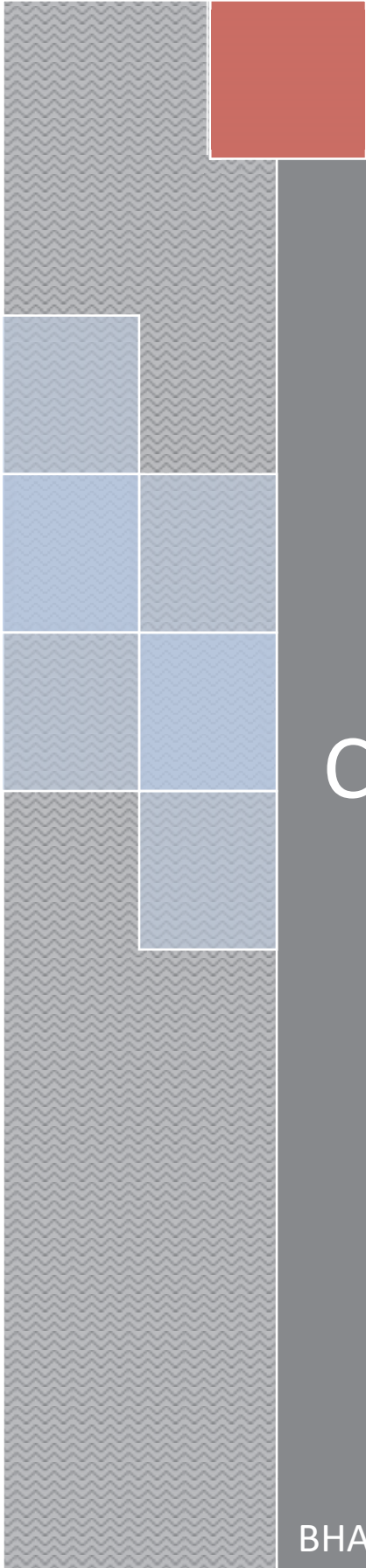




VOLUME – IA Part I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED



TECHNICAL CONDITIONS OF CONTRACT (TCC)

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VOLUME-IA PART – I CHAPTER – I

PROJECT INFORMATION

INTRODUCTION

ENNORE SEZ SUPERCRITICAL TPS UNITS- 1 & 2 [2 x 660 MW] is being set up by TAMILNADU GENERATION AND DISTRIBUTION CORPORATION at a site in Vayalur Village Near Ennore Port, Tamilnadu, India. Plant will be set up in existing Ash Dyke of NCTPS by reclamation of some portion of the Ash Dyke. The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on BHEL/Owner. All relevant site data /information as may be necessary shall have to be obtained /collected by the Bidder.

APPROACH TO SITE

The proposed plant will be located at Ash dyke of North Chennai Thermal Power, approximately 35 km from Chennai, in the state of Tamilnadu, India. The site is occupying a coastal site near the village of Vayalur. The nearest commercial airport is at Chennai located at a distance of 60 km from the project site.

Nearest Airport – Chennai

Nearest Airstrip – Chennai

Nearest Seaport – Ennore

A. Project Information & Location

Project Title: Ennore SEZ project of 2 x 660 MW Coal Based Super Critical Thermal Power Project at ash dyke of NCTPS

Plant Capacity: 1320 MW (2 units of 660 MW each)

Type of Project: Green field

Owner: Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)

Plant site location: Ash dyke of North Chennai Thermal Power Station (NCTPS)

Location co-ordinates: 80o 18' E to 80o 19' E Longitude

13o 17' N to 13o 18' N Latitude

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Nearest Village: Vayalur

Nearest Town & City: Chennai (35 Km)

State Capital: Chennai (35 Km)

Nearest Railway Station: Athipattu Pudunagar (~5 Km)

Nearest Airport: Chennai (~60 Km)

Nearest Seaport: Ennore (~5 Km)

Nearest Road access: All weather road from Pattamandri on the Thiruvottiyur – Ponneri district highway.

B. Meteorological Condition

Owner: Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)

Owner Consultant: DESEIN, DELHI,

Site Elevation: (+) 10.0 m above Mean Sea Level

Ambient Temperature: a. Maximum 32.0 Deg. C

b. Minimum 24 Deg. C

c. Design ambient temperature 35 Deg. C

Relative Humidity: a. Maximum 100%

b. Minimum 36%

c. Design 75%

Annual Rainfall: a. Maximum 2540 mm

b. Average 1600 mm

c. Minimum 1175 mm

Wind Data: a. Basic wind speed at 10m height: 50 m/sec

b. Wind pressure As per IS: 875 Part III-1984

Seismic Zone: Zone III as per IS: 1893-2002

Design ambient temperature: 50 Deg. C (For electrical Equipments)

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VOLUME-IA PART – I CHAPTER – II

SCOPE OF WORKS

- 1.2.1 The scope of works covers mainly Balance Design, Engineering and Construction of Natural Draft Cooling Tower (NDCT) and other allied works including Civil, Architectural, Mechanical, Electrical and C&I works for Unit-1&2 of 2 X 660 MW Ennore SEZ Super Thermal Power Project at Ash dyke of North Chennai TPS, Chennai, TamilNadu, as mentioned below, including supply of all materials for civil(excluding Ready mix concrete and epoxy coated Reinforcement steel), Mechanical, Electrical & C&I works required, all labour, tools and plants and hand over the structures to TANGEDCO in all respect as per BOQ, Specifications and drawings.
- 1.2.2 BHEL shall provide Ready mix concrete & Epoxy coated Reinforcement steel for civil works as free supply.
- 1.2.3 Ready mix concrete shall be supplied by BHEL's sub agency to the delivery Point at ground level as per the instructions of engineer in charge. Further transportation of the concrete to the respective pouring locations at ground level and pouring of concrete through Concrete Pump/Suitable concrete Boom Placer shall be in the scope of bidder. RCC measurements for the payment purpose shall be considered actuals as per drawing, any usage beyond the actual drawing requirement shall be back charged as per the penal rate mentioned under Chapter XIII Accounting of Materials Issue.
- 1.2.4 Supply of structural steel for the structural works shall be in the scope of bidder. Embedments/ inserts required, if any, for the works in general shall be supplied by the bidder.
- 1.2.5 Following indicative list is provided for the works completed at site for both the NDCTs,
1. All Underground works of NDCT -1
 2. All Raker columns of NDCT-1
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3. RCC works in Shell upto 5th lift of NDCT-1
4. All Underground works except minor backfilling of NDCT -2
5. 47/48 pedestals of NDCT -2

Notwithstanding above, the scope of work of this contract includes execution of NDCT works on AS IS WHERE IS basis.

- 1.2.6 After award of the contract, before commencement of the work, joint measurement protocol along with BHEL shall be made for the work which is completed under contract ref. SCT-1575 to avoid any future disputes in measurements.
- 1.2.7 The concrete surface of the shell and other area where painting/coating has to be carried out shall be properly finished for any honeycomb after removing any concrete drippings or protrusions or any other foreign material including oil, algae etc. For finishing of honeycombs, polymer modified cement slurry shall be used. Concrete surface shall be thoroughly cleaned using water jetting to remove any dust, loose materials and curing compound, if any prior to the painting/coating works.
- 1.2.8 The works to be performed under this contract, consist of providing all labour, supervision, material, scaffolding, construction equipment's, tools and plants, temporary works, supplies including POL (Petroleum, oil & lubricants), transportation and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of work in all respects. Testing of all materials, earthwork other allied works, preparation of bar bending schedules on the basis of construction drawings, preparation of fabrication drawings etc. are included in the rates of items of work. Works shall only be carried out with approved structural fabrication drawings.
- 1.2.9 One dedicated quality control team should be deployed by the contractor during the execution of entire NDCT concreting works. The team shall involve in day to day testing of materials, mixing and producing of the concrete. The authorized

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team member shall sign in all joint protocols prepared on daily basis at the RMC Quality control laboratory in the presence of BHEL/Customer officials.

- 1.2.10 The area of work shall be cleared of all vegetation, rubbish and other objectionable matter and materials removed shall be burnt or otherwise disposed of as directed by the Engineer-in-Charge. No separate payment for these operations shall be made. The cost of all these operations shall be deemed to have been included in the unit rates rendered for the different items under bill of quantities.
- 1.2.11 All the works areas shall be adequately flood lighted to the satisfaction of the Engineer-in-Charge when the work is in progress during the night shifts.
- 1.2.12 The Lumpsum rate shall include all material equipment, fixtures, labour construction plant, temporary works and everything whether of permanent or temporary nature necessary for the completion of job in all respects.
- 1.2.13 The Lumpsum rate shall include all the stipulations mentioned in technical specifications and nothing extra over B.O.Q rates shall be payable.
- 1.2.14 The bidder should fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, local conditions, soil strata and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may have not been specifically brought out in the specifications.
- 1.2.15 The work covered under scope shall be taken up on AS IS WHERE IS basis, as applicable in site as per the instructions of BHEL Engineer in charge.
- 1.2.16 Special arrangements to be made for tackling COVID-19 pandemic –
- 1.2.16.1 Government order (state/ center) being issued time to time for protective measures of COVID-19 pandemic shall be complied with strictly until government (state/ center) declares end of pandemic.
- 1.2.16.2 Contractor shall make arrangements for implementation of STANDARD OPERATING PROTOCOL (SOP) as per government order. Any person violating the COVID -19 measures published vide government order time to
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time will be liable to be proceeded for legal action as per the government order.

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VOLUME-IA PART – I CHAPTER – III

FACILITIES & CONSUMABLES IN THE SCOPE OF CONTRACTOR / BHEL (SCOPE MATRIX)

1.3.1 PART I

Sl.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.1	ESTABLISHMENT			
1.3.1.1.1	FOR CONSTRUCTION PURPOSE:			
1.3.1.1.1.1	Open space for office	Yes		As provided by TANGEDCO
1.3.1.1.1.2	Open space for storage	Yes		
1.3.1.1.1.3	Construction of bidder's office, canteen and storage building including supply of materials and other services		Yes	At Bidder's Own Cost
1.3.1.1.1.4	Bidder's all office equipments, office / store / canteen consumables		Yes	
1.3.1.1.1.5	Canteen facilities for the bidder's staff, supervisors and engineers etc.		Yes	
1.3.1.1.1.6	Firefighting equipments like buckets, extinguishers etc.		Yes	
1.3.1.1.1.7	Fencing of storage area, office, canteen, labour hutment, etc. of the bidder,		Yes	
1.3.1.1.2	FOR LIVING PURPOSES OF THE BIDDER			
1.3.1.1.2.1	Open space		Yes	At Bidder's Own Cost
1.3.1.1.2.2	Living accommodation		Yes	
1.3.1.2.0	ELECTRICITY			
1.3.1.2.1	Electricity for construction purposes	YES		Chargeable to bidder as provided by TANGEDCO

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Sl.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
	PART I			
1.3.1.2.1.1	Single point source (In general) For detail, refer clause no. 1.3.4.1	Yes		On chargeable basis to bidder as per Prevailing rate of TANGEDCO
1.3.1.2.1.2	Further distribution for the work to be done which include supply of materials and execution		Yes	At Bidder's Own Cost
1.3.1.2.2	Electricity for the office, stores, canteen etc. of the bidder which include:		Yes	
1.3.1.2.2.1	Distribution from single point including supply of materials and service		Yes	
1.3.1.2.2.2	Supply, installation and connection of material of energy meter including operation and maintenance		Yes	
1.3.1.2.2.3	Duties and deposits including statutory clearances for the above		Yes	
1.3.1.2.2.4	Living facilities for office use including charges		Yes	
1.3.1.2.2.5	Demobilization of the facilities after completion of works		Yes	
1.3.1.2.3	Electricity for living accommodation of the bidder's staff, engineers, supervisors, labour hutment etc. on the above lines		Yes	
1.3.1.3.0	WATER SUPPLY			
1.3.1.3.1	For construction purposes:	Yes		Chargeable to bidder as per prevailing rate of TANGEDCO
1.3.1.3.1.1	Making the water available at single point	Yes		Chargeable to bidder as per prevailing rate of TANGEDCO
1.3.1.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	At Bidder's Own Cost

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Sl.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
	PART I			
1.3.1.3.2	Water supply for bidder's office, stores, canteen etc.		Yes	
1.3.1.4.0	LIGHTING			
1.3.1.4.1	For construction work (supply of all the necessary materials) i. At office storage area ii. At the preassembly area iii. At the construction site / area		Yes	At Bidder's Own Cost
1.3.1.4.2	For construction work (Execution of the lighting work / arrangements) i. At office storage area ii. At the preassembly area iii. At the construction site /area		Yes	
1.3.1.5.0	COMMUNICATION FACILITIES for site operations of the bidder			
1.3.1.5.1	Telephone, Fax, internet, intranet, email etc.		Yes	At Bidder's Own Cost

1.3.2 PART II

Sl. No.	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
	PART II			
	CONSTRUCTION FACILITIES			
1.3.2.1	Engineering works for construction			
1.3.2.1.1	Providing the construction drawings for all the equipment's covered under this scope	Yes		
1.3.2.1.2	Drawings for construction methods		Yes	In consultation with BHEL
1.3.2.1.3	As-built drawings – wherever deviations observed and executed and also based on the decisions taken at site- example – routing of small bore pipes	Yes	Yes	In consultation with BHEL

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Sl. No.	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
	PART II			
1.3.2.1.4	Shipping lists etc. for reference and planning the activities	Yes	Yes	In consultation with BHEL
1.3.2.1.5	Preparation of site construction schedules and other input requirements		Yes	In consultation with BHEL
1.3.2.1.6	Review of performance and revision of site construction schedules in order to achieve the end dates and other commitments		Yes	
1.3.2.1.7	Weekly construction schedules based on SI No 1.3.2.1.5		Yes	
1.3.2.1.8	Daily construction / work plan based on SI No 1.3.2.1.7		Yes	For daily monitoring meeting at site
1.3.2.1.9	Periodic visit of the senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of the bidder should be done once in every two months.		Yes	At bidder's own cost
1.3.2.1.10	Preparation of preassembly bay		Yes	At bidder's own cost

1.3.3 OPEN SPACE:

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

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purpose shall be provided as per availability free of cost. The contractor will be responsible for handing back all lands, as handed over to him by BHEL.

Contractor has to make his own arrangements for labour colony at their own cost. The contractor to construct labour colony/ hutment as per his requirements after obtaining approval of formalities from statutory body. The contractor shall provide adequate water arrangement for drinking/washing/bathing with required toilets, drainage system, lighting facilities etc. in labour colony at their own cost. Suitable paved area to be provided in the labour colony at their own cost.

1.3.4 ELECTRICITY:

1.3.4.1 In general, Construction power will be provided to the contractor on prevailing rates of TANGEDCO on chargeable basis at one single point WITHIN THE PLANT AREA by BHEL. Bidder to make his own arrangement for further distribution to their work area or make suitable arrangement for alternative source of power supply through deployment of adequate number of DG sets.

1.3.4.2 The contractor to provide necessary energy meter for measuring the power consumption. The contractor shall make his own arrangement for further distribution with necessary isolator/LCB etc. However, based on request of Contractor and requirement of project, BHEL Site in charge, at his discretion, may provide construction power at multiple point (as close to work area as possible), for smooth execution of the work at site. If, BHEL provides electricity at more than one point (as close to work area as possible), it will be responsibility of the contractor to provide all the support necessary for enabling BHEL for extending such provision to contractor. However, the Construction power provided to the contractor shall be on chargeable basis at prevailing rates of TANGEDCO. The contractor has to Provide necessary meter for measuring the power consumption. The contractor shall make his own arrangement for further distribution with necessary isolator/ LCB etc. Any dispute, BHEL engineer's decision shall be final and binding on contractor.

Construction power prevailing charges are as below,

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The present LT tariff VI rate of TANGEDCO is

- a) Consumption charges at Rs.12.00 per unit
- b) Maximum demand (MD) charges as applicable per month
- c) Low Power Factor (LPF) charges
- d) Electricity Tax on total amount
- e) Any other miscellaneous charges charged by M/s TANGEDCO pertaining to construction power supply.

Note - The TANGEDCO tariff and tax may vary from time to time and the same is applicable for the bidder.

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

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

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

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

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

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

1.3.5 WATER:

1.3.5.1 Water (Raw water) required for construction purposes will be provided at one single point WITHIN THE PLANT AREA on chargeable basis to contractor at the prevailing rates of TANGEDCO. The contractor to Provide necessary meter for measuring the water consumption. The required pumps & accessories, pipes for drawing water from the given point and further distribution will be arranged by the contractor at their cost to go on without interruptions.

1.3.5.2 Successful Bidder to make his own arrangements for drinking water / water for sanitation for their labourer & staff at bidders cost.

1.3.5.3 The water charges may vary from time to time as per TANGEDCO/ Metro conditions. However, the prevailing water charge is Rs 191.00 per Kilo litres and may be liable to changes. Any dispute regarding consumption, the BHEL engineer decision will be final. The TANGEDCO tariff and tax may vary from time to time and the same is applicable for the successful bidder.

1.3.5.4 In case non-availability of water or the TANGEDCO is not able to supply the water, the contractor shall make his own arrangements of water suitable for construction purpose to have uninterrupted work. No separate payment shall be made for any contingency arrangement made by contractor, due to delay / failure for providing water supply. Contractor has to make his own arrangements for their water requirement for their labour colony at their own cost.

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1.3.6 MATERIAL SUPPLY:

1.3.6.1 Supply / providing all the materials required (except free supply materials i.e. epoxy coated reinforcement steel and ready mix concrete till the delivery Point at ground level) for the work are in the scope of the contractor.

1.3.6.2 The steel material will be issued from BHEL stores, within the plant premises. Collection and transporting to the place of work is in contractor's scope without any extra cost to BHEL. The steel will be issued to the agency in standard lengths.

1.3.6.3 If any matching sections of steel are not available with BHEL, contractor may arrange these sections on certification of BHEL and the landing cost of sections to site will be reimbursed based on the prevailing rate at SAIL at the time of procurement at the nearest SAIL outlet with the freight charges against supporting document.

1.3.6.4 Material specification for Structural Steel I is given below:

1.3.6.4.1 Steel will conform to Grade-A of IS:2062 (latest) for rolled steel members or plates upto 20 mm thickness. For plates above 20 mm thickness and upto 40 mm thickness steel conforming to Grade-BR (with impact test at room temperature) (killed and normalizing rolling) of IS: 2062(latest) shall be used. For plates above 40 mm thickness steel conforming to Grade-B0 (killed and furnace normalizing) of IS: 2062(latest) shall be used. Plates of thickness 32 mm and above shall be ultrasonically tested as per ASTM-435.

However, steel conforming to Grade-C (IS: 2062) (killed, ultrasonically tested as per ASTM-435 and furnace normalizing) shall be used for crane girder. Steel shall be procured from SAIL or any other approved main producers.

Chequered plate shall conform to IS: 3502 (latest) and minimum thickness of chequered plate for floorings, covers etc shall be 8 mm O/P.

1.3.7 CONSUMABLE

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

1.3.8 LIGHTING FACILITY:

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

1.3.9 CONTRACTOR'S OBLIGATION ON COMPLETION:

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

1.3.10 DEWATERING

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

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VOLUME-IA PART – I CHAPTER – IV T&Ps TO BE DEPLOYED BY CONTRACTOR

- 1.4.1 All the tools and plants required for satisfactory completion of the work have to be arranged by the contractor.
- 1.4.2 The contractor is required to arrange the following tentative Major T&Ps and other T&Ps for the satisfactory completion of the work

Sr No	Major T&P	Mobilizing time from the date of start of work
B1	1 No. Pocklain CK90 excavator	As per site requirement.
B2	Suitable capacity tyre mounted crane – 1 nos	As per site requirement.
B3	Tower crane of suitable capacity for height of approx. 200m and bottom radius 75m along with operator and necessary spares – 1 nos for each NDCT	As per site requirement.
B4	Jump form for shell concreting along with all accessories e.g. required no. of jacks (including spare jacks), power packs, ropes, safety accessories, etc. all complete required for smooth operation of jump form – 1 set for each NDCT	As per site requirement. Date for mobilization of jump form shall be fixed at site with mutual agreement between BHEL site in-charge and contractor.
B5	Suitable passenger lift cabin for carrying (min 8 passengers) along with all accessories – 1nos for each NDCT	To be arranged at site before completion of work of shell upto existing ground level
B6	2 nos. concrete pump(60 cum/ hr min capacity & lift 90M)/ concrete boom placer of 36m boom length (as applicable).	As per site requirement
B7	Mobile tower crane – 1 nos for each NDCT for grillage works	As per site requirement.
B8	Power winch -3 T – 10 nos. for concreting work	As per site requirement.
B9	5 nos of shuttering sets for raker column and required staging material	As per site requirement

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	Sufficient rings shall be mobilized to support the columns after de-shuttering so that shuttering plates will be used for subsequent column activities.	
	Other T&Ps	Mobilizing time from the date of start of work
B10	2 No. JCB	As per site requirement.
B11	2 nos. dumper (Min 15 cum each)	As per site requirement.
B12	2 nos. diesel Mixer machine of 0.5 cum capacity	As per site requirement.
B13	2 nos. self-priming dewatering pump 5 HP (diesel)	As per site requirement.
B14	2 nos. self-priming dewatering pump 5 HP (electric)	As per site requirement
B15	4 nos. curing pump – 1.5 /2 HP (pump for curing at heights)	As per site requirement.
B16	4 nos. reinforcement bending machine	As per site requirement
B17	1 no. Vibromax (earth compactor)	As per site requirement.
B18	4 nos. reinforcement cutting machine	As per site requirement
B19	Welding rectifiers – 6nos for piping erection	As per site requirement.
B20	8 sets of raker column steel shuttering – for NDCT - 2	As per site requirement.
B21	MS scaffolding pipe / ACROW SPAN	As per site requirement.
B22	Welding machine (submerged arc) – 5 nos	As per site requirement.
B23	1 nos. power driven earth rammer (Roller Type 1/2 T)	As per site requirement.

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B24	Optical/laser plumb – 3 nos for each NDCT	Before start of shell concreting
B25	2 no total station with adequate arrangement for Surveyors.	As per site requirement
B26	2 no theodolite 1 second accuracy	As per site requirement
B27	3 no's auto level & staff + 2 no's as required	As per site requirement
B28	300 no's concrete cube moulds	As per site requirement
B29	Adequate no. of small trucks 2T/5T for shifting of reinforcement/shuttering etc. within site	As per site requirement.
B30	4 nos. drinking water tank – 5000 lit.	As per site requirement.
B31	4 nos. mobile toilet blocks for labour use.	As per site requirement.
B32	1 nos. truck mounted 125 KVA DG set	As per site requirement.
B33	Construction power cable	As per site requirement.
B34	Construction water Pipeline	As per site requirement.
B35	1 Nos ultra-sonography testing machine	As per site requirement.
B36	Concrete vibrator with adequate needle (Minimum 15 Nos diesel/electric)	As per site requirement.
B37	Portable fire extinguishers as below: Soda acid – 10 sets. Dry chemical powder – 10 sets CO2 – 10 sets. Water & sand bucket (4 buckets in one stand) – 10 sets. Fire hose with nozzle (50 M length) – 5 sets.	25% within 15 days and balance progressively within 45 days.

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B38	1 Nos. Multi stage high lift water pump (for curing) (lifting height 210 metres). One shall be working and other shall be stand by.	Before of start of NDCT shell
B39	Power winch -2.5 T – 3 nos. for Internal / External Finishing as applicable	As per site requirement.
B40	Walky Talky – 6 Nos	As per site requirement.

Note:

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

2. All T&P and all IMTEs, which are required for successful and timely execution of the work covered within the scope of this tender, shall be arranged and provided by the contractor at his own cost in working condition.

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

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

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

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

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4. In the event of need of change of type of any of major T&Ps, approval shall be taken from BHEL Engineer in-charge prior to mobilization. The decision of Number of T&P required due to replacing the enlisted T&P as per above table, shall be taken after analyzing the production capacity and suitability of both the T&Ps.
5. Clause no. 1.6.1.1 of this specification may please be referred for date of start of work

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

1.4.4. The Bidder shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time for testing. Alternately, bidder can have a tie up with other laboratory established inside the site premises for all kind of testing except the test related to concrete as per quality plan for the day to day requirement.

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

1.4.4.2 Field and laboratory testing procedures for materials follow Indian Standard Specifications with necessary equipment's like as given in table below:

Soil Testing Equipment				
SL NO	NAME OF TEST	NAME OF EQUIPMENT	SIZE OF EQUIPMENT	IS REF.
1	Liquid limit test	Liquid limit apparatus	Standard	IS 2720
2	Core Cutter test	core cutter apparatus	Rammer, 6 no's of std. core cutter mould, dolly	IS 2720
3	Proctor density test	Std proctor Compaction apparatus	Standard	IS 2720
4	Moisture Content	Rapid moisture meter	Standard, at least 04 no's	IS 2720

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

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- 1.4.6. In construction projects of this magnitude it is possible that all the areas/ approaches may not be ready. In such cases consolidation of ground and arrangement of sleepers / sand bag filling, construction of Temporary approach road for all their working area etc. for safe operation / movement of equipment including cranes / trailers etc. shall be the responsibility of the contractor at his cost. No compensation on this account shall be payable.
- 1.4.7 In case the contractor fails to provide any T&P which is in the scope of contractor and if BHEL provides such T&P available with BHEL, hire charges prevailing (as per BHEL norms) as on that day will be recovered from the contractor as per the prevailing BHEL Corporate Crane hire charges (may vary from time to time). Corresponding pages of Corporate Crane hire charges are enclosed in relevant chapter of part II of Technical Conditions of Contract (Volume-I Book-I). This may get revised further as per the BHEL corporate guidelines. However, prevailing rates as on date of execution may be applicable. Crane operators deployed by the contractor shall be tested by BHEL before they are allowed to operate the cranes.
- 1.4.8 The age of the contractor deployed cranes upto 150 T should be within 15 years as on date of deployment. Contractor has to provide documentary proof for the age of the crane at the time of deployment to the BHEL Engineer.

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VOLUME-IA PART – I CHAPTER – V T&Ps PROVIDED BY BHEL

1.5.1 BHEL shall not provide any T & Ps. However, if in any unforeseen circumstances, requirement of any T&Ps (available with BHEL at site) arises, on request of bidder the same may be provided on chargeable basis but BHEL reserves the right of provision of such T&Ps. Charges shall be applied as per BHEL norms and guidelines and direction of engineer in-charge.

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VOLUME-IA PART – I CHAPTER-VI

TIME SCHEDULE

- 1.6.1 The date of commencement of work at site shall be mutually agreed between bidder and BHEL site in-charge.
- 1.6.2 The entire works of both the cooling towers as detailed in the Tender Specification shall be completed within 17 Months (seventeen months) from the date of commencement of work with intermediate milestones as mentioned in clause no. 1.6.8.2
- 1.6.3 During the total period of contract, the contractor has to carry out the activities in a phased manner as required by BHEL and the program of milestone events.
- 1.6.4 The contractor is required to refer Form 15 in Volume 1- BOOK 2 for all the instructions to be taken immediately after receipt of LOI.
- 1.6.5 MOBILISATION
- 1.6.5.1 The Contractor has to subsequently augment his resources in a prudent manner to achieve the COMPLETION SCHEDULES:
- 1.6.5.2 The above time allowed for completion of work including Sundays and Holidays is from the date of commencement of work. Detailed program to be prepared by the successful bidder taking in to consideration of the COMPLETION SCHEDULES /site decision on drawings flow (latest) and submitted for BHEL's approval.
- 1.6.5.3 In order to meet above schedule in general, and any other intermediate targets set, to meet customer / project schedule requirements, contractor shall arrange & augment all necessary resources from time to time on the instructions of BHEL.
- 1.6.5.4 In case the project is to be advanced, the civil works in the scope of the contractor is to be advanced to meet the project requirement. No extra payment whatsoever shall be paid on this account.
- 1.6.6 SUBMISSION OF L3 SCHEDULE
-

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The contractor shall submit a detailed area/structure wise L3 schedule within 15 days from date of issue of LOI, in consultation with BHEL based on the tentative schedule provided as per the clause 1.6.8. The detailed L3 schedule shall be approved by BHEL and same shall be implemented. Bidder shall submit L3 schedule in MS Projects (or any suitable format as agreed between contractor and BHEL engineer in-charge) to meet the agreed project schedule covering various mile stone activities and their split up details such as construction, procurement of materials, fabrication & erection activities, etc. This schedule shall also clearly indicate the interface facilities/inputs to be provided by BHEL/Customer and the dates by which such facilities/inputs are required. The schedule shall be acceptable to BHEL for meeting their mile stone targets/schedule.

1.6.7 GUARANTEE PERIOD FOR THE PACKAGE

1.6.7.1 The Guarantee period shall be as mentioned below:

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

or

18 calendar months from the date of completion of supplies

or

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

1.6.7.2 Performance guarantee for both the NDCTs shall be in the scope of the bidder including works already executed in NDCT.

1.6.7.3 Seller/ contractor's liability in respect of any complaints, defects and claims shall not be limited to supply and installation of replaced parts free of charge, or repair of defective parts to the extent that such replacements are attributable to or arise from faulty workmanship, material or design, in the manufacture, of the stores but at the option of purchaser, to the payment of the value, expenditure and damages as mentioned hereafter, provided

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defects on being discovered are brought to the notice of the seller/ contractor within a period of three (3) months from the date of expiry of the guarantee period.

1.6.8 CONSTRUCTION SCHEDULE –

1.6.8.1 Tentative construction schedule for the scope of works is as mentioned below

TENTATIVE PLAN FOR NDCT-1 OF ENNORE SEZ		
Sl. No	Area of work	Completion from the date of commencement of civil work
1	RCC shell	Progressively up to 4 th month
2	Grillage structure	Progressively by 5 th month
3	RCC for Cold water channel	Progressively by 5 th month
4	Basin wall	Progressively by 2 nd month
5	RCC hot water duct	Progressively by 6 th month
6	Completion of precast beams	Progressively by 6 th month
7	Completion of fills	Progressively by 7 th month
8	Completion of hot water inlet pipes	Progressively by 7 th month
9	All electrical works, staircase, internal painting, cage ladder erection	Progressively by 8 th month
10	PU Coating	Progressively by 8 th month
11	Readiness for unit sync	Progressively by 8 th month
12	Inspection, testing, entire finishing and handing over	Progressively by 11 th month

TENTATIVE PLAN FOR NDCT-2 OF ENNORE SEZ		
Sl. No	Area of work	Completion from the date of commencement of civil work
1	Pedestals	Progressively by 1 st month
2	Basin wall	Progressively by 2 nd month
3	Basin floor	Progressively by 1 st month
4	Tower crane erection	Progressively by 2 nd month
5	Raker column	Progressively by 4 th month
6	RCC shell	Progressively up to 8 th month
7	Grillage structure	Progressively by 9 th month
8	RCC for Cold water channel	Progressively by 9 th month
9	RCC hot water duct	Progressively by 10 th month
10	Completion of precast beams	Progressively by 10 th month
11	Completion of fills	Progressively by 11 th month
12	Completion of hot water inlet pipes	Progressively by 11 th month

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13	All electrical works, staircase, internal painting, cage ladder erection	Progressively by 12 th month
14	PU Coating	Progressively by 12 th month
15	Readiness for unit sync	Progressively by 12 th month
16	Inspection, testing, entire finishing and handing over	Progressively by 15 th month
17	Material reconciliation & Final bill submission (for both the NDCTs)	17 th month

1.6.8.2 INTERMEDIATE MILESTONES

Intermediate milestones are as below.

S No	Description	Completion month from the contractual date of start of the work	Intermediate Milestone
1	Completion of fills of NDCT-1	7 th Month	M1
2	Completion of fills of NDCT-2	11 th month	M2

1.6.8.3 Penalty for Intermediate Milestones

1.6.8.3.1 M1 and M2 shall be intermediate Milestones for this work.

1.6.8.3.2 In case of slippage of these identified Intermediate Milestones, Delay Analysis shall be carried out on achievement of each of these two Intermediate Milestones in reference to Form 14.

1.6.8.3.3 Incase delay in achieving M1 milestone is solely attributable to the contractor, 0.5% per week of executable contract value* limited to Maximum 2% of executable contract value will be withheld.

1.6.8.3.4 Incase delay in achieving M2 milestone is solely attributable to the contractor, 0.5% per week of executable contract value* limited to maximum 3% of executable contract value will be withheld.

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

1.6.8.3.6 Amount required to be withheld on account of slippage of identified intermediate milestone(s) shall be withheld out of respective milestone

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payment and balance amount (if any) shall be withheld @10% of RA Bill amount from subsequent RA bills.

- 1.6.8.3.7 Final deduction towards LD (if applicable), on account of delay attributable to contractor shall be based on final delay analysis on completion / closure of contract. Withheld amount, if any due to slippage of intermediate milestones shall be adjusted against LD or released as the case may be.
- 1.6.8.3.8 In case of termination of contract due to any reason attributable to contractor before completion of work, the amount already withheld against slippage of intermediate milestones shall not be released and be converted in to recovery.
- 1.6.8.3.9 Note: *Executable contract value-value of work for which inputs/fronTS were made available to contractor and were scheduled for execution till the date of achievement of that milestone.
- 1.6.9 The above schedule is tentative. In case the project is to be advanced, works in the scope of the contractor is to be advanced to meet the project requirement. No extra payment whatsoever shall be paid on this account. The above schedule is for entire completion and handing over the structure/ Building to BHEL. Date of commencement of work shall be as mutually agreed at site between BHEL & contractor.
- 1.6.10 The foundations, pedestals, floors, etc., required for the mechanical equipment erection/ structural erection shall be handed over to BHEL progressively within the scheduled period given in the above table, as per the BHEL site requirement. Detailed area handing over plan shall be mutually discussed and agreed upon with BHEL site in-charge.
- 1.6.11 The left out minor finishing works shall also be completed and handed over to BHEL within the contract period.
- 1.6.12 The above time allowed for completion of work including Sundays and Holidays is from the date of commencement of work. Detailed program to be prepared by

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the bidder taking in to consideration of the COMPLETION SCHEDULES / site decision on drawings flow (latest) and submitted for BHEL's approval.

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

1.6.14 The bidder must submit a detail schedule (area wise) for completion of work to meet civil work schedule given in Clause 1.6.8.1 within 15 days from the date of issue of LOI.

1.6.15 The major activities as mentioned against the work schedule given in clause No. 1.6.8.1 are to be indicated in detailed schedule which shall be prepared by the bidder.

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VOLUME-IA PART – I CHAPTER-VII

TERMS OF PAYMENT

1.7.1 Secured Advance

Not applicable

1.7.2 Advance for Mobilization

Not applicable

1.7.3 Interim Payment

1.7.3.1 After award of work, detailed billing schedule shall be proposed by the bidder and approved by BHEL after review.

1.7.3.2 85% on prorata basis based on the approved billing schedule.

1.7.3.3 5% on prorata basis in line with BBU after submission of the quality check formats / documents as per the quality plan for the quantum of work billed and duly certified by engineer.

1.7.3.4 10% on completion of PG test.

1.7.3.5 Retention amount shall be applicable on above 85% as per clause 1.7.3.2 and 5% as per clause 1.7.3.3 as per the GCC.

1.7.4 Royalty for construction materials:

Payment of royalty for borrowed earth is to be made by contractor and challan of deposit of royalty/ seigniorage fee shall be submitted to BHEL along with RA bill.

In absence of production of challan following methodology shall be adopted:

Sl. No.	Construction Material	Rate of seigniorage/ royalty per cum (In rupees) to be withheld in RA bill	Volume to be considered for calculation	Remarks
1	Borrowed earth	26.00	Actual volume of filling shall be considered	Rate mentioned herein is indicative and for information. Actual prevailing rate for

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				seigniorage fee / royalty fee shall be considered for operation in RA bills/ Final bill. The amount so calculated shall be withheld from RA bill and on production of challan, payment of relevant portion will be released.

1.7.3 METHOD OF MEASUREMENT

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

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

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VOLUME-IA PART – I CHAPTER VIII TAXES AND DUTIES

1.8.0 Goods and Service Tax (GST) & Cess

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

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

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

BHEL GSTN - 33AAACB4146P2ZL

NAME – BHARAT HEAVY ELECTRICALS LIMITED

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

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

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

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

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

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

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

1.8.11 All taxes and duty other than GST & Cess

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

1.8.12 Statutory Variations

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

1.8.13 New Taxes/Levies

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

1.8.14 Direct Tax

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

TECHNICAL CONDITIONS OF CONTRACT (TCC)

VOLUME 1A PART-1 CHAPTER IX BILL OF QUANTITY

1.9.1 As mentioned in the price bid.

1.9.2 Bidder to mandatorily submit duly signed break up of their quoted price for Civil works in the following categories as mentioned in the table and to be submitted along with the Price bid.

S. No.	Description	Amount
1	<u>Civil works</u>	
1.A	All Civil works excluding interior & outer coating on NDCTs as per the specification	
1.B	Interior Coating (PU coating as per specification)	
1.C	Outer coating (Cement paint as per the specification)	
	<u>TOTAL VALUE FOR CIVIL WORKS (1.A + 1.B +1.C)</u>	

1.9.3 BHEL reserves the right to award the total complete work of NDCTs or exclude the categories 1.B and 1.C as mentioned above. Quantity variation compensation owing to any exclusion of category shall not be applicable.

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VOLUME-IA PART-I CHAPTER-X GENERAL

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

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

1.10.1 Contractors are requested to furnish the following documents at PSSR-HQ, Chennai immediately after release of Letter of Intent (LOI).

- i) Security Deposit and additional Security Deposit.
- ii) Unqualified Acceptance for Detailed LOI / Work Order.
- iii) Rs.100/- Stamp Paper for preparation of Contract Agreement.

