Flow, throughput
CG	Distance, Length, Position
CK	Time
CL	Level

SECTION III

DOCUMENTS TO BE SUBMITTED BY BIDDER

1.	Guaranteed Cold water temperature at design capacity & parameters with the working cells	33 Deg. C

Authorized Signatory

Company seal

COMPLIANCE CERTIFICATE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnish same with the offer.

a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions with regard to same.

b) There are no other deviations w.r.t. specification other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'

c) We will submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL/ CUSTOMER approval & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc.

d) All drawings/ data-sheets/ calculations etc. submitted along with the offer shall be considered for reference only, same shall be subject to BHEL/ CUSTOMER approval in the event of order.

e) The offered materials shall be either equivalent or superior to those specified in the specification.

For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

f) We will supply commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself. Prices for special tools & tackles, if any, shall also be included in the base price.

g) All sub vendors shall be subject to BHEL/ CUSTOMER approval in the event of order.

h) The Performance guarantees shall stand valid till at least eighteen (18) months after full load commissioning of CT or as per commercial terms and conditions, whichever is later.

i) Specifically confirm compliance with Cl. Nos. 11.0 and their sub clauses of Sec. II of Technical Specification specification.

j) We will carry out hydrostatic testing of piping shall be carried out as specified i.e. at 1.5 times the design pressure.

Bidder's Authorized Signatory

Company Seal.

1. Guaranteed Cold water temperature at design capacity & parameters of approved Design of NDCT. ..... Deg. C

Authorized Signatory

Company seal

FORM NO PEM 6036-1

	TITLE *** SCHEDULE OF DEVIATIONS** ( ) From Conditions of Contract (Volume – 1) ( ) From General Technical Conditions (Volume – II A) ( ) From Technical Specifications (Volume –II B)	SPECIFICATION NO VOL III SHEET…….. OF……

We the undersigned hereby certify that the above mentioned are the only deviations.

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE				
NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL