

**KARNATAKA POWER CORPORATION LIMITED  
BELLARY TPS UNIT-III  
(1 X 700 MW)**


**VOLUME -IIB**

**TECHNICAL SPECIFICATION  
FOR  
COOLING TOWER**

**Specification No. : PE-TS-367-165-N001 (REV. 0)**



**BHARAT HEAVY ELECTRICALS LIMITED  
POWER SECTOR  
PROJECT ENGINEERING MANAGEMENT  
NOIDA - 201301**

	TITLE:	SPEC. NO.: PE-TS-367-165-N001
	<b>TECHNICAL SPECIFICATION COOLING TOWER</b>  <b>PREAMBLE</b>	VOLUME: IIB
		SECTION:
		REV. NO. 0      DATE: 09.05.11
		SHEET 1      OF 1

1.0      The tender document contains three (3) volumes. The bidder shall meet the requirements of all the three volumes.

1.1      Volume -I   CONDITIONS OF CONTRACT

            This consists of four parts as below :

            Volume - I A      : This part contains instructions to bidders for making bids to BHEL.

            Volume - I B      : This part contains general commercial conditions of the tender and include provision that vendor shall be responsible for the quality of item supplied by their sub-vendors.

            Volume - I C      : This part contains special conditions of contract.

            Volume - I D      : This part contains commercial conditions for erection and commissioning site work, as applicable.

1.2      Volume - TECHNICAL SPECIFICATIONS

            Technical requirements are stipulated in Volume II which comprises of :

            Volume - II A      : General Technical Conditions

            Volume - II B      : Technical specification including drawings, if any.

1.2.1      Volume - II B :

            This volume is sub-divided into following sections:

            Section - A      : This section outlines the scope of enquiry.

            Section - B      : This section provides "Project Information"

            Section - C      : This section indicates technical requirements specific to the contract, not covered in Section-D.

            Section - D      : This section comprises of technical specifications of equipments complete with data sheet A, B & C.  
                                 Data sheet-A specifies data and other requirements pertaining to the equipment.  
                                 Data sheet - B specifies data to be filled by the bidder (Data Sheet B is contained in Volume - III)  
                                 Data sheet - C indicates data documents to be furnished after the award of contract as per agreed schedule by the vendor (as applicable).

1.2.2      Volume - III TECHNICAL SCHEDULES

            This volume contains technical schedules and Data Sheets – B (to be submitted at contract stage), which are to be duly filled by the bidder and the same shall be furnished with the technical bid.

2.0      The requirements mentioned in Section C/Data Sheets-A of Section-D shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the descriptive portion in Section -D.



**TITLE:**  
**TECHNICAL SPECIFICATION  
COOLING TOWER**

**CONTENTS**

**SPEC. NO.: PE-TS-367-165-N001**

**VOLUME: IIB**

**SECTION:**

**REV. NO. 0 DATE 09.05.11**

**SHEET 1 OF 2**

**CONTENTS**

<b>SECTION</b>	<b>TITLE</b>
A	Scope of Inquiry
B	Project Information
C	Specific Technical Requirements
C1	Specific Technical Requirements (Mechanical) including Data Sheet – A.
C2	Specific Technical Requirements (Elec.)
C3	Specific Technical Requirements (Civil)
D	Standard Technical Specifications
D1	Standard Technical Specifications (Mechanical)
D2	Standard Technical Specifications (Elec.)



**TITLE:**

**TECHNICAL SPECIFICATION  
COOLING TOWERS**

**SCOPE OF ENQUIRY**

**SPEC. NO.: PE-TS-367-165-N001**

**VOLUME: IIB**


**SECTION: A**

**REV. NO. 0      DATE 09.05.11**

**SHEET 1      OF 2**

**SECTION - A**

**SCOPE OF ENQUIRY**

	<b>TITLE:</b> <b>TECHNICAL SPECIFICATION</b> <b>COOLING TOWERS</b>  <b>SCOPE OF ENQUIRY</b>	<b>SPEC. NO.: PE-TS-367-165-N001</b>	
		<b>VOLUME: IIB</b>	
		<b>SECTION: A</b>	
		<b>REV. NO. 0</b>	<b>DATE 09.05.11</b>
		<b>SHEET 2</b>	<b>OF 2</b>

**1.00.00 SCOPE**

**1.01.00** This enquiry covers the complete cooling towers including design, manufacture, assembly, inspection and testing at manufacturer's and/or his sub-contractors works, proper packing, delivery at site, transportation, unloading/handling at site, erection, site painting, commissioning, testing of Natural draft cooling tower (NDCT) including electrical, C&I, civil & structural works, as specified & as necessary for completeness in all respects and for efficient & trouble free operation for BELLARY TPS UNIT-III 1X700 MW

The Structural and reinforced Steels (fusion bond epoxy coating as per IS13620) for CT are excluded from Bidder's scope, they shall be free issue by BHEL. Terms and conditions for free issue items being given along with NIT.  
However for Bid evaluation of the Cooling Tower, Bidder's total price shall be determined after adding cost of Steel as per rates specified else where in Bidder's total quoted price for the CT.

Cost of Piling (if any) shall be included by bidder's in their quoted price.

**2.00.00 GENERAL TECHNICAL INSTRUCTIONS**

**2.01.00** It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship, and shall be capable of performing the required duties in a manner acceptable to Engineer/Owner, who will interpret the meaning of drawing and specifications and shall be entitled to reject any component, work or material, which in his opinion is not in conformity with the duty requirements.

**2.02.00** The omission of specific reference to any component/ accessory necessary for the proper performance of the equipments shall not relieve the bidder of the responsibility of providing such facilities to complete the supply/ erection / commissioning etc. of cooling tower and its drives at quoted prices.

**2.03.00** BHEL's/ owner's representative shall be given access to the shop in which the equipments are being manufactured or tested and all test records shall be made available to him.

**2.04.00** The equipments covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and shipping release issued by BHEL.

**2.05.00** In case of any deviation from this technical specification (Vol. IIB) and General Technical Conditions (Vol. IIC), the same shall be indicated in the schedule of deviations. In the absence of duly filled schedules it will be assumed that the bid strictly conforms to the specification.

**2.06.00** Un priced copy of the price bid shall be furnished along with the technical bid.





**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWERS**  
**PROJECT INFORMATION**

**SPEC. NO.: PE-TS-367-165-N001**  
**VOLUME: IIB**  
**SECTION: B**  
**REV. NO. 0**      **DATE 09.05.11**  
**SHEET 1 OF 1**

**SECTION - B**

**PROJECT INFORMATION**

KPCL/TP&U/EPCC		KARNATAKA POWER CORPORATION LIMITED		SECTION: B	
		BELLARY TPS UNIT-3 OF 700 MW		VOLUME-II	
		TITLE		SHEET 1 OF 2	
		PROJECT INFORMATION			
1.0	Owner	:	Karnataka Power Corporation Ltd Shakthi Bhavan No.82, Race Course Road Bangalore-560 001 Karnataka, India		
2.0	Project Title	:	1x700 MW Bellary Thermal Power Station		
3.0	Location	:	Unit No3, Stage-3 Kudatini Village Bellary Dist Karnataka state INDIA		
4.0	Latitude and Longitude	:	15° 11' 58" N Latitude 76° 43' 23" E Longitude		
5.0	Elevation above mean sea level	:	478 meters		
6.0	<u>Climatic Conditions</u>				
	(a)	<u>Temperature</u>			
	i.	<u>Monthly basis</u>			
		Mean of daily maximum temperature	:	42.5° C (in the month of April)	
		Mean of daily minimum temperature	:	19.5° C (in the month of Dec)	
	ii.	<u>Monthly basis</u>			
		Mean of daily maximum	:	37.5° C	
		Mean of daily minimum	:	19.5° C	
	iii	Highest temperature recorded	:	42.5° C	
	iv	Lowest temperature recorded	:	14.6° C	
	(b)	Relative Humidity	:	Varies between 11% and 70%	
	(c)	<u>Rainfall</u>			
		Annual average rain	:	492 to 846 mm most of which occurs during August to October	
	(d)	<u>Wind Speed</u>			
	i.	Annual mean wind speed	:	8.4 km / hr	
	ii.	Maximum mean wind speed	:	19 km / hr in the month of July.	
8.0	<u>Wind Load</u>				
	(a)	Basic wind speed of 39 m/sec as given in Fig.1 of the code.			
	(b)	Factor K1 shall be taken as 1.06			
	(c)	Terrain category shall be 2 and corresponding values shall be taken for K2			
	(d)	Factor K3 shall be taken as 1.0			
9.0	<u>Wind Loading for Stack</u>				
	(a)	For wind pressure as per clause 8.0 above			
	(b)	For RC stacks as per IS: 4998			
10.0	<u>Seismic data (as per IS:1893 latest issue)</u>				
	(a)	Zone	:	Zone III	
	(b)	Importance factor (I)	:	2.5 for electrical equipment 1.5 for others.	
11.0	Auxiliary power supply	:	Auxiliary electrical equipment to be supplied against this specification shall be suitable for operation on the following supply system.		


KPCL/BTPS/03/EPC 	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW TITLE PROJECT INFORMATION	SECTION: 8 VOLUME: II SHEET 2 OF 2
(a) For motors rated above 175 kW (b) For motor control centre (c) For motor rated 175 kW and below (d) DC motor starters, DC solenoids, DC alarm, control and protections (e) AC control & protective devices (f) Uninterrupted power supply (g) AC solenoids, indicators/recorders, space heaters (for motors rated 30kW and above) (h) Winding heating of motors below 30kW (i) Solid state controls (including solenoid valves) (j) Lighting fixtures (k) Lighting fixtures and space heaters in panels (l) Construction supply (m) The above voltages may vary as follows: All devices shall be suitable for continuous operation over the entire range of voltage and frequency indicated below without any change in their performance. i. AC supply ii. DC supply	: 11000V, 3 phase, 3 wire, 50Hz medium earthed AC : 3300V, 3 phase, 3 wire, 50Hz medium earthed AC : 415V, 3 phase, 3 wire solidly earthed AC : 415, 3 phase, 3 wire solidly earthed AC : 220 V DC, 2 wire, unearthed DC : 110 V 1 phase, 50Hz, 2 wire AC supply. The single-phase 110V AC supply shall be derived by Contractor by providing 415V/110V control transformers of adequate rating with MCCB /MCB on both the primary and secondary sides. : 110 V, 1 phase, 50Hz, 2 wire AC supply from UPS system for I&C (including Indicator recorders) and UCMS only : 240V 1 phase, 2 wire, 50Hz AC system with effectively earthed neutral. The power supply shall be derived by Contractor by providing 415V/ 240V transformer of adequate rating with MCCB/MCB on primary/secondary sides. : 24 V 1 phase, 50Hz, AC with one point earthed. This shall be derived by Contractor by providing 415V 3 phase, 3 wire, AC supply through an adequately rated step-down transformer of adequate rating with MCCB / MCB on primary/secondary sides. : 24 V DC, 2 wire, supply from Battery chargers for instrumentation system only. : 240 V, 1 phase, 2 wire, 50Hz system. : 240 V, 1 phase, 2 wire, 50Hz system. : 415 V, 3 phase, 4 wire, 50 Hz AC supply with neutral lead solidly earthed. : Voltage variation $\pm 10\%$ Frequency variation $\pm 5\%$ Combined voltage & frequency variation $\pm 10\%$ : Voltage variation $+10\%$ $-20\%$	



**CLARIFIED WATER ANALYSIS FOR 1 X 700 MW BELLARY TPS, UNIT-III**

1. Turbidity : < 20 NTU
2. TSS : < 20 PPM
3. pH : 7.5 to 8.5
4. Color : Colorless
5. Residual chlorine : <0.5 PPM


**Note : Rest of the parameters for clarified water shall be as per raw water analysis.**

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION: D1. VOLUME-III
	TITLE  WATER SYSTEMS	Page 23 OF 69

**Annexure-1**

**THE DESIGN RAW WATER QUALITY PARAMTERS ARE AS INDICATED IN CONTRACT DOCUMENT**

Sl.No	Description	Unit	Water Quality Considered for design
<b>Physical Parameters</b>			
1	pH		7.5-8.5
2	Temperature	Deg. C	30
3	Conductivity	mic.mhos/cm	1980
4	Total Suspended Solids	mg/l	10-15
5	Total Dissolved Solids	mg/l	1500 (max)
6	Turbidity	NTU	15
7	Oil & grease	mg/l	Nil
<b>Chemical Parameters</b>			
8	Calcium as Ca	mg/l	50.0
9	Magnesium as Mg	mg/l	40.0
10	Sodium as Na	mg/l	347
11	Potassium	mg/l	5.1
12	Iron - Total (Fe)	mg/l	1.0
13	Alkalinity-m as CaCO3	mg/l	550.0
14	Alkalinity-p as CaCO3	mg/l	50.0
15	Bicarbonate as HCO3	mg/l	671
16	Carbonate as CO3	mg/l	10
17	Sulphate as SO4	mg/l	24.0
18	Chloride as Cl	mg/l	307
19	Silica reactive as SiO2	mg/l	32.0
20	C.O.D	mg/l	60.0
21	Colloidal silica	mg/l	3 to 18
22	Dissolved oxygen	mg/l	5.2
<b>Additional Parameters</b>			
23	BOD	mg/l	8.2
24	TOC	mg/l	12.4
25	Nitrate	mg/l	19.0
26	Ammonia	mg/l	Nil

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION: D1. VOLUME-III
	TITLE WATER SYSTEMS	Page 24 OF 69

Sl.No	Description	Unit	Water Quality Considered for design
27	Total Silica	mg/l	22 to 46
28	Zinc	mg/l	0.37
29	Nickel	mg/l	< 0.005
30	Chromium Total	mg/l	0.009
31	Barium	mg/l	Nil
32	Bromide	mg/l	Nil
33	Fluoride	mg/l	0.9
34	Hydrogen Sulphide	mg/l	Nil
35	Manganese	mg/l	0.16
36	Strontium	mg/l	Nil
37	Ammonical Nitrogen	mg/l	<0.1
38	Phosphate	mg/l	1 to 2
	Bacteriological Parameters		
39	Coliforms (e coli)	Cfu/ml	present
40	Faecal Coliforms	Cfu/100ml	86.0
41	Total Viable Count at 48 hrs	Cfu/100ml	$67 \times 10^{-2}$



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWERS**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**

**VOLUME: IIB**

**SECTION: C**

**REV. NO. 0 DATE 09.05.11**

**SHEET 1 OF 1**

## **SECTION - C**

### **SPECIFIC TECHNICAL REQUIREMENTS**

**SECTION C1 - Specific Technical Requirements (Mech.)**

**SECTION C2 - Specific Technical Requirements (Electrical)**

**SECTION C3 - Specific Technical Requirements (Civil)**



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWERS**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**  
**VOLUME: IIB**  
**SECTION: C1**  
**REV. NO. 0      DATE : 09.05.11**  
**SHEET 1    OF 1**

**SECTION – C1**

**SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)**



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**  
**BELLARY TPS, UNIT-III (1 X 700 MW)**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**  
**VOLUME: IIB**  
**SECTION: C1**  
**REV. NO. 0 DATE 09.05.11**  
**SHEET 1 OF 10**

**1.00.00 INTENT OF SPECIFICATION:**

**1.01.00**

This specification is intended to cover the design, manufacture, inspection/ testing at manufacturer's works, delivery at site properly packed for transportation, unloading/ handling and storage at site, erection including civil works/ testing/ commissioning at site and performance testing of Natural draft type cooling tower for Bellary TPS Unit-III (1 X 700 MW) including complete Electrical, C&I and Civil Works as specified and as necessary.

The Structural and reinforced steel required for complete civil works of Cooling Tower are excluded from bidder's scope. These shall be free issue items.

The Natural draft type Cooling Tower covered under this specification is as under.

a) Bellary Thermal Power Station, Unit-III (1 X 700 MW) - 1 (One) No Cooling Tower

The performance parameters and other particulars of Cooling Tower is detailed in Data Sheet-A.

**2.00.00 SCOPE OF EQUIPMENTS & WORKS UNDER THIS SPECIFICATION:**

The equipment and works to be provided under this specification shall be as detailed below and as indicated in relevant portion of enclosed documents.

The items not specifically mentioned but deemed necessary to make the cooling tower complete in all respects, as self-contained package for reliable and efficient operation shall also be deemed to have been included in the scope of the bidder.

The scope of supply/ works including civil works as complete turnkey package includes complete civil works between the terminal points which are stated or unstated but required as per the system requirements except for items specifically mentioned in exclusion list of works. Scope of works includes preparation of design and drawings, obtaining necessary approvals, materials, execution as per codes, specification, best Engineering practices and to the satisfaction of BHEL/ Owner for all mechanical, architectural, civil structural, building electrification, etc. BHEL will not bear any liability for any extra work, which might not have been perceived by the bidder but functionally required. The cost of such work will be entirely borne by the bidder.

Bidder shall visit and apprise himself fully with existing site conditions including soil condition, rainfall data, availability of all construction materials including backfill, graded material etc. and other aspects for construction of plant, building structures etc. No extra claim whatsoever on any account shall be entertained by BHEL.

The bidder shall furnish list of items/ services not included in his scope, otherwise the complete package shall be deemed to be in bidder's scope & Purchaser's interpretation in this regard shall be final & binding on the bidder.

The brief scope of supply, services & works for Cooling Tower, complete with hot water distribution system, cold water basin and outlet channels, sludge pit, stair case from ground level to deck and all other equipments and accessories as mentioned herein after. It is not the intent to list all details herein; scope of supply listed is in brief.

**2.01.00 Each Cooling Tower shall be complete with following:**

**2.01.01 Scope (Mechanical):**

a) Incoming hot water piping, including vertical run, supported on cooling tower, Butterfly valves on hot water risers. Terminal point for hot water pipe shall be as marked in the tender drawing enclosed at Annexure 1 & 2 to Data Sheet - A. Welding at terminal point shall be in bidder's scope. Bidder shall also supply a pressure gauge at the terminal point. Any reducer/ expander required at the terminal point shall also be in the bidder's scope.



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**  
**BELLARY TPS, UNIT-III (1 X 700 MW)**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**  
**VOLUME: IIB**  
**SECTION: C1**  
**REV. NO. 0 DATE 09.05.11**  
**SHEET 2 OF 10**

- b) Inlet louvers, tower fills & fill supports, drifts eliminators, including all supporting structures, fastening arrangements & accessories.
- c) Screens, along with guides embedded in concrete shall be provided at the outlet of cold water channel.
- d) Stop log gates and guides embedded in concrete at the outlet of cold water channel.  
  
Manual chain pulley hoist, complete with chains and hooks, for lifting of the screens & gates..
- e) Valves in sludge pits complete with extension spindle & pedestal type manual operator. The pipe spools shall be embedded in the wall through which extension spindle will be protruding.
- f) Pipe spools to be embedded in sludge pit walls and terminated with flanged end at suitable distance from outer face of respective wall.
- g) Water Distribution system consisting of troughs/ Pipes. Hangers & pipe supports & anchoring arrangement for all piping coming under the scope of supply.
- h) Two (2) Nos. (1+1) sludge pumps (submersible type) complete with electric motors, non-return valve, isolation valve, piping supports, hangers etc. for cold-water basin drainage. The bidder shall terminate pump discharge pipe work at a distance of 25 M from sludge pit.
- i) Counter flanges, bolts, nuts & gaskets for all piping connections in the scope of bidders and also at terminals.

**2.01.02 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 temperature gauge at Hot water pipe header at T.P.
- c) One no of Anemometer for measurement of wind velocity
- d) One no of Psychrometer.

**2.01.03 Scope (Electrical):**

- a) Complete electrical equipments as per specification/ details indicated in Section C2 & D2 shall be in bidders' scope.
- b) The scope of power & control cables & special cables shall be as per Annexure-1 of section C-2 (electrical).
- c) Base plate, foundation plates, anchor bolts, sleeves, inserts in concrete work for electrical and mechanical equipments & accessories.

**2.01.04 Scope (Civil):**

- a) Complete civil works as detailed in Section - C3 including excavation, shoring, dewatering, strutting, backfilling around underground structures and plinth filling, concrete work including reinforcement, shuttering, sand filling, disposal of surplus soil outside plant boundary sidewalls, 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. 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



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**  
**BELLARY TPS, UNIT-III (1 X 700 MW)**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**  
**VOLUME: IIB**  
**SECTION: C1**  
**REV. NO. 0 DATE 09.05.11**  
**SHEET 3 OF 10**

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 design and 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 stop log 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 final painting at site.

**Note :** Minimum grade of concrete for various RCC structure components shall be M30.

**2.01.05** The following are also included in bidder's scope:

- a) One set of special tools & tackles required for maintenance of equipments & 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.
- f) Recommended spares for 3 years operation – bidder to furnish list with item wised prices. These prices not to be included in the base price but to be furnished separately.

**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 and Civil works refer Sections C2/ D2 & C3 respectively enclosed herein.

**4.00.00** The cooling tower shall comply with standard technical specifications of cooling towers enclosed in section -'D' & data sheet- A. In the event of any conflict between Section -'D' / data sheet-A' & section 'C', the latter shall prevail.

**5.00.00** **Thermal Design of Cooling Towers:**  
The thermal design of cooling towers shall fulfill following design criteria.

**5.01.00** Sensible heat of evaporated water shall be taken into account for calculating the air flow requirement, as per the following equation.

$$G \cdot H = L (T_1 - T_2) + (E \cdot V \cdot T_2)$$





**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**  
**BELLARY TPS, UNIT-III (1 X 700 MW)**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**  
**VOLUME: IIB**  
**SECTION: C1**  
**REV. NO. 0**      **DATE 09.05.11**  
**SHEET 4 OF 10**

Where

L = Water flow rate in Kg/hr.  
T<sub>1</sub> = Water inlet temperature to the tower in Deg.C  
T<sub>2</sub> = Water outlet temperature to the tower in Deg.C  
EV = Evaporation loss in Kg/hr. at RH (as specified in Data Sheet-A)  
G = Air flow rate in Kg/hr.  
H = Change in enthalpy of air in Kcal/kg.

**5.02.00** For the specified design conditions of water rate, range, approach, wet bulb and dry bulb temperatures Bidder shall calculate and furnish the duty coefficient "D". A nomogram indicating the ratio of water rate and duty coefficient, recooled water temperature and other thermal conditions specified shall be furnished with the bid. The nomogram shall cover the entire operating range and shall extend up to a wet bulb temperature of as specified in Data Sheet-A.

Along with the thermal design calculations as specified above, bidder has to submit the calculations for:

- Total height of Natural Draft Cooling Tower
- Basin sizing
- Height of the hot water distribution header
- Drift Eliminator sizing
- Inlet Louver Sizing
- Sludge pit sizing

**5.03.00** Based on the duty co-efficient and performance characteristics of the fill the bidder shall furnish an equation expressing the relationship between the plan area of packing and the square root of tower height.

**5.04.00** Bidder shall furnish performance characteristic curves for following variations in design parameters. 15%, 25%, 60%, 70%, 80%, 90%, 100%.

Bidder shall also clearly identify various "Guaranteed Zones" as per the requirement of code.

**5.05.00** Bidder may note the calculations specified above must be enclosed with the offer without which bids run the risk of rejection. In case these calculations are based on the collaborator's design then these calculations should be duly vetted by his collaborator. The bidder shall show, explain and prove the validity of the basis, procedures and methods used in these calculations.

**5.06.00** The tower configuration shall be such that it shall offer minimum restriction to air flow.

**5.07.00** The Cooling Tower Thermal design calculations shall be got vetted and approved by bidder from any of the IIT's (Indian Institutes of Technology) in the event of order along with the related CT drawings for fill arrangements etc. and charges for same shall be included in the bidder's base price itself.

The Purchaser/ Customer however also reserve the rights to check the detailed calculations in the event of order and their interpretation shall be final in the event of any conflict.

**5.08.00** The total CW Pumping head (MWC) within bidder's terminal points shall not exceed the respective maximum limits specified in Data Sheets A.

The CW pumping head specified limit is inclusive of static head plus frictional losses including 10% margin on frictional losses.

No technical advantage shall be given to any bidder for total CW pumping head (MWC) offered less than above maximum limits.



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**  
**BELLARY TPS, UNIT-III (1 X 700 MW)**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**  
**VOLUME: IIB**  
**SECTION: C1**  
**REV. NO. 0 DATE 09.05.11**  
**SHEET 5 OF 10**

In the event of total CW pump head (MWC) offered being more than above maximum limits, the bids will be summarily rejected.

The bidder's Cooling Tower thermal design shall take care of above aspects including maximum permissible plan dimensions indicated in Data Sheet A.

**6.00.00 Specific Requirements**

In addition to the salient technical requirements stipulated in Section "D", the bidder may note specific requirements detailed herein for design of the cooling towers.

**6.01.00** No wood/ timberwork shall be used in any component of the cooling tower.

**6.02.00** The quality of water in CW sump shall be clarified water with analysis as given in data sheet-A of Section. D.

a) The COC in CW System shall be '5'.

b) Ozonation to control biological/ algae growth is envisaged in purchaser's scope.

**6.03.00** The location, orientation, wind rose, scope demarcation, water levels etc. for the cooling tower shall be as per the sketch enclosed at Annexure – 1 & 2.

**6.04.00** Fills shall be PVC Film fills in easily removable sections.

**6.05.00** PVC Drift eliminator blades shall be of three-pass full wave type supported on concrete framework & shall limit the drift losses to a value not greater than 0.05 % of the design water circulation rate.

**6.06.00** All parts subjected to periodical maintenance & inspection such as Inlet louvers (if applicable), fills, drift eliminators etc. shall be readily accessible.

**6.07.00** Access doors shall be provided for entry into cooling water distribution level. The doors shall have easily operable shutter of leak proof design & shall be of MS construction with 2 coats of red oxide zinc chromate primer

**6.08.00** Two R.C.C. staircase for approach to hot water distribution level.

**6.09.00** Two external cage ladders for approach to top of cooling tower from ground level.

**6.10.00** Access platforms and walkways with handrails for inspection and maintenance of hot water distribution system.

**6.11.00** All steel parts in direct contact with water or humid air shall be of SS 304. All other steel parts not in direct contact with water/ humid air shall be galvanized steel. No hardware shall be of Cu or Cu based alloys. Material of construction shall be as indicated in Datasheet "A". Wherever the material of construction for any component is not given, same shall be suitable for the intended service & shall be subject to purchaser's approval during detailed engineering stage in the event of order.

**6.12.00** The sizing of the hot water distribution system shall be done by limiting the velocity through the pipes to a maximum of 2 m/sec.

**6.13.00** a) Piping for sizes above 150 Nb Carbon steel plates to IS 2062, rolled and welded as per IS 3589 with PU coating (polyurethane) internally with minimum 2 mm DFT as per AWWA-C-222.  
b) Piping from 65 Nb Upto 150 Nb shall be SS conforming to ASTM A-312- Gr.316 Sch 10S  
c) Piping Upto 50 Nb shall be SS conforming to ASTM A-312- Gr.316 Sch 40S.

**6.14.00** The buried piping in bidders scope shall be steel pipe. Welding of pipe header with Purchaser's pipe at terminal point shall be in bidder's scope. The thrust block etc. shall also be in bidders scope.

Provision of at least 2 nos. welding sockets at water distribution level shall also be in bidders scope.



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**  
**BELLARY TPS, UNIT-III (1 X 700 MW)**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**  
**VOLUME: IIB**  
**SECTION: C1**  
**REV. NO. 0 DATE 09.05.11**  
**SHEET 6 OF 10**

- 6.15.00** Manually operated B.F. valves shall be provided in hot water distribution riser.
- 6.16.00** The cold-water basin of cooling tower shall be provided with a partition wall to facilitate isolation of each half of CW basin whenever required through isolating gates viz. minimum two nos. gates shall be provided for each cooling tower. CT basin shall be provided with adequate slope (Min slope of 1:150) towards the sludge sump for drainage purpose.
- 6.17.00** Under each valve, flange joint & such other items prone to gland/ joint leakage, suitable trays/ channels shall be provided so that any leakage water does not spread on the surroundings. This is also applicable for any air release valve that has to be mounted on hot water riser top. Erection of such air release valves has also to be done by the bidder.
- 6.18.00** Bidder to note that all sub vendors shall be subject to BHEL/ Customer approval in the event of order.
- 7.00.00** Deleted
- 8.00.00** **PERFORMANCE TESTING AT SITE**
- 8.01.00** **Scope:**
- To ascertain the fulfillment of guarantees after completion of erection and commissioning of the cooling tower, contractor shall carry out performance test at site in presence of employer / purchaser through CTI approved testing agency. Under no circumstances, the bidder himself will conduct the test even if approved by CTI. The testing agency shall be independent from the bidder.
- Cooling Tower testing during single visit of CTI approved testing agency is envisaged.
- 8.02.00** **Codes:**
- The following codes and standards shall be applicable for conducting test unless otherwise modified or supplemented by the enclosed procedure and mutually agreed to between Owner, BHEL and bidder.
- a) Code ATC-105: Acceptance test code for water cooling towers. (latest Version).
  - b) BS-4485 : Specification for Water Cooling Tower.
  - c) BS-1042 : Methods for the measurement of fluid flow in pipes.
  - d) BS-3435 : Measurement of electrical power and energy in acceptance testing.
  - e) ASME 19.5 : Supplements on instruments and apparatus.
- 8.03.00** **Conductance of tests:**
- Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by the bidder for the design conditions of CW flow, range, ambient WBT as specified
- 8.03.01** The bidder shall submit cooling tower performance test procedure as per ATC 105 in consultation with CTI approved testing agency for approval & conduct the test as per the approved procedure, in the event of order.
- 8.03.02** The bidder shall be given permission to inspect the Cooling Tower in advance and ready it for the test.
- 8.03.03** Test shall be conducted jointly by CTI approved testing agency of the bidder, BHEL and Owner for all the cooling towers. All the representatives shall jointly record data of test.
- i. The responsibility for conducting the test will be with the bidder.



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**  
**BELLARY TPS, UNIT-III (1 X 700 MW)**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**

**VOLUME: IIB**

**SECTION: C1**

**REV. NO. 0 DATE 09.05.11**

**SHEET 7 OF 10**

- ii. All test instruments required for the PG test will be provided by CTI approved testing agency / or the instruments provided by contractor if the same meets the stipulations of the CTI testing agency and acceptable to testing agency
- iii 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.
- iv List of instruments to be arranged by the bidder along with the calibration certificates of the instruments to be used and psychometric charts and tables should be submitted to CTI/ owner for approval.

**8.03.04** PG test shall be carried out by the bidder after completion of trial operation of the cooling tower and at a time when the atmospheric conditions are within limits of deviation from the design conditions as specified in this section preferably in the period from May to September.

**8.03.05** Performance test shall be carried out based on ambient WBT. The performance curves of the towers showing variation in performance with change in ambient wet bulb temperature, cooling range, relative humidity water loading of the tower etc, required to ascertain the performance of the tower shall be furnished along with the bid. Performance curves applicable to 90%, 100% and 110% of the design water flow rate shall be furnished. Each set shall consist of three or more cooling range curves and at least four relative humidity curves, arranged to show the effects of wet bulb temperature, relative humidity and cooling range on outlet water temperature. The range curves shall be presented in uniform increments of 0.5 deg. C, with sufficient scope to cover approximately  $\pm 20\%$  of design range. The relative humidity curves shall be presented for spaced increments to cover the extent of expected conditions such as 5%, 20%, 40%, 60% and 100% relative humidity. The design conditions shall be indicated on the set applicable to design water flow rate. The dry bulb temperature associated with the wet bulb on each fixed relative humidity graph shall be included. The curves shall fully cover (but not necessarily be limited to) the range of variations specified. All performance curves shall be based on ambient wet bulb temperature.

**8.03.06** The guaranteed performance of the equipments shall be demonstrated by the bidder after evaluating the P.G. test should the result of the test deviate from the guaranteed values the bidder shall be given an opportunity to modify the equipment as required to enable it to meet the guarantees. In such cases the PG test shall be repeated within one month from the date on which the equipment is ready for retest and cost of modification, including labour, materials and cost of additional testing shall be borne by the Bidder. The chance for repeat testing will be given only once during the contract period. All the modifications carried out by the bidder in the Cooling Tower to meet the contractual requirements shall be carried out free of cost to the Owner in other towers (if applicable for the package).

**8.031.07** In case the test cold water temperature as determined from the PG test is higher than the predicated value (based on the performance curves). Owner reserves the right to reject/ accept the tower after assessing the liquidated damages as specified.

**9.00.00** The makes of all the equipments under this specification shall be subject to purchaser's approval in the event of order.

**10.00.00** It is mandatory for the bidder's to furnish along with the bid the deviations if any, whether major or minor in the 'Schedule of Deviations' only. In the absence of the deviations listed in the 'Schedule of Deviations', the offer shall be deemed to be in full conformity with the specification not withstanding anything else stated elsewhere in the offer, data sheets etc. The hidden deviations or stated/ implied deviations in the offer shall not be acceptable and binding on the purchaser.

**11.00.00 PERFORMANCE GUARANTEES AND LIQUIDATED DAMAGES**

- a) Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**  
**BELLARY TPS, UNIT-III (1 X 700 MW)**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**  
**VOLUME: IIB**  
**SECTION: C1**  
**REV. NO. 0 DATE 09.05.11**  
**SHEET 8 OF 10**

specification shall be guaranteed by bidder for the design conditions of CW flow, range, ambient WBT as specified.

In case the test cold-water temperature as determined from the PG test is higher than the predicted value (based on the performance curves). Owner reserves the right to reject the tower. In the event of its acceptance by purchaser liquidated damages as follows shall be applicable.

0.1°C over the guaranteed value	=	400 lacs
0.2°C over the guaranteed value	=	800 lacs
0.3°C over the guaranteed value	=	1200 lacs
0.4°C over the guaranteed value	=	1600 lacs
0.5°C over the guaranteed value	=	2000 lacs
0.6°C over the guaranteed value	=	2400 lacs
0.7°C over the guaranteed value	=	2800 lacs
0.8°C over the guaranteed value	=	3200 lacs
0.9°C over the guaranteed value	=	3600 lacs
1.0°C over the guaranteed value	=	4000 lacs

Bidder to note that the liquidated damages (as specified) for shortfall in performance shall be worked out independently for each cooling tower. To ascertain the fulfillment of guarantees of the cooling towers, the test results of the tower tested through CTI approved testing agency shall be considered for PG test evaluation and based on the test result, the liquidated damage if applicable shall be levied.

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

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

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

Frictional losses for pipes shall be as per William & Hazen formula with  $C = 100$ . Frictional losses for various valves & fittings e.g. Miter bends, valves, tees, reducers etc. shall be as per crane handbook. Ft Value for fitting friction drop calculation to be considered as 0.012 for all sizes greater than 600NB. The frictional losses shall be computed considering 10% margin on same.

William & Hazen formula:  $V = 0.85 \times C \times (i)^{0.54} \times (d/4)^{0.63}$

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

- c) 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 outright 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.



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**  
**BELLARY TPS, UNIT-III (1 X 700 MW)**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**  
**VOLUME: IIB**  
**SECTION: C1**  
**REV. NO. 0 DATE 09.05.11**  
**SHEET 9 OF 10**

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



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**  
**BELLARY TPS, UNIT-III (1 X 700 MW)**  
**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**

**VOLUME: IIB**

**SECTION: C1**

**REV. NO. 0 DATE 09.05.11**

**SHEET 10 OF 10**

**15.00.00 DRAWINGS, CURVES AND INFORMATION REQUIRED:**

**15.01.00 The following documents only shall be furnished by the bidder with his offer:**

- a) Compliance certificate duly signed and stamped (enclosed herein).
- b) General arrangement drawing for cooling tower, incorporating all relevant dimensions, Fill layout, water distribution layout, cold water channels / sludge chamber/ screens/ gates in the cold water channel, staircase etc.
- c) Pumping head calculations.
- d) Thermal design calculations (NDCT diameter & height calculation).

**Note: The GA drawing/ calculations shall be only for reference purpose, same shall not be reviewed/commented by purchaser at this stage and shall be subject to approval only during contract).**

- e) Tower performance curves.
- f) Guarantee Schedule duly signed and stamped (enclosed herein)
- g) Technical deviation schedule (if reqd.) (enclosed herein)

**Apart from above no other drgs./docs./data sheets etc. are required to be submitted at bid stage and even if furnished shall not be taken cognizance of.**

**16.00.00 Successful bidder in the event of award of contract shall furnish the drawings/ documents as listed in Data Sheet-C. Distribution of various documents shall be as per the Annexure to Data Sheet-C:**



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**

**SPEC. NO.: PE-TS-367-165-N001**

**VOLUME: IIB**

**SECTION: C2**

**REV. NO. 0**      **DATE: 09.05.11**

**SPECIFIC TECHNICAL REQUIREMENTS**

**SHEET 1 OF 1**

**SECTION – C2**

**SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)**

**BELLARY TPS UNIT-III, (1 X 700 MW)**






**ELECTRICAL EQUIPMENT SPECIFICATION  
FOR  
COOLING TOWER  
1X700 MW BELLARY THERMAL POWER  
STATION UNIT # III**

**SPECIFICATION NO.**  
**PE-TS-367-165-0001**  
**VOLUME NO. : II-F**  
**SECTION : C**  
**REV NO. : 00 DATE : 09.05.11**  
**SHEET : 1 OF 1**

**LIST OF CONTENTS**

		<b>NO. OF SHEETS</b>
1)	<b>SECTION - C</b>	<b>03</b>
2)	<b>SCOPE BETWEEN BHEL AND VENDOR</b>	<b>01</b>
3)	<b>SECTION - D</b>	
A) 1)	<b>COOLING TOWER AREA LIGHTING NOTES &amp; DETAILS. PE-DG-277-558-0001</b>	<b>18</b>
2)	<b>COOLING TOWER AREA LIGHTING SPECIFICATION &amp; DATA SHEETS (A &amp; C) PES-558-02</b>	<b>12</b>
3)	<b>QUALITY PLAN</b>	<b>03</b>
D) 1)	<b>CABLING, EARTHING AND LIGHTNING PROTECTION SYSTEM SPEC- VOLUME-II-F/2 SECTION-IX.</b>	<b>17</b>
2)	<b>QUALITY PLAN</b>	<b>02</b>

	<p align="center"><b>ELECTRICAL EQUIPMENT SPECIFICATION FOR COOLING TOWER 1X700 MW BELLARY THERMAL POWER STATION UNIT #III</b></p>	<b>SPECIFICATION NO.</b> PE-TS-367-165-0001
		<b>VOLUME NO. :</b> II-F
		<b>SECTION :</b> C
		<b>REV NO. :</b> 00 <b>DATE :</b> 09.05.11
		<b>SHEET :</b> 1 OF 3

## 1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER

The equipment and services to be provided by Tenderer under this specification shall be as detailed here below and as also specified in Electrical equipment Data sheets but shall not be limited to the following:

- a) Supply and installation of all lighting fixtures for illuminating the cooling tower and surrounding areas including 15 Amp receptacles and 63 Amp welding sockets as per specification no. PE-DG-277-558-0001.

This includes supply & installation of necessary lighting accessories, lighting panels, cables, conduits, wires, junction boxes etc.

- b) Supply and installation of all cable racks, trays, cable supports, galvanised steel conduits etc. From top to the bottom of cooling Tower area as necessary for routing of all cables as per Cabling, grounding and lightning protection Technical specification VOLUME-II-F/2 section -IX.

- c) Installation of the complete above ground Earthing System in the cooling tower area and connecting individual drives, local control stations, panels etc with the ground mat through risers as per Cabling, grounding and lightning protection Technical specification VOLUME-II-F/2 section -IX.

- d) Supply and installation of air terminals for lightning protection of cooling tower including down comer connection of air terminals with the grounding mat as per Cabling, grounding and lightning protection Technical specification VOLUME-II-F/2 section -IX.


- e) Any item of 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 and shall be provided by the tenderer without any extra charge.

- f) Various drawings, data, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified.

- g) All equipment offered shall have suitable provision for termination and connection of power, control and special cables and shall also be complete with cable boxes, double compression Ni-Cr plated brass cable glands, cable lugs (Heavy duty) etc.

- h) Bidder to furnish list of supplier for each equipment at contract stage. which shall be subject to customer /BHEL approval without any commercial and delivery implication to BHEL.

- i) Supply of mandatory spares as specified in the specifications of electrical equipments. Bidder to furnish unpriced list for the same.

	<b>ELECTRICAL EQUIPMENT SPECIFICATION FOR COOLING TOWER 1X700 MW BELLARY THERMAL POWER STATION UNIT #III</b>	<b>SPECIFICATION NO.</b> <b>PE-TS-367-165-0001</b>
		<b>VOLUME NO. : II-F</b>
		<b>SECTION : C</b>
		<b>REV NO. : 00 DATE : 09.05.11</b>
		<b>SHEET : .1 OF 3</b>


- j) List of recommended spares for 3 years for all Electrical equipments with unit price.
- k) Erection and commissioning spares list.
- l) List of Erection & maintenance tools & tackles.
- m) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- n) Bidder to furnish electrical load requirements for cooling tower in the enclosed Format E01-1.

**2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:**

- A) 415V MCC required for feeding power to various loads of cooling tower. Any control panel distribution board required for cooling tower shall be provided by bidder.
- B) All power & control cables shall be supplied as free issue item as per requirement indicated in offer. Bidder shall furnish size and quantity of cables required for the cooling tower loads. Any other special cable if required is to be arranged by the bidder.
- C) Lighting distribution board shall be located in CW pump house MCC room. One feeder for feeding lighting panel located in each cooling tower area shall be provided.
- D) Cabling space for purchaser's cables like communication, PA system etc shall be provided by bidder on the trays.
- E) 415V 3 phase 4 wire power supply for 63A welding sockets(2/CT) shall be provided from corresponding MCCs up to top of the cooling tower.
- F) Cable trench & cable trays up to the boundary limits of the cooling tower. Bidder shall coordinate with the purchaser for layout and matching.
- G) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.

**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 two signed and stamped copies of the following shall be furnished by the bidder as technical offer:

	<b>ELECTRICAL EQUIPMENT SPECIFICATION FOR COOLING TOWER 1X700 MW BELLARY THERMAL POWER STATION UNIT #III</b>	<b>SPECIFICATION NO.</b> PE-TS-367-165-0001 <b>VOLUME NO. :</b> II-F <b>SECTION :</b> C <b>REV NO. :</b> 00 <b>DATE :</b> 09.05.11 <b>SHEET :</b> 1 OF 3
<p>a) A copy of "Electrical equipment Specification for Cooling tower" and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.</p> <p>b) List of Erection and Commissioning spares.</p> <p>c) List of Erection &amp; Maintenance tools &amp; tackles.</p> <p>d) Electrical load requirement</p> <p>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.</p> <p>4.0 List of enclosures:</p> <ol style="list-style-type: none"> <li>1. Cooling tower area lightning notes &amp; details. PE-DG-277-558-0001</li> <li>2. Cooling tower area lightning specification &amp; data sheets (A&amp;C) PES-558-02.</li> <li>3. Cabling, earthing &amp; Lightning protection system spec-section-IX, Vol.-II-F/2.</li> <li>4. Quality plan.</li> <li>5. Load data format.</li> </ol>		

## ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

**PROJECT: 1X700 MW BELLARY THERMAL POWER STATION, UNIT #III**  
**PACKAGE: NATURAL DRAFT COOLING TOWER**

REV: 0

DATE: 09.05.11

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V Switchgear/MCC & LT Transformer	BHEL	BHEL	
2	Power cables, ordinary control cables and screened control cables between equipments supplied by vendor.	BHEL	Vendor	Vendor shall furnish size and quantity of cables required at contract stage.
3	Power cables, ordinary control cables and screened control cables between equipments supplied by vendor & BHEL.	BHEL	BHEL/ Vendor*	1. Laying of cables by BHEL. 2. Termination at BHEL equipment by BHEL. 3. * : Termination at vendor equipment by vendor
4	Any special type of cable like compensating, co-axial, prefab, MICC & fibre optical	Vendor	Vendor	LT Power cables & LT control cables shall comply the specification volume-II-F/2, Section IV.
5	Cabling material (cable trays & accessories, cable tray supporting system, conduits, M boxes/ J boxes) for cabling between equipments supplied by vendor and BHEL	Vendor	Vendor	
6	Conduit and conduit accessories for cabling between equipments supplied by vendor	Vendor	Vendor	Cabling shall be through conduits. However vendor can use the trunk route where available for laying of cables. Conduits shall be supplied by vendor and shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537. Makes of conduits shall be subject to customer/ BHEL approval at contract stage.
7	Equipment earthing	BHEL	Vendor	At two point on equipment supplied by vendor.
8	Below ground earthing	BHEL	Vendor	
9	a) Input cable schedules b) Cable interconnection details (diagram) c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for control cables for vendor supplied equipment (soft copies in the BHEL cable schedule format) shall be furnished during detail engineering by vendor.
10	Equipment layout drawings	Vendor	-	ACAD drawing shall be furnished by vendor.
11	Electrical equipment GA drawing	Vendor	-	



**TITLE:**  
**TECHNICAL SPECIFICATION**  
**COOLING TOWER**

**SPECIFIC TECHNICAL REQUIREMENTS**

**SPEC. NO.: PE-TS-367-165-N001**

**VOLUME: IIB**

**SECTION: C3**

**REV. NO. 0 DATE: 09.05.11**

**SHEET 1 OF 1**

**SECTION – C3**

**SPECIFIC TECHNICAL REQUIREMENTS (CIVIL)**

**BELLARY TPS UNIT-III, (1 X 700 MW)**



**1x700MW BELLARY THERMAL  
POWER STATION, UNIT# III- SPECIFIC  
TECHNICAL REQUIREMENTS**

**SPECIFICATION NO.**

**VOLUME – II B**

**SECTION - C**

**SUB-SECTION -**

**REV.0**

**DATE 04.05.2011**

**SHEET 1 OF 3**

3.00.00	<b>GEO-TECHNICAL INVESTIGATION &amp; FOUNDATION SYSTEM</b>					
3.01.01	<p>BHEL had carried out detailed geo-technical investigation in the proposed cooling tower site. The sub-strata details encountered at various bore holes (BH-43, BH-44 &amp; BH-45) in the cooling tower area are attached. The geotechnical data attached shall be solely for the purpose of guidance to the bidder. BHEL/owner does not take any responsibility about the accuracy and applicability of the geo-technical data furnished herewith. The onus of correct assessment/interpretation and understanding of the existing sub-strata conditions is on the bidder. Any variation in the data between the one furnished and to that found during execution of the work at site shall not constitute a valid reason in affecting the terms &amp; conditions of this bid and the bidder shall note that nothing extra will be payable on this account. The bidder shall fully satisfy himself about the nature of sub-strata expected to be encountered including the type of foundation, ground water table and construction methodology to be adopted etc prior to the submission of the bid.</p>					
3.01.02	<p>Detailed geo-technical Investigation report shall be made available to the successful bidder during contract engineering stage. If the bidder desires to carry out additional geo-technical investigation he/she may do so with prior information/permission of BHEL/owner at no extra cost to BHEL/owner. No extension in time schedule shall be permitted on this account. The bidder shall obtain approval on the agency for conducting geo-technical investigation work, field and laboratory testing schedule proposed by the bidder etc from BHEL/owner before undertaking the geo-technical investigation work. However, the net safe bearing capacity (SBC) of foundations to be adopted for the design at contract stage during detailed engineering shall be limited to the following</p>					
	Founding Level(m)	Type of Foundation	Net Safe Bearing Capacity (T/sq.m)	Founding stratum	Finished Ground Level (FGL) (m)	Re- marks
	RL(+ )476.00	Isolated/ Raft	20	Sandy Clay	RL(+ )478.00	However minimum depth of foundation shall be 2m below natural ground level
	RL(+ )475.00	Isolated/ Raft	30	Silty/sandy With Gravels		
	RL(+ )474.00	Isolated/ Raft	45	weathered rock*/rock		
	RL(+ )473.00	Isolated/ Raft	50	weathered rock*/rock		
*Founding stratum should be weathered rock/rock for adopting the said net						



**1x700MW BELLARY THERMAL  
POWER STATION, UNIT# III- SPECIFIC  
TECHNICAL REQUIREMENTS**

**SPECIFICATION NO.**

**VOLUME - II B**

**SECTION - C**

**SUB-SECTION -**

**REV.0**

**DATE 04.05.2011**

**SHEET 2 OF 3**

	<p>safe bearing capacity. In case soil/any loose strata is encountered at the respective founding levels the same shall be completely removed down to weathered rock/rock level and filled with PCC Grade M7.5 up to the said founding level</p> <p>However, bidder shall note that the net safe bearing capacity and foundation design to be adopted for design during detailed engineering shall be got approved by BHEL/Owner</p>
3.02.00	<b>Foundation System</b>
3.02.01	<p><b>General Requirements</b></p> <p>a. All equipments/structures shall be supported on suitable open foundation or pile foundation as required along with any special requirements/remedial measures/treatment called for subsoil/foundations as approved by BHEL/owner.</p> <p>b. All foundations shall be designed in accordance with the provisions of relevant part of the latest revision of Indian Standards.</p> <p>c. No foundation shall rest on filled up soil.</p> <p>d. No foundation shall rest on expansive soil.</p> <p>e. A combination of open and pile foundations shall not be permitted under the same structure.</p> <p>f. Foundations shall be designed to resist loading derived from environmental loads including loads due to wave, current, wind or seismic, gravity loads, construction loads, static and moving loads and any other loads as applicable and as specified elsewhere in the specification.</p> <p>g. Foundation shall be designed for worst combination of loads as described elsewhere in the specification.</p> <p>h. Ground water table shall be considered at finished ground level for design purposes unless specified elsewhere in the specification.</p>
3.02.02	<p><b>Open foundations</b></p> <p>The following shall be strictly adhered to for open foundations.</p>





**1x700MW BELLARY THERMAL  
POWER STATION, UNIT# III- SPECIFIC  
TECHNICAL REQUIREMENTS**

**SPECIFICATION NO.**

**VOLUME - II B**

**SECTION - C**

**SUB-SECTION -**

**REV.0**

**DATE 04.05.2011**

**SHEET 3 OF 3**

- i. Minimum width of foundation shall be 1m.
- ii. Minimum founding level shall be RL(+)476.0m or 2m depth below natural ground level whichever is deeper
- iii. The net safe bearing capacity (SBC) of foundations at different founding level shall be limited to the values as furnished in clause 3.01.02 and any values of net SBC higher than the one indicated shall not be accepted. However, Bidder shall note that the net safe bearing capacity and depth of foundation to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.
- iv. It shall be ensured that all foundations of a particular structure/building/equipment shall rest on one bearing stratum.
- v. The permissible settlement as mentioned under para "permissible settlement of foundations" or permissible settlement from functional requirements which ever more stringent shall be adopted for the design.
- vi. Permissible settlement foundations  
  
The permissible total settlement and differential settlement of foundation resting on soil mass shall be governed by IS: 1904 and from functional requirements whichever is more stringent. However, the total settlement of cooling tower foundation resting on soil shall be restricted to 25mm and to that on rock shall be restricted to 12mm
- vii. Analysis and proportioning of footings to minimize differential settlements shall be carried out for all major foundations and the same shall be submitted for BHEL/owner's approval.
- viii. In case any soft soil/loose stratum is met with at the founding level or below during execution, the same shall be completely removed and filled back with PCC 1(cement):4(sand):8(stone aggregates) up to desired foundation level.
- ix. Expansive soil shall not be used for filling/back filling around foundations

<b>CLIENT : BHARAT HEAVY ELECTRICALS LIMITED</b>												
PROJECT : Geotechnical Investigation For 1 X 700 MW Bellary Thermal Power Station, Unit -3 at Kudathani, Bellary Dist (Karnataka)												
BORE HOLE NO. : BH 43						SHEET NO. : 1 OF 1						
LOCATION : Coolig Tower						DATE : 29/01/2011 TO 11/02/2011						
CO-ORDINATES : S 458.00, E 354.00						METHOD : ROTARY DRILLING						
EXISTING GROUND LEVEL : RL = (+)477.990m.						CASING : 150mm Ø Upto 1.50m Below GL.						
GROUND W. T. : RL = (+) 473.69m (4.30m Below GL.)						NX mm Ø Upto 3.00m Below GL.						

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CR %	RQD %	Other Tests
				DEPTH (m)	TYPE	15	15	15	15				
0.00/	150 mm Ø		Dark greyish, sandy CLAY with gravels	0.00/	DS1								
0.50													
1.00/													
1.45				SPT1	06	09	33	-	42				
2.00/	NX		Medium dense, brownish grey, silty GRAVEL	2.00/									
2.03				SPT2	54	-	-	-	N				
3.00/													
3.01				SPT3	51	-	-	-	R				
4.00/			Completely weathered, greyish, ROCK	4.00/							NIL	NIL	
4.02				SPT4	52	-	-	-	R				
5.00													
6.50													
7.00			Highly to moderately weathered, greyish, GRANITE								70	NIL	
8.00													
9.50													
10.00													
8.00			Moderately to slightly weathered, greyish, GRANITE								73	68	
8.00													
9.50													
10.00													
7.00			Moderately to slightly weathered, greyish, GRANITE								67	57	UCS= 977 Kg/cm <sup>2</sup>
8.00													
9.50													
10.00													
8.00			Moderately to slightly weathered, greyish, GRANITE								83	77	UCS= 426 Kg/cm <sup>2</sup>
9.50													
10.00													
10.00													
9.00			Moderately to slightly weathered, greyish, GRANITE								84	84	
9.50													
10.00													
10.00													

SPT N = STANDARD PENETRATION TEST VALUE		RQD = ROCK QUALITY DESIGNATION		UCS = UNDISTURBED SOIL SAMPLE	
CR = CORE RECOVERY		DS = DISTURBED SOIL SAMPLE		PLI = POINT LOAD INDEX	
				UCS = UNIAxIAL COMPRESSIVE STRENGTH	

REMARKS : BORE HOLE TERMINATED AT DEPTH 10.00m. Below GL.		SCALE : 1: 50	Checked By : Ravi Achari	Drawn By : Sandeep
DBM GEOTECHNICS AND CONSTRUCTIONS PVT. LTD. MUMBAI.		JOB NO. : 2871		

<b>CLIENT : BHARAT HEAVY ELECTRICALS LIMITED</b>													
<b>PROJECT : Geotechnical Investigation For 1 X 700 MW Bellary Thermal Power Station, Unit -3 at Kudathani, Bellary Dist (Karnataka)</b>													
<b>BORE HOLE NO. : BH 44</b>						<b>SHEET NO. : 1 OF 1</b>							
<b>LOCATION : CW Pump House</b>						<b>DATE : 30/01/2011 TO 02/02/2011</b>							
<b>CO-ORDINATES : S 523.00, E 344.00</b>						<b>METHOD : ROTARY DRILLING</b>							
<b>EXISTING GROUND LEVEL : RL =(+ )478.306m.</b>						<b>CASING : 150mm Ø Upto 1.50m Below GL</b>							
<b>GROUND W. T. : RL=(+) 474.006m (4.30m Below GL)</b>						<b>NX mm Ø Upto 2.50m Below GL</b>							
DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CR %	RQD %	Other Tests
				DEPTH (m)	TYPE	15	15	15	15				
1.00	150 mm Ø		Dark greyish, sandy CLAY with gravels	0.00/ 0.50	DS1								
				1.00/		15	15	15	-	N			
2.00			Medium dense, greyish brown, silty SAND with gravels SM	1.45	SPT1	04	06	16	-	22			
				2.00/		15	15	15	-	N			
3.00			Completely weathered, brownish, ROCK	2.45	SPT2	14	23	30	-	53			
				2.50/		02	-	-	-	N			
4.00			Moderately to slightly weathered, greyish, AMPHIBOLITE/ GRANITE	2.52	SPT3	55	-	-	-	R	95	20	
				3.00									
5.00	NX			4.50							93	54	PLI = 138.61 Kg/cm <sup>2</sup>
6.00				6.00							88	73	UCS = 99 Kg/cm <sup>2</sup>
7.00				7.50							89	79	
8.00				8.00							96	84	
9.00													
10.00													
SPT N = STANDARD PENETRATION TEST VALUE      RQD = ROCK QUALITY DESIGNATION      UDS = UNDISTURBED SOIL SAMPLE CR = CORE RECOVERY      DS = DISTURBED SOIL SAMPLE      PLI = POINT LOAD INDEX      UCS = UNIAxIAL COMPRESSIVE STRENGTH													
REMARKS : BORE HOLE TERMINATED AT DEPTH 8.00m. Below GL						SCALE : 1: 50		Checked By :		Drawn By :			
DBM GEOTECHNICS AND CONSTRUCTIONS PVT. LTD. MUMBAI.						JOB NO. : 2871		Ravi Achari		Sandeep			

<b>CLIENT : BHARAT HEAVY ELECTRICALS LIMITED</b>												
<b>PROJECT : Geotechnical Investigation For 1 X 700 MW Bellary Thermal Power Station, Unit -3 at Kudathani, Bellary Dist (Karnataka)</b>												
<b>BORE HOLE NO. : BH 45</b>						<b>SHEET NO. : 1 OF 2</b>						
<b>LOCATION : ACW Pump House</b>						<b>DATE : 21/01/2011 TO 28/01/2011</b>						
<b>CO-ORDINATES : S 578.00, E 299.00</b>						<b>METHOD : ROTARY DRILLING</b>						
<b>EXISTING GROUND LEVEL : RL =(+ )479.295m.</b>						<b>CASING : 150mm Ø Upto 1.50m Below GL.</b>						
<b>GROUND W. T. : RL=(+) 474.006m ( 3.60m Below GL)</b>						<b>NX mm Ø Upto 2.80m Below GL.</b>						

DEPTH (m.)	DIA. OF BORE HOLE	LOG.	STRATA DESCRIPTION	SAMPLE		BLOWS/15cm				SPT N	CR %	RQD %	Other Tests
				DEPTH (m)	TYPE	15	15	15	15				
0.00/	150 mm Ø		Brownish, silty SAND with gravels	0.00/	DS1								
0.50/													
1.00/													
1.45			SPT1	01	05	11	-	16					
2.00/													
2.45			SPT2	07	15	22	-	37					
2.80/				01	-	-	-	N					
2.81			SPT3	53	-	-	-	R	94	40	UCS = 230 Kg/cm <sup>2</sup>		
3.50													
4.00													
5.00													
6.00	NX		Slightly weathered to fresh, greyish, AMPHIBOLITE/GRANITE	6.50						91	78	UCS = 393 Kg/cm <sup>2</sup>	
7.00									93	77			
8.00									93	75			
9.00									87	55			
10.00													

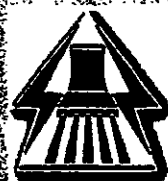
  

SPT N = STANDARD PENETRATION TEST VALUE		RQD = ROCK QUALITY DESIGNATION		UDS = UNDISTURBED SOIL SAMPLE	
CR = CORE RECOVERY		DS = DISTURBED SOIL SAMPLE		PLI = POINT LOAD INDEX	
				UCS = UNIAxIAL COMPRESSIVE STRENGTH	

<b>REMARKS : CONTINUED ON NEXT PAGE.</b>		<b>SCALE : 1: 50</b>	<b>Checked By :</b>	<b>Drawn By :</b>
<b>DBM GEOTECHNICS AND CONSTRUCTIONS PVT. LTD. MUMBAI.</b>		<b>JOB NO. : 2871</b>	<b>Ravi Achari</b>	<b>Sandeep</b>

KARNATAKA POWER CORPORATION LIMITED



BELLARY THERMAL POWER STATION  
1 X 700 MW STAGE III



BID SPECIFICATIONS

VOLUME V

CIVIL WORKS

CHIEF ENGINEER, THERMAL DESIGN

NO. 22/3, SHEELSHADI ROAD

2<sup>ND</sup> FLOOR, SUDARSHAN COMPLEX

BENGALURU 560 009

MAY 2010

**KARNATAKA POWER CORPORATION LIMITED**



**BELLARY THERMAL POWER STATION  
1 X 700 MW , STAGE - III**

**BID SPECIFICATIONS**


**VOLUME - V**

**CIVIL WORKS**

**CHIEF ENGINEER (THERMAL DESIGNS)  
NO.22/23, SHEASHADRI ROAD,  
2<sup>ND</sup> FLOOR, SUDARSHAN COMPLEX  
BENGALURU-560 009**

**MAY 2010**

**001**

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <b>CONTENTS</b>	<b>CONTENTS</b> <b>VOLUME-I TO VI</b>  <b>SHEET 1 OF 1</b>
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## BID SPECIFICATIONS-CONTENTS

### VOLUME - I

SCOPE OF ENQUIRY, INSTRUCTIONS TO  
BIDDERS, BID QUALIFICATION REQUIREMENTS,  
AND GENERAL CONDITIONS OF CONTRACT

### VOLUME - II

SCOPE OF WORKS, TERMINAL POINTS AND  
SCHEDULES

### VOLUME - III

D1 MECHANICAL WORKS

### VOLUME - IV

D2 ELECTRICAL WORKS


D3 INSTRUMENTATION & CONTROL WORKS

### VOLUME - V


D4 CIVIL & STRUCTURAL WORKS

### VOLUME - VI

DRAWINGS

KPCL/BTPS/03/EPC 	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW CONTENTS	CONTENTS VOLUME-V SHEET 1 OF 1
<b>VOLUME- V- CIVIL WORKS CONTENTS</b>		
<b>SUB- SECTION</b>	<b>TITLE</b>	<b>NO. OF PAGES</b>
D 4.1	GENERAL	3
D 4.2	SCOPE OF WORK	2
D 4.3	ADDITIONAL DOCUMENTS TO BE SUBMITTED WITH BID PERTAINING TO CIVIL WORKS	2
D 4.4	DOCUMENTS TO BE SUBMITTED AFTER AWARD OF WORK	2
D 4.5	DESCRIPTION OF BUILDING, STRUCTURE, FACILITIES	28
D 4.6	TECHNICAL SPECIFICATION	
	PART A - GENERAL REQUIREMENT	6
	PART B - LOADS AND LOAD COMBINATIONS	11
	PART C - REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS	10
	PART D - STEEL STRUCTURES	15
	PART E - OUTDOOR CIVIL WORKS	5
	PART F - FINISHES	11
	PART G - COOLING TOWER	13
	PART H - R.C.C. CHIMNEY + DATA SHEET - A	19 + 5
	PART I - CODES, STANDARDS AND REFERENCES	4



<b>KPCL/BTPS/03/EPC</b> 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <hr/> <b>TITLE</b> <b>GENERAL</b>	<b>SECTION: D4.1</b> <b>VOLUME - V</b> <b>SHEET 1 of 3</b>
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1. This specification is to cover design, preparation of general arrangement, construction as well as Fabrication drawings, supply of all labour as well as materials and construction of all civil, structural as well as architectural work on EPC basis for the 1 x 700 MW, Unit 3, Bellary Thermal Power Project being set up at Kudatini village, Bellary District, promoted by M/s Karnataka Power Corporation Limited (KPCL) in the state of Karnataka.
2. Description of various items of work under this contract and nature of work in detail are given hereinafter. The complete work under this scope is referred to as **CIVIL WORKS**. List of various civil works covered under the scope is given in Section D4.2.
3. The work to be performed under this contract consists of design, engineering as well as providing all labour, materials, consumables, equipment, temporary works, temporary labour and staff colony, constructional plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications and including revisions and amendments thereto as may be required during the execution of the work.
4. All materials including cement, reinforcement steel, structural steel etc. shall be arranged by the **BIDDER**.
5. The scope shall also include setting up by the **BIDDER** a complete testing laboratory in the field to carry out all relevant tests as per BIS or other international standards required for the civil works for the project.
6. The work shall be carried out according to the design/drawings to be developed by the **BIDDER** and approved by the **OWNER**. For all buildings and structures, foundations, etc., necessary layout and details are to be developed by the **BIDDER** keeping in view the statutory & functional requirements of the plant & facilities and providing enough space & access for operation, use & maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the **BIDDER's** offer shall cover the complete requirements as per the best prevailing practice and to the complete satisfaction of the **OWNER**.
7. Wherever excavation is to be carried out in the vicinity of existing structures care shall be taken for the safety of the structures by resorting to controlled blasting.
8. **BIDDER** shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials, water etc., and their rates, local working conditions, weather, flood levels, subsoil conditions, natural drainage, etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time. The submission of a bid by the **BIDDER** will be construed as evidence that, such an examination was made and any later claims / disputes in this regard to rates / lumpsum amount quoted shall not be entertained or considered by the **OWNER**.



## 9.0 GEO-TECHNICAL INVESTIGATION

- 9.1 A detailed Geotechnical investigation was carried out at the site during June - July 2008 and the report is available with KPCL. However, this along with the recommendations given in paras 9.2 & 9.3 here below shall be considered by the BIDDER for reference only.

BIDDER is advised to verify the content of the report before submission of Bids. However, the Contractor has to carryout detailed Geotechnical investigation after the award of contract, through some approved / reputed agency and submit Geotechnical investigation report with recommendation for OWNER'S review and approval. The recommendation given in approved final report becomes binding on the contractor. The contractor is not eligible to increase his cost or demand any extension of time because the final report is in variance from earlier report available with KPCL.

### 9.2 (a) Main Plant Area (TG, Boiler & ESP):

Bore holes have been sunk to a maximum depth of about 18.0 m in main plant area. It is observed from these borelogs / soil investigation report that subsoil strata in this site generally consists of top nil to an average depth of 1.5 m / 3.0 m is found to brownish to greyish white medium to fine sandy silt followed by greyish to whitish weathered rock is observed upto an average depth of 4.5 m / 6.0 m depth below to this greyish to whitish soft rock upto 7.5 m depth. Beyond which there is grayish to whitish hard rock encountered upto termination depth. During the time of investigation (ie., June / July 2008) encountered upto termination depth.


### (b) Chimney Area:

One Bore hole has been sunk in this area upto a depth of 8.5 m. The subsoil generally, consists of top nil to an average depth of 1.0 m is found to be brownish clay followed by greyish weathered rock is observed upto 3.0 m depth extends to greyish soft rock is encountered upto 5.0 m depth. Below to this there is blackish grey hard rock upto termination depth. During the time of investigation water table was not encountered upto termination depth.

### (c) ODY Area:

One bore hole has been sunk in the area upto a depth of 7.5 m, subsoil generally, consists of top nil to an average depth of 1.0 m is found to be whitish boulders extends to greyish to whitish hard rock is encountered upto termination depth. During the time of investigation water table was not encountered upto termination depth.

- 9.3 From the preliminary report, it is observed that all major structures like Station building, TG foundation, Boiler foundations, Chimney etc. and all other heavily loaded structures can be founded on Shallow foundation. The shallow foundations may be isolated or combined footings or raft foundation depending upon the type and requirement of structures as well as loads, spacing and construction of columns. Foundation depth can be generally about 2.0 m to 3.0 m below existing ground level. Net safe bearing capacity can be taken as 25 t / m<sup>2</sup>, 33 t / m<sup>2</sup> and 40 t / m<sup>2</sup> at 1.5 m, 3.0 m & 4.5 m depth respectively. For load bearing walls, or filler walls spread foundation can be adopted.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <hr/> TITLE <b>GENERAL</b>	SECTION: D4.1 VOLUME - V SHEET 3 of 3
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## 10.0 SURVEY DATA

The OWNER has carried out a detailed survey of the plant area and drawings indicating the survey detail along with contour are furnished to the BIDDER. The same shall be treated as for reference only. It is the responsibility of the CONTRACTOR, to verify the various features on his own before submission of bid. The OWNER does not take any responsibility for correctness of various features / contour shown on the drawing. The CONTRACTOR is not eligible for any extra cost or any extension of time, if the results from his detailed survey and actual conditions at site are at variance to any extent from the ground levels derived from the drawing furnished by the owner.

11.0 The bid drawing indicating grade levels is based on the preliminary survey work. It is the Contractor's responsibility to fix the grade levels at various locations of the plot considering the following.

- (a) Highest flood level at the site during the last 50 years.  
Based on the catchment area and rainfall, the CONTRACTOR has to compute the HFL. The rainfall data is furnished in Vol-V, section D 4.5, sheet 7 of 42, clause 2.4.1. The catchment area is 2.3 sq.km.
- (b) Efficient disposal of storm water by gravity to the nearest water course even during high water.


The grade levels for different areas shall be as followed for existing Units viz.


- |                        |           |
|------------------------|-----------|
| (a) Main Plant         | RL 476.00 |
| (b) CHP                | RL 476.00 |
| (c) Cooling tower area | RL 476.00 |


## 12.0 STATUTORY REQUIREMENT

CONTRACTOR shall comply with all the applicable statutory rules pertaining to Factory act, Fire safety rule of Tariff Advisory Committee, Water act for Pollution control Board, Explosives act etc. Provisions of Safety, health and welfare according to Factories act shall also be complied with. Statutory clearances and norms of State Pollution Control Board shall be followed. CONTRACTOR shall obtain approval of Civil / Architectural drawings from concerned authorities before taking up the construction work.


13.0 In case the contractor fails to achieve the targeted progress as stipulated due to non-procurement / arrangement of materials like Steel (Reinforcement / Structural), Aggregates, Cement, Centering & shuttering, Machinery, Labour (Skilled / Unskilled) etc., KPCL reserves the right to arrange for the above at the risk and cost of the contractor.

KPCL/BTPS/03/EPC	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	SECTION: D4.2 VOLUME - V SHEET 1 OF 2
	TITLE <b>SCOPE OF WORK</b>	
1.0	<p>The work covered in this section consists of collection of all site related data, conducting site investigations, design, preparation of all construction drawings, supply of all materials, construction, fabrication, erection and testing wherever necessary, of all structures required for housing all equipment and civil works for all services required for Power Plant defined in the bid document. The Civil works shall include those required for Installation, Commissioning, testing, operation and maintenance of the Power Plant. The Scope will cover but not limited to the following buildings / structure / systems / facilities etc. Generally, the buildings /structure/systems/facilities shall match with the existing Units 1 &amp; 2.</p>	
1.01	<p>Site related investigations Topographical Surveying Geo technical investigation</p>	
1.02	<p>Site development works</p> <p>Site clearance wherever required including diversion of existing services: Any modification or diversion of existing nallas is in the scope of the CONTRACTOR, as per the requirement of their layout, with the approval of the owner. The nalla shall be protected in such a way that HFL shall not flood the plant area. The natural course of the nalla shall be maintained to the extent possible and as approved by the OWNER.</p> <p>The site grading shall be carried out by the contractor.</p> <p>Engineering, Construction &amp; overall layout of all Roads including approach roads, drains and cross drainage works in the unit - 3 area shall be carried out by the CONTRACTOR. Temporary roads required for construction purpose and its routine maintenance shall be done by the CONTRACTOR.</p>	
1.03	Construction enabling works	
1.04	Steam Turbine Generator Building.	
1.05	Control Room / Electrical bay structures.	
1.06	Steam Generator / ESP / Duct supporting structures	
1.07	Mill and Bunker building including Bunkers	
1.08	Steam Generator elevator supporting system.	
1.09	ESP Control / Switch Gear Rooms	
1.10	RCC Chimney	
1.11	BTG Island area paving.	
1.12	Transformer Yard structures.	
1.13	Switch Yard	
1.14	Coal handling System	
1.15	Loco shed	
1.16	Ash handling system.	
1.17	Mill Reject handling system.	


KPCL/BTPS/03/EPC	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	<b>SECTION: D4.2</b> <b>VOLUME - V</b> <b>SHEET 2 OF 2</b>
	<b>TITLE</b> <b>SCOPE OF WORK</b>	
<p>1.18 Fuel Oil Pump House.</p> <p>1.19 RO - DM Plant.</p> <p>1.20 Condenser cooling water system.</p> <p>1.21 CW Makeup reserve tank of Capacity 10000 Cum. including pump house and filtration plant</p> <p>1.22 Natural draught Cooling Tower.</p> <p>1.23 Miscellaneous plant Buildings.</p> <p>Air Washer Building.</p> <p>Compressor House.</p> <p>AC plant.</p> <p>Diesel Generator House.</p> <p>Ware House &amp; Chemical /Hazardous Stores.</p> <p>Bull Dozer Shed and Auto repair shop</p> <p>DM make-up pump house</p> <p>1.24 CPU &amp; Neutralising pit</p> <p>Service water overhead tank 750 cum. &amp; Potable water tank of 50 cum.</p> <p>1.25 Effluent Treatment Plant &amp; CMB of 1000 Cum</p> <p>1.26 Pipe &amp; cable Racks.</p> <p>1.27 Railway Track inside maintenance building and ODY.</p> <p>1.28 Any other structures required for completion of the plant.</p> <p>2.0 It is not the intent to specify herein all the works in the scope of this contract. The scope also includes all other buildings, structures and works necessary which are not specifically mentioned here but required for construction, operation and maintenance of the power plant are deemed to be included in the scope of the CONTRACTOR. All works shall conform to the specification. The works shall conform to high standards of design, engineering and workmanship. Design and construction shall conform in every respect to all local and state regulations governing such works and to stipulations of Indian Standards unless stipulated otherwise in detailed specification.</p> <p><b>NOTE:</b> Wherever any component is not included in the list of scope of civil works and / or exclusions and also wherever the details are not furnished in their offer, the CONTRACTOR shall carry out the works as per stipulations.</p>		

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS UNIT-3 OF 700 MW</b> TITLE <b>ADDITIONAL DOCUMENTS TO BE SUBMITTED WITH BID PERTAINING TO CIVIL WORKS</b>	SECTION: D4.3 VOLUME V SHEET 1 OF 2
-------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------

- 1 Suggested plot plan locating all buildings, structures, facilities, roads, temporary site office, etc., with their plan dimensions.
- 2 A study note on proposed site grading with levels along with certified data collected from various agencies on Maximum flood level based on once in 50 years flood etc., to arrive at the same. Also the source of earth to be used as back fill having quality as per specification should be indicated.
- 3 Write-up on proposed storm water drainage system furnishing layout of the drains, types of drains and suggested disposal system.
- 4 Write-up on proposed sewage disposal system for the toilet in various buildings and scheme for usage / disposal of the clear water.
- 5 Write-up on proposed treatment and disposal of effluent / waste water generated in the plant and scheme for usage / disposal of clear water.
- 6 A detailed write - up on Condenser cooling water system along with schematic drawing showing preliminary sizing and details of Cooling towers, channels, forebay and pump house, cold and hot water conduits and the method of construction.
- 7 A detailed write-up on make up water system for the cooling tower blow down, covering, source of water, Intake / withdrawal arrangement, pump houses, conduits along with method of construction.
- 8 A report on foundation proposed for various structures, buildings and facilities based on the data furnished by OWNER and further data collected by the CONTRACTOR. Allowable safe bearing capacity for open foundation, depth of foundation, need for pile foundations, soil improvement if any required, special precaution against aggressive soil etc., shall also be covered in the report.

KPCL/BTPS/03/EPC, 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS UNIT-3 OF 700 MW</b> TITLE <b>ADDITIONAL DOCUMENTS TO BE SUBMITTED WITH BID PERTAINING TO CIVIL WORKS</b>	<b>SECTION: D4.3</b> <b>VOLUME V</b> <b>SHEET 2 OF 2</b>
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- 9 A write-up on dewatering system proposed at the time of construction where deep construction such as for Reclaim hoppers pit / track hopper pit, conveyor tunnels, CW forebay and pump house etc. are to be executed.
- 10 Detail general arrangement / architectural drawings for all buildings and structures showing dimensions, levels, plans, section, elevations, materials proposed, types of framings, wall / cladding, floors, roofs, types of finishes etc.
- 11 Detail design criteria proposed to be adopted for each building, structures, foundations, facilities etc.
- 12 A write - up on the sizing and constructional details of RCC chimney with sketch showing detail of foundations, wind shield and liner along with list of appurtenances.
- 13 List of software proposed to be used in various areas for analysis, design, drafting as well as project monitoring along with their sources and validation report for software.
- 14 List of all sub-contractors that the CONTRACTOR proposes to employ, in case the contract is awarded to him, indicating their addresses with telephone number, experience on similar jobs, name, qualification and experience of persons who shall be employed in the job on behalf of the sub-contractor etc., shall be submitted to the OWNER. Only the Sub-Contractor, approved by OWNER shall be engaged by the CONTRACTOR on the job.
- 15 Details of quality control laboratory with a list of testing equipments shall be furnished.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS.UNIT-3 OF 700 MW</b> TITLE <b>DOCUMENTS TO BE SUBMITTED AFTER THE AWARD OF WORK</b>	SECTION: D4.4 VOLUME V SHEET 1 OF 2
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The following documents are to be submitted for the approval of the OWNER, prior to commencement of fabrication & erection / construction. All drawings shall be of standard sizes (Metric system) and shall be made on AUTOCAD Version 2008/10 and its latest version in executable format.


1. General plant layout drawing with Co-ordinates of roads, boundary wall, watch tower buildings and facilities, piping / cable corridors, pipe and cable trestles, provision of landscaping and green belt development, diversion roads and drains, equipment lay down areas etc.
2. Drawing showing underground facilities with coordinates of these facilities like buried pipes, buried cables, trenches, ducts, sewer, drains, sumps pits, culverts, foundations etc.,
3. Soil investigation report based on additional geotechnical investigation carried out by CONTRACTOR along with foundation recommendation for various buildings/structures/facilities.
4. Topographical survey drawings along with location and details of Bench mark, grid and boundary pillars based on detailed survey conducted after the award of work.
5. Site grading and storm water drainage study furnishing levels of various terraces arrangement and details of drains, culverts etc for storm water drainage system.
6. Study note on disposal of effluent from the plant to satisfy the statutory requirement.
7. Design basis memorandum for all buildings, facilities, services and structures. Separate design memorandum reports shall be submitted for all plant buildings / structures including Power house building, mill building, TG foundation, Fan foundations / other block type foundations etc., Designs shall commence only after approval of memorandum.
8. Architectural floor plans, elevations, cross sections and perspective view in colour of all buildings, shall match with existing units.
9. Design calculations and drawings for foundations / substructure and superstructure of all buildings including pump houses and other structures.
10. Design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundations for TG, BFP, Mill, Fans (PA, FD, ID) etc., Design and drawing of vibration isolation system shall also be furnished.
11. Design calculations and drawings for all facilities and services like roads, culverts, bridges, pavings, road/rail crossings, drainage pump house ( if required), drains, sewers, water supply, water tank, sumps, tunnels, trenches, ducts etc.,
12. Drawings of all architectural works including finishing schedule, colour schemes (both internal and external), doors & windows, flooring and false ceiling etc.,
13. Design calculations and drawings for plumbing and building drainage.



KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS UNIT-3 OF 700 MW</b> TITLE <b>DOCUMENTS TO BE SUBMITTED AFTER THE AWARD OF WORK</b>	SECTION: D4.4 VOLUME V SHEET 2 OF 2
-------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------

14. Design calculations and drawings for switchyard structures, transformer yard, etc.
15. Design calculations and drawings for structures pertaining to Cooling Water System.
16. Design calculations and drawings for civil structures/works associated with fuel oil handling system, ash handling system, coal handling system etc.
17. All other designs, details/drawings or any other submissions as indicated elsewhere in this specification and as required by the OWNER.
18. Details of corrosion protection measures for all structures.
19. Total quantity of concrete (grade wise), reinforcement steel (diameter wise) and structural steel (section wise) shall be indicated in all construction drawings.
20. All design and drawings for the Cooling tower basin supports etc.
21. All design and drawings for RCC chimney.
22. All design calculations and drawings for Boiler and ESP structures.
23. Shop drawings/fabrications of all structural steel works (only for reference) and design calculations for important joint connections. Designs for structural steel connections and detailed fabrication drawings to be furnished before commencement of work.
24. Construction and erection procedure for all major structure with specific reference to main plant building, bunker structures, transfer towers, conveyor galleries, TG foundation and other machine foundations.
25. Write-up on various statutory requirements and their compliance for various buildings and facilities.
26. Quality assurance and Quality Control procedures.
27. Copies of all reports on investigation and studies carried out by the CONTRACTOR as per the scope.
28. Soft copies of all design calculation and drawings shall be submitted for records after approval of the OWNER.
29. Soft copy (executable files) of all STAAD-PRO (or other software) packages and excel files used for analysis & design shall be submitted. Also typical hand calculations to validate the computer generated calculations shall be furnished.
30. Standard notes and details for RCC and Structural Steel works.

KPC/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <b>TITLE</b> <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 1 of 28</b>
------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------


### DESCRIPTION OF BUILDING, STRUCTURES AND FACILITIES

Following structures / buildings / areas / facilities are to be included in the contract. The description against each building / system is indicative only and not exhaustive. Although almost all the systems are covered here, but any other system (Civil, Structural and Architectural) required for successful completion of the project shall form a part of this contract and shall be deemed to be included in the scope of works.

#### 1.0 SITE RELATED INVESTIGATION

##### 1.1 Topographical surveying

- 1.1.1 Precision Surveying shall be carried out under the direction and control of a Licensed Land Surveyor. Precision theodolites shall be of one second accuracy. Self-aligning levels shall be used for precision level survey. All Bench Mark ( BM ) levels of the survey shall be established with reference to the nearest GTS bench mark available. Precision levelling shall be carried out for establishing the BM at site by carrying levels from GTS BM adopting double circuit levelling.
- 1.1.2 All boundary lines shall be located with their distances, included angle and bearings and boundary pillars constructed. Number of pillars shall be adequate to mark the boundary limits without any dispute. A closed traverse survey shall be carried out with theodolite to form the framework for the detailed survey work.
- 1.1.3 Two reference lines, North-South line and East-West line at right angles to each other shall be established with grid pillars constructed at 100 metres c/c in both directions in such a way that these pillars will not be disturbed during construction. Coordinates shall be painted on these grid pillars. Pillars shall also be painted using synthetic enamel paint for easy identification. Bench mark pillars shall be provided atleast at 6 locations. These pillars shall be properly protected to prevent their disturbance during construction activities. BM shall be distinguished from grid pillars with different type of painting.
- 1.1.4 Spot levels shall be taken in a grid of 5 metres and contours shall be established at an interval of 500 mm depending on the terrain. All Contour levels shall be with respect to MSL.
- 1.1.5 The survey map should identify all topographical features such as but not limited to buildings, structures, burial grounds, wells, natural drains, roads, footpaths, depressions, rock outcrops, underground sources, overhead transmission lines, telephone lines or any other obstruction, trees and prominent vegetation. In addition, all wet land and marshy stretches shall also be identified. CONTRACTOR shall prepare contour map to a scale of 1 in 1000 in AutoCAD. In addition, CONTRACTOR shall prepare LS and CS of the site at suitable intervals to adequately represent actual topography. For natural drains and other water courses, sections at closer intervals shall be provided. Since the northern part of site is situated close to Thungabhadra high level canal, Maximum Water Level occurring once in 50 years shall be clearly marked in the contour plan.
- 1.1.6 CONTRACTOR shall furnish one soft copy in executable format along with six hard copies of all survey drawings to the OWNER for his reference.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 2 of 28</b>
-------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------

### 1.1.7 Geo-technical Investigations

Detailed geo-technical investigation to verify the results of the preliminary investigation carried out by KPCL shall be carried out by the CONTRACTOR. Based on the plot plan developed, the CONTRACTOR shall identify proposed borehole locations and obtain the approval of OWNER prior to commencing the investigation. In the power block, bore holes shall be provided and spread judiciously to cover all major building as well as equipment foundations. Generally, a grid of 50 metres c/c both ways is recommended from Chimney to end of Switchyard. For major structures boreholes shall be provided at closer intervals. In the offsite areas also it shall be ensured that the boreholes are provided near all major structures.

#### 1.2.1 Following field tests shall be conducted:

- (i) Boreholes
- (ii) Static Plate load tests
- (iii) Cyclic Plate load test
- (iv) Field Permeability tests
- (v) Field Density tests
- (vi) Vane Shear tests
- (vii) Static Cone Penetration tests
- (viii) Electric resistivity tests.
- (ix) Seismic Refraction Test.
- (x) Dynamic Cone Penetration tests.
- (xi) Trial Pits

1.2.2 Boreholes shall be located to cover the entire area. All boreholes shall be sunk up to a depth of 18.0 m or 5 m continuous into hard rock whichever is earlier in areas of TG foundation, Bowl mill, Cooling tower and Chimney. In other areas, boreholes shall be sunk upto a depth of 15.0 m or 3 m continuous into hard rock whichever is earlier.


1.2.3 Standard penetration tests (SPT) and collection of undisturbed soil samples (UDS) shall be carried out alternatively at 1.0m intervals and at significant change of strata. The interval shall be increased to 1.5m below 5m depth of boring. UDS shall be replaced by SPT in cohesionless strata. Even in highly weathered / disintegrated rock, where core recovery is poor, SPT shall be conducted. The first SPT in any borehole shall be conducted at 1m depth.

1.2.4 In rock strata, core recovery and Rock Quality Designation (RQD) shall be noted carefully for each run, immediately after cores are taken out of barrel.

1.2.5 During boring, the level at which groundwater is struck shall be carefully noted. Groundwater samples shall be collected for chemical analysis. Boring shall be carried out without the use of water or drilling mud up to the depth of ground water table.

#### 1.2.6 Following laboratory tests shall be conducted:


- (i) Grain size analysis
  - a) Hydrometer analysis
  - b) Sieve analysis

<b>KPCL/BTPS/03/EPC</b> 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <b>TITLE</b> <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 3 of 28</b>
--------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------

- (ii) Field Density and Moisture Content
- (iii) Specific Gravity
- (iv) Chemical Analysis of soil and Ground water including Sulphates, Chlorides, pH value, etc.
- (v) Chemical Analysis of 2:1, Water: Soil extract of the samples giving SO<sub>2</sub> content.
- (vi) Consistency Index : Liquid Limit, Plastic Limit, Plasticity Index, Shrinkage Limit and Shrinkage ratio.
- (vii) Consolidation test giving all relevant information.
- (viii) Swelling pressure and free swell index for expansive soils.
- (ix) Unconfined Compressive Strength on undisturbed soil samples
- (x) Direct Shear Test
- (xi) Triaxial Compressive Strength Tests:
  - (a) Unconsolidated Undrained Test
  - (b) Consolidated Undrained Test
  - (c) Consolidated Drained Test
- (xii) Moisture-density relations for Standard Proctor and Modified Proctor tests.
- (xiii) Crushing Strength of rock on specimens of NX size.

**1.2.7 The soil investigation report shall necessarily include but not be limited to the following information.**

- a) Recommended types of foundation.
- b) Allowable safe bearing capacities and settlement values in different strata for shallow foundations indicating relevant design criteria adopted, method of analysis adopted etc.
- c) Recommendations for values for modulus of subgrade reaction for foundation design by elastic method.
- d) Type of cement to be used for concrete substructures and in stone masonry foundations with reference to the chemical nature of subsoil and ground water.
- e) Recommendations regarding excavations (shallow & deep), embankment, Safe side slopes for excavation and embankment, dewatering, site drainage, etc.
- f) Recommended soil properties such as density, specific gravity, cohesion, angle of internal friction etc. for design.
- g) Precautions to be taken for design of lightly loaded structures when expansive soil is encountered with respect to swelling pressure and free swell index values obtained.

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED	SECTION D4.5
	BELLARY TPS, UNIT-3 OF 700 MW	VOLUME V SHEET 4 of 28
TITLE	DESCRIPTION OF BUILDINGS, STRUCTURES & FACILITIES	

**1.3 Hydrological Survey for development of nalla**

**1.3.1** Hydrological survey is mainly to be carried to find out the availability of ground water for extraction through tube wells in any area. The hydrological survey for any subsurface water source will generally cover any one or more of the following:

- a) Geological investigation
- b) Auger holes
- c) Slug tests and pump tests

**1.3.2** The actual investigation may be preceded by a reconnaissance survey of the area by an expert hydro-geologist to decide the type of investigations. For geophysical investigations, direct current electrical resistivity method is normally employed. Vertical electrical sounding and horizontal profiling are to be carried out as part of investigations to find out information on the succession of different conducting zones and their thickness. Wherever possible auger holes and slug tests / pumps to be carried out to find out properties of the water bearing strata. On the basis of hydro-geological investigations, aquifer characteristics like average thickness of strata, permeability, transmissivity and properties of the material like grain size etc is arrived at. Based on this data the type of development shall be decided and the yield shall be estimated. The contractor shall base his Engineering for various components of the plant in their scope on such field survey data. The Contractor shall also be responsible for (structural or otherwise like flooding etc.,) all the structures in their scope.

**2.0 SITE DEVELOPMENT WORK**

**2.1 Site clearance**

**2.1.1** The plant and building areas in the site shall be cleared of all trees, shrubs or other vegetation, rubbish, slush etc and other objectionable matters. If any roots or stumps of trees are met during excavation, they shall also be removed. Where earth fill is intended, the area shall be stripped of all loose / soft patches, BC soil or top soil containing objectionable matter before filling commences. Any structure or services existing at the site shall be removed / re-routed with the permission of the OWNER. Existing wells, pits, marshy areas etc., shall be filled up with earth of approved quality.

**2.1.2** The CONTRACTOR shall be deemed to have visited and carefully examined the site and surroundings and to have satisfied himself about the nature of the existing structures, underground services, general site conditions, the site for disposal of surplus materials, debris etc., (The useful and non-useful surplus materials out of site grading / excavation shall be dumped in their respective specified dump areas) and all other items affecting the work. Claims due to ignorance of site conditions will not be considered after submission of the Bid.

**2.1.3** The unusable materials obtained from the excavation of all components of unit 3, shall be disposed off to the dump area to be identified outside the BTPS Complex.



TITLE

DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES

## 2.2. Site grading

2.2.1 Based on the detailed topographical survey conducted at site by the CONTRACTOR, duly taking into account information collected he shall conduct a study on the site grading. The preliminary objective of the study shall be

- (a) To ensure that the grade level of all important buildings / facilities are kept above the highest flood levels.
- (b) Storm water can be drained by gravity even during normal high water level in the river / water course.

2.2.2 In order to optimise the use of locally available earth, the CONTRACTOR may consider terraced grading, provided the above two objectives are achieved. Fills shall normally be made up of Cohesive Non Swelling material capable of being compacted up to 95% Modified Proctor density. Filling may also be made using dredged sand in which case a relative density of 85% shall be achieved. In case earth has to be borrowed from outside the plant boundary, the same shall be arranged by the CONTRACTOR himself. Earth from Swamps, marshy as well as logs, expansive type of clays, peats, organic material, material susceptible for combustion, material which will react with other material already used in work shall not be used as borrow material. A minimum side slope of 1 vertical: 2 horizontal shall be maintained at all slopes.

2.2.3 Slopes shall be provided with proper protection to prevent erosion.


2.2.4 The grade levels for the areas shall generally be 476.00 for Main plant/ switchyard / Cooling tower area and coal handling area.

## 2.3 Roads, Drains and Culverts:

2.3.1 Access roads and vehicular parking areas shall be of flexible pavement type with Wet Mix Macadam base and bituminous topping on prepared surface.

2.3.2 The roads shall be designed to cater to the loads and needs of construction and maintenance of heavy trucks carrying machinery and heavy cranes. All roads providing access to buildings / structures / systems requiring maintenance by vehicles shall be 7.50 m wide. All other minor roads shall be 4 m wide. 1500 mm wide road shoulder shall be provided on either side of all two lane roads with appropriate topping and 750mm wide road shoulder shall be provided on either side of all single lane roads..

2.3.3. Wet Mix macadam base with bituminous topping shall be provided in areas requiring parking facilities. Bituminous topping of all plant roads and parking areas shall preferably be taken up after construction of the plant is completed. On either side of the roads, open drains shall be provided. Minimum clear width of the drain shall be 600 mm. The drains shall be designed using RCC. Drainage lines and other under ground services shall be located at least 1 m clear from the edge of the road. All service and utility lines crossing the roads shall be taken up through NP3 class RCC pipe designed for impact loading. Culvert shall also be generally using NP3 class pipe. In case the diameter of the pipe required is more than 600 mm, cast-in-place RCC box culverts shall be provided.

KPCL/BTPS/03/EPC 	KARNATAKA POWER CORPORATION LIMITED <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	SECTION D4.5 VOLUME V SHEET 6 of 28
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#### 2.4. Storm water drainage:

2.4.1 The drainage system shall be designed for a maximum hourly rainfall of 70 mm. Run off coefficient for paved and unpaved areas shall be taken as 0.9 and 0.6 respectively.

2.4.2 Storm water drainage system for non-plant area shall be designed in two parts.

(i) Main drains

(ii) Auxiliary drains

Main drains shall be designed as a network covering total plant area and shall ultimately be led to nearest natural Nalla. Auxiliary / branch drains shall cover individual graded terraces to collect discharge from plant buildings and shall connect to main drain at suitable locations.

2.4.3 Drainage for plant effluent and storm water shall be carried by gravity. The drains shall generally be open type and constructed of RCC. RCC pipe culverts / box culverts shall carry drainage under roads.

2.4.4 At places where covered drainage system is required, channels with removable cover shall be preferred to piping system, as piped system tend to get blocked. Underground storm water piping shall be restricted strictly to areas where surface drains are not desirable or practicable from functional point of view.

2.4.5 Drainage shall be provided where necessary to prevent ponding and ground erosion and to carry surface water away from building, structures and other works including roads, building or equipment foundations.

2.4.6 The storm water drainage for the contaminated area such as coal stack pile etc., shall be designed separately and the discharge shall be led separately for treatment and disposal.

#### 2.5 Sewage / Waste water drainage

2.5.1 For plant area sanitary sewage disposal, the proposal of the CONTRACTOR, to suitably convey the effluent from various building blocks to the existing combined sewage treatment plant directly. For areas where it is not feasible to connect to sewage Treatment plant, separate septic tanks shall be provided with the approval of the OWNER. The treated effluent shall conform to the requirements of Pollution Control Board.

2.5.2 Waste water generated from the plant and Canteen waste water shall be treated in sewage treatment system. The treated effluent shall be used for watering the trees and maintenance of green belt area. Provision shall also be made for collection and disposal of solid waste. Generally, salt glazed stone ware pipes shall be used to carry sewage / waste water where pipes are laid in original ground. Where pipes are to be laid on filled up soil or below roads / paved areas Cast iron pipes shall be used. They shall be encased in concrete at road crossings. Manholes shall be provided at junctions and at points of change of



TITLE

DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES

direction. In straight stretches manhole shall be provided at a maximum spacing of 30metres.

### 3.0 CONSTRUCTION ENABLING WORKS

#### 3.1 Construction water:

The Construction water will be arranged by the owner free of cost at ground level reservoir within the plant area. Arrangements for drawing the water from ground level reservoir and distribution of pipe line network for various locations as required shall be arranged by the Contractor at his own cost. In case of shortage of water, the Contractor has to make alternative arrangements at his own cost.

#### 3.2 Temporary site building

The CONTRACTOR shall provide for, at his cost, the following building facilities for proper execution and quality control of the job, while meeting the provisions stipulated by Factory Rules regarding staff welfare facilities. All these buildings shall have brick cladding, AC sheet roofing over steel roof truss with cement concrete flooring and false ceiling with A/C as required. The facilities indicated are only for CONTRACTOR's use.

##### 3.2.1 Stores

A covered store shall be provided with brick cladding and AC/GI/colour coated sheeting to store at least one-month requirement of cement by the CONTRACTOR. Cement in bags shall be stored on a raised floor well away from outer walls and insulated from the floor to avoid moisture as per codal provisions. Not more than 15 bags shall be stacked in any tier. Each consignment of cement shall be stored separately and consumed in its order of receipt.

3.2.2 Covered storage area may also be provided to store other construction material, which will be affected on exposure to wind, sun and rain.

3.2.3 Reinforcement shall be stacked on top of timber sleepers to avoid contact with ground / water.

3.2.4 Storage yard paved or unpaved shall be provided within the stores complex for storage of other materials.

3.2.5 Proper fencing and security arrangement shall be provided for the stores complex.


#### 3.3 Temporary Workshop and Garage

The CONTRACTOR shall provide a temporary workshop and garage to attend to routine maintenance and repair of the construction equipment as well as fleet of vehicles used for construction activities.

#### 3.4 Fabrication yard

Depending on the extent of fabrication envisaged at site, the CONTRACTOR shall establish a full fledged structural fabrication yard with adequate handling facility during and after the fabrication. A fully equipped testing laboratory providing



KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION D4.5 VOLUME V
	TITLE DESCRIPTION OF BUILDINGS, STRUCTURES & FACILITIES	SHEET 8 of 28

radiography, ultrasonic, dye penetration, magnetic particle test facilities shall be ensured adjacent to the fabrication yard to enforce strict quality control. Portion of the yard shall have covered shed with H.O.T / E.O.T cranes, so that, fabrication work can proceed even during inclement weather.

### 3.5.1 Quality control laboratory

A fully equipped quality control laboratory shall be established at site with qualified personnel to conduct acceptance test on all construction material, weldments, concrete cubes etc. This laboratory shall be housed in a covered building with A/C facility as required by the testing facility. All testing equipment shall be periodically calibrated to the satisfaction of the OWNER. All the sampling and testing shall be done in the presence of OWNER's representative and the contractors shall abide by the observations of owners representative and rectification as suggested shall be effected. The owner shall have the right to carryout such tests independently, as and when so desired by the owner.

### 3.5.2 Fuel storage area

CONTRACTOR shall obtain necessary permission from competent authorities and establish and operate a POL outlet with proper storage, dispensing and adequate fire fighting facility.

### 3.7 Staff Welfare facility

3.7.1 CONTRACTOR shall provide adequate facility for his staff inside the plant boundary, such as, Toilets for both gents and ladies, Canteens, drinking water facility, rest places, Dispensary, creches etc.


3.7.2 Necessary approach roads to the construction facility complex and internal roads within the complex as well as proper drainage of the area shall be the CONTRACTOR's responsibility. He shall also provide for proper disposal of sewage and other wastewater to meet with the requirement of Pollution Control Board.


3.7.2 CONTRACTOR shall identify sufficient area outside the plant boundary to locate his staff and labour colony. Construction and maintenance including insurance of the staff and labour colony to satisfy all statutory requirement is the sole responsibility of the CONTRACTOR.

### 4.0 STEAM TURBINE GENERATOR BUILDING

4.1 Turbine building (TG Bay and Heater Bay) framing shall be of structural steel with moment connected framing in the transverse direction and bracing in the longitudinal direction.

4.2 Service and maintenance bays shall not have any intermediate floors, however a 1500 mm wide observation gallery with hand rails shall be given along the wall at the operating floor level to observe the TG erection operation. Intermediate floors shall preferably be provided at 8.50 m and operating floor at 17.0 m. Floor at 8.50 m and operating level shall be RCC floors over steel framing, whereas the floor at any other level, as required, may have chequered plate / gratings supported on structural steel frame work.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <hr/> <b>TITLE</b> <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 9 of 28</b>
<p>4.3 Crane capacity and crane rail level shall be fixed based on the equipment to be lifted and the method of lifting generator stator. At crane girder top flange level a crane walkway shall be provided in line with Factory rules. Access shall be provided to crane walkway through staircase from operating floor in addition to cage ladder at two ends. Bottom level of roof framing shall be decided by the crane clearance required, duly taking into account clearance required for mounting light fixtures. All other requirements of Crane shall be as outlined in Mechanical section of the document.</p> <p>4.4 Roofing shall consist of in-situ RCC slab of minimum 50 mm thickness laid to a slope of 1 in 100, constructed over permanently colour coated galvanised M.S. troughed metal sheet of approved profile supported on steel purlins and trusses. Roof of Heater bay shall be of RCC slab over the steel roof beams. Over the TG Bay roof, monitor shall be provided with Exhaust system mounted on the side wall of the monitor. Sidewall at location of exhaust fan shall be of brickwork supported on the steel beam. Roof of the monitor shall be of RCC over steel beams. Side cladding and end cladding of monitor shall be of translucent sheets except in areas where fans are mounted.</p> <p>4.5 Cladding shall be of brickwall / concrete block supported on concrete encased steel wall beams, upto a height of 3000 mm above operating floor level on the transformer side. For Gable ends Cladding shall be of brickwall / concrete block supported on concrete encased steel wall beams upto operating floor level. Above the operating floor level structural glazing shall be provided. Walls in front of transformers shall be of adequate thickness to satisfy "fire rating" as per TAC regulations. On the Heater bay side the brickwall shall be provided upto 1 m above de-aerator floor level. Cladding beyond the above level shall be that of permanent colour coated sandwiched insulated metal cladding system.</p> <p>4.6 Windows shall be side-hung, steel glazed using 6 mm thick wired glass generally. However, in areas where cladding is of sheeting, fixed glazing in anodized aluminium frame work and in accessible areas sliding windows of anodized aluminium frame work using 6 mm thick wired glass shall be provided. All the doors on external walls shall be of double plate flush steel doors. For equipment entry into the service bay specially designed steel sliding cum folding / rolling shutters shall be provided with appropriate operating mechanism. Rolling shutter shall also be provided in front of condenser to facilitate tube removal.</p> <p>4.7 Staircases protected on all sides with fire proof enclosure shall be provided to satisfy Tariff Advisory Committee regulations. All the doors leading to the inside of the power house from staircase shall be automatically closing fire proof door satisfying TAC regulations. Access cage ladders shall be given to T.G building roof.</p> <p>4.8 Roof shall be provided with Elastomeric liquid membrane treatment. To protect the liquid membrane, screed of min 25 mm thick shall be provided. HDPE rain water pipe of min 150 dia OD conforming to IS: 4985 shall be provided to drain off the rain water from roof. They shall be suitably concealed from the facade.</p> <p>4.9 Thickness of structural RCC floor shall be minimum 150 mm above the steel floor beams for the intermediate floors with an additional 50 mm floor finish which shall be provided later.</p>		


KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION D4.5
	TITLE DESCRIPTION OF BUILDINGS, STRUCTURES & FACILITIES	VOLUME V SHEET 10 of 28

All the intermediate floors shall be provided with proper drainage. Catch pit with C.I grills shall be provided near the internal column in a regular pattern and the floor shall be sloped towards the catch pit by varying the thickness of the bedding concrete for the floor finish. Catch pits shall be at the same co-ordinate for all floor levels. 80 NB galvanised M.S pipes conforming to IS:1239 shall be provided to carry the drainage down. The pipes shall be clamped on to the intermediate column. Sumps shall be provided in ground floor to receive the water. Proper drainage arrangement shall be provided in the ground floor by means of RCC gravity channels with M.S grills on top. The drainage shall be led to sumps from where the water shall be pumped to plant drainage arrangement. Around equipment liable to frequent drainage, concrete kerb shall be provided to isolate the area and water shall be led through sump and channels to the floor drainage system. Oil water separator should be provided as required to isolate oil from the drainage water where the water is mixed with oil.

- 4.10 In operating floor the design live load shall be painted on the floors prominently showing the extent of the area where such loading is permitted.
- 4.11 Wherever openings are provided in the floor for handling of equipment using EOT crane, such openings shall be covered with gratings provided over removable steel beams.
- 4.12 Expansion joint shall be provided in the building to satisfy the requirements of IS:800 and IS:3414.
- 4.13 Foundations for major equipment like Turbo-generator and Boiler feed pumps shall be mounted on properly designed vibration isolator system. However, the foundation shall be isolated from the building frame work.

#### 5.0 CONTROL ROOM / ELECTRICAL BAY STRUCTURES

- 5.1 The building framing shall be structural steel with moment connection in the transverse direction and bracing in longitudinal direction located by the side of turbine building. It shall be ensured that, in front of control room no cross bracing is provided.
- 5.2 This building shall have minimum five floors. Ground floor houses cable vault, first floor houses LT and HT Switchgear, second floor again houses cable vault, third floor houses control room, electronic cubicle room and UPS room and fourth floor accommodates AC plant room, APRDS, Battery room and with roof above.
- 5.3 A minimum headroom of 2200 mm shall be given in the cable vaults. In control room false ceiling level shall be kept at 3500 mm above the floor level.
- 5.4 All floors shall be of in-situ RCC slab, provided over structural steel frame work.. Minimum thickness of structural concrete shall be 150 mm with an additional 50 mm provided for finish. Roof shall also be of in-situ concrete laid over permanent shuttering, but the concrete shall be given a slope of min 1 in 100 to effect proper drainage. No openings will be permitted on the roof of control room excepting possibly opening for A/C duct to exercise proper control on air conditioning. No openings will be permitted on the roof also, as this will interfere with effective water proofing.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 11 of 28</b>
-------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------

5.5 Cladding shall be of brickwall. Windows for Switchgear room and control room / electronic cubicle room will not normally be allowed on the Boiler side to avoid coal dust nuisance. Walls shall normally be supported on wall / floor beams. If wall beams cannot be avoided, they shall preferably be given at the level of floor beams and shall be encased in concrete.

5.6 Portion of the structural steel column projecting into the room shall be encased with brick masonry to shield it from fire hazards. Cable Vault in ground and second floor shall be provided with minimum 2 doors per unit. The doors shall be flush steel doors. No windows shall be provided on the turbine bay side.

5.7 Switchgear room shall be provided with minimum two steel doors to satisfy statutory requirement. In addition, a two leaf sliding doors of flush welded steel construction shall be provided to move the switchgears into the room making use of equipment lifting hatch provided in turbine building.

5.8.1 Main entrance to control room shall be provided with air locked lobby with automatic closing sliding glass doors. Lobby shall be formed of anodised aluminium framing with toughened sheet glass 6 mm thick. Partition between control room and adjoining rooms shall be of glazed aluminium partition. All the doors shall be single leaf glazed aluminium doors for all cabins. For movement of panels, suitably sized double leaf aluminium glazed doors shall be provided. Control room wall upto the false ceiling level shall be of aluminium glazed partition on either side of air lock. In other area cladding shall be of brick wall. UPS room shall be provided with brick cladding around to reduce sound nuisance. The Civil & Architectural features / aspects for lighting system, identical to existing Units, shall be provided for unit control room.


Battery room shall be provided with PVC doors in PVC framing. For Air washer room, steel doors shall be used which shall be airtight. No window shall be provided in Air washer room.

5.9 Staircase properly enclosed to satisfy TAC regulations shall be provided at either ends of each unit. All doors leading to staircase shall be automatic closing fireproof doors. Staircase shall not be provided around the passenger lift. Staircase shall extend upto the roof. Toilets shall be provided at the switchgear room level and control room level. Toilet floors shall be sunk and shaft shall be provided to route the soil pipe. Sunken floor shall be provided with damp proofing treatment.

5.10 Control room and electronic cubicle room are to be provided with false ceiling. False ceiling shall be designed aesthetically, properly arranging supply air diffuser, return air grill, fire protection sprinklers and light fittings. Aluminium ceiling system shall be provided. Under deck insulation shall be provided on the ceiling, on the walls and beams above false ceiling. Under deck insulation shall be provided for Air washer room also.

Roof shall be given a fall of about 300 mm for proper drainage. Elastomeric liquid membrane treatment shall be provided over the roof as in the case of TG building.

5.11 Floor above control room where APRDS and other pipes are located as well as floor below the de-aerator area shall be provided with proper drains to prevent any

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION D4.5
	TITLE DESCRIPTION OF BUILDINGS, STRUCTURES & FACILITIES	VOLUME V SHEET 12 of 28

accumulation of water. This is very important to prevent seepage of water into the control room.

- 5.12 All openings in floor for Switchgear and other panels shall be sealed with fireproof material after cables are connected. Adequately designed RCC storm water drains shall be provided to lead the roof drainage on to the plant drainage system. These drains shall have pre-cast RCC slotted cover. Plinth protection shall be given on the side of the drain upto the brick wall.


#### 6.0 STEAM GENERATOR/ESP/DUCT SUPPORTING STRUCTURE


- 6.1 Criteria for designing the steel structure are described elsewhere in this section. Roof shall be covered with permanently colour coated galvanised MS trough sheet of approved profile having a minimum of 0.8 mm base metal thickness. Proper drainage of the roof shall be provided for by means of gutters and down -corner (water) pipes. Down corner pipe shall conform to IS. 4985

- 6.2 Side cladding shall be of permanent colour coated non- insulated metal cladding as per clause No.3.2, part F- Finishes. Extent of cladding has been described elsewhere in the specification. Types of foundation for the structures are covered under separate section based on the subsoil condition and recommendations based on detailed geo-technical investigations. In addition to foundations for structures other major equipment foundation in the area are those for Primary Air fan, Forced draft fan and Induced draft fan. The above foundation shall be designed with vibration Isolator system.

#### 7.0 MILL AND BUNKER BAY BUILDING


- 7.1 The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coal bunkers, coal feeders and tripper arrangement to feed the coal into coal bunkers.
- 7.2 The bunker shall be circular in plan and shall have the capacity as per the requirement of steam generator. A comprehensive flowability study shall be conducted by the CONTRACTOR for the coal bunker hopper to ensure smooth flow of coal in all seasons with different moisture contents and different percentage of fines. Geometric parameter of hopper and lining material shall be decided considering the findings of flowability study. However, minimum 8mm thick SS liner over the skin plate shall be provided. For the cylindrical portion of the bunker, MS skin plate of minimum 12mm thick shall be provided.
- 7.3 Mills are to be located on the ground floor. Mill foundations are to be designed with vibration isolation system. In addition to Mill foundations, provision has to be made in the Mill bay ground floor for trenches accommodating Mill reject conveyors.
- 7.4 A Mill maintenance platform shall be provided at appropriate elevation to attend to routine maintenance. This shall be a platform with chequered plate over steel framing with handrails around. Above this floor a framing shall be provided to support under slung crane used for handling mill maintenance work. The crane runaway girders shall extend to the full length of Mill bay to enable approach to the service bay also.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 13 of 28</b>
<p>7.5 Above this framing, feeder floor is provided. The extent of the feeder floor shall be decided by the CONTRACTOR based on his maintenance requirements. Feeder floor shall be of RCC supported on structural steel framework. Handrails shall be provided on all the sides. A steel staircase shall be provided for access to feeder floor from ground floor.</p> <p>7.6 Frameworks for supporting the circular bunker are provided above the feeder floor based on geometry of the hopper.</p> <p>7.7 Bunker shall be provided with a top steel cover with slit openings for entry of coal. On sides of the bunker necessary openings shall have to be provided for bunker ventilation / dust extraction.</p> <p>7.8 Tripper floor is immediately above the bunker. This floor is of RCC supported on structural steel framework.</p> <p>7.9 Tripper roof shall be of RCC supported on structural steel framework. A fall of about 300 mm is given for the roof framing to effect proper drainage. Tripper roof supports bunker ventilation / dust supporting structure. An RCC parapet or steel handrail shall be provided for the tripper roof. An access stair / ladder shall be provided from tripper floor to roof in each unit.</p> <p>7.10 In addition to the above, framing arrangement for structural steel platform at various levels around the bunker shall be provided with proper access ladder, for poking, striking and attending to air cannons.</p> <p>7.11 Tripper floor and roof shall be given access through Boiler staircase / Elevators.</p> <p>7.12 Bunker supporting structure is normally left un-cladded upto the bottom of tripper floor. For tripper floor upto 3000 mm above finished tripper floor level, brick wall shall be provided. Above this level permanent colour coated non- insulated metal cladding as per clause No.3.2, Part F- finishes, cladding shall be provided. Fixed steel windows with 6 mm thick wired glass shall be provided in the tripper house as per requirements for conveyor gallery.</p> <p>7.13 Roof slab will be sloped to one side to permit easy drainage. Liquid membrane water proofing treatment is to be provided. As the roof is accessible and maintenance crew is likely to work on this floor, the entire roof shall be provided with min 50 mm thick screed concrete over the water proofing treatment.</p> <p>7.14 Rain water down-comer pipes of galvanised MS conforming to class- 'medium' of IS: 1239 shall be provided.</p> <p>7.15 All structural steel work shall be given two coats of primer and minimum 2 coats of synthetic enamel paint of approved brand and shade. All exposed gratings and handrails shall be galvanised. Expansion joint shall be provided in the structure as required by IS: 800.</p> <p>8.0 <b>STEAM GENERATOR ELEVATOR SUPPORTING STRUCTURE</b></p> <p>8.1 Capacity and number of the elevator shall be as shown elsewhere. (Vol-II, Section-C1) The elevator supporting structure shall be of structural steel braced in both directions. Plan bracings are provided at all the landing locations. Where</p>		


KPCL/BTPS/03/EPG 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> VOLUME V. SHEET 14 of 28
-------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------

landing locations are far apart, plan bracings shall be considered at least at every 8 m centres.

- 8.2 Elevator shaft shall be constructed with colour coated insulated metal cladding system supported on structural steel work. Lift pit shall be of RCC construction. Ground floor entry shall be kept about 500 mm above general graded / paved level with a ramp for approach. A sump for drainage and Aluminium ladder shall be provided in the lift pit.
- 8.3 Machine room floor shall be of RCC, with 300mm kerb wall around. Roof also shall be that of RCC construction with permanently colour coated galvanised MS trough metal sheet decking. Roof shall be sloped to one side for drainage purpose.
- 8.4 Side cladding shall be of insulated type as specified for lift cage. Adequate windows shall be provided for admitting natural light. Adequate / designed monorail with equipment hatch in the machine room floor shall be provided to lift heavy machinery. Steel staircase shall be given to the M/C room from last landing. Landing levels are generally governed by the floor levels in the Boiler structure. In addition, landing shall be provided at feeder floor and tripper floor levels. Structural steel gallery shall be provided from the elevator-landing platform to these floors.
- 8.5 Windows in the M/C room shall be of steel glazed type using 6 mm thick wired glass. Doors shall be of flush welded hollow steel type. All structural steel works shall be provided with 2 coats of primer and a minimum of 2 coats of synthetic enamel paint.
- 9.0 ESP CONTROL ROOM**
- 9.1 This shall be a ground plus four floors RCC framed structure. In Ground Floor – Cable vault, First Floor – Switch gear, Second Floor- Cable vault, Third Floor- Control room, Fourth Floor- AHU & AC Plant room. One elevator shall be provided near to one of the stair cases similar to the provision made for existing Units. An auxiliary transformer yard with fencing and gate shall be provided adjoining to the building. Side cladding shall be of brick wall with wall in front of transformer yard made sufficiently thick to satisfy fire rating as per TAC / LPA regulations, package air conditioners for EC control room and VFD room.
- 9.2 Staircase area shall be protected from fire safety angle, as per TAC regulations. Main door to switch gear room shall be steel sliding door having adequate area to admit switchgear. There shall be minimum two doors to the switch gear room, of flush welded steel type. Control room should have one swing type aluminium glazed double panel door and one single panel door. Windows shall be steel glazed for switchgear room with wired glass. For control room if window is provided the same shall be of fixed glass type with 6 mm thick sheet glass. Main entrance of the building shall be a rolling shutter with appropriate ramp approach. Aluminium false ceiling shall be provided in the Control room. Underdeck insulation shall be provided above false ceiling. Main entrance to control room shall be provided with air locked lobby with sliding glass doors. Lobby shall be formed of anodised aluminium framing with toughened sheet glass 6 mm thick.

<div>KPCL/BTPS/03/EPC</div> <div></div>	<div><b>KARNATAKA POWER CORPORATION LIMITED</b></div> <div><b>BELLARY TPS, UNIT-3 OF 700 MW</b></div> <div><b>TITLE</b></div> <div><b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b></div>	<div><b>SECTION D4.5</b></div> <div><b>VOLUME IV</b></div> <div><b>SHEET 15 of 28</b></div>
	<div>9.3 Roof shall be given access by means of cage ladder. An equipment hatch shall be given in the first floor with lifting beam to lift the switchgear / control panel to the first floor.</div> <div>9.4 Roof shall be given a slope of minimum 1 in 100 towards the side opposite to transformer yard. Roof shall be given Elastomeric liquid membrane water proofing treatment. Adequate number of rain water down take pipe shall be provided using HDPE pipe conforming to IS: 4985. Garland drain as well as plinth protection shall be given around the building.</div> <div>9.5 Transformer yard shall be provided with 3 m high chain link fencing with gates. In case, more than one transformer is being provided, fire wall shall be constructed in between to separate the transformers. Oil soak pit shall be provided below the transformer. Burnt oil pit shall be provided connecting the soak pits with RCC pipes. The transformer area shall be provided with paving using hard stone aggregates of 40 mm single size.</div> <div>10.0 <b>RCC CHIMNEY</b></div> <div>10.1 Parameters of the Chimney shall be designed based on the exit flue dia, the fuel burnt, and quantity of gas generated and probable composition of the flue gas. Minimum height of the Chimney shall be 275 m. Chimney shall be of brick lining and for one unit only. Effect of adjoining tall structures such as boilers, cooling towers etc on magnifying wind loading on the Chimney shall be studied in a wind tunnel before the designs are finalised. Chimney shall be provided with caged ladder with ladder safety device for maintenance. Proper aviation warning signals shall also be provided for the Chimney. Chimney shall also be provided with Rack and Pinion type Lift for access and maintenance.</div> <div>11.0 <b>STEAM GENERATOR AREA PAVING</b></div> <div>11.1 Entire steam generator area upto the end of Chimney shall be provided with RCC -M20 Grade paving over rubble soling.</div> <div>11.2 Paving shall be carefully planned such that maintenance access roads of minimum 4 m wide to all major equipment are available. This area shall be designed for heavy loads similar to design of roads. Such approach road shall be provided to the S.G elevator also to enable handling of equipment at higher level during maintenance. Such roadways shall be clearly identified with kerbs / painting. All drain / trench covers in these areas shall be designed to withstand truck loading.</div> <div>11.3 The drainage of the entire SG area shall be properly planned. Network of RCC drains with RCC cover with slotted holes or MS grills shall be provided covering the entire area which leads the storm as well as process leakage water to the peripheral drains, which in turn will lead to plant drainage system. Where open drains are not permitted, under ground pipes may be provided. In which case, at all junctions and ends proper manholes shall be provided to permit periodic cleaning of the pipes. All structural steel columns in the area shall be provided with encasing to a height of minimum 450 mm above paving level and in addition, the bases also need encasing, if base plate are below paving level. The maximum paved level in SG area shall be kept a minimum 200 mm below the finished ground floor level in Turbine building area.</div>	



KPCL/BTPS/03/EPC 	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION D4.5 VOLUME V SHEET 16 of 28
	TITLE DESCRIPTION OF BUILDINGS, STRUCTURES & FACILITIES	

## 12.0 TRANSFORMER YARD

12.1 Generator transformer, station transformer, unit auxiliary transformer, service transformer etc., are located in front of the turbine building. Transformers shall be founded on RCC foundations with rails on the top and oil soak pits filled with hard stone aggregate. Burnt oil pits are provided to collect leaked oil from the soak pit through salt glazed pipes laid to slope. RCC blast wall / RCC frame with brick wall of adequate thickness and height to satisfy TAC regulations shall be provided in between transformers as Fire barrier wall.

12.2 RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. Entire area shall be surrounded with 3 m high chain link fencing with gates. Where rails cross the fencing, fencing shall be made of removable type to facilitate transport of transformer. Floors shall be paved with plain cement concrete and shall be sloped towards peripheral drains, which shall lead to a sump from which the drainage is led through an oil water separator. The clear water shall be led to plant drainage.

## 13.0 SWITCH YARD

Extent of the Switchyard will depend on the layout of the switchyard, which has been outlined in the Electrical section of this document.

### 13.1 Galvanised steel structure

All steel structures for the Switchyard shall be hot dip galvanised structure with welded / bolted connections at shop and bolted connection at site. All bolts and nuts shall also be galvanised. Minimum zinc consumption shall be 610 gm per square meter of exposed surface. Design criteria of Switchyard structure are furnished elsewhere in this document.

13.2 Major steel structures are towers, beams, lighting masts etc. They are all of latticed construction using angle sections. In addition, supporting structure for equipment such as, isolator, lightning arresters etc., shall also be provided. These structures may be of tubular section or latticed as the case may be. Towers, beams etc shall be trial assembled at shop, keeping in view the actual site condition, prior to dispatch to erection site, so that, they can be conveniently pre-assembled before erection or conveniently assembled during erection. Lighting masts shall be provided with cage ladder. Where platforms are provided on lighting masts for mounting of lighting fixtures, they shall have protection hand rails formed of galvanised section. Platforms shall be of galvanised gratings.

### 13.3 Foundations for structures and equipment

Criteria for design of foundation are given in separate section of the document. Foundations shall be of open type.

#### 13.3.1 Trenches / Paving / Fencing

Trenches shall be of RCC construction. Trench walls shall be designed to withstand a surcharge load of 2000 kg / sq.m. Trench wall shall project 150 mm above the paved / graded level to prevent ingress of storm / rain water. All trenches shall be covered with trench cover after cable laying is completed. All



## TITLE

## DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES

trenches, floors shall be given a slope of minimum 1 in 750 and the slope shall lead to a sump, where pump can be installed for drainage.


13.3.2 The complete area within the fencing shall be provided with a mild slope towards peripheral RCC drains, which in turn will be connected to the plant drainage system. Entire switch yard shall be provided with 75 mm paving of 40 mm single size stone aggregate on top and 75 mm paving of 20 mm single size stone aggregate below. Before laying the paving, the ground surface shall be treated with anti weed chemicals as per manufacturer recommendations

13.3.3 Fencing around switch yard area, shall comprise of PVC coated GI chain link fencing of minimum 8G (including PVC coating) of mesh size 75 mm and of height 2400 mm above toe wall with 600 mm high galvanised anti-climbing device with barbed wire (8 rows) such that, total fence height of 3 m above toe wall is achieved.

#### 13.4 Switchyard relay room

13.4.1 Switchyard control room will be a two storied RCC framed structure. The ground floor will accommodate cable vault, AHU rooms, Stores, Staircase, panel handling arrangements, battery rooms etc., and first floor will have relay panels / PLCC panels, etc., Floor elevation shall be decided by the CONTRACTOR to suit his requirement of operation and maintenance, package air conditioners for Relay room.

13.4.2 Cladding shall be of brick wall and the same will be supported on RCC wall beams and plinth beam such that, unsupported length is not more than about 3 m. Pleasing architecture shall be provided for the building. The external wall surfaces shall be provided with 20 mm thick plaster in two layers, with an underlayer of 14mm thick in CM 1:6 and top 6 mm thick layer in CM 1:4 with approved Waterproofing compound. Internal plastering shall be of 13 mm thick in CM 1:6. Ceiling in areas where false ceiling is not provided shall be given ceiling plaster 6 mm thick in CM 1:3. All partition walls in the ground floor shall be of single brick wall. Wall around cable vault shall extend upto the ceiling. Cable vault shall be provided with two flush type sheet steel doors. Wall around stores, air washer rooms and staircase also should extend upto ceiling. Stores and AHU room shall have flush type of sheet steel door. Door in AHU room shall be made airtight. Staircase shall have fire proof, automatically closing glazed aluminium door in the first floor. On the ground floor also similar doors shall be provided. Main entrance shall be aluminium glazed double leaf swing door of adequate size with fixed sheet glass glazing in anodized aluminium framework on either side. Separate rolling shutter entry shall be planned for panel movement with a hatch and lifting beam on the first floor. In the first floor, staircase shall be given brick enclosure. Entry to the air-conditioned area shall be through air lock lobby with aluminium glazed automatic sliding door of adequate size. At least two doors shall be given from the control room to move out during emergency. All partitions shall be of anodized aluminium framing with 6 mm sheet glass upto false ceiling. The external partition separating A/C area and non-A/C area, above the glazed partition shall be provided in brickwork. All internal partitions in the A/C area will extend upto the false ceiling. Doors in Aluminium glazed partition shall be single leaf glazed aluminium swing door. Control room proper on the switch yard side shall have continuous fixed glazing in aluminium framework above 900 mm high Brick wall. For other rooms aluminium glazed sliding windows may be provided

KPCL/BTPS/03/EPC 	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION D4.5 VOLUME V SHEET 18 of 28
	TITLE DESCRIPTION OF BUILDINGS, STRUCTURES & FACILITIES	

with 6 mm sheet glass. False ceiling with aluminium ceiling system shall be provided in the A/C areas. Under deck insulation shall be provided above the false ceiling on the ceiling as well as for walls. Roof shall be laid to slope of 1 in 100 using screed or by sloping the top of slab. Elastomeric liquid membrane water proofing treatment shall be given to roof with HDPE pipe down comers as per IS:4985.

#### 14.0 COAL HANDLING SYSTEM


This section covers the general requirements for concept, design, construction / fabrication and erection of various structures, buildings and facilities for the Coal handling system, covering complete Civil and Structural works. Requirements shall be as specified in Volume III Mechanical works. Some of the important areas of works are described below.

##### 14.1 Crusher house

14.1.1 Crusher house shall be of steel structure of framed / braced design. Floors and roofs shall be RCC, over structural steel framing and permanent decking sheet. Side cladding shall be of permanently colour coated non-insulated metal cladding as per clause No.3.2, part F-Finishes, above 3000 mm wall on ground floor. Roof shall be given adequate slope for drainage. Roof shall be given with Elastomeric liquid membrane water proofing treatment. Proper arrangement shall be provided to convey the rain water through gutters made out of plain sheets having same material and coating specifications as mentioned for cladding of matching colour and HDPE pipe down comers as per IS: 4985. Adequate windows shall be provided with steel glazed side hung windows using wired glass. Wherever monorails are projecting outside for lifting of equipment, steel sliding doors shall be provided. Main entrance doors shall be of rolling shutter adequately sized to carry equipment inside. Other doors shall be of flush welded steel construction. Ramps shall be provided in front of main door. Grade slab as well as intermediate floors shall be of RCC. Intermediate floor shall be supported on steel beams. Crusher shall be mounted on the floor framing using Vibration Isolation system. Handrail shall be provided around all big openings and kerb plates shall be provided around all small openings.

14.1.2 Two staircases of structural steel shall be provided, one inside and one outside. Elevator shall be provided for serving all the floors. Elevator cage wall shall be that of permanently colour-coated metal cladding system. Elevator pit shall be of RCC. Machine room floor and roof shall be of RCC. Side cladding of M/C room shall be of non-insulated metal cladding as per clause No.3.2, part F-Finishes, above 3m high brick wall. An RCC kerb wall of 300 mm shall be given around the floor over which hand railing shall be provided. M/C room shall be given adequate slope for drainage purposes. Elastomeric liquid membrane water proofing treatment shall be given to roof with HDPE pipe down comers as per IS 4985. Main door to M/C room shall be of steel of flush welded construction. Adequate ventilation shall be given using steel glazed window. Elevator pit shall be kept atleast 500 mm above general grade level to prevent flooding. A sump shall be provided inside the pit to collect and pump out water. Sump shall be given an aluminium ladder for access. Toilets shall be provided in the Crusher house.

14.1.3 Foundation of the building columns shall be of RCC. Foundation design criteria are given elsewhere. All the foundations shall be connected together by tie / plinth

KPCL/BTPS/03/EPC  	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b>  <b>VOLUME V</b> <b>SHEET 19 of 28</b>
-----------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------

beams. Top of the pedestals for the columns shall be 150 mm above finished ground floor level.

#### 14.3 Junction houses

Construction details of Junction houses are similar to the Crusher houses except that, Elevator and toilet may be necessary unless otherwise specified in the Mechanical section of the document.

#### 14.4 Conveyor Galleries and Trestles

14.4.1 Overhead conveyors shall be housed in a suitably enclosed gallery of structural steel. Maximum span of gallery shall be limited to 24 m unless higher span is necessitated due to site constraints, which shall be subject to approval of OWNER.


14.4.2 For double stream conveyor gallery one central and two side walkways shall be provided. For single conveyor, walkways shall be provided on either side. Width of the walkway and clear height of the gallery shall be as specified in Mechanical section of the document. Both sides of the central and side walkways shall be provided with pipe hand rails with kerb plates using pipe of 'medium' class as per IS:1161 having 32 mm nominal size. Handrails shall not be connected to conveyor supporting stringer. Walkway shall be of chequered plate construction with anti skid arrangement. Floors of the conveyor gallery shall be provided with seal plates as specified in Mechanical section.

14.4.3 Conveyor gallery shall have permanently colour coated metal sheet roof and side cladding shall be of permanently colour coated non-insulating metal cladding as per clause No.3.2 Part F-finishes. Roof framing shall be given a slope of 1 vertical: 3 horizontal. A continuous slot opening of 500 mm height shall be provided on both side walls just below the roof sheeting. Adequate provision of windows shall be provided on both sides. Windows shall have grills of wire mesh. Cross-over shall be provided at approximately 100 metres interval along the conveyor preferably at 4 legged trestle locations.

14.4.4 In between transfer points four legged trestles shall be given at a spacing of about 100 m. In between 4 legged trestles, two legged trestles may be provided. Trestles shall generally be provided using rolled beams only.

14.4.5 Sliding PTFE bearing support shall be provided at one end of the gallery for relieving forces due to temperature variation. Accordingly, for the purposes of analysis one end of the gallery shall be treated as hinged and the other end on rollers.

14.4.6 End of conveyor gallery, which will be supported over transfer tower, shall be so detailed that, only vertical reaction is transferred from conveyor gallery. This side of the gallery shall therefore be supported on sliding PTFE support. For design criteria for foundation please refer separate section given in the document. The top of pedestal for the foundations shall project 300 mm above the grade level.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 20 of 28</b>
-------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------

#### 14.5 Stacker cum reclaimers


14.5.1 Stacker cum reclaimer rail shall be supported on RCC foundations giving continuous support to the rails. The beams supporting the rails shall be given expansion joint preferably every 30 metres. Stacker / reclaimer conveyor support shall also be provided connecting the above two beams. The entire coal storage area from drain to drain shall be provided with properly sloped PCC paving over rubble soling with properly compacted subgrade. The PCC paving shall be of nominal mix of grade M15, 150 thick with nominal temperature reinforcement laid over 230 thick compacted sand and rubble filling. RCC drains with removable precast RCC slotted cover shall be provided on either sides of each coal stack. These drains shall be so designed to carry the drainage from coal yard to the decantation tank. Decantation tanks shall be of RCC with baffles to induce settlement of the coal dust and shall be sized to store about 30 minutes storage which will be ultimately lead to a pond. Decanted water shall be lead to coal pile run off pond and further pumped to ash pond. RCC supports for dust suppression piping system shall also be provided. Beyond the stockpile area till the junction towers on either side, foundations for trestles and short supports will have to be given. The top of pedestal shall project a minimum of 300 mm above the grade level.

#### 14.6 Wagon tippler hoppers/Emergency Reclaimer Hopper and Shed

14.6.1 Hoppers shall be of RCC construction. The pit shall accommodate the hoppers along with feeder and conveyors below. The hopper pit shall be of RCC construction and designed as water retaining structure. During construction, proper provision shall be made to make the pit completely waterproof. For Reclaimer hopper sloping surfaces, 5mm thick Stainless Steel liner of grade SS409M shall be provided. Suitable sump shall be provided in the pit to effect removal of surface drainage water. RCC access shaft shall be provided with staircase to the bottom of the pit. Monorail for taking machinery into the pit shall be provided in the access shaft projecting through two leaf steel sliding door. Plinth level of the pit shall be kept at least 500 mm above graded level with RCC sloped paving around to enable bulldozer movement. Shed above hopper pit shall be of structural steel construction. The columns shall be raised from the two sides of the pit and shall be designed as free standing, supported only by roof framing, to facilitate dozer movement. Roof shall be provided with permanently colour coated non-insulating metal cladding as per clause No.3.2 Part F-finishes.

#### 14.7 Tunnels, Pent houses and Transfer Houses

14.7.1 Tunnels shall be of RCC construction and designed as a water retaining structure. During construction proper provision shall be made to make the tunnel completely waterproof. A PCC screed shall be provided to direct the drainage on to one side of the tunnel. A small trench shall be provided on that side of the tunnel to lead the drainage to the nearest sump. The tunnel shall be provided with RCC / brickwork, for ventilation duct. Brickwork shall be constructed with grills for supply air. Where the tunnel enters the ground level a pent house is provided of RCC construction. Pent house shall be provided with a lifting beam to lift equipment to the tunnel. Tunnel shall be provided with walkway on either side of the conveyor. Single pipe handrail shall be fixed to the tunnel wall to serve as handrail. Tunnel floor shall be provided with PCC steps to facilitate movement of operating /

KPC/ BTSP/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <b>TITLE</b> <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 21 of 28</b>
-------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------

maintenance personnel. In the case of double conveyor, such steps shall be provided in the centre also.

**14.7.2** Where two tunnels meet, a Transfer house is to be provided. Transfer house is by and large a junction tower but the meeting of conveyors takes place below ground level. Transfer house shall be of RCC construction with RCC floors and roof, with RCC access shaft with staircase and monorail arrangement for carrying equipment down. Proper drainage arrangement shall be provided in the bottom-most floor. Handrails shall be provided around all openings. Around access shaft proper plinth protection shall be provided with ramp towards the door. Access shaft should have one equipment entry, which shall be two leaf steel sliding door and a single leaf flush welded steel door for entry of personnel. Transfer house shall be designed as water retaining structure and provision shall be made during construction to ensure proper water proofing after concreting is over.

**14.7.3** Portion of the tunnel or transfer house over which railway line or road passes shall be appropriately designed to support the additional imposed load. Tell tale signs shall be provided above graded ground to identify the extent of the underground structure.

#### **14.8 Switch gear room / Control room**

**14.8.1** Number of switch gear rooms shall be decided based on the arrangement of various buildings and their electrical load requirement as discussed in the Electrical portion of this document. Switchgear room shall generally be two storied RCC framed structure with cable vault on the ground floor and switch gears on the first floor. In the case of switch gear cum control room, an additional floor shall be provided to accommodate the control room & offices above the switch gear room. Other constructional details shall be similar to ESP control room. Roof shall be given proper slope and parapet shall be avoided to prevent the accumulation of coal dust. Similarly, above sunshade, fascia shall be avoided to prevent accumulation of dust.


**14.8.2** Transformer yard, toilets, equipment hatch, staircase etc., shall be provided similar to ESP control room.

#### **14.9 Dust Suppression, Dust extraction and Ventilation system structures**

**14.9.1** Civil works on account of the above system will generally consist of pump houses, RCC reservoirs, slurry sumps, pump foundations, fan foundations etc., spread over the complete Coal handling area. Location and details of these structures will depend on requirement based on system design.

#### **14.10 Bulldozer shed / Auto repair Shop**


This shall be a steel frame structure with permanently colour coated non-insulated metal cladding as per clause No.3.2 Part F-finishes, with a column free area for bulldozer movement in shed area. The minimum area for this facility shall be 250 Sqm. The auto repair shop shall have sides with colour coated sheeting as mentioned above except for bottom 3 metres of brick work. Ventilation and natural lighting shall be provided with steel glazed side hung windows. Doors shall be of flush welded steel for personnel movement. Rolling shutters of adequate size shall be provided for movement of vehicle.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 22 of 28</b>
-------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------

The floor shall be RCC grade slab designed for heavy duty loading with granolithic finish and non-metallic hardener. Necessary pit for servicing of vehicles with all necessary steps etc., shall be provided in the repair area.


#### 15.0 ASH HANDLING SYSTEM

- 15.1 The superstructure of pump houses and compressor house shall be of steel-framed structure with rigid framing in transverse direction and bracing in the longitudinal direction and gable end. The buildings shall support an EOT crane of adequate capacity. Roof shall be of in-situ RCC, properly sloped, constructed on colour coated permanent metal deck shuttering. Side cladding shall be of brick work, adequately ventilated with steel windows with 6 mm thick wired glass. Adequate nos & size of rolling shutters & steel doors of flush welded construction shall be provided as per layout requirements. RCC foundations shall be provided to support the structure based on soil condition.
- 15.2 Ash water tank shall be above ground level. The tanks shall be designed as a water retaining structure as per IS:3370. RCC sumps of Ash Slurry Pump house shall be designed as per IS:3370 duly considering water table as well as additional surcharge pressure. RCC staircase shall be provided for access to all the sumps. All basements shall be provided with handrails around.
- 15.3 MCC and Switchgear room shall be a single / two storied RCC framed structure with cable vault on ground floor and switch / control room on the first floor. Control room shall be air-conditioned, hence; the same shall be given false ceiling of gypboard and under deck insulation. Main entrance to control room shall be provided with air locked lobby with sliding glass doors. Lobby shall be formed of anodised aluminium framing with toughened sheet glass 6 mm thick. Toilets shall be provided on the ground floor. Walls of the Control / Switch gear room shall be of brick, with wall on the Transformer yard side being designed as per TAC regulations.
- 15.4 Roofs shall be properly sloped and provided with elastomeric liquid membrane water proofing treatment. Rain water downcomer HDPE pipe conforming to IS: 4985 shall be provided. Garland drains shall be provided around the building to carry the storm water to plant drainage system. Plinth protection shall be given all round the building. For roof of control and switch gear room below water proofing course, a 50 mm thick foam concrete insulation layer shall be provided.
- 15.5 Windows in switchgear / control room shall be of side hung steel glazed type using wired glass. Switchgear room shall have atleast two steel flush-welded doors. Entry to control room shall be with aluminium swing type glazed door. Size of main entrance door to Switch gear room shall be adequate to allow movement of switchgear panels. This shall preferably be steel sliding door with two leaves. Provision shall be made to lift the Switchgear panel to the first floor with equipment hatch and lifting beam. Staircase shall be provided with fireproof enclosure around to satisfy TAC regulations. Toilets shall be provided with PVC doors. Roof of all buildings shall be given access through cage ladder. Sewage from toilets shall be disposed off through plant sewage disposal system.
- 15.6 Auxiliary transformer yard may be required near the Switchgear room. The Transformer yard shall be provided with chain link fencing and gates along with fire wall, paving, soak pit, burnt oil pit etc similar to ESP control room.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V<sub>1</sub></b> <b>SHEET 23 of 28</b>
-------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------

- 15.7 Work shall include bottom ash hopper supports, bottom ash extraction equipment supports, pipeline supports and trenches from Bottom ash hopper to Ash slurry sump. Support for fly ash pipeline from ESP etc. to fly ash silo is also included in the scope of civil works.
- 15.8 Dry fly ash silo of adequate capacity alongwith development of the silo area such as paving, fencing, access roads / drainage of the dry fly ash silo area etc., included in the scope. Fly ash silo shall be RCC construction.
- 15.9 Pipe line from Ash slurry pump house to the final disposal area shall be run on piperacks in the main plant area and on RCC pedestals upto & over the bund upto disposal point. All related Civil and structural works shall be included in the scope. At all road / rail crossings, pipe bridges are to be provided with bottom of the bridge at least 8.00 m above the road / rail level. If the OWNER permits at road crossings the pipes may be run inside box culverts also.
- 15.10 Dry fly ash storage area shall be provided with fencing and gates. All other Civil / Structural work to ensure smooth functioning of the Ash handling system are deemed to be included in the scope of work under the sub section.
- 16.0 In general, all provisions made shall be as per layout requirements specified in the Volume III titled Mechanical Works of the Bid document.
- 17.0 FUEL OIL HANDLING SYSTEM**
- 17.1 DELETED
- 17.2 Fuel oil pressurisation pump house will house fuel oil pumps (HFO & LDO), heaters and MCC's. This is also single storied structural steel framed structure with pre-coated galvalume sheet roofing. The pumps will be located on ground floor MCC shall be located at ground level. The pump house shall be given proper drainage facility. The oil / water mixture collected in the sump will be led to an oil water separator / ETP. Electric hoist crane or monorail facilities will have to be provided in all the pump houses as specified in the Mechanical section of the specification.
- 17.3 DELETED.
- 17.4 DELETED.
- 18.0 D.M PLANT**
- 18.1 Dimension and height of the building shall be decided based on equipment layout and height of the vessels accommodated inside. The DM plant building shall be of RCC framing to result in large column free space. The roof shall be of RCC.
- 18.2 Adjoining control room and laboratory shall be provided in an RCC framed building with brick cladding Control room and switchgear room shall have a cable vault below. Control room and laboratory shall be air-conditioned. False ceiling with gypboard shall be provided in this area. Underdeck insulation shall be provided in the A/C area as well as in the Air washer room. Staircase in the Control static room Complex shall be extended to the roof also. Flooring on Control room shall be of anti-static PVC tiles. Toilets shall be provided in the ground floor. In case a




KPC/LBTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION D4.5 VOLUME V
	TITLE DESCRIPTION OF BUILDINGS, STRUCTURES & FACILITIES	SHEET 24 of 28


transformer yard is provided the wall in front shall be designed to satisfy fire rating as per TAC. Details / requirements of transformer yard shall be same as those provided for ESP control room.

- 18.3 Floor where acid / alkali spillage are expected shall be isolated with RCC kerb and the flooring inside shall be of acid / alkali resistant brick. The drains inside the building carrying acid / alkali mixed discharge shall be provided with epoxy lining. Outside the building upto neutralising pit these drains shall be provided with AR brick lining. Specification for lining is given elsewhere in this document. Acid / alkali unloading and storage area outside the building shall also be provided with kerb with a sump inside. This area shall also be provided with AR brick lining.
- 18.4 Neutralising pit shall be designed as a water retaining structure with external damp proofing. Floor and walls of the pit shall be given A.R brick lining. Ceiling as well as floor, supporting pumps, pumping the clear water from neutralising pit shall be given epoxy lining. DM water storage tank outside the DM plant shall be supported on sand pad with ring wall.
- 18.5 Walls inside the DM plant area shall be provided with chlorinated rubber based painting. Main door shall be rolling shutter of adequate size to permit entry of the largest vessel. All doors and windows in the DM plant area shall be of aluminium glazed type. Windows shall be of sliding type.
- 18.6 The requirements shall be as per Mechanical specifications. Volume-III

#### 19.0 CONDENSER COOLING WATER SYSTEM

- 19.1 Clarified water shall be used for circulating water system. RCC cooling water channel shall be of rectangular shape and designed as a water retaining structure. Depth of channel and width of channel shall match with the width and depth of the cooling water channel from cooling tower. The branch channel shall join together and form common channel leading to the forebay of the pump house. Dimension of the channel shall be decided on the basis of the quantity of water to be carried by the channel. Floor of the channel shall be given a mild slope to ensure necessary velocity of flow. The top of the channel shall be kept at least 500 mm above ground level with suitable galvanised M.S pipe hand railing on either side. Expansion joint shall be given at a spacing of about 30 m. Pedestrian crossover shall be given across the channel at approximately 300 m centres. The channel shall smoothly diverge and form the forebay in front of the pump house. It is suggested that the bottom of the forebay shall be kept flat and the difference in level between the channel and CW pump sump shall be made up in the channel stretch before joining the forebay, using a slope of 1 Vertical : 5 Horizontal.
- 19.2 Depth of the forebay shall generally match with the C.W sump level, which shall be decided based on submergence requirement of the C.W pumps at the lowest water level in the sump. Forebay shall be provided with cage ladder at four corners constructed of galvanised steel. Top of the forebay shall be kept 500 mm above grade level and handrail of galvanised M.S pipes shall be provided for the entire length on either sides. Water level indicator (float type) shall be provided in the forebay close to the pump sump on either side to observe the depth of water.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 25 of 28</b>
	<p>19.3 Dimension of the pump sumps shall be so selected as to prevent dead water areas, reverse currents, flow separation and eddies. Recommendations of British Hydro-mechanic Research Association (BHRA) and Hydraulic Institute Standards shall be followed. CONTRACTOR shall conduct Hydraulic Physical Model study to demonstrate trouble free operation of the pump sump and forebay for all possible alternatives / combination of pump operation. Pump sump shall be designed as water retaining structure. Each sump shall be provided with mild steel groove for inserting coarse screen, fine screen and stop logs. Grooves for stop log shall be provided before and after the screens. Where as number of coarse screen and fine screen shall be the same as the number of pump sumps the number of stop log shall be a minimum of two. Top of the sump floor shall be kept same as of the top of forebay. This floor shall have openings for lowering and lifting of stop logs and screens. These openings shall be covered with galvanised mild steel gratings when the screens are placed in position. Provision for handling of the screens and stop logs shall be made. Sufficient paved space shall be provided to keep the stop log when not in use and also for maintenance of screens. Galvanised MS handrails shall be provided on 3 sides of the pump floor (sump roof). Each individual pump sump shall also be provided with a drain sump to empty the sump for attending to maintenance of pump.</p> <p>19.4 Pumps generally have common base plate with the motor and hence the pump foundation is provided at the motor floor level. A thrust block shall be provided connecting the pump and motor floors to resist the pump thrust. Staircase shall be provided from the pump floor to motor floor. Motor floor shall be given handrail on the two sides. Pump maintenance area shall be provided on one side at the pump floor level.</p> <p>19.5 Side of the pump house upto motor floor level on the pump discharge side shall be of RCC. Maintenance bay of the pump house shall have R.C.C grade slab with granolithic finish and non-metallic floor hardener. Motor floor shall also have similar finish.</p> <p>19.6 An annex to the C.W pump house shall be provided in RCC framed structure to accommodate Switchgear and Control room with cable vault below, Ozonisation room and toilet block. Side cladding shall be of brickwork. All floors and roofs shall be of RCC. Roof shall be given proper slope and liquid membrane water proofing treatment. Rain water down comers shall be of HDPE pipes conforming to IS 4985. Roofs shall be made accessible by MS cage ladder. CW treatment skids, acid dosing skids and Sulphuric acid storage tanks shall be housed in a separate AC sheet roofed shed.</p> <p>19.7 All doors shall be of flush welded steel construction. For Switch gear room, the main entrance door shall be of adequate size to transport the panels. All windows shall be steel glazed side hung. Wall in front of Transformer yard shall be designed to satisfy fire rating as per TAC regulations.</p> <p>19.8 An auxiliary transformer yard may be required in front of the Switch gear room. Civil work similar to the transformer yard in front of ESP control room shall be included in the scope of work.</p> <p>19.9 Outside the pump house support blocks for butterfly valves and pipes along with proper handling facility shall be provided.</p>	

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 28 of 28</b>
-------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------

19.10 Cooling water conduits of adequate size shall be provided from C.W pumps to condenser and hot water conduits from condenser to cooling tower. These conduits shall be formed of structural steel conforming to IS:2062 laid under ground with an earth cushion of 1500 mm above the pipes. The pipes shall be given an epoxy painting on internal surface. The pipe shall be encased in R.C.C with a minimum thickness of 250 mm with reinforcement. Pipe shall be designed for the shut off pressure of the pump or 1.5 times the maximum pump head whichever is higher. A surcharge of 2 t / sq m in addition to backfill may also be considered. Where pipes are not encased the pipe shall be given sand bedding up to the centre line of the pipe. At location of the bends anchor blocks shall be provided. Manholes shall be provided along the length of pipe at about 150 m centres and near locations of bend in each pipe. The pipes shall be line tested before commissioning of the system. At road / rail crossing, the encasement shall be designed adequately to withstand the additional imposed loads.

19.11 CW Makeup reserve tank of capacity 1x10000 Cum. OR 2x5000 cum. with filtration plant shall be provided.

## 20.0 COOLING TOWER

20.1 Cooling tower shall be Natural draft type.


20.2 RCC basin shall be in two compartments with supporting structures and foundations. The basin shall be provided with drain sump, cold water, outlet duct with screen, stop log and all associated handling facilities.

20.3 Cold water open channel of RCC leading from cooling tower basin to forebay of CW pump house shall be provided.

## 21.0 MISCELLANEOUS PLANT BUILDINGS

### 21.1 Air Washer Room & Compressor House

21.1.1 This shall be located in between unit-2 & unit-3 station building. This shall be a single/double storied steel framed building adjoining to the Turbo generator bay. Roof shall be of RCC supported on colour coated trough shaped permanent decking supported on steel framing. Side cladding shall be by brick supported on concrete encased steel beams. Internal wall surfaces shall be given 20 mm cement mortar plastering mixed with water proofing compound. Water tank and RCC supporting structures for louvres, filter and foundation for equipment such as fans and pumps are also included in the scope. Proper drainage of the floor has to be provided. Doors shall be of flush welded steel and they shall be made airtight. Rolling shutter of adequate size should be provided for taking the equipment inside and truck with compressor. The roof framing shall support an under-slung crane of adequate capacity. Compressor foundation shall be isolated from the grade slab. Air receiver and Air drier can be supported from RCC grade slab. All trenches shall be sloped towards drain sumps. Trenches shall be provided with chequered plate cover. Steel glazed windows shall be provided for ventilation and natural lighting. A minimum of 2 flush type steel doors shall be provided for movement of personnel. Dimension of the building shall be decided by the CONTRACTOR to suit the dimension of the equipment he is supplying duly taking into account the maintenance requirements.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>DESCRIPTION OF BUILDINGS, STRUCTURES &amp; FACILITIES</b>	<b>SECTION D4.5</b> <b>VOLUME V</b> <b>SHEET 27 of 28</b>
-------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------

## 21.2 Warehouse and Chemical / Hazardous Stores

21.2.1 This building shall be of structural steel framework with limited number of internal column to result in large column free area. Roofing shall be of permanent colour coated trough shaped steel sheeting supported by steel truss. Side cladding shall be permanent colour coated non- insulated metal cladding as per clause No.3.2, Part F- finishes over 3000-mm high brickwork. The minimum area for this facility/building shall be 1000Sqm including an area of 75 Sqm for Chemical/Hazardous stores.

21.2.2 Loading and unloading platform for trucks, ramps for movement of forklift etc shall also be provided. Separate office space, chemical storage, hot storage, electrical storage, A/C stores, Toilets etc shall be provided. All windows shall be provided with M.S grills for security. Rolling shutter of adequate size shall be provided for movement of truck / forklift etc. Grade slab shall be designed for truck traffic. Provision for open and semi-covered storage areas shall also be provided in stores complex. The stores complex shall be cordoned off with chain link fencing with an entry gate and security post

## 21.3 Diesel Generator House

21.3.1 This shall be a single storied RCC framed structure with electric hoist. The dimension of the building shall be decided by the CONTRACTOR to suit equipment supplied. D.G set foundation shall be isolated from the floor.

21.3.2 All trenches shall be of RCC and shall be designed as water retaining structure. There shall be no entry of cables / pipes to these trenches below grade level from outside. All these trenches shall be covered with chequered plate over steel framing. Adequate number of sumps shall be provided to drain these trenches.

## 21.4 A C Plant


This shall be a single storied steel framed building with in-situ RCC roof over colour coated trough shaped permanent metal decking supported on steel beam. Side cladding shall be brickwork. The roof framing shall support an electric hoist of adequate capacity. The dimension of the building shall be decided by the CONTRACTOR to suit the layout and maintenance requirement of the equipment being supplied. Main entry shall be through a rolling shutter permitting entry of truck with machinery. A minimum of two numbers of single leaf steel flush doors shall be provided for movement of personnel. Steel glazed side hung windows shall be provided for natural lighting and ventilation.

## 22.3 Service Water Overhead Tank

This shall be of RCC construction with all necessary piping, access stairs, pump room, etc., complete.

## 22.4 Potable Water Tanks

This shall be standard Polyethylene storage tanks of required capacity conforming to IS-12701 with all necessary piping connection and fittings etc., and fixed over an appropriate base / roof of buildings.

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW		SECTION D4.5
	TITLE		VOLUME V
	DESCRIPTION OF BUILDINGS, STRUCTURES & FACILITIES		SHEET 28 of 28

## 22.5 DELETED

## 23.0 EFFLUENT TREATMENT PLANT

23.1 The effluent treatment plant shall be as per the description mentioned elsewhere in the specification.

23.2 All sumps and pits in waste water treatment plant shall be of RCC construction with proper acid / alkali liners. Electrical / control panel shall be located in an RCC building with office space for operating personnel as per system requirement.

## 24.0 PIPE AND CABLE RACKS

24.1 All cable and pipe routing in outlying area shall be clubbed and shall run over ground on structural steel pipe / cable racks at a height not less than 3000 mm above grade level. Where the pipes cross roads / railway clear headroom shall be 8000 mm. The racks can be multitiered. Cable shall normally be laid above the pipes.

24.2 The racks are generally designed as a rigid frame in the transverse direction and braced in the longitudinal direction. Expansion provision shall be provided wherever there is a change in direction or where length of the rack exceeds 100 metres. Access ladder shall be provided at suitable location. Where so required chequered plate platforms shall be provided for maintenance purpose. Pipe rack columns shall be supported on RCC foundations with bottom of base plate about 300 mm above ground level.


## 25.0 Clarified Water Storage Tank

This shall be of RCC construction of capacity 1000 cum. Water tight and above ground. All requirements enumerated in mechanical section of this document are to be catered for by this facility.

## 26.0 GENERAL:

The CONTRACTOR shall take up all buildings, structures and facilities as per bid stipulations in respect of type and area to meet the functional requirements adequately.

Wherever the requirement of specific area (floor area etc.,) for any building is not specified, the CONTRACTOR shall provide adequate space, as per OWNER's requirement, to avoid congestion in the building for movement of men and material.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <b>PART A - GENERAL REQUIREMENTS</b>	SECTION: D4.6 VOLUME V SHEET 1 OF 6
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## 1. GENERAL

- 1.1 Design and construction of buildings, structure etc., shall take into account requirement for operation and maintenance of all equipment and its users. The buildings will have good architectural features. The surrounding area shall be properly micro levelled and graded.

### 1.2 Architectural concepts for Buildings

The architectural design concept of buildings structure shall be evolved considering the functional, technological and other requirements to match with structures of existing Units for efficient operation, ensuring comfortable working environment for personnel, satisfying the aesthetic requirements. Special care shall be taken to provide elegance and aesthetics, with effective use of appropriate treatment, materials, fittings and finishes. To achieve the above objective CONTRACTOR shall employ a qualified architect / architectural firm to carry out all designs and hold all other architectural responsibilities for the project.

- 1.2 The CONTRACTOR shall obtain and be conversant with all laws, by-laws, regulations of local and Statutory Bodies as applicable to the project. The architectural concept evolved should also take care of these requirements. The CONTRACTOR shall provide the drawings and documents for such statutory approvals.

## 2. ROOF ACCESS


All roofs shall be provided with access through a staircase / cage ladder. Minimum 1000 mm wide access path shall be provided with tiles to approach equipment on roof.

## 3. PLATFORMS AND WALKWAYS

- 3.1 Platforms shall be provided to all major equipment, not directly accessible from the floors, for maintenance. Platforms and connecting walkways shall have a minimum width of 750 mm. However, in case of space restriction, the minimum allowable clear width shall be 600 mm with prior approval of the OWNER. Platforms in front of the entry shall be atleast 900 mm wide. Platforms located close to each other shall be connected with walkways.

- 3.2 All steel platforms above grade level shall be constructed with kick plates at edge of the platform to prevent tools or materials from falling off. It shall consist of 8 mm thick steel plate projecting 100 mm above the platform surface. Kick plate shall be painted with the same type of coating as the material to which it is attached.

- 3.3 Continuous walkway at least 500 mm wide shall be provided along the crane girder level with handrails, on both side of the building. Approach to EOT crane shall be ensured by Cage ladder or staircase.

KPCL/BTPS/03/EPC 	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW PART A - GENERAL REQUIREMENTS	SECTION: D4.8 VOLUME V SHEET 2 OF 6
-------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------	-------------------------------------------

#### 4. STAIRS & LADDERS

##### 4.1 Steel stairs

All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000 mm and minimum inclination with horizontal of  $35.75^\circ$ . However, in case of space restriction, minimum clear width upto 750 mm and slope upto  $45^\circ$  may be provided. The vertical height between successive landings shall not exceed 5 m. Channels (min MC 200) shall be provided as stair stringers. Treads shall be minimum 250 mm wide of chequered plate/grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 180 mm (200 mm in exceptional cases).

##### 4.2 Steel Ladders

Ladders shall be provided to platforms, walkways, instruments and equipment which do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed  $5^\circ$ . Ladders shall be of minimum 450 mm clear width with 20 mm dia. MS rungs spaced at 300 mm (maximum). Ladders shall be provided with a safety cage of minimum 750 mm diameter clear when the top of ladder is more than 4.5 m above the landing level. However, safety cages shall start at 2.5 m above the lower landing level.

##### 4.3 RCC stairs

All stairs shall have maximum riser of 180 mm and a minimum tread of 250 mm. However, for public buildings riser shall be limited to 150 mm and tread width of 300 mm. Minimum width of stairs shall be 1500 mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminum angle nosing with minimum 50 x 25 x 3 angle shall be provided for edge protection of RCC stairs.

#### 5. HANDRAILS

5.1 Handrails shall be provided at appropriate places to ensure safety e.g. around all floors / roof openings, projections / balconies, walkways, platforms, steel stairs etc.

5.2 All handrails shall be of 32 mm nominal bore MS pipes (medium class) as per IS: 1161 galvanised using 750 gm/sq. m of zinc. Handrailing shall be a two-rail system with the top rail 1000 mm above the walkway surface and the intermediate rail 450 mm below the top rail. Handrail post spacing shall be limited to 1500 mm as far as possible, but, can be proportioned to the length of the opening. In such a case, spacing shall not exceed 1850 mm center to center of posts. Handrailing shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel.

5.3 For RCC stairs, handrailing with 20 mm square MS bar balustrade with suitable MS flat and Aluminum / Teakwood handrail shall be provided, unless specifically mentioned otherwise. The overall provision of this component shall be aesthetically impressive.



## 6. EDGE PROTECTION

Wherever possible around floor openings an RCC kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corner is expected shall be provided with angles of minimum size L 50x50x6 with lugs for edge protection e.g. around the cut-outs / openings in floor slab, edges of drains supporting grating covers, edges of RCC cable / pipe trenches supporting covers, edges of manholes supporting covers and supporting edges of precast covers etc.

## 7. ANCHOR BOLTS AND INSERT PLATES

7.1 Anchor bolts shall be designed for working stress, in tension and shear, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked. Increase in allowable stress for loading including seismic and wind loads shall not be permitted in design of anchor bolts.

7.2 Insert plates shall be designed / checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall be checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug.

## 8. VERTICAL HEADROOM

8.1 All accessible areas shall be provided with minimum clear headroom as follows, unless otherwise specified.


Finished floors to ceiling (buildings)	3000 mm
Doors, Walkways, Platforms, Stairs etc	2100 mm
False ceiling of office areas	2400 mm
Walkway above false ceiling	1000 mm
Safety cage for ladders	2500 mm
Access for fork lift trucks	2800 mm
All roads / Railway crossings & crane access	7000 mm
Cable & Pipe rack	3000 mm except at Road / Rail crossings.


## 9. EXPANSION / CONSTRUCTION JOINTS


9.1 Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made water tight using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops may be used for the base slabs and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6 mm and minimum width 225 mm. At other joints these shall be 150 mm wide.

9.2 Two part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound



KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED	SECTION: D4.8
	BELLARY TPS, UNIT-3 OF 700 MW	VOLUME V
	PART A - GENERAL REQUIREMENTS	SHEET 4 OF 6
<p>conforming to IS: 1834 can be used. Pre-formed bitumen impregnated fibre board conforming to IS:1838 shall be used as joint filler.</p> <p><b>10. BRICK / STONE MASONRY AND PARAPET WALL</b></p> <p>10.1 All masonry works shall be designed in accordance with IS: 1905, IS: 2212, IS: 4326 and other relevant IS codes as applicable. Structural design of load bearing and non-load bearing walls constructed with solid or perforated burnt clay bricks or concrete blocks shall be in accordance with criteria specified by Section 4 of National Building Code of India Part VI.</p> <p>10.2 All walls shall be non-load bearing infilled panels walls. External walls of all buildings shall be at least one brick thick. All internal wall shall be at least one brick thick except for internal partition walls for office area, canteen, change rooms, first aid rooms and toilets which may be half brick thick. RCC bands shall be provided wherever necessary. Stone masonry / PCC wall shall be provided upto 300 mm above the finished grade level (FGL). Brick masonry shall be provided above this level.</p> <p>10.3 50 mm thick DPC (1:1.5:3) with water proofing admixture shall be provided at plinth level before starting masonry work.</p> <p>10.4 Minimum 50 kg/ sq cm compressive strength brick shall be used for non-load bearing super structure brickwork. Cement sand mortar 1:6 for one brick thick wall and 1:4 for half brick thick wall shall be used. For half brick walls, RCC transoms and mullions shall be provided.</p> <p>10.5 Type, thickness and height of external walling, facing the transformer yard to take care of fire accidents in transformer yard shall be according to the requirements of Tariff Advisory Committee (TAC).</p> <p>10.6 Even where metal cladding is specified, for initial 3 m height from the ground level, minimum one brick thick masonry wall shall be provided.</p> <p>10.7 All upstands and parapet walls on roof shall be of RCC constructions, minimum height of parapet walls shall be 750 mm and thickness 125 mm with aesthetics of architectural designs as approved by the owner.</p> <p><b>11. DRAINAGE</b></p> <p>11.1 Floor drainage</p> <p>11.1.1 For all buildings and areas, suitable arrangement for draining out water collected from equipment blowdowns, leakage, floor washing, fire fighting, etc., shall be provided on each floor. Gully traps, inspection pits, collecting pits etc., shall be located suitably and designed considering flow volume, easy access, maintenance and safety.</p> <p>11.1.2 All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating. These drains shall lead the water to drain sump.</p>		

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <b>PART A - GENERAL REQUIREMENTS</b>	SECTION: D4.6 VOLUME V SHEET 5 OF 6
<p>11.1.3 Garland drains shall be provided around all buildings to receive the drainage water from roof and floor and lead them to the plant storm water drainage system.</p> <p><b>11.2 Roof drainage</b></p> <p>11.2.1 Roof drainage system shall be provided for quick and efficient draining of rainwater from roof to avoid seepage and damage to roof. The runoff gradient for the roof shall not be less than 1 in 100. Roof drainage system shall consist of roof drain heads, rainwater down comers and fixtures. System shall be designed to handle design rain fall for the specific site and shall be in accordance to stipulations of IS: 1742 and IS: 2527. Roof drains shall conduct water to storm drains through down comers.</p> <p>11.2.2 Rainwater down comers shall be of HDPE Pipe conforming to IS: 4985.</p> <p><b>11.3 Sumps</b></p> <p>In case of underground structures, sumps with pumping arrangement shall be provided at suitable location to collect and pump out any incidental water collection to nearest storm water drain.</p> <p><b>* 12. WATER PROOFING OF UNDERGROUND STRUCTURES</b></p> <p>12.1 All underground structures like basements, pump houses, water retaining structures etc., shall have plasticiser cum waterproofing cement additives conforming to IS: 9103. In addition, limits on permeability as given in IS: 2545 shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS: 9862 @ 1.7 kg/sqm (minimum) for water / damp proofing. Also provision shall be made on the inner surface of walls and base slab, so that water proofing grouting can be injected later in case of leakage.</p> <p><b>13. ANTI TERMITE TREATMENT</b></p> <p>Pre-constructional anti termite treatment shall be given to all vulnerable areas susceptible to termite attack and shall include column pits, wall trenches, foundations filling below the floors etc., as per IS: 6313 and other relevant Indian Standards.</p> <p><b>14. Plinth level</b></p> <p>14.1 Finished ground floor level (plinth level) of all buildings and pump houses shall be minimum 500 mm above the formation level / grade level.</p> <p>14.2 All cable vaults shall be located above ground level i.e., vaults shall not be provided as basements in the buildings.</p> <p>14.3 Finished floor levels of Boiler area / transformer area yard paving shall be kept 200 mm lower than the finished floor level of turbine building.</p>		


KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION: D4.8 VOLUME V
	PART A - GENERAL REQUIREMENTS	SHEET 6 OF 6

**15.0 Backfilling of over excavated area:**

Over excavated area / loose soil / pockets shall be backfilled filled with M10 grade of concrete

**16.0 STATUTORY REQUIREMENTS**

- 16.1** All the applicable statutory rules pertaining to Indian Factories act, Factory rules of State Government, Fire safety rules of Tariff Advisory committee, Water act of Pollution Control boards, Explosives act etc., and stipulations of other relevant statutory authorities shall be taken into consideration at the time of design and construction.
- 16.2** Provisions of safety, health and welfare according to Factories act shall be complied with at design stage. These shall include provision of continuous walkway (minimum 500 mm wide) along crane-girder at crane girder level on both sides of the building, comfortable approach to EOT crane cabin, railings, fire escape locker room for workmen, pantry, toilets, rest rooms etc.
- 16.3** Adequate no. of fire escapes shall be provided in a building. Fire proof doors, no. of staircase, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall be made according to the recommendation of TAC. For fire safety requirements of buildings IS: 1641 and IS: 1642 shall be followed in addition to TAC requirements. All masonry firewalls shall be minimum 345 thick and RCC firewall shall be minimum 200 mm thick.

KPC/LBTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <b>TITLE PART - B: LOADS AND LOAD COMBINATION</b>	<b>SECTION : D4.6</b> <b>VOLUME - V</b> <b>SHEET 1 of 11</b>
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## 1. GENERAL

All structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, steam piping (static & dynamic) and other piping loads, wind loads, seismic loads, temperature loads, loads and forces developed due to differential settlement and any other loading conditions which can occur during the design life of the facility.

## 2. DEAD LOADS

2.1.1 Dead loads consist of the weights of the structure complete with finishes, fixtures, partitions, wall panels and all equipment of semi-permanent nature including tanks, silos, bins, partitions, roofing, piping, cable trays, bus ducts etc. The content of tanks, silo, bins and hoppers etc., shall be measured at full capacity for this purpose.

2.2 The piping loads, cable tray loads and the contents of the tank, silos, bins and hoppers shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilising load for uplift.

2.3 The following unit weight of material shall be considered for computation of loads. Loads given in IS: 875 (part-I) shall be made use of for material not listed below.

Materials	Unit weight
Plain cement concrete	2.40 t/cum
Reinforced cement concrete	2.50 t/cum
Structural steel	7.85 t/cum
Brick work	1.9 t/cum
Cement plaster	2.1 t/cum
Floor Finish	2.4 t/cum
Coal	1.20 t/cum
Fly Ash	1.60 t/cum
Bottom Ash	1.60 t/cum

## 3. IMPOSED LOADS

3.1 Imposed loads in different areas shall include live loads, dust loads, minor equipment loads, cable trays, small pipe racks / hanger, erection loads, operation / maintenance loads, etc. The loads considered shall not be less than that specified in IS: 875 (part II). The loads listed here under are the minimum loads for the areas involved. Special use areas shall be investigated and loads revised upward as necessary. Floors and supporting members which may be subjected to heavy equipment live loads shall be designed on the basis of the weight of equipment or specifically defined live loads, whichever is greater.



### 3.2 The specific minimum floor live loads are listed below:

#### 3.2.1 Roofs:

(a)	Flat Roof	1.5 kN/sqm for roofs
		5.0 kN/sqm for accessible roofs with HVAC
		Equipment etc.
(b)	Sloped Roof	As per IS: 875
3.2.2	Turbine Building	
(a)	Ground floor	General area 25 kN/sqm
		Heavy eqpt. Storage area 50 kN/sqm
(b)	Operating Floor	Rotor removal Area 30 kN/sqm
		Eqpt. Laydown Area 30 kN/sqm
		Other areas (Corridors etc.) 15 kN/sqm
		Rotor removal area beams shall also be checked for ½ the rotor load at the center of the beam.
(c)	Heater bay floor	10 kN/sqm
(d)	Deaerator floor	10 kN/sqm
(e)	Precast concrete covers	12 kN/sqm
(f)	Mezzanine floors	10 kN/sqm
(g)	Platform around deaerator	10 kN/sq,
(h)	Floor around feed water tank	20 kN/sqm

3.3	Boiler / Bunker area	
(a)	Floor at (+/-) 0.00	15 kN/sqm (under operation) or actual loads specified by Boiler manufacturer.
(b)	Feeder / Tripper floor	20 kN/sqm. Beams however shall be checked for feeder / tripper load.
3.4	Main control room/electrical buildings	
(a)	Control Room Floor	10 kN/sqm



	(b)	MCC Room	15 kN/sqm
	(c)	Cable vault floor	5 kN/sqm
	(d)	Battery Rooms	20 kN/sqm
	(e)	AHU, AC & ventilation plant floors	10 kN/sqm
	(f)	Switchgear room	15 kN/sqm
	(g)	PLCC, relay room	15 kN/sqm
3.5		Pump houses	
	(a)	Operating floor slab	15 kN/sqm, or as required by equipment supplier whichever higher.
3.6		Workshop	10 kN/sqm
3.7		Other Areas	
	(a)	RCC floors	5kN/sqm for offices, laboratories, conference rooms and general floors.
	(b)	Stairs and balconies	5 kN/sqm
	(c)	Chequered plate/gratings	5 kN/sqm
	(d)	Walkways	3 kN/sqm
	(e)	Toilet rooms	2 kN/sqm

3.8 Railway supporting bridges such as bridges, culverts etc., shall be designed as per Railway bridge rules.

3.9 Culverts and allied structures including RCC pipes shall be designed for Class "AA" loading and checked for Class "A" loading as per IRC standards for two-lane road and above.

3.10 Covers for trenches & channels which are not exposed to vehicular traffic shall be designed for Live load of adjoining area or 2 t/sqm whichever is higher. Where channels are likely to be exposed to vehicular traffic, the requirements of Code of practice for road bridges shall be adhered to.

3.11 Piping anchor and restraint forces of major piping shall be obtained from piping analysis results and be considered as live load in the structure design.

3.12 Ponding effects due to framing deflections for roofs, if any shall be considered.

3.13 In addition to the live loads, a minimum of 1.50 kN/sqm shall be considered as Hung loads for electrical, ventilation & air conditioning. A load of 2.5 kN/sqm shall be considered as Hung loads for piping unless otherwise mentioned.

3.14 Live loads reduction shall be in accordance with the provisions of IS: 875 & IS:1893 in case of seismic analysis.



#### 4. EARTH PRESSURE LOADS

4.1.1 Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of substructure of pump house, cold water basin of cooling water and under ground liquid storage tanks earth pressure at rest shall be considered.

- a) Angle of internal friction for foundation of underground structures for calculation of earth pressure shall be from soil report or 36 degrees whichever is less.
- b) For backfilled soil, angle of internal friction shall be limited to 33 degrees.

4.2 In addition to earth pressure and ground water pressure, etc., a minimum surcharge load of 2.0 t/sqm shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure.

#### 5. WIND LOAD

5.1 Wind load on structures shall be calculated as per provisions of IS: 875 (part 3). The wind shall be assumed to blow in any direction and most unfavourable condition shall be considered for design.

5.2 In design of structures, wind force on equipment supported on frame including all fixtures, piping, staircase, ladders, etc., shall also be considered.

5.3 Wind loads generally be estimated based on 3 seconds gust wind as per IS 875 (part -3). However, wind loads for slender structure (having height to width ratio exceeding 5) shall be calculated using gust factor method also and higher of the two wind load values shall be considered for analysis.

#### 6. SEISMIC LOADS

6.1 Seismic forces shall be as per zone III of IS:1893.


6.2 For following structures, the design methods listed below shall be used.

Turbine Building and Bunker Buildings	Response spectrum method
All other Buildings	Seismic Coefficient Method

6.3 The importance factor for all power plant buildings and structures shall be taken as 1.75 and for other minor structures as per IS:1893.

6.4 Ductile detailing in accordance with IS 13920 to be adopted for all concrete

6.5 structures which is mandatory for Zone - III.

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED	SECTION : D4.6
	BELLARY TPS, UNIT-3 OF 700 MW	VOLUME - V
TITLE	PART - B: LOADS AND LOAD COMBINATION	SHEET 5 of 11

## 7. TEMPERATURE LOAD

- 7.1 Expansion and contraction due to changes of temperatures of materials of a structure shall be considered and adequate provisions shall be made for the effects produced (as per provision in relevant IS codes). Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint shall be as per the provisions of IS: 800 and IS:456 for steel and concrete structures respectively.
- 7.2 Analysis shall be carried out for ambient temperature variation. The temperature variation shall be considered as 2/3 of average maximum annual variation in temperature. The average maximum annual variation in temperature for this purpose shall be taken as the difference between the mean of the daily minimum temperature during the coldest month of the year and mean of daily maximum temperature during the hottest month of the year. The structure shall be designed to withstand thermal stresses due to 50% of the temperature variation.
- 7.3 Coefficient of thermal expansion of steel shall be taken as per IS : 800.  
Coefficient for thermal expansion for concrete shall be taken as per IS: 456.

## 8. EQUIPMENT LOADS

- 8.1 Static and dynamic loads of major equipment such as deaerator, heaters, etc., shall be based on the manufacturer's data of the specified equipments and shall be considered in design in addition to the live load. However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load shall not be considered. Eg: switchgear and control room floors are usually designed for a live load that includes the equipment weight.
- 8.2 All equipment, tanks and piping design loading shall include hydraulic testing loading. Weight of equipment, ducts, tanks, pipes, conduits, etc., supported by structure shall include maximum possible loading conditions i.e flooded conditions and associated impacts, test loading, anchorages and constraint effects.
- 8.3 Air and gas duct loads shall include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads applicable.

## 9. CRANE, MONORAIL, ELEVATOR & TRACK MOUNTED VEHICLE LOADS

- 9.1 Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter.


### 9.2 Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS: 875. The minimum impact factor to be used in design shall be as follows:

#### 9.2.1 Crane loads:

- (a) For vertical force, an impact factor of 25% of the maximum crane wheel load



KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED	SECTION: D4.6
	BELLARY TPS, UNIT-3 OF 700 MW	VOLUME - V
TITLE	PART - B: LOADS AND LOAD COMBINATION	SHEET 6 of 11

(b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail divided in proportion to the relative lateral stiffness of the rail support system

(c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.

**9.2.2 Monorail loads**

(a) Impact factor of 10% of lifted load of hoist for monorail and support design

(b) Impact factor of 25% of the lifted load for electrical pulley and support design

**9.2.3 Elevator**

A 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams.

**9.2.4 Pedestals supporting gravity take ups for conveyors and pedestals in elevator pits shall be designed assuming 100% impact factor.**

**9.3 Track mounted vehicle supporting structures shall be designed assuming 100% impact factor**

**10. OTHER LOADS**

**10.1 Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance loads, creep and shrinkage shall also be considered in design of all structures.**

**10.2 In order to allow for unusual loading during steel member erection or during the construction period, all beams on major column lines acting as column struts or ties are designed to withstand an axial force of 45t in combination with the dead load of the beam. End connections on these beams are designed to transfer its axial load. A minimum of 12mm thick connection angles are to be provided unless thicker angles are required by design.**

**10.3 Roof girders / trusses in the service / maintenance bay of Turbine building shall be designed for crane erection loads.**

**10.4 Columns in turbine building near transformer yard shall also be designed to support tension due to strung conductors and shield wire if the conductors are connected to the Turbine building columns.**


**11.0 BASIC LOAD CASES**

The following basic load cases shall be considered for the analysis:

(a) Dead load : D

(b) Self weight of permanent equipment : EL

(c) Live load on floor / walkway : L

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED	SECTION : D4.8
	BELLARY TPS, UNIT-3 OF 700 MW	VOLUME - V
TITLE	PART - B: LOADS AND LOAD COMBINATION	SHEET 7 of 11

(d)	Live load on roof	:	LR
(e)	Crane load with lift	:	CR1
(f)	Crane load without lift	:	CR2
(g)	Wind load	:	WL
(h)	Seismic load	:	SL
(i)	Load due to soil pressure	:	SP
(j)	Load due to surcharge	:	SCL
(k)	Load due to hydrostatic pressure	:	HP
(l)	Load due to temperature	:	TL
(m)	Special loads	:	SPL

## 12.0 LOAD COMBINATIONS

12.1 The individual members of the frame shall be designed for worst combination of forces such as bending moment, axial force, shear force and torsion. Permissible stresses for different load combinations shall be taken as per IS: 875 (Part-V) and other relevant IS codes. Wind and seismic forces shall not be considered to act simultaneously.

12.2 Criticality of erection / maintenance loads shall also be checked separately in combination with other simultaneously occurring loads for possible design loading.

12.3 For design of main plant structures during seismic conditions, the deaerator feed water tank shall be considered full up to operating level. However for other load combinations flooded condition shall be assumed.

12.4 "Lifted load" of crane shall not be considered during seismic condition.

12.5 In case more than one crane is provided and Tandem operation is not envisaged, the load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane.


## 13. LOAD COMBINATIONS FOR UNDERGROUND STRUCTURES

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure of pump house, channels, sumps, tanks, reservoirs, trenches and other under ground structures.

13.1 Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).

13.2 Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

13.3 Base slab of the pump house shall be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of pump sumps and

KPCL/BTPS/03/EPC 	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION : D4.6 VOLUME - V
	TITLE PART - B: LOADS AND LOAD COMBINATION	SHEET 8 of 11

partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

13.4 Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS: 3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

13.5 Effect of uplift pressure due to created water bodies like raw water pond / ash pond shall be considered.

#### 14. SPECIAL STRUCTURES

For the following structures, additional loading criteria as mentioned below in addition to the criteria discussed above shall be considered:

##### 14.1 Coal bunkers

14.1.1 The following densities shall be considered for design of coal bunkers :

- (a) For volume calculations : 800 kg/cum
- (b) For structural design : 1200 kg/cum

14.1.2 The coal bunker will be designed as per criteria outlined in IS:9178 (Part I&II)

##### 14.2 Ash silos

14.2.1 The following densities shall be considered for design of coal bunkers :


- (a) For volume calculation of bottom ash silo : 650 kg/cum
- (b) For volume calculation of fly ash silo : 750 kg/cum
- (c) For load calculation of both types of silos : 1600 kg/cum

14.2.2 The steel ash silo shall be designed generally as per the criteria laid down in IS: 4995 (Part I&II). The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top 1/3 rd portion and by a factor of 1.75 for the bottom 2/3 rd portion. Special attention shall be given in assessing the effect of hot temperature of ash on the wall. Temperature of ash shall be taken as 150°C.

##### 14.3 Switchyard structures

14.3.1 The loading for the design of switchyard structures shall be as per IS: 802 Part 1/Sec1-1995 (latest edition). Following loads shall be considered:

- (a) Dead load due to equipment and dead load due to structure
- (b) Wind load on towers, conductors, ground wires and insulator strings calculated as per clause 8 and 9 of IS: 802

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	<b>SECTION : D4.6</b> <b>VOLUME - V</b>
	<b>TITLE</b> <b>PART - B: LOADS AND LOAD COMBINATION</b>	<b>SHEET 9 of 11</b>

(c) Temperature effects consisting of effect of temperature variation and sag tension as per clause 10 of IS: 802

(d) Climatic loads as per clause 11.2 of IS: 802

(e) Anti cascading loads as per clause 11.3.1 of IS:802

(f) Torsional and longitudinal loads caused by breakage of conductor as per clause 11.3.2 and 16 of IS:802

(g) Construction and maintenance loads

(h) Seismic loads as per IS: 1893

(i) Short circuit forces including "snap effect" in the case of bundled conductors


14.3.2 Switchyard structure shall be designed for the worst combination of above loads. The factor of safety for design of members shall be considered as 2 for normal and broken wire conditions and 1.5 for combined short circuit and broken wire conditions. Short circuit forces and wind forces shall not be considered simultaneously.

14.3.3 Foundation shall be designed for a factor of safety 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire conditions. Design of foundation shall be carried out as per IS: 4091.

**14.4 Coal Handling System**

In addition to the loads specified in section 3 above, following additional loads shall be considered for design of various structures:

(a) Flat roof – accessible	: 0.50KN/sqm dust load
- non accessible	: 1.25KN/sqm dust load
(b) Inclined roof	: 0.50KN/sqm dust load
(c) Building floors	: 5KN/sqm or equipment load whichever is higher + 1KN/sqm Spillage load (where equipment is located)
(d) Load due to material on belt	: 1.6 times design weight of the Material on belt
(e) Spillage load	
(i) Gallery walk way	: 1KN/sqm
(ii) Seal plate	: 1KN/sqm
(f) Belt tension for twin	: One belt at starting conveyors condition and one in running condition
(g) Impact factor for drive machines	: 1.50

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART - B: LOADS AND LOAD COMBINATION</b>	<b>SECTION: D4.6</b> <b>VOLUME - V</b> <b>SHEET 10 of 11</b>
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#### 14.5 Boiler ESP support structures


14.5.1 The supporting structure shall be designed for the following :

- (a) Live / imposed loads
- (b) Dead loads
- (c) Static and dynamic loads of piping, movable equipment and maintenance parts
- (d) Cantilever loads of not less than 2000 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the ESP, for cable trays and walkways.
- (e) Cantilever loads of not less than 500 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the boiler, for cable trays and walkways.
- (f) Dry ash piping supported from the main columns of ESP structure
- (g) Ash water piping supported on the outermost row of boiler column
- (h) All ESP hoppers filled up with ash upto the top of the hoppers or the bottom of the electrodes (whichever is more) using a bulk density of not less than 1350 kg/cum for the ash, along with additional ash build-up from the end of the third field upto the inlet duct bottom level at a natural repose angle (not less than 30 degree to horizontal in any case)
- (i) Seismic or wind loads as specified elsewhere in the specification
- (j) Temperature variation of  $\pm 25$  deg. C for atmospheric temperature variations
- (k) Temperature variations under ESP operating conditions
- (l) The loads listed above indicate the minimum requirements

14.5.3 Boiler supporting structures shall be so configured that the temperature of steel does not exceed 60 deg.C unless specified otherwise. Brackets shall be provided on both sides of the outermost row of columns of both the boiler and ESP for supporting cable trays and walkways, at a height not exceeding 10.0m. The exact levels shall however, be decided during detail engineering. Each ESP hopper shall be supported at four corners by providing four columns from the ground.

14.5.4 Dry ash transportation pipes and supply air pipes shall be supported on the structural members of the ESP.

14.5.5 The bracings in the boiler structure shall be provided such that under no circumstances normal / convenient access to all points in the boiler is blocked or obstructed.

KPC/LBTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED	SECTION : D4.8
	BELLARY TPS, UNIT-3 OF 700 MW	VOLUME - V
TITLE	PART - B: LOADS AND LOAD COMBINATION	SHEET 11 of 11

14.5.6 The ESP hopper outlet flanges shall be terminated at a height of 3.5m above ground level.

14.5.7 Boiler and ESP support structures shall be checked for differential settlement of foundations which shall be restricted to 1 in 1000 of span or 8 mm whichever is less.

14.5.8 In design of boiler /ESP support structures dynamic piping loads need not be considered acting simultaneously with wind or seismic loads. Increase in permissible stresses shall be allowed in load combinations where dynamic piping loads are considered and shall be as permitted under seismic load conditions.

14.5.9 Design criteria for foundations and some other facilities / areas are covered separately in this specifications.

#### 14.6 R.C.C chimney

Reference shall be made to IS: 4998 Part I (1992) – "criteria for design of Reinforced concrete chimneys – part I, assessment of loads" for loading details. For wind loading IS: 875 and for seismic loading IS: 1893 shall be referred to. Wind load magnification on the Chimney induced by adjacent tall structures such as Cooling towers/Boiler structures shall be included in model study conducted in wind tunnel, and necessary modification shall be made in the wind loading for design.


#### 15.0 Specific design Requirements:

To account for revisions & additions of new loads likely to occur as the design work progress, the stress ratio / design margin for design of members shall be as follows:

(a) for foundations, the actual to allowable bearing pressure ratio shall not exceed 0.90. Further there shall be a margin of 10% on the reinforcement provided as compared to the required reinforcement.

(b) the minimum diameter of bar for foundation shall be 12 mm.

(c) for column & beams the stress ratio shall not exceed 0.90 for normal loading conditions and not to exceed 1.20 for wind/seismic loading combination.

KPCL/BTPS/03/EPC	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	SECTION: D4.6 VOLUME V
	TITLE <b>PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS</b>	SHEET 1 of 10

1. **GENERAL**  
 All structures, building foundations, machines / equipments foundation, water retaining structure, trenches, pits, etc., shall be designed as per relevant IS codes in general. Construction in general shall follow provisions of IS: 456 and IS: 3370 for normal and water retaining structures respectively.
2. **DESIGN METHODOLOGY**
  - 2.1 **General**
    - 2.1.1 All foundations to be designed as per working stress method. All designs of RCC structures shall be carried out by limit state method as per IS: 456 unless use of working stress method is specifically mentioned. Design strength of materials and design loads shall be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS: 456:
    - 2.1.2 Steel silos shall be designed as per IS: 4995 (part 1 & 2).
    - 2.1.3 For reinforcement detailing IS: 5525 and SP: 34 shall be followed.
    - 2.1.4 The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.
  - 2.2 **Foundation and Underground structures**
    - 2.2.1 **General**  
 The depth of all the foundations from design consideration shall be reckoned from the NGL (Natural Ground Level) or FGL (Finished Grade Level): whichever is lower. The minimum depth of the foundations for structures shall be 1.5m except for minor equipment foundations.
    - 2.2.1.1 Type of foundation system, i.e., isolated, strip or raft shall be decided based on the loading arrangement, load intensity and soil strata. Design of foundations at various levels shall be dependent upon the soil bearing capacity at that level.
    - 2.2.1.2 Foundation system adopted shall ensure that settlement / relative settlement is as per provision of IS: 1904 and other Indian Standards. However, the settlement shall be restricted to 25 mm & 12 mm in soil & disintegrated rock respectively.
    - 2.2.1.3 All foundation including machine / equipment foundations shall be of RCC construction. All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian standards IS: 2974 and IS: 456. Raft foundations shall be designed as per IS: 2950.



**2.2.1.4** For design of underground structures, subsoil water level below the formation level shall be based on the detailed investigations carried out by the CONTRACTOR. Any variation in such assumptions during the execution shall be to the CONTRACTOR's account only. All underground pits, tunnels, basements, cable and pipe trenches, etc., shall be leak proof RCC structure where specified design depth of ground water table so warrants. Effects of uplift and reduction in bearing capacity due to underground water table shall also be considered.

## **2.2.2 Liquid retaining structures**

**2.2.2.1** RCC water retaining structure like storage tanks, reservoirs, cooling tower basin, etc., shall be leak proof and designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses in accordance with IS: 3370 (part I to IV) by working stress method.

**2.2.2.2** Water channels and substructure of pump houses shall be designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses as per IS: 3370 (part I to IV) by working stress method.

**2.2.2.3** All water retaining / storage structures shall be designed assuming liquid upto the height of wall irrespective of provision of any over flow arrangement. No pressure relieving devices shall be permitted in underground structures.

**2.2.2.4** In all liquid retaining structures, PVC water bar shall be provided at each construction / expansion joint. The sequence of construction shall also be specified on drawings showing construction joints. Fillets of minimum size 200 x 200 shall be provided at both the horizontal & vertical joints.

**2.2.2.5** Where anchors are prescribed to resist uplift, the design of the same shall be based on the recommendation of IS 10270 or the recommendations & parameters furnished below whichever is more critical.


(a) Minimum diameter of anchor rod shall be 25 mm and that of anchor hole shall be 75 mm. The diameter of anchor hole shall not be less than 2.5 times the diameter of the anchor rod.

(b) The anchor hole shall be grouted with cement, sand aggregate ( of size 6 mm and down) grout 1:1:2 with non-shrink additive and shall be of strength not less than M30 or one grade higher than the grade of concrete to be used.

(c) Minimum depth of anchor in rock shall be 2 m. Anchor strength in soil layer shall not be accounted. The allowable bond stress between grout & rock shall be 0.2 N/sqmm and 0.5N/sqmm for disintegrated rock and hard rock respectively.

(d) The anchor rod shall be protected by corrosion resistant paint as per IS 10270.



KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	SECTION: D4.6 VOLUME V
	TITLE <b>PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS</b>	SHEET 3 of 10

(e) Adequate number of pull-out tests as per IS 11309 shall be conducted to verify the capacity of the anchors both for test and working anchor.

**2.3 Machine Foundations**

The design of equipment foundation shall be as per IS: 456 and IS: 2974. The provisions of DIN 4024 shall also be followed for machine foundations.

**2.3.1** All machine / equipment foundations and structures subject to vibrations shall suitably proportioned so that amplitude and frequency of the foundation / structures are within permissible limits.


**2.3.2** All block foundations resting on soil shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than the two and a half (2.5) times mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all modes including coupled modes and to calculate vibration amplitudes. The Minimum reinforcement shall also be governed by IS: 2974 and IS: 456.

Frequency & amplitude criteria as laid down by relevant ISO/IS/DIN/VDI codes or machine manufacturers shall be satisfied. Unbalance loads shall be calculated as per relevant IS/VDI/ISO requirements as applicable for the relevant machines and compared with the data furnished by the manufacturers and higher of the two values shall be considered for amplitude calculation. However minimum reinforcement for raft shall be 0.12 % of the gross area in each face and in each direction. Minimum reinforcement for block foundations shall also be not less than 50 kg/cum.

**2.3.3** For the foundations supporting minor equipment weighing less than one ton or of the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably.

**2.3.4** Steam turbine generators, Boilers Feed Pumps, FD Fans, ID Fans, PA fans, Crushers and mills shall be supported on vibration isolation system. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC deck which support the machine. The spring units shall conform to DIN 2089 and DIN 2098. The whole system is supported on block foundation consisting of common raft and pedestals.

Dynamic analysis for frame type foundations like TG shall be carried out using special finite element soft ware packages ANSYS, NISA or

KPCL/BTPS/03/EPC  	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>  TITLE <b>PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS</b>	SECTION: D4.6 VOLUME V  SHEET 4 of 10
	<p><b>NASTRAN.</b> The foundation shall be modelled using solid elements with element width not exceeding 300 mm. Harmonic analysis shall be carried out to obtain responses upto +10% of the operating frequency.</p> <p><b>2.3.5</b> All such foundation shall be separated from adjoining part of building and other foundations. Joints at floor / slab shall be suitably sealed. All appendages to such foundations shall be reinforced suitably to ensure integral action.</p> <p><b>2.4</b> <b>Increase in Stresses</b></p> <p><b>2.4.1</b> Where stresses due to wind (or seismic) and temperature are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel shall be increased by 33.33% in case of working stress design. However, when stresses due to wind (or seismic) loads are combined with dead load alone, no increase in allowable stresses is permitted.</p> <p><b>2.4.2</b> Bearing capacity of the soil shall be allowed to increase by 25% under seismic / wind load condition or as per applicable codal provisions whichever is lower. However, when wind (or seismic) loads are combined with dead load alone; no increase in bearing capacity is permitted.</p> <p><b>2.5.1</b> Shear enhancement as per IS 456:2000 clause shall not be considered.</p> <p><b>2.5.2</b> Walls/slabs more than 150 mm thick and footings more than 300 mm thick shall be provided with reinforcement on each face /top &amp; bottom, even if not required from design consideration. Minimum reinforcement for slabs/footings/ shafts shall be 0.12% of the gross area in each face and in each direction.</p> <p><b>2.5.3</b> Pedestals for steel columns shall be treated as column for design and detailing purposes. Minimum reinforcement shall not be less than 0.25% of the cross sectional area.</p> <p><b>3</b> <b>Stability of structures</b></p> <p><b>3.2</b> Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like under ground tanks, pits trenches, basements, etc. Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken in to consideration.</p> <p><b>3.3</b> All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these</p>	



cases shall be taken as mentioned in IS: 456 and other relevant IS codes. However, following minimum factor of safety shall be followed.

- (a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.
- (b) Factor of safety against sliding shall be 1.5 minimum.
- (c) Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5.


**3.4** Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

**3.5** In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

#### **4 MINIMUM THICKNESS OF STRUCTURAL ELEMENTS**

The following minimum thickness shall be followed:

- |                                                                            |                |
|----------------------------------------------------------------------------|----------------|
| (a) Suspended floor / slab / walkways / Canopy slabs, etc                  | 125 mm         |
| (b) Ground floor slab (non-suspended)                                      | 150 mm         |
| (c) Water Retaining slabs / walls                                          | 200 mm         |
| (d) Cable / pipe trenches / underground pits / Launder walls and base slab | 125 mm         |
| (e) All footings (including raft foundations)                              | 300 mm         |
| (f) Parapets                                                               | 125 mm         |
| (g) Sunshades                                                              | 75 mm at stage |
| (h) Precast louvers / fins                                                 | 50 mm          |
| (i) Precast trench cover slabs / floor slabs / louvers                     | 75 mm          |
| (j) Paving                                                                 | 100 mm         |
| (k) Basement walls and base slab                                           | 200 mm         |
| (l) Silo / bin walls                                                       | 150 mm         |

KPCL/BTPS/03/EPC	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>		<b>SECTION: D4.6</b> <b>VOLUME V</b>
	<b>TITLE</b> <b>PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS</b>		<b>SHEET 6 of 10</b>

(m)	<b>Underground reservoir</b> <b>Below ground water table</b>	<b>200 mm</b>
	<b>Above ground water table</b>	<b>150 mm</b>

**4.2** From fire resistance point of view minimum cover for reinforced Concrete members shall be as per fig 1 of table 16a of IS 456.

**5 MINIMUM HEIGHTS FOR PEDESTALS OF STEEL COLUMNS**

**5.1** Pedestals to Steel Columns for building structures :  
 Top or RCC foundations (pedestals) shall normally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below finished floor level (FFL) unless specified otherwise. Foundation levels for some columns shall be changed suitably to accommodate underground services, pits trenches, etc.

**5.2** Stair and ladder pedestal shall be kept 200 mm above the finished floor level.

**5.3** Pedestals to Steel Columns for Equipment structure :

(a)	Equipment in open area	: as required (300mm min)
(b)	Equipment in covered area	: as required (150 mm min)
(c)	Structures and equipment supplied by vendor	: as per vendor's data subject to minimum as specified above

**6 MINIMUM HEIGHTS FOR ENCASEMENT TO STEEL COLUMNS**


In case the top of pedestal is kept at a lower level so that the column base plate together with gussets and stiffeners remain below finished floor level (FFL) the column bases as well as the column sections shall be encased in concrete above FFL as per following.

(a)	Open area	: 300 mm above paved level
(b)	Covered area :	150 mm above FFL

**7 CONCRETE MIX**

**7.1** The following minimum grades of concrete as per IS: 456 shall generally be used for the type of structures noted against each grade. Ordinary Portland Cement (OPC) shall be used. Pozzalona Portland Cement (PPC) shall also be used if directed by the Owner. Grade of cement shall be 43 conforming to IS 8112. For super structure of RCC chimney, natural draft cooling towers and inertia blocks of spring supported foundation richer mix may be used as per the design requirement.

**M10** : Backfilling of over excavated area.

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION: D4.6 VOLUME V
	TITLE PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS	SHEET 7 of 10

M15 : Foundation below brick wall, blinding layer below foundations, trenches and underground structures, minimum thickness of the layer shall be 100 mm.

Grade M20 : Base plate encasement, paving plinth protection works, encasement of structural steel work, etc.

Grade M25 : All RCC members except where other grades are specified e.g. Foundation and super structure, grade beams, pedestals, ground floor slabs, roof slabs, cable and pipe trenches, Water retaining structures below and above ground, Precast concrete work, etc.

7.2 Minimum cover to the reinforcement shall be as per IS:456 .

7.3 Minimum cement content shall be governed by the requirement of IS:456.

8 REINFORCEMENTS

8.1 Reinforcement bars shall be as per the following codes :

High Yield Strength Deformed bars	:	IS: 1786
Mild steel bars	:	Grade I of IS: 432
Welded wire fabric	:	IS: 1566

8.2 Intermixing of different grades of rebars or rebars of different material composition in same structure shall not be allowed.

9 GROUTING


9.1 Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticiser admixture shall be added in the grout. For grouting of base of machine foundation high strength flowable ready mixed non-shrink grout shall be used.

9.2 Type and grade of grouting for structural columns and equipment bases shall be indicated. Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M30.


9.3 Nominal thickness of grouting shall be atleast 50 mm for building columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting shall not be less than 25 mm thick.

10 MINIMUM COVER TO FOUNDATION BOLTS

Minimum distance from the center line of foundation / anchor bolt to edge of pedestal shall be the maximum of the following:

KPCL/BTPS/03/EPC  	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	<b>SECTION: D4.6</b> <b>VOLUME V</b>
	<b>TITLE</b> <b>PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS</b>	<b>SHEET 8 of 10</b>
	<p>(a) Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 50 mm.</p> <p>(b) Clear distance from the face of pocket to the outer edge of pedestal shall be 75 mm.</p> <p>(c) Clear distance from the edge of sleeve or anchor plate to the outer edge of pedestal shall be 75 mm.</p> <p><b>11.0 MISCELLANEOUS REQUIREMENT</b></p> <p><b>11.1</b> Fillets at the junction of roof and vertical walls shall be provided with cast in situ cement concrete grade M 15 followed by 12 mm thick 1:4 cement mortar.</p> <p><b>11.2</b> A screed layer not less than 100 mm thick of cast in situ concrete of nominal grade M10 shall be provided below all water retaining structures. A sliding layer of craft paper or bitumen paper shall be provided over the screed layer to destroy the bond between screed and base slab.</p> <p><b>11.3</b> All under ground structures such as conveyor tunnels, wagon tippler pits, reclaim hopper pits, slurry pump house, etc, shall be designed as per IS: 456 limiting the crack width to 0.1 mm. Check for crack width shall be in accordance with BS: 8007/IS: 456. In case of leakage in the above structure injection grouting method shall be applied to repair the structure according to the requirement of IS: 6494.</p> <p><b>11.4</b> For switchyard foundations anchor bolt with mechanical anchorage shall be provided and cast along with foundation concrete. Bolts in pockets shall not be adopted. Foundation for all switchyard towers shall be designed as per IS: 4091. Contact between foundation and the soil strata shall be ensured for all conditions and combinations of loading</p> <p><b>11.5</b> Plywood formwork shall be used for all water retaining / conveying structures and for all over ground concrete works. For other areas steel / plywood formwork shall be used.</p> <p><b>11.6</b> Unless specified 20mm and down graded aggregates shall be used for all structural concrete works. However 40mm and down graded aggregates may also be used for mass / deep foundations like coal mill foundations, fan foundations etc., under specific approval from the owner.</p> <p><b>11.7</b> Tolerance for formed and concrete dimension shall be as per IS:456</p> <p><b>12.0 MAJOR EQUIPMENT FOUNDATIONS</b></p> <p>Special requirements for concreting of major equipment foundations shall be as given below:</p>	



KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	<b>SECTION: D4.6</b> <b>VOLUME V</b>
	<b>TITLE</b> <b>PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS</b>	<b>SHEET 10 of 10</b>

**12.7 Ultrasonic Testing**

Ultrasonic pulse velocity test shall be carried out for the top decks of all machine foundations and TG substructure to ascertain the homogeneity and integrity of concrete. In addition, additional cubes (at the rate of one cube per 150 cum of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes to serve as reference UPV values

Testing shall be done as per IS: 13311 (Part-1). In case of any defects, the CONTRACTOR shall rectify the defects suitably using cement / epoxy grout etc.

**12.8 Quality Control**

Refer Clause 3.5 of Section 4.5 of Volume-V.





TITLE

PART D : STEEL STRUCTURES

1. **GENERAL**

1.1 Design of structural steel work shall include generally but not be limited to the steel constructions listed below:

- i) Steel building structure and open structures:  
This shall include beams, columns, bracings, supporting structures for floors, roof slabs, cladding etc.
- ii) Crane gantry girder, monorails etc.
- iii) Coal bunkers
- iv) Coal conveyor galleries and trestles
- v) Large diameter oil tanks
- vi) Large diameter pipe line for cooling water
- vii) Galvanised latticed structures for switchyard
- viii) Pipe and cable racks
- ix) Platforms and walkways
- x) Ladders, staircases, handrails etc.

2. **FRAMING**

2.1 All steel framed structures shall be either "rigid frame" or "simple space frames" or a combination of two.

2.1.1 Lateral forces shall be resisted by stiff jointed moment connections in rigid frame design. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

2.1.2 Simple space frame design utilises single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. The most of plant steel buildings shall be designed as simple space frame structures.

2.2 The turbine building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction. Two plane bracing each along the flange of columns shall be adopted for columns of depth 800 mm and above.


2.3 Pipe rack shall consist of rigid main frame in transverse direction spaced longitudinally as required. In longitudinal direction, pipe rack shall be divided into sections of suitable length with an anchor bay. The main transverse frames shall be connected with longitudinal beams, which will transmit horizontal forces to braced anchor bays. The pipe and cable rack bridge structure shall be adequately rigid to carry the forces from pipelines at anchor points without undue deflection so that pipelines are really anchored at the anchor points.

- 2.4** Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However, shear connectors / Lugs of minimum 65X65X6 angle at 500 c/c shall be provided. In addition, wherever large cut-outs are provided in the floor slabs, horizontal floor bracing shall be provided. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support and horizontal bracing shall be provided as required. For Axial compression, concrete floor shall not be assumed to provide restraint unless bottom flange is also restrained. Suitable stays, secondary beams with stiffener connecting the bottom flange shall be provided to have lateral restraint.
- 2.5** Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimise vibration, avoid resonance and maintain alignment and level.
- 2.6** Columns shall be designed to support the load combination, which produces the maximum interaction ratio. Exterior columns shall be designed to resist wind moments between braced elevation as appropriate. Columns shall also be designed to resist moments caused by discontinuous vertical bracing or non-concentric bracing work points.

**3.1** Structural steel shall conform to Grade A of IS: 2062 for rolled steel members or plates up to 20 mm thickness. For plates above 20 mm thickness or welded construction, steel conforming to Grade B (Killed) of IS: 2062 shall be used except for crane girders where Grade C (IS: 2062) steel shall be used.

- 3.2** Chequered plates shall conform to IS: 3502. All gratings shall be pressure locked type (preferably electro-forged) manufactured in accordance with applicable Indian standard. Pipes for handrail shall be as per medium grade of IS: 1161. Crane rails shall conform to IS: 3443.
- 3.3** Stainless steel used as liner in Coal bunker shall be of grade designation SS 409M. Stainless steel used in flue shall be of grade designation SS 316L.

**4.1** Welding shall be used for shop fabrication and joints. For site connections, welding or high strength friction grip (HSFG) type bolts shall be used, except in few cases for shear connections of lighter members or removable beam connections where bolted joints may be adopted e.g. purlins, side girts etc. A minimum of two bolts per connection shall be used.

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS,UNIT-3 OF 700 MW	SECTION: D4.6
	TITLE PART D : STEEL STRUCTURES	VOLUME V SHEET Page 3 of 15

4.2 IS:816 and IS:9595 shall be followed for welding of structures.

4.3 For high strength friction grip bolt connections IS: 4000 shall be followed. High strength friction grip bolts shall be of property class 6.6 or 8.8 and shall conform to IS: 3757 and shall not be less than 20 mm in diameter unless designated otherwise. High strength bolts shall be installed as bearing type joint except where loads are reversible.

4.4 All bolted connections shall have bolts of minimum 16 mm dia. The connections of stairs and handrailing shall be made with 20 mm diameter threaded fasteners conforming to IS: 1363. Erection bolts shall be black bolts of minimum 12 mm dia.

4.5 All bolts and nuts shall have property / class compatible to each other. For bolts carrying dynamic or fluctuating loads and those in direct tension shall be provided with an additional double coil helical spring washer conforming to IS: 6755. The threaded portion of the bolt shall project through the nut at least by one thread.


4.6 Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.

4.7 For crane girders, welding between web and flange plates shall be carried out by submerged arc welding process. Full penetration of weld between web plate and top flange shall be ensured. Intermediate stiffeners shall be connected with top flange plate by full penetration butt weld. Welding across tension flange will not be permitted. Bearing edges of crane girders shall be machined.

4.8 The working point of the bracing connection shall be the center of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plate in between shall not be used in dust laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.

4.9 Horizontal bracings shall be angle / tee section located at the bottom of framing beams. Field welding of bracing at the underside of beam as required to meet slenderness requirement of bracing member shall be indicated on the drawings. Horizontal bracing shall be arranged to avoid framing into the beams at column locations.

4.10 For Major columns of main building, column splices shall be designed to resist the greater of the design axial tension load and moments or an axial tension load of 45 t plus 50% of the member capacity in bending in either the major or minor axis, whichever produces the greatest number of bolts.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <hr/> TITLE <b>PART D : STEEL STRUCTURES</b>	SECTION: D4.6 VOLUME V SHEET Page 4 of 15
	<p>4.11 Minimum size of fillet weld shall be 5 mm. Main structural elements shall be welded continuously. Intermittent weld shall be used only on secondary members, which are not exposed to weather or other corrosive influence.</p> <p>4.12 Efficiency of site welds to be considered shall be as follows:</p> <p>a) Butt weld above 25 m from ground -- 50%</p> <p>b) Others -- 80%</p> <p>5. <b><u>DESIGN METHODOLOGY</u></b></p> <p>5.1 The Design of steel structures shall be done by working stress method in accordance with the provisions of IS: 800 and other relevant IS Codes as applicable to specific structures.</p> <p>5.2 All buildings/structures shall be framed structure. Basic consideration for structural framing shall be stability, rigidity, building uses, ease of fabrication / erection and overall economy. Additional bracings/moment connections shall be used to assure stability of structures. Structure shall be designed such that the surfaces of all parts shall be accessible for inspection, cleaning, painting and maintenance.</p> <p>5.3 Crane gantry girders shall be single web plate girder of welded construction with bearing and intermediate stiffeners. Crane girder shall be designed as simply supported and of single span length. Chequered plate shall be used for gantry girder walkway flooring. For lifting / monorails beams ISMB sections shall be preferred and the bottom flange of all beams shall be checked separately for distortion and reinforced suitably if required.</p> <p>5.4 Permissible stresses for different members shall be allowed to exceed upto 33 1/3 % only when wind / seismic loads are combined with dead &amp; live loads. No increase is permitted when wind / seismic loads are combined with dead loads alone. However members which are designed primarily to resist wind / seismic, such as bracing members, no increase in permissible stresses will be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed upto 25% only under wind and seismic conditions.</p> <p>5.5 For design which requires the use of the minimum column load (such as, uplift on anchor bolts, column axial tension, etc.) the following criteria shall be used in determining minimum load: Use 85% of the column dead load, No live load is used, Uplift forces from vertical bracing are included where applicable and Wind uplift on the roof is included where applicable.</p> <p>5.6 Base plates shall be placed on foundation pedestal with grouting. For large base plates necessary grout holes shall be provided. All anchor bolts for fastening steel columns on foundation shall be embedded in</p>	



foundation during concreting itself. No anchor pockets in foundation shall be allowed. Design of base plates shall be based on design pressure on foundation which shall not exceed the following:

Pedestal in concrete grade M25	6.25 N / sq.mm
Pedestal in concrete grade M30	7.5 N / sq.mm

- 5.7 The total horizontal shear force at the base of column is transferred to the column pedestals through friction between the base plate and the grout. A coefficient of friction of 0.30 shall be used in conjunction with the minimum column load as defined above. If the horizontal shear force exceeds the frictional resistance force or if the column is subjected to a net uplift load, the total force shall then be transmitted through shear bars / shear keys welded to the base plate. Anchor bolts are not assumed to resist any horizontal shear force. Necessary recesses shall be kept in the foundation concrete for shear lugs.

- 5.8 The following criteria shall be followed for posting loads on the design drawings. For vertical beam reactions, the load shall be posted whenever the value exceeds the maximum allowable uniform distributed load. For axial loads in floor beams, the actual horizontal load which the beam end connection must resist shall be posted for each end of the beam. Note that this value may be different for opposite end of the same beam. For truss members, only one member force shall be noted for each member.

## 6 PERMISSIBLE DEFLECTIONS

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members dynamic effects shall not be considered, unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

### 6.1 Vertical Deflection

- 6.1.1
- a) For beams supporting dynamic equipment : Span / 500
  - b) For beams supporting floors / masonry : Span / 325
  - c) For beams supporting pipes ( pipe racks ) : Span / 400
  - d) For roofing and cladding components : Span / 250
  - e) For gratings and chequered plates : Span / 200 subject to a maximum of 6 mm
  - f) Coal conveyor gallery bridges : Span / 450

- 6.1.2 For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

- a) For manually operated cranes & monorails : Span / 500



TITLE

**PART D : STEEL STRUCTURES**

b) For electric overhead cranes

i) up to 50 t capacity : Span / 750

ii) over 50 t capacity : Span / 1000

**6.2 Horizontal deflections**

The permissible horizontal deflections shall be as per following unless specified otherwise:

- |                                                                                     |   |                                           |
|-------------------------------------------------------------------------------------|---|-------------------------------------------|
| a) Single storey building (without crane load)                                      | : | Height / 325                              |
| b) Multistoried building (without crane load)                                       | : | Height / 500                              |
| c) Pipe rack columns                                                                | : | Height / 200                              |
| d) Open Structures                                                                  | : | Height / 200                              |
| e) Crane gantry girder due to surge                                                 | : | Span / 2000 limited to maximum of 15 mm   |
| f) Building main columns at crane rail level due to action of crane surge load only | : | Height / 2500 limited to maximum of 10 mm |
| g) Open gantry columns at crane rail level due to action of crane surge load only   | : | Height / 4000 limited to maximum of 10 mm |
| h) Coal handling trestles/ Junction Towers                                          | : | Height / 1000                             |
| i) Coal conveyor Galleries.                                                         | : |                                           |

**6.3** Provisions of IS: 800 and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

**7 MINIMUM THICKNESS AND SIZES OF STEEL ELEMENTS****7.1 Minimum Thickness**

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgement in each instance.

- |                                        |   |      |
|----------------------------------------|---|------|
| a) Trusses, purlins, girts and bracing | : | 6 mm |
| b) Columns and beams                   | : | 8 mm |
| c) Gussets                             | : | 8 mm |
| d) Stiffeners                          | : | 8 mm |



TITLE

**PART D : STEEL STRUCTURES**

- e) Base plates : 10 mm & above
- f) Chequered plates : 6 mm o/p & above
- g) Grating flats : 5 mm
- h) Minimum thickness of structural members other than gratings and chequered plate, directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

**7.2 Minimum Sizes**

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at least 50 mm. The depth of beams for platform of all structures shall not be less than 125 mm.

**8. SLENDERNESS AND DEPTH RATIO**

- 8.1 The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS:800.

- 8.2 The following limiting ratios of depth to span shall be considered as a general guide.


- (a) Truss 1 / 10
- (b) Rolled beams and girders for Ordinary floors and rafters 1 / 24
- (c) Supporting floor beams for vibrating Machinery / equipment 1 / 15
- (d) Roof purlins and girts 1 / 45
- (e) Gable columns 1 / 30

**9. FABRICATION AND ERECTION**


- 9.1 CONTRACTOR shall prepare detailed fabrication drawings and erection scheme based on the design drawings approved by OWNER. Fabrication drawings are not to be submitted to OWNER for approval as the responsibility for correct detailing rests exclusively on the CONTRACTOR. However these drawings will be furnished to OWNER for their reference to effect payment. Detailed fabrication drawings to be furnished before commencement of work. Fabrication shall commence only on the basis of the fabrication drawings approved by the CONTRACTOR'S Consultant.


- 9.2 Fabrication shall in general follow the provisions of IS:800, and good engineering practice where provisions of IS:800 are not clear.


- 9.3 Tolerance in fabricated steel work shall be as per IS:7215.


<div>KPCL/BTPS/03/EPC</div> <div></div>	<div><b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b></div> <div>TITLE</div> <div><b>PART D : STEEL STRUCTURES</b></div>	<div>SECTION: D4.6</div> <div>VOLUME V</div> <div>SHEET Page 8 of 15</div>
9.4	Erection of fabricated steel components shall be as per erection drawings prepared by CONTRACTOR and approved by his CONSULTANT.	
9.5	Tolerance for erected steel structures shall be as per IS:12843.	
10	<b>INSPECTION OF WELDING</b>	
	The extent of quality control in respect of welds for structural elements shall be as follows.	
10.1	<b>Visual Examination</b>	
10.1.1	All welds shall be 100% visually inspected to check the following:	
	(i) Presence of undercuts	
	(ii) Surface cracks in both welds and base metals.	
	(iii) Unfilled craters	
	(iv) Improper weld profile and size	
	(v) Excessive reinforcement in weld	
	(vi) Surface porosity	
10.1.2	Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.	
10.2	<b>Dye Penetration Test (DPT)</b>	
10.2.1	This shall be carried out for all important fillet welds and groove welds to check the following:	
	(i) Surface cracks	
	(ii) Surface porosities	
10.2.2	Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E165.	
10.3	<b>Ultrasonic testing</b>	
10.3.1	Ultrasonic test shall be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by OWNER to detect the following:	
	(i) Cracks	
	(ii) Lack of fusion	
	(iii) Slag inclusions	
	(iv) Gas porosity	



KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART D : STEEL STRUCTURES</b>	SECTION: D4.6 VOLUME V SHEET Page 9 of 15
	<p>10.3.2 Ultrasonic testing shall be carried out in accordance with American National Standard ANSI / AWS D1-92 Chapter 6 : Part C.</p> <p>10.3.3 Before Ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.</p> <p>10.4 <b>Radiographic Testing (X - ray and Gamma - ray Examination)</b></p> <p>10.4.1 This test shall be limited to 2% of length of welds for welds made by manual or semi-automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method shall be decided by OWNER to detect the following defects:</p> <ul style="list-style-type: none"> <li>i) gas porosity</li> <li>ii) slag inclusions</li> <li>iii) lack of penetration</li> <li>iv) lack of fusion</li> <li>v) cracks</li> </ul> <p>10.4.2 Radiographic testing shall be conducted in accordance with American National Standard ANSI / AWS D1.1-92.</p> <p>10.4.3 Any surface irregularity like undercuts, craters, pits etc shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than 0.75 x focal distance. The width of the radiographic film shall be width of the welded joint plus 20 mm on either side of the weld.</p> <p>10.5 CONTRACTOR shall provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the OWNER / consultant.</p> <p>10.6 <b>Acceptable Limits of defects of weld</b></p> <p>10.6.1 Limits of Acceptability of welding defects shall be as follows.</p> <ul style="list-style-type: none"> <li>i) <b>Visual Inspection &amp; Dye Penetration Test</b>           The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clauses 8.15.1 &amp; clauses 9.25.3 of American National Standard ANSI / AWS D1.1-92 respectively, for statically and dynamically loaded structures.</li> </ul>	

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART D : STEEL STRUCTURES</b>	SECTION: D4.6 VOLUME V SHEET Page 10 of 15
	<p>ii) <b>Ultrasonic Testing</b>          The limits of acceptability of defects detected during ultrasonic testing shall be in accordance with clause 8.15.4 &amp; clause 9.25.3 of American National Standard ANSI / AWS D1-92 respectively, for statically and dynamically loaded structures.</p> <p>iii) <b>Radiographic Testing</b>          The limits of acceptability of defects detected during Radiographic testing shall be in accordance with clause 8.15.3 &amp; 9.25.2 of American National Standard ANSI / AWS D1.1-92 respectively for statically and dynamically loaded structures.</p> <p><b>10.7 Rectification of Defects in Welds</b></p> <p><b>10.7.1</b> In case of detection of defects in welds, the rectification of the same shall be done as follows:</p> <p>(i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld</p> <p>(ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.</p> <p>(iii) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld and shall be re-welded. Defective weld shall be removed by chipping hammer gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.</p> <p><b>11.0 PAINTING</b></p> <p><b>11.1</b> All steel structures shall receive two primer coats and two finish coats of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two finish coats shall also be applied after erection.</p> <p><b>11.2</b> Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be cleaned to grade ST-2 as per SIS05-5900 or as per IS:1477 (part -I). Primer paint shall be red oxide zinc chromate conforming to IS:2074. Dry film thickness of each coat shall be 25 microns.</p> <p><b>11.3</b> Finish paint shall be 2 coats synthetic enamel paint conforming to IS:2932. Dry film thickness of each coat shall be 25 microns. The undercoat and finish coat shall be of different tint to distinguish the same</p>	

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART D : STEEL STRUCTURES</b>	SECTION: D4.6 VOLUME V SHEET Page 11 of 15
	<p>from finish paint. All paints shall be of approved brand and shade as per the OWNER's requirement.</p> <p>11.4 Joints to be site welded shall have no paint applied within 100 mm of welding zone. Similarly where Friction grip fasteners are to be used no painting shall be provided. On completion of the joint the surfaces shall receive the paint as specified.</p> <p>11.5 Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams supporting gratings or chequered plate shall receive one additional coat of finish paint over and above number of coats specified before erection. Portion of steel member embedded / to be encased in concrete shall not be painted.</p> <p>12. <b>REQUIREMENTS FOR SPECIFIC STRUCTURES</b></p> <p>12.1 <b>Coal handling system structures</b></p> <p>12.1.1 Toe guards shall be provided on sides of conveyor gallery, toe guard shall have a minimum size of 65 x 6 mm.</p> <p>12.1.2 In case the inclination of the conveyor is more than 10°, walkway shall be given steps.</p> <p>12.1.3 For the design of conveyor gallery, load due to cables, light fittings and pipes as well as effect of gravity take up loads shall also be considered, in addition to dead load, wind load and imposed load.</p> <p>12.1.4 Lattice girders supporting the conveyor shall be suitably braced at top and bottom chord levels to transmit the wind load to the end portals connected to trestles. Roof purlins and walkway runners shall also be suitably braced at both ends.</p> <p>12.1.5 In the case of galleries, temperature expansion joint shall be introduced at intervals less than 180 m to divide the galleries into temperature block. In each block at least one number four legged rigid support guaranteeing stability of structure in the longitudinal direction shall be provided. This shall also take care of all longitudinal forces in the given block. Effect of wind load acting on 2-legged trestle shall also be considered while designing the 4-legged trestle.</p> <p>12.1.6 Base plates for trestles shall be designed as gusseted bases with shear lugs to transfer horizontal forces. Anchor bolts shall be designed only for uplift forces.</p> <p>12.1.7 Conveyor galleries and trestles having two conveyors belt shall be designed for both conveyors working together.</p> <p>12.1.8 Chute loads on floors of houses shall be considered plugged with material for the entire height of the chute.</p>	

<b>KPCL/BTPS/03/EPC</b>  	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>  <b>TITLE</b>  <b>PART D : STEEL STRUCTURES</b>	<b>SECTION: D4.6</b>  <b>VOLUME V</b>  <b>SHEET Page 12 of 15</b>
<div> <div>12.1.9</div> <div>In case chequered plates are used as floor covering the thickness of plate o/p shall be 8 mm. Suitable plan bracings shall be provided 75 mm from top of steel to transfer all the horizontal forces.</div> </div> <div> <div>12.1.10</div> <div>Anchor fasteners shall not be used for supporting equipment imparting dynamic forces.</div> </div> <div> <div>12.1.11</div> <div>Bracing patterns and locations shall be so planned such that they do not hinder movement of personnel and movement of equipment during maintenance. When floor beam form part of vertical bracing system, additional loads from the floor beams transferred to the bracing shall be taken into account.</div> </div> <div> <div>12.1.12</div> <div>Angle section shall not be used as flexural members except for purlins, side girts and walkway runners. Minimum angle size used shall be L50x50x6.</div> </div> <div> <div>12.1.13</div> <div>All foundation bolts shall be provided with double nuts.</div> </div> <div> <div>12.1.14</div> <div>End connection for rolled beams and channels shall be designed for a minimum of 60% of their shear capacity and built up beams for 80% of their shear capacity in addition to axial load.</div> </div> <div> <div>12.1.15</div> <div>Dynamic analysis shall be carried out for beams supporting screens, vibrating feeder, rotating equipments and conveyor supporting beam in conveyor gallery.</div> </div> <div> <div>12.1.16</div> <div>To admit proper light into the conveyor gallery perspex sheet shall be provided at the rate of 0.1 square metre per metre length of gallery on the roof and 0.2 square metre per metre length of gallery per side on the sides of conveyor gallery.</div> </div> <div> <div>12.2</div> <div><b>Switchyard Structures</b></div> </div> <div> <div>12.2.1</div> <div>All switchyard structures comprising of towers, gantries, lightning masts, lighting towers, equipment structures etc shall be galvanised steel with bolted site connection.</div> </div> <div> <div>12.2.2</div> <div>Three dimensional analysis shall be carried out for structures like towers and gantries whereas two dimensional approach may be followed for equipment support structures.</div> </div> <div> <div>12.2.3</div> <div>All structural steel shall be of tested quality and shall conform to IS:2062. Steel tubes where used for equipment support structures shall conform to IS:1161.</div> </div> <div> <div>12.2.4</div> <div>All bolts and nuts shall be galvanised. In addition to heavy washers conforming to IS:6610, spring washers conforming to IS:3063 shall be provided at all bolted connections. Bolts shall conform to IS:12427.</div> </div>		



TITLE

**PART D : STEEL STRUCTURES**

**12.2.5** Fabrication and erection shall in generally be as per IS:802 and IS:800; wherever there is a contradiction between two codes the provision in IS:802 shall govern.

**12.2.6 Galvanising**

**12.2.6.1** Galvanising of the towers shall be as per IS: 4759 and 2633 and as given in the following paras.

**12.2.6.2** Before Galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such other foreign matters as are likely to interfere with the Galvanising process.

**12.2.6.3** The acceptable values of the coating of zinc on the steel materials shall be in accordance with Table below:

KIND OF MATERIAL	COATING	
	Average value	Minimum value
Structural steel members except bolts, nuts and washers	Over 750 gm/sq.m	610 gm/sq.m
For bolts, nuts and washers	Over 550 gm/sq.m	500 gm/sq.m

**12.2.6.4** The galvanised surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth, and shall be free from defects like discoloured patches, bare spots, globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.


**12.2.6.5** There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanised steel member shall withstand minimum four no. of one minute successive dips in copper sulphate solution as per IS:2633 unless specified otherwise.


**12.2.6.6** All galvanised members shall be treated with sodium dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.


**12.2.6.7** Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted.

**12.2.6.8** Wherever galvanised bolts, nuts, washers, accessories etc are specified, these shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.


**12.2.6.9** CONTRACTOR shall ensure that galvanising is not damaged in transit. In the event of occurrence of any damage, CONTRACTOR shall at his


KPC/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION: D4.6 VOLUME V SHEET Page 14 of 15
	TITLE PART D : STEEL STRUCTURES	
12.3	Large diameter Oil tanks	
12.3.1	Design, fabrication and erection of the cylindrical welded oil storage tank shall follow the provisions of IS: 803. The stresses in the tank shall be computed on the assumption that tank is filled with water. Tension in each course shall be computed at 30 cm above the centre line of lower horizontal joint of the course under consideration.	
12.3.2	Wind and internal vacuum loads shall be considered together to check the stability of tank.	
12.3.3	Joint efficiency factor shall be taken as 0.85 for butt joints to determine the minimum thickness of shell plates provided all the vertical and horizontal butt welds are spot radiographed. Where welds are not inspected by radiography joint efficiency factor of 0.7 shall be used. However it is recommended that all butt welded joints shall be radiographed.	
12.3.4	Minimum thickness of shell plate shall be as given in clause 6.3.3.2 of IS:803 to which corrosion allowance shall be added. Maximum thickness of shell plate shall not exceed 40 mm. Width of shell plate shall not be less than 1500 mm.	
12.3.5	Bottom plate uniformly resting on the substructure shall have a minimum thickness of 6 mm for tanks upto 10 m in diameter and 8 mm for higher diameter. Bottom plate shall project atleast 25 mm around beyond the outer edge of weld attaching the bottom to the shell plate.	
12.3.6	For large diameter oil tanks supported cone roof shall be provided. Arrangement of columns and rafter shall in general be as per fig 9 & 10 of IS: 803. Roof plates shall have a minimum thickness of 6 mm and shall not be attached to the supporting member. A curb angle shall be provided at the top of the shell in line with clause 6.3.6.2 of IS: 803. Roof plates shall be attached to the curb angle with a continuous fillet weld on the top side only. Minimum slope of roof shall be 1 in 16.	
12.3.7	Rafter clips for the outer row of rafters shall be welded to the shell. Columns shall not be rigidly attached to the bottom plates guide. Clips shall be welded to the tank bottom to prevent lateral movement.	
12.3.8	Roof supporting columns shall be made from structural shapes or pipe or built up section. Suitable base frames or reinforcing pads shall be provided at the column base to distribute loads coming on the tank bottom.	
12.3.9	Appurtenances and mountings covered under section 7 of IS: 803 shall be provided in addition to any other appurtenance which the	


KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	SECTION: D4.6 VOLUME V SHEET Page 15 of 15
	TITLE <b>PART D : STEEL STRUCTURES</b>	
<p>CONTRACTOR considers essential for the safe and smooth operation of the fuel oil storage and oil handling system.</p> <p>12.3.10 After erection and inspection of the tank, the tanks shall be tested as per clause 12 of IS: 803. Leakage if any noticed shall be repaired to the satisfaction of the OWNER and the tank retested to satisfy acceptance criteria.</p> <p>12.4 <b>Large diameter steel pipes</b></p> <p>Design, installation and testing of the pipe shall in general be in accordance with the following provision</p> <p>" Steel pipe – A guide for design and installation " – AWWA Manual M11 – published by American Water Works Association. Steel used shall conform to IS: 2062. Minimum earth cover over the pipe shall be 1500 mm. Internal surface of pipe shall be epoxy painted. The pipe shall be encased in RCC with a minimum thickness of 250 mm with reinforcement. Bedding shall be of sand. Thrust blocks shall be provided at all bends. Internal design pressure shall be the shut off head as furnished by the pump vendor, 1.5 times the pump working head or maximum surge pressure computed from surge analysis whichever is greater. However for surge pressure the allowable stresses can be increased by 25%. External pressure shall be due to earth pressure, surcharge pressure of 2 T/sqm and at road crossings pressure due to vehicles. In addition a vacuum pressure of 9 m water column shall be considered while checking against buckling. All site joints shall be inspected by radiography.</p> <p>12.5 <b>Circular Coal bunkers</b></p> <p>Design of the bunkers shall be as per IS : 9178. Plates shall be cut to the maximum width to reduce the number of horizontal joints. Vertical joints shall be staggered. All vertical joints above bunker supporting zones and both vertical and horizontal joint below the zone shall be inspected by radiography to ensure quality. Trial assembly of the bunker including hopper shall be made at least for one bunker before commencing regular fabrication of the bunkers.</p> <p>Hopper shall be of stainless steel plate of grade designation SS 409 M.</p>		


KPCL/BTPS/03/EPC	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	<b>SECTION: D4.6</b>
	<b>TITLE</b> <b>PART E : OUTDOOR CIVIL WORKS</b>	<b>VOLUME - V</b> <b>SHEET 1 OF 5</b>
<b>1.</b>	<b>DRAINAGE AND SEWERAGE</b>  All drainage lines for storm water, sewage and waste drainage etc. shall preferably be laid in service aisles close to the road. Separate network shall be provided for lines of storm water, sewage, and waste drainage.	
<b>1.1</b>	<b>Surface Drainage</b>	
<b>1.1.1</b>	All the paved and unpaved areas shall be adequately drained. The surface drainage system shall be designed for surface washings and / or rain / fire water as the case may be. Unpaved open areas shall be drained through RCC drains and connected to main storm drains.	
<b>1.1.2</b>	The paved area shall be sloped towards the drains with a minimum slope of 1 in 100. The maximum drainage travel extent shall be limited to 10 metres.	
<b>1.1.3</b>	The surface drainage from uncontaminated area shall be connected to nearest open storm water drains through rectangular drains. Contaminated area surface drainage shall be collected through separate network.	
<b>1.1.4</b>	The interconnecting pipes and rectangular drains shall be sized for carrying the design discharge when running full.	
<b>1.1.5</b>	The rectangular drains shall be minimum 800 mm wide of RCC. The pipes for water drainage system shall be of RCC class NP2 conforming to IS:458 with minimum size of 150 mm NB. However for road crossings etc. pipe of class NP3 shall be provided. For rail crossings, pipes conforming to railway loading standards shall be provided. If sufficient clearance cannot be provided between the top of the pipe and road top, the pipes shall be encased in RCC.	
<b>1.1.6</b>	The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However minimum velocity for self cleansing of 0.6m/sec shall be ensured. Slope of drain shall not be milder than 1 in 1000.	
<b>1.1.7</b>	Minimum earth cover of 450 mm shall be provided over drainage pipes in paved areas.	
<b>1.1.8</b>	Garland drains minimum 300 mm wide shall be provided allround the building to lead away roof drainage to plant drainage system. Plinth protection in PCC M15 grade shall be provided between brickwall and drain with appropriate slope.	
<b>1.2</b>	<b>Storm Water Drainage System</b>	
<b>1.2.1</b>	The plant storm water drainage system shall take into account the topography of the plant area, area drainage patterns and intensity of rainfall etc. The drainage system shall be designed for precipitation	





KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <hr/> <b>TITLE :</b> <b>PART E : OUTDOOR CIVIL WORKS</b>	<b>SECTION: D4.6</b> <b>VOLUME - V</b> <b>SHEET 2 OF 5</b>
	<p>intensity equal to hourly rainfall for a return period of 1 in 50 years. However, storm frequency of 100 years return period shall be applied for Coal Storage area.</p> <p>1.2.2 All storm water drainage shall preferably be through open storm water drains. These shall be provided on both sides of the roads and shall be designed to drain the appropriate catchment area including road surface, open and covered area etc. The drains shall be minimum 600 mm wide at the base.</p> <p>1.2.3 All open drains rectangular in cross section shall be in RCC. In the main plant block, rectangular section RCC drains in minimum M20 grade concrete shall be provided. The thickness of side and bottom shall be minimum 125 mm or as per design considerations whichever is higher.</p> <p>1.2.4 The pipes for water drainage system shall be concrete pipes of class NP2 conforming to IS:458. However, for road crossings etc. higher strength pipe of class NP3 shall be provided. Diameter of pipes used for drainage / culverts shall be between 300 mm to 600 mm. Beyond 600 mm, box drains / culverts shall be provided.</p> <p>1.2.5 Surface drains shall normally have a bed slope not milder than 1 in 1000 along longitudinal direction and RCC pipes shall have such slopes so as to have effective discharge. The maximum velocity for pipe drains and open drains shall be limited to 2.4 m/sec and 1.8 m/sec respectively. However, minimum velocity for self cleansing of 0.6 m/sec shall be ensured at peak flow condition ( i.e. 3 times average flow ) for pipes flowing at half full.</p> <p>1.2.6 Suitable manholes shall be provided to piped drainage lines at every 30 m intervals, at junctions and at change of gradient, alignment and diameter of pipe and shall be of masonry or RCC construction. Minimum size of manholes shall be 1.0m x 1.0m or circular manhole of 1 m dia. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.</p> <p>1.2.6 The cushion over the pipes for storm water culverts shall be minimum 600 mm. Where less cushion is available, pipe shall be encased in RCC M-20. Suitable RCC or masonry structures shall be provided at drops / falls to prevent scouring or damage to surface.</p> <p>1.2.6 Invert of drainage pipe / drain shall be decided in such a way that the water can easily be discharged above the high water level in water course outside the plant boundary to which the storm water is to be led.</p> <p>1.3 <b>Plant Effluent Drainage ( Oily Waste / Process Waster Drainage )</b></p> <p>1.3.1 The oily / process waste shall be drained / collected through a separate sewer system consisting of underground ( overground if required ) concrete / cast iron pipes. Catch pits shall be provided at the source</p>	


KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART E : OUTDOOR CIVIL WORKS</b>	SECTION: D4.6 VOLUME - V SHEET 3 OF 5
	<p>location and they shall be interconnected by buried pipes. No bends and branches shall be provided in the pipe line. Manholes shall be provided at all junction of pipes. Catch pits shall have a minimum internal dimension of 600 mm x 600 mm. They shall be of RCC construction and provided with CI grills.</p> <p>1.3.2 The main and branch connection pipes shall be sized for the expected maximum discharge subject to a minimum of 250 mm NB and 100 mm NB respectively. The pipes shall be adequately sloped for drainage and shall carry flow to neutralisation pit / ETP / Oil water separator as required.</p> <p>1.3.1.1 <b>Sewage System</b></p> <p>1.4.1 Cement concrete pipes shall be used below ground level for sewage disposal. Pipes connecting toilet facilities to manholes shall be minimum 100 mm NB. Pipes connecting various manholes shall be minimum 150 mm NB. However salt glazed stoneware pipes of diameter not exceeding 150 mm can be used in localised areas not subject to any traffic loads. For main power block below paved area, cast iron spun pipe of Class LA conforming to IS:1536 shall be used.</p> <p>1.4.2 Sewers shall have such slopes so as to have effective discharge. Sewers shall be designed for a minimum self cleansing velocity of 0.75 m/sec for peak flow condition ( assumed as 3 times the average flow ) and pipes flowing half full. The maximum velocity shall not exceed 2.4 m/sec.</p> <p>1.4.3 Suitable manholes shall be provided to piped sewage lines at every 30 m intervals, at junctions and at change of gradient, alignment &amp; diameter of pipe and shall be of masonry or RCC construction. Details of manholes shall be as per IS: 4111 (Part-I). Minimum size of manholes shall be 1.0m x 1.0 m for square section or 1 m dia for circular. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.</p> <p>1.4.4 Separate septic tanks shall be provided at suitable locations for each building block. Sewage from septic tanks shall be connected to the existing common sewerage treatment plant.</p> <p><b>2 INTER PLANT TRENCHES</b></p> <p>2.1 All cable and pipe trenches shall be of RCC with minimum M20 grade. Trenches located outside buildings shall be projecting at least 150 mm above finished formation level to avoid entry of storm water into the trenches. The bottom of trench shall be provided with suitable slope for draining out collected water into a sump pit.</p> <p>2.2 Trenches shall be covered using precast RCC cover of minimum M20 grade, each not weighing more than 65 kg and shall be provided with lifting hooks.</p>	


KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART E : OUTDOOR CIVIL WORKS</b>	SECTION: D4.6 VOLUME - V SHEET 4 OF 5
	<p>2.3 As far as possible in the open area trenches shall be provided for running cables.</p> <p>3.0 <b>ROADS &amp; PARKING AREA</b></p> <p>Roads and parking areas shall be of flexible type of construction and shall be designed in accordance with the provision of the relevant IRC Codes of Practice. Top level of parking area shall be flushed with crown of the connecting roads with a cross slope.</p> <p>3.1 Roads shall be designed for class 'E' of traffic i.e. traffic intensity of 450-1500 vehicles per day (heavy vehicles exceeding 3 tonnes laden weight) as per IRC-37:1984 "Guidelines for the design of flexible pavements". California Bearing Ratio (CBR) method shall be adopted for the design of roads.</p> <p>3.2 Sub-base shall be of granular material i.e. laterite, murrum, natural sand, gravel, crushed stone (grading-1) or combination thereof laid over well compacted subgrade. Granular base shall be of wet mix macadam course (WMM) construction. The wearing coarse shall be bituminous macadam binder course with open graded premix carpet laid over it. Shoulder provided on either sides shall be in murrum construction of 150 mm compacted thickness. Kerbs of PCC or stone shall be provided to distinguish carriage way.</p> <p>3.3 The geometric design of roads shall be done in accordance with IRC-73. Road widths, curves and parking areas shall have adequate space for manoeuvring of vehicles. The ruling gradient for roads in longitudinal direction shall be 1 in 30. Normally the roads shall have much flatter gradient. Transverse camber of 1 in 60 shall be provided for the black topping of roads and a slope of 1 in 40 shall be provided on shoulders. Finished top (crest) of roads shall be 250 mm above the surrounding grade level.</p> <p>3.4 Minimum radius of curvature along the inner side of the carriage way shall be generally 12m. However for minor roads this shall be reduced suitably as per layout requirements and site conditions. Road width and turning radii shall also be checked for to take largest foreseeable vehicles and equipment which can reasonably be expected.</p> <p>3.5 All service and utility lines crossing under roads shall be taken through concrete pipes / ducts and designed for imposed loadings. Number of such crossings shall however be kept to a minimum.</p> <p>4. <b>PAVING</b></p> <p>4.1 <b>R.C.C Paving</b></p> <p>4.1.1 R.C.C paving of grade M20, minimum 125 mm thick laid to a slope of 1 in 100 towards the nearest drain, with reinforcement placed 50 mm from the top surface, shall be provided in the following areas.</p>	

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART E : OUTDOOR CIVIL WORKS</b>	SECTION: D4.6 VOLUME - V SHEET 5 OF 5
	<p>(i) Entire backside of the main Turbine building up to the farther edge of Chimney. The paving shall extend to a minimum of 5 m on either side from the outer most face of equipment structures in the other direction.</p> <p>(ii) Ash silo area extending at least 10 m on all sides from outer periphery of the silos.</p> <p>(iii) 5 m wide corridor all along the entire width of TG and De-aerator bay at both gable ends.</p> <p>(iv) Fuel oil decantation platforms</p> <p>4.1.2 The under-bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 230 mm with interstices properly filled with grits, followed by a layer of PCC of grade M15, 75 mm thick.</p> <p>4.2 <b>P.C.C. Paving</b></p> <p>4.2.2 PCC paving of nominal grade M15, 100 mm, laid over 230 mm thick compacted rubble soling shall be provided in the following area.</p> <p>i) Complete Transformer Yard, covering area between A-row of the turbine building upto the fencing of the Transformer yard</p> <p>ii) Plinth protection around all building to a width of 750 mm or the distance between the brick wall to the garland drain.</p> <p>iii) Fuel oil tank farm area, DM water storage tank area and CST farm area for a width of 1 m.</p> <p>4.3 <b>Stone Aggregate paving</b></p> <p>4.3.1 Entire switch yard shall be provided with 75 mm paving of 40 mm single size stone aggregate on top and 75 mm paving of 20 mm single size stone aggregate below. Before laying the paving, the ground surface shall be treated with anti weed chemicals as per manufacturer recommendations.</p> <p>4.3.2 For auxiliary transformer yard, paving of stone aggregate of 75 mm thick using 20 mm single size aggregate shall be provided after compacting the under bed and treating with anti-weed chemicals.</p>	


KPCL/BTPS/03/EPC 	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW TITLE PART F : FINISHES	SECTION: D4.8 VOLUME - V SHEET 1 OF 11
	<p>The minimum quality of finishes to be used for various building areas are furnished in this section. However, the Bidder is at liberty to use superior finishes provided all specific requirements for the finish specified herein below are satisfied.</p> <p><b>1. FLOORING</b></p> <p>The nominal total thickness of floor finish shall be 50 mm including under bed and topping. The flooring shall be laid on already matured concrete base. The under bed for floors shall consist of cement concrete M15 with stone chips, 12.5 mm down graded as coarse aggregates. The under bed shall be provided with appropriate slope towards catch pit for floor drainage.</p> <p><b>1.1 PVC Floor Finish</b></p> <p>Two mm thick PVC as per IS: 3462 laid as per IS: 5318 over concrete under bed of 48 mm.</p> <p><b>1.2 GRANITE FLOORING</b></p> <p>This shall be provided for Turbine building operating floor. The Granite slabs shall be of minimum 20mm thick with approved colour.</p> <p><b>1.3 Terrazo Tiles</b></p> <p>This shall be provided in general circulation areas such as lift entrance area, office area, laboratory etc. Tiles shall generally be of size 250 x 250 x 20 mm laid over concrete bedding to result in an overall thickness of 50 mm.</p> <p><b>1.4 Granolithic flooring</b></p> <p><b>1.4.1</b> Granolithic flooring (cement concrete flooring in M25 with non metallic floor hardener topping 12 mm thick with a total thickness of 50 mm shall be provided in maintenance and unloading area of Station building, Mill and bunker bay, Workshop floors, operating floor of pump house, permanent stores and other plant building areas where heavy duty flooring is required.</p> <p><b>1.5.2</b> Granolithic flooring without floor hardener shall be provided in all MCC and switchgear rooms, which are not air-conditioned.</p> <p><b>1.5.3</b> Granolithic flooring shall also be provided in areas, which are not provided with any special finish. Areas which are likely to be subjected to oil spillage shall be provided with two coats of oil resistant painting over Granolithic flooring.</p> <p><b>1.6 Heavy Duty Ceramic Tiles</b></p> <p>Heavy duty ceramic tiles with matt finish shall be used in toilets, pantry, dining hall of canteen, locker rooms etc. The tiles shall be 300 x 300 x 7 mm of approved shade brand and colour.</p>	


KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION: D4.6
	TITLE PART F : FINISHES	VOLUME - V SHEET 2 OF 11
1.7	<b>Acid / Alkali resisting Tiles</b>	
	Battery rooms and other areas coming into contact with acid / alkali vapours or fumes shall be given acid / alkali resistant tiles 25 mm thick, jointed with acid / alkali resistant cement slurry. Bedding shall comprise of potassium silicate mortar conforming to IS: 4832 (Part-I) and resin based mortar like epoxy for jointing. Total thickness of flooring shall be 50 mm. Ceramic unglazed vitreous tiles conforming to IS: 4457 with minimum thickness of 20 mm may also be used as acid / alkali resistant tile. The above specification do not apply to D.M. Plant.	
1.8	<b>Integral floor finish</b>	
	For cable vaults floor finish integral to the concrete base shall be provided as per IS: 2571.	
1.9	<b>POLISHED VITRIFIED TILES</b>	
	Polished vitrified tiles of size 600X600X10 mm of approved shade, brand and colour laid with CM 1:3 shall be provided in control rooms.	
1.10	<b>Cast-in-situ Terrazo</b>	
	Risers and treads of staircases shall be provided with cast in situ terrazo. This shall be laid as per IS: 2114, using white cement or cement with colouring pigment. Chequered finish shall be provided for treads. Total thickness of the finish shall be 25 mm.	
1.11	<b>Acid / Alkali resistant Tiling / Brick lining in D.M Plant</b>	
1.11.1	Bitumen primer followed by 12 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 38 mm thick alkali / acid resistant bricks as per IS: 4860 shall be provided for CPU regeneration area, Chemical house floor, effluent drains, floors around equipment & chemical handling vessels, chemical storage area for the floor, kerbs and sumps, all as per the acid / alkali proofing specialist Contractor's requirement.	
1.11.2	For floor of neutralising pit the finish shall be as follows. Bitumen primer followed by 18 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 75 mm thick acid / alkali resistant brick as per IS:4860.	
1.11.3	For walls of neutralising pit, the same specification as 1.10.2 shall apply except that thickness of the brickwork shall be 115 mm with suitable plasters at 2000 mm c/c.	
1.11.4	Special instruction to be followed for acid resistant lining in neutralising pit shall be as follows.	
	i) The structures shall be tested for water tightness. ii) Surface on which lining is to be applied shall be prepared as per IS:2395.	


KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART F : FINISHES</b>	SECTION: D4.6 VOLUME - V SHEET 3 OF 11
	<p>iii) Joints between acid resistant bricks / tiles shall be filled with resin type mortar conforming to IS:4832 ( Part II ). Seal coat of ready made epoxy paint shall be provided at the joints to cover up any porosity.</p> <p>iv) Acid resistant bricks shall be laid with 6 mm wide and 20 mm deep pointing. Pointing shall be with epoxy / furane / CNSL as per the requirement of the agency guaranteeing the performance of lining.</p> <p>v) Under side of all precast slabs / steel covers over effluent drains shall be given two coats of epoxy coating, 150 microns thick.</p> <p>vi) Acid / alkali resistant treatment shall extend at least 1 metre on all sides from the outermost periphery of pedestals / saddles for indoor installations and 2 metres around for outdoor installations.</p> <p><b>1.12 Miscellaneous</b></p> <p>1.12.1 Aluminum angle nosing with minimum size (50 x 25 x 3) shall be provided for edge protection of R.C.C. stair treads.</p> <p>1.12.2 Angles 50x50x6 mm (min) with lugs shall be provided for edge protection of cut-outs / openings in floor slabs, edge of drains covering gratings, edge of R.C.C cable / pipe trenches and at any other place where breakage of edges / corners is expected.</p> <p>1.12.3 Floors of switchgear rooms shall have embedded steel channel suitable for easy movement of breaker panel.</p> <p><b>2 SKIRTING / DADO</b></p> <p>2.1 150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.</p> <p>2.2 Toilets &amp; locker rooms shall be provided with dado of 2100 mm high with glazed tiles of minimum 5 mm thickness generally as per IS:777.</p> <p>2.3 For main Control room and control equipment room minimum 5 mm thick decorative coloured ceramic tiles shall be provided upto false ceiling level.</p> <p>2.4 For battery room and other areas coming in contact with acid / alkali spillage / fume, dado of acid / alkali resistant tiling as per IS:4457 shall be provided to a height of 2100 mm set in potassium silicate mortar and joints pointed with resin bonded mortar.</p> <p>2.5 Staircase wall shall be given dado of cast in situ terrazo to a height of 2100 mm.</p> <p>2.6 Entrance lobby and lift area in Service building and Admin building shall be provided with granite tile dado to a height upto false ceiling level.</p>	


KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <hr/> TITLE <b>PART F : FINISHES</b>	SECTION: D4.6 VOLUME - V SHEET 4 OF 11
<b>3.</b>	<b>METAL CLADDING</b>	
<b>3.1</b>	<b>Permanent colour coated sandwiched insulated metal cladding system</b>	
<b>3.1.1</b>	Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6 mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm / sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF2) of Dry Film Thickness (DFT) 20 microns (min) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.	
<b>3.1.2</b>	Galvanised M.S.sheets of minimum 0.6 mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (min) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanisation shall not be less than 150 gm / sq.m.	
<b>3.1.3</b>	The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.	
<b>3.1.4</b>	Inner sheet shall fixed directly to side runners and Z spacers made of atleast 2 mm thick galvanised steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50 m centre to centre to hold the insulation and external sheeting.	
<b>3.1.5</b>	The insulation shall be of bonded mineral wool of minimum thickness 50 mm conforming to IS:8183, having a density of 32 kg / cum for glass wool & 48 kg / cum for rock wool.	
<b>3.2</b>	<b>Permanent colour coated (non-insulated) metal cladding system</b>	
<b>3.2.1</b>	Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S.sheets having 0.6 mm minimum thickness (or High tensile steel sheet of 0.5 mm minimum thickness) shall be used for the cladding system. The outside (exposed face) shall be permanently colour coated with PVF2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 10 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.	
<b>3.3</b>	<b>Flashings, caps, trim closures etc</b>	
	All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.	





<div>KPCL/BTPS/03/EPC</div> <div></div>	<div><b>KARNATAKA POWER CORPORATION LIMITED</b></div> <div><b>BELLARY TPS, UNIT-3 OF 700 MW</b></div> <div>TITLE</div> <div><b>PART F : FINISHES</b></div>	<div>SECTION: D4.6</div> <div>VOLUME - V</div> <div>SHEET 5 OF 11</div>
<div>4.</div> <div>4.1</div> <div>4.2</div> <div>4.3</div> <div>4.4</div> <div>4.5</div> <div>4.6</div> <div>5.</div> <div>5.1</div> <div>5.2</div> <div>5.3</div> <div>5.4</div> <div>5.5</div> <div>5.6</div> <div>5.7</div> <div>5.8</div>	<div><b>PLASTERING</b></div> <div>Details furnished below does not include special types of plaster / plaster finishes which may be provided to enhance the architectural appeal. CONTRACTOR shall provide such superior plaster finish as indicated in his Bid.</div> <div>External face of all walls shall be provided with 20 mm thick cement mortar plastering with an under layer 14 mm thick in CM 1:6 and top 6 mm thick layer in CM 1:4 with approved water proofing compound.</div> <div>For internal walls 18 mm thick plaster in CM 1:6 shall be provided on the uneven side of the wall and 13 mm thick plaster in CM 1:6 on the even side of the wall.</div> <div>Inside surfaces of walls shall be provided with 2 mm thick plaster of paris punning over the plastered surfaces in office areas, entrance lobby, corridor, control equipment room and all other air conditioned rooms.</div> <div>Ceiling of all buildings except in cable vaults and over false ceilings shall be given 6 mm thick cement sand plaster 1:3</div> <div>All plastering work shall conform to IS:1661.</div> <div><b>PAINING</b></div> <div>Details furnished here in below are the minimum acceptable standard for painting. Superior finish if any required by CONTRACTOR to enhance overall appearance will be permitted if such finish meet with the technical requirements.</div> <div>Water proof cement based paint as per IS:5410 shall be provided on external faces of walls, sunshades, etc.</div> <div>Inside surfaces shall be provided with Acrylic emulsion paint as per IS:5411 for Control room, Control equipment rooms, all air conditioned areas and all other areas and above dado in buildings like time office, canteen, first aid centre, toilets etc.</div> <div>Inside surfaces shall be provided with oil bound distemper as per IS:428 for plant buildings like Workshop, Permanent stores, D.G. house, Compressor house, pump houses, Ash handling pump house etc.</div> <div>Walls in D.M.Plant shall be provided with chlorinated rubber based paint as per IS : 9862 over walls. Walls above Dado in battery rooms shall also be provided with similar painting.</div> <div>All plastered ceilings shall provided with water bound distemper.</div> <div>Oil resistant paint as per IS:161 shall be provided for oil canal and oil equipment room.</div> <div>All wood work shall be provided with fire resistant transparent paint as per IS162 over french polish as per IS:348 or flat oil paint as per IS:137.</div>	


<b>KPCL/BTPS/03/EPC</b> 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> <b>TITLE</b> <b>PART F : FINISHES</b>	<b>SECTION: D4.6</b> <b>VOLUME - V</b> <b>SHEET 6 OF 11</b>
<p>5.9</p> <p>5.10</p>	<p>Painting for structural steel have been specified else where in this document..</p> <p>Following general instruction for painting shall be followed.</p> <ul style="list-style-type: none"> <li>i) For painting on concrete, masonry and plastered surfaces IS:2395 parts I and II shall be followed.</li> <li>ii) For painting on wood work IS:2338 part I &amp; II shall be followed.</li> <li>iii) All paints shall be of brand and make to the approval of OWNER.</li> <li>iv) A minimum of two finishing coats of paint over a coat of primer shall be provided to give a smooth uniform finish for the painted surface.</li> <li>v) All painting on masonry or concrete surfaces shall preferably be applied by rollers.</li> <li>vii) Thinner shall not be used with textured paint (sandtex matt etc) finish.</li> <li>viii) All fire exits shall be painted in Post office red colour shade which shall not be used any where except to indicate emergency or safety measure.</li> </ul>	
<p>6.</p> <p>6.1</p> <p>6.2</p> <p>6.3</p>	<p><b>ROOF</b></p> <p>All the buildings having R.C.C slabs over structural steel framing are provided with troughed metal sheet decking which acts as permanent shuttering. These sheets shall meet the general requirements of IS:14246 and shall conform to class 3 for durability. The sheeting shall be permanently colour coated galvanised M.S. troughed metal sheet decking of approved profile with minimum base metal thickness of 0.8 mm and minimum trough depth of 38mm. Silicon modified polyester painting shall be used for permanent coating over galvanised surface with minimum rate of galvanising of 180 gm of zinc per sq.m. Dry film thickness of colour coating shall be at least 20 micron.</p> <p>Roof of all buildings having R.C.C. frame work shall have cast in situ R.C.C. slab with conventional shuttering.</p> <p>Roof of conveyor galleries and steam generator shall be of permanently colour coated galvanised M.S. troughed metal sheet of approved profile. Minimum base metal thickness shall be 0.8 mm. The rate of zinc consumption for galvanising shall be 275 gm/sq.m. The external face shall have permanent colour coating of PVF2 paint of minimum DFT of 20 microns and inner surface shall be coated with silicon modified polyester paint with DFT of 20 microns.</p>	


KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART F : FINISHES</b>	SECTION: D4.6 VOLUME - V SHEET 7 OF 11
	<p><b>7. ROOF DRAINAGE AND WATER PROOFING</b></p> <p><b>7.1</b> For efficient drainage of rain water, roof concrete shall be given a gradient of a minimum of 1 in 100. The gradient shall preferably provided by sloping the structural framing system itself. Gradient may also be provided using screed concrete 1:2:4 using 12.5 mm downgraded aggregate. But the average thickness of such screed concrete may be restricted to about 50 mm. In the case of metal roofing system the roof slope shall be 1 vertical: 3 horizontal.</p> <p><b>7.2</b> All Roofs shall be provided with high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM C-898. Thickness of the membrane shall be a minimum of 1.5 mm. The treatment includes application of polymerised mortar over sloped roof to achieve a smooth surface and a primer coat. Wearing course shall be 40 mm screed of 1:2:4 concrete as above cast in panels of 1.2mx1.2m and reinforced with 0.56 mm dia galvanised chicken wire mesh and joints sealed using sealing compound. Accessible roof shall be provide with chequered cement tiles as above.</p> <p><b>7.3</b> Number and size of rain water down comer pipe shall be decided based on the provisions of IS:1742 and IS:2527. The pipes shall be HDPE pipe conforming to IS:4985. It is recommended that the minimum diameter of the pipe be kept as 150 mm and there shall be a minimum of two pipes provided on each gutter. The down comer pipes shall be suitably concealed with masonry work, cement concrete or sheeting to match with the exterior finish.</p> <p><b>8. FALSE CEILING AND UNDER DECK INSULATION</b></p> <p><b>8.1</b> All air conditioned areas, entrance lobbies and corridors in Service building as well as Administrative building shall be provided with the suspended false ceiling system. Under deck insulation system shall be provided on the under side of the roof / floor slab of the air conditioned areas based on the functional requirement. Ceiling of air washer room also shall be provided with under deck insulation.</p> <p><b>8.2</b> Aluminium false ceiling system shall comprise of 84 mm wide 12.5 mm deep closed type plain panels of approved colour, roll formed out of 0.5 mm thick corrosion resistant aluminium alloy AA 5050 fixed on roll formed carriers. Additional hangers and height adjustment clips shall be provided for return air grills, supply air diffusers, light fixtures, AC ducts etc.</p> <p><b>8.3</b> Gyp board false ceiling system shall consist of 600x600x12.5 mm gyp board with one coat of primer and two or more coats of acrylic emulsion paint. The suspension system shall consist of 6 mm dia galvanised steel rods suspended from ceiling supporting aluminium grid of 38x25x1.5 mm and cross tie of 25x25x1.5 mm and aluminium angle of 25x25x1.5 mm.</p>	

KPC/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW	SECTION: D4.6
	TITLE PART F : FINISHES	VOLUME - V SHEET 8 OF 11
8.4	Suitable M.S channel (minimum ISMC100) grid shall be provided above false ceiling for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.	
8.5	CONTRACTOR shall prepare a layout of the false ceiling system incorporating light fixtures, supply air diffuser, return air grills, fire protection sprinklers etc. such that the ceiling looks aesthetically pleasing. Work shall commence only after the OWNER approves the layout.	
8.6	Under deck insulation shall comprise of 50 thick resin bonded mineral wool insulation mat conforming to IS:8183. This mat shall be backed with 0.05 mm thick aluminium foil and 24 Gx25 mm wire mesh netting. They shall be fixed to ceiling or wall as the case may be with 100x50x6 slotted mild steel plate welded to M.S. plate inserts embedded at the soffit of the slab at 600 mm c/c and 14 G steel wire drawn through slots and fixed to wire netting.	
9.	<b>DOORS &amp; WINDOWS</b>	
9.1	Unless specified all doors, windows and ventilators of air conditioned areas, entrance lobby of all buildings and windows/ventilators provided on the outer face of all buildings shall have, electro colour coated (anodised) aluminium framework with glazing. All doors of office areas shall be of factory made pre-laminated particle board (MDF exterior grade). All other doors (unless otherwise specified) shall be of steel.	
9.2	Main entrance of the control room and control equipment room shall be provided with air-locked lobby with provision of double doors of aluminium frame work with glazing. Doors shall be of double swing type or sliding type.	
9.3	For common control building, double glazed wall panels with aluminium frame shall be provided between air-conditioned and non air-conditioned areas and on the side of control room and control equipment room(s) facing the operating floor to have a clear view.	
9.4	Single glazed panels with aluminium frame work shall be provided as partition between two air-conditioned areas wherever clear view is necessary.	
9.5	Coal conveyor galleries shall have steel windows/ventilators.	
9.6	All steel doors shall consist of double plate flush door shutters. The door shutter shall be 45 mm thick with two outer sheets of 18 G rigidly connected with continuous vertical 20 G stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 18 G. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, etc.	

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS,UNIT-3 OF 700 MW	SECTION:D4.6 VOLUME - V
	TITLE PART F : FINISHES	SHEET 9 OF 11
9.7	Steel windows and ventilators for coal conveyor gallery shall be as per IS:1361 and for all other areas as per IS:1038. Windows of coal galleries shall be provided with wire mesh.	
9.8	Wherever functionally required rolling shutters with suitable operating arrangement Manual / Electric shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248.	
9.9	All windows and ventilators on ground floor of all buildings located in isolated areas shall be provided with suitable anodised aluminium grill.	
9.10	Fire proof doors with panic devices shall be provided at all fire exit points as per the recommendations of Tariff Advisory Committee (TAC). These doors shall generally be as per IS:3614 (Part I and Part II). Fire rating of the doors shall be as per TAC requirements. However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral wool insulation.	
9.11	Hollow extruded section of minimum 3 mm wall thickness as manufactured by INDAL or equivalent shall be used for all aluminium doors, windows and ventilators.	
10.	GLAZING	
10.1	All ventilators and windows on external face of turbine building, conveyor gallery, pump house, compressor house, DG set building, transfer points, workshop building, fire escape staircase and those buildings located in fire prone areas shall be provided with wired glass of minimum 6 mm thickness conforming IS:5437.	
10.2	Where specified, double glazing shall consist of two 6 mm thick clear toughened safety glass conforming to IS:2553, hermetically sealed and separated by 12 mm thick gap for thermal insulation.	
10.3	For single glazed aluminium partitions and doors, Float glass or flat transparent sheet glass of minimum 5.5 mm thickness shall be used.	
10.4	Ground glass / frosted glass of minimum 4 mm thickness shall be used for all windows / ventilators in toilets.	
10.5	Unless specified otherwise in this specification minimum thickness of plain sheet glass used for windows/ventilators shall be 4 mm.	
10.6	Float glass or flat transparent sheet glass shall conform to IS:2835.	
10.7	All glazing work shall conform to IS:1083 and IS:3548.	
11.	WATER SUPPLY AND SANITATION	
11.1	Roof water tank of adequate capacity depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tank conforming to IS:12701 shall be used. The tank shall be complete with all fittings including float valve, stop cock etc.	

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS, UNIT-3 OF 700 MW.		SECTION: D4.6
	TITLE	PART F : FINISHES	VOLUME - V SHEET 10 OF 11
11.2	Galvanised M.S. pipe of medium class conforming to IS:1239 shall be used for internal piping works for potable water supply.		
11.3	Sand C.I. pipes with lead joints conforming to IS:1729 shall be used for sanitary works above ground level.		
11.4	Minimum one toilet block with all the facilities shall be provided on each floor of main plant building and service building. Separate toilets for ladies shall be provided wherever required. Attached toilets shall be provided for all senior executive rooms and conference rooms. One toilet shall be provided in the boiler area. All other buildings where toilet is specified shall have one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated below. IS:1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS:2064 and IS:2065 shall also be followed.		
11.5	Each toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of chromium plated brass (fancy type).		
	<ul style="list-style-type: none"> <li>i) WC (Indian type) Orissa pattern (580x440mm) as per IS:2556 (Part-3) with all fittings including flushing arrangement of appropriate capacity and type-1 no.</li> <li>ii) WC western type 390 mm high as per IS:2556 (part 2) with toilet paper roll holder and all fittings including flushing system of appropriate capacity and type - 1 no.</li> <li>iii) Urinal with all fittings with photo voltaic control flushing system as per IS:2556 (Part-6, Sec.1) - 2 nos.</li> <li>iv) Wash basin (oval shape) with all fittings as per IS:2556 to be fixed on concrete platform finished with 12 mm thick polished granite stone - 2 nos.</li> <li>v) Wall to wall Bathroom mirror (5.5 mm thick float glass) with bevelled edges including all fittings.</li> <li>vi) Stainless steel towel rail (600 x 20mm) - 2 nos.</li> <li>vii) Stainless steel liquid soap holder cum dispenser - 2 nos.</li> <li>viii) Janitor room.</li> <li>ix) Provision for installation of water cooler.</li> <li>x) Provision of ventilation shaft.</li> </ul>		
11.6	Attached toilets provided for senior executive rooms and conference rooms shall have 1 WC, 1 urinal, 1 washbasin, 1 mirror, 1 no. towel rail, 1 liquid soap holder cum dispenser. WC shall be of western type 390 mm high as per IS:2556(Part-2) with toilet paper roll holder and all fittings including flushing valve of appropriate capacity and type.		
11.7	Boiler area toilet shall have minimum 2 no. WC (Indian type), 4 no. urinals, 4 no. wash basins, 4 no. mirrors, 4 no. towel rails, 4 no. soap holder cum dispenser, 2 no. Showers, janitor room and a provision for installation of water cooler.		

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART F : FINISHES</b>	SECTION: D4.8 VOLUME - V SHEET 11 OF 11
	<p>11.8 An eye &amp; face fountain (combined unit with receptacle) conforming to IS:10592 shall be provided in battery room, D.M plant and Chlorination plant.</p> <p>11.9 Unless specified all fittings and fixtures in the toilets shall have same specifications as stipulated in Cl.No.11.5</p> <p>11.10 Stainless steel kitchen sink (750 mm size) for pantry shall be provided. Platform in pantry shall be finished with 12 mm thick polished granite stone.</p> <p>11.11 Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS:2556(Part-5) in laboratories and in Battery room.</p> <p>11.12 In Main Turbine building, Service building and Administrative building at least one toilet block shall be provided for ladies.</p> <p>12. <b>MISCELLANEOUS REQUIREMENTS</b></p> <p>12.1 Doors and windows on external walls of buildings shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the opening. Projection of sunshade from the wall shall be minimum 600 mm over window openings, 750 mm over door openings and 1200 mm over rolling shutters.</p> <p>12.2 Doors and windows on the external walls of buildings with metal cladding shall be fixed by creating recesses in the cladding system.</p> <p>12.3 No cable trenches shall be provided in TG hall, Boiler/ESP area, fuel oil pump house, Ash pump houses etc.</p> <p>12.4 Duct banks consisting of MS/PVC conduits for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.</p> <p>12.5 All floor openings for cables below electrical panel shall be sealed with fire sealing compound after cables are laid.</p> <p>12.6 All openings in external walls provided for pipes, cables, ducts etc. shall be effectively sealed to prevent water seepage, after the routing of the services are completed.</p> <p>12.7 <b>Natural lighting &amp; Ventilation</b></p> <p>12.7.1 The area of windows shall be a minimum 15 % of the floor area to ensure adequate natural lighting.</p> <p>12.7.2 Fans shall be provided in general office area as per standard norms.</p> <p>12.8 Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.</p>	

KPC/BTPS/03/EPC  	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	<b>SECTION: D4.6</b>  <b>VOLUME - V</b>
	<b>TITLE</b> <b>PART G : COOLING TOWER</b>	<b>SHEET 1 OF 13</b>

**1.0 SCOPE**

**1.1** This specification covers the general requirements of engineering by the CONTRACTOR, of material, design, supply, manufacture, construction, testing and commissioning for satisfactory performance of natural draught cooling tower including all associated appurtenances and equipment as well as electrical works.

**2.0 APPLICABLE CODES AND STANDARDS**

**A. Materials**


i. IS: 432 (Parts 1 & 2)	Mild steel and medium tensile steel and bars and hard drawn steel wire for concrete reinforcement.
ii. IS: 1785 (Parts 1&2)	Plain hard drawn steel wire for pre-stressed concrete.
iii. IS: 1786	High strength deformed steel bars and wires for concrete reinforcement.
iv. IS: 2062	Steel for general structural purposes.
v. IS: 3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3mm - 2032mm).
vi. IS: 8112	43 Grade Ordinary Portland cement
vii IS:12330	Sulphate resistant Portland cement


**B. Codes of Practice**

i. IS: 456	Code of practice for plain and reinforced concrete.
ii. IS: 800	Code of practice for general construction in steel.
iii. IS: 875 (Part 1 to part 5)	Code of practice for design loads (other than earthquakes for building and structures).
iv. IS:1080	Code of practice for design and construction of simple spread foundations.
v. IS:1343	Code of practice for pre-stressed concrete.
vi. IS:1893	Criteria for earthquake resistant design of structures.

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KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED BELLARY TPS,UNIT-3 OF 700 MW		SECTION: D4.6
	TITLE	PART G : COOLING TOWER	VOLUME - V SHEET 2 OF 13
			
vii.	IS:2309	Code of practice for the protection of buildings and allied structures against lightning.	
viii.	IS:2629	Recommended practice for hot dip galvanising on iron and steel.	
ix.	IS:2950 (part 1)	Code for practice for design and construction of raft foundation.	
x.	IS:3043	Code of practice for earthing.	
xi.	IS:3370 (part 1 to 4)	Code of practice for concrete structures for storage of liquids.	
xii.	IS:11504	Criteria for structural design of reinforced concrete natural draught cooling towers.	
xiii.	IS:12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.	
xiv.	BS:4485 (All parts)	Specification for water cooling towers.	
xv.	BS:8007	B.S.Code of Practice for design of Concrete structures for retaining aqueous liquid.	
2.2	The applicability of the provisions for conformity to the various codes and standards stipulated shall be in the following order.		
	a. Bureau of Indian Standards. b. British Standards Institution.		
2.3	Wherever the above Standards are in conflict with the stipulations of this specification, the latter shall govern.		
3.0	GENERAL REQUIREMENTS		
3.1	The cooling tower shall be capable of cooling the rated quantity of water through the specified thermal range at the design wet bulb temperature and it shall conform to the other design parameters as stipulated in Data Sheet – A enclosed in Mechanical section of this document.		
3.2	The scope of the CONTRACTOR's work for a cooling tower shall include preparation of detailed designs and construction drawings and execution of work including but not limited to supply of all material for foundations, shell, basin, fill with its supporting structure, staircases/walkways/platforms with handrailing, cold water outlet channels including gates, screens with handling arrangement, painting, access doors, water distribution system, aviation warning system, lighting, lightning protection system, with their		

KPCU/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b> TITLE <b>PART G : COOLING TOWER</b>	SECTION: D4.6 VOLUME - V SHEET 3 OF 13
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associated hardware, etc., complete all as required to give satisfactory performance and as stipulated in various clauses in this document.

3.3 CONTRACTOR shall submit detailed design calculations and construction drawings to OWNER for obtaining his approval prior to commencement of work at site.

3.4 In the event, CONTRACTOR has quoted in collaboration with another firm (either Indian or foreign), each and every drawing and design calculations submitted shall bear collaborator's seal and signature indicating their approval. CONTRACTOR shall also furnish, along with the offer, back-up guarantee for the performance of the cooling tower from the collaborator.

3.5 **QUALITY CONTROL:** Shall be as per Section C3, Volume-II.

4. **CONCRETE**

4.1 Cement used shall be Ordinary Portland Cement complying IS: 8112. Same brand of cement shall be used as far as possible throughout the construction of the entire structure to enable achieve uniform colour and surface finish throughout the shell.


4.2 Minimum grade of concrete to be used for all the structural elements shall be as specified below considering environmental conditions as per Table 3 of IS 456.

<u>STRUCTURAL CONCRETE</u>	<u>Minimum Grade</u>
a) Foundations	M25
b) Basin	M25
c) Diagonal Columns	M40
d) Shell	M30
e) Precast works (Fill Supporting Structure)	M25

4.3 The minimum cement content per cubic meter of concrete as per Table 5 of IS 456 for severe exposure for super structure and moderate exposure for basin & foundation.

4.4 In locations where sulphate resisting cement is specified for concrete work below ground level, the minimum cement content per cubic metre of concrete shall be as stipulated in the table 5 of IS 456 as applicable to the type of exposure.

4.5 Materials, design, construction and workmanship of prestressed concrete members shall be in accordance with IS:1343.

KPCL/BTPS/03/EPC 	<b>KARNATAKA POWER CORPORATION LIMITED</b> <b>BELLARY TPS, UNIT-3 OF 700 MW</b>	<b>SECTION: D4.6</b> <b>VOLUME - V</b>
	<b>TITLE</b> <b>PART G : COOLING TOWER</b>	<b>SHEET 4 OF 13</b>

## 5. REINFORCEMENT STEEL

- 5.1 Reinforcement bars shall be either of mild steel conforming to IS:432 grade I quality or high yield strength deformed bars conforming to IS:1786.
- 5.2 Steel wires for prestressing shall conform to IS:1785 (part 1&2).
- 5.3 Reinforcement for the shell shall be corrosion resistant steel.

## 6. STRUCTURAL STEEL

- 6.1 Steel for all structural steel works shall conform to IS:2062.
- 6.2 All exposed steel work shall be protected by hot dip galvanising. The minimum coating of zinc shall be 900 gm/sq.m. and comply with the requirements of IS:2629 and IS:2633. In addition, galvanizing shall be followed by the application of one coat of etching primer conforming to IS:5666 and 2 coats of bituminous paint conforming to IS:9862.

## 7. LOADINGS

### 7.1 Wind Load


- 7.1.1 Basic wind speed as well as factors K1/K2/K3 shall be taken from IS:875. Additional intensification factor to be considered due to natural turbulence in the incident wind / induced turbulence owing to nearby tall structures shall be as per BS4485, Part 4, or based on wind tunnel studies, whichever is higher.
- 7.1.2 Steady pressure distribution around the shell for the wind loading shall be as per clause 5.1.3 of IS:11504, for cooling towers not more than 120m in height and not more than 100 m in base diameter. The value obtained shall be increased by 10 percent to take into account any geometrical imperfections.
- 7.1.3 For cooling towers of height more than 120m and/or more than 100m in base diameter, wind pressure distribution shall be as determined by model test in a wind tunnel.

### 7.2 Earthquake Load

- 7.2.1 The coefficient of horizontal acceleration shall be as applicable to seismic zone III - IS:1893

### 7.3 Dead Load

- 7.3.1 For assessing the self weight of the structure, the specific weight of the concrete shell shall be taken as 25kN per cubic metre. All other dead loads shall be assessed as per IS:875.

KPCL/BTPS/03/EPC	KARNATAKA POWER CORPORATION LIMITED	SECTION: D4.6
	BELLARY TPS, UNIT-3 OF 700 MW	VOLUME - V
	TITLE PART G : COOLING TOWER	SHEET 5 OF 13
7.3.2	The loadings brought upon the shell by permanent fixings shall be minimised to the greatest extent possible. However, when these attachments are made, their effect upon the structure shall be thoroughly investigated.	
7.4	<b>Constructional Loadings</b>	
	Contractor shall be fully responsible for ensuring safety by checking the designs, for all the temporary construction loadings as applicable.	
7.5	<b>Miscellaneous Loads</b>	
	Effect on account of the following loads shall also be investigated.	
	a) Thermal restraint loads	
	b) Subsoil deformation	
8.0	<b>LOAD COMBINATIONS AND PERMISSIBLE STRESSES</b>	
8.1	All structural components except Fill Supporting Structures, Stairs and Platforms of the cooling tower shall be designed by both working stress and limit state method. The load combinations shall be as follows:	
	a. For working stress method	
	i. $DL + WL$	
	ii. $DL + 1/3WL + EQ$	
	b. For limit state method	
	i. $1.5DL + 1.5WL$	
	ii. $0.9DL + 1.5WL$	
	iii. $1.5DL + 1.5EQ + 0.5WL$	
	iv. $0.9DL + 1.5EQ + 0.5WL$	
	where DL = Dead Load WL = Wind Load EQ = Earthquake Load	
8.2	While considering the above load combinations, the appropriate stress resultants shall be superimposed most unfavourably. Stress due to subsoil deformation, temperature and constructional loads shall also be added to arrive at the most unfavourable load combination.	
8.3	Since cooling tower is more a wind predominant structure, increase in permissible stresses as per B - 2.3 Annexure - B of IS 456, shall not be allowed. Increase in safe bearing capacity for design of foundation under wind load combination shall also not be permitted.	