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

- i) Provident Fund Registration Number.
- ii) Labour License Number.
- iii) Workmen Insurance Policy Number.

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

1.10.1.1 BOCW Act & BOCW Welfare Cess Act

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

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

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

1.10.1.1.3 The contractor should ensure compliance regarding Registration of Building Workers as Beneficiaries, Hours of work, welfare measures and other conditions of service with particular reference to Safety and Health measures like Safety Officers, safety committee, issue of Personal protective equipments, canteen, rest room, drinking water, Toilets, ambulance, first aid centre etc.

1.10.1.1.4 The contractor irrespective of their nature of work and manpower (Civil, Mechanical, Electrical works etc) should register their establishment under

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BOCW Act 1996 and comply with BOCW Welfare Cess Act 1996.

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

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

1.10.1.2 **PROVIDENT FUND**

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

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

1.10.1.3 **OTHER STATUTORY REQUIREMENTS**

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

1.10.1.3.2 The contractor shall submit monthly running bills along with the copies of monthly wages (of the preceding month) u/r78(1)(a)(1) of Contract Labour Rules, copies of monthly return of PF contribution with remittance Challans under Employees Provident Fund Act 1952 and copy of renewed WC Insurance policy or copies of monthly return of ESI contribution with Challans under ESI Act 1948 (if applicable) in respect of the workmen engaged by them.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.10.1.3.3 The Contractor should ensure compliance of Sec 21 of Contract Labour (R&A) Act 1970 regarding responsibility for payment of Wages. In case of “Non-compliance of Sec 21 or non-payment of wages” to the workmen before the expiry of wage period by the contractor, BHEL will reserve its right to pay the workmen under the orders of Appropriate authority at the risk and cost of the Contractor.
- 1.10.1.3.4 The Contractor shall submit copies of Final Settlement statement of disbursement of retrenchment benefits on retrenchment of each workman under ID Act 1948, copies of Form 6-A (Annual Return of PF Contribution) along with copies of PF Contribution Card of each member under PF Act and copies of monthly return on ESI Contribution – Form 6 under ESI Act 1948 (if applicable) to BHEL along with the Final Bill.
- 1.10.1.3.5 In case of any dispute pending before the appropriate authority under ID Act 1948, WC Act 1923 or ESI Act 1948 and PF Act 1952, BHEL reserves the right to hold such amounts from the final bills of the Contractor which will be released on submission of proof of settlement of issues from the appropriate authority under the act.
- 1.10.1.3.6 In case of any dispute prolonged / pending before the authority for the reasons not attributable to the contractor, BHEL reserves the right to release the final bill of the contractor on submission of Indemnity bond by the contractor indemnifying BHEL against any claims that may arise at a later date without prejudice to the rights of BHEL.

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

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

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

TECHNICAL CONDITIONS OF CONTRACT (TCC)

rate of Rs. 100 per such tradesman per day. Decision of Engineer-in-Charge as to whether particular tradesman possesses requisite skill and amount of compensation in case of default shall be final and binding.

1.10.1.5 RECOVERY OF COMPENSATION PAID TO VICTIMS BY BHEL IN CASES OF DEATH/ PERMANENT INCAPACITATION OF PERSON DUE TO AN ACCIDENT DURING THE WORKS

BHEL shall recover the amount of compensation paid to victim(s) by BHEL towards loss of life / permanent disability due to an accident which is attributable to the negligence of contractor, agency or firm or any of its employees as detailed below.

- a) **Victim:** Any person who suffers permanent disablement or dies in an accident as defined below.
- b) **Accident:** Any death or permanent disability resulting solely and directly from any unintended and unforeseen injurious occurrence caused during the manufacturing / operation and works incidental thereto at BHEL factories/ offices and precincts thereof, project execution, erection and commissioning, services, repairs and maintenance, trouble shooting, serving, overhaul, renovation and retrofitting, trial operation, performance guarantee testing undertaken by the company or during any works /during working at BHEL Units/ Offices/ townships and premises/ Project Sites.
- c) **Compensation in respect of each of the victims:**
In the event of death or permanent disability resulting from Loss of both limbs: Rs. 10,00,000/- (Rs. Ten Lakh)
In the event of other permanent disability: Rs. 7,00,000/- (Rs. Seven Lakh)
- d) **Permanent Disablement:** A disablement that is classified as a permanent total disablement under the proviso to Section 2 (I) of the Employee's Compensation Act, 1923."

1.10.2 GENERAL

1.10.2.1 Site Visit by the Bidder

The bidder shall, prior to submitting his tender for the work, visit, examine and acquire full knowledge & information and necessary conditions prevailing at the site and its surroundings of the plant premises together with all statutory, obligatory, mandatory requirements of various authorities about the site of works at his own expense, and obtain and ascertain for himself on his own responsibility that may be for preparing his tender and entering into a contract, and take the same into account in the quoted contract price for the work.

1.10.2.2 The bidder shall satisfy themselves about the following factors:

- i). Site conditions including access to the site, existing and required roads and

TECHNICAL CONDITIONS OF CONTRACT (TCC)

other means of transport/communication for use by him in connection with the work including diverting and re-routing of services.

- ii). Requirement and availability of land and other facilities of his enabling works, establishment of his nursery, office, stores etc.
 - iii). Ground conditions including those bearing upon transportation, disposal, handling and storage of materials required for the work or obtained therefrom.
 - iv). Source and extent of availability of suitable materials, including water etc., and labour (skilled and unskilled) required for work, and laws and regulations governing their use and employment.
 - v). Geological, meteorological, topographical and other general features of the site and its surroundings as are pertaining to and needed for the performance of the work.
 - vi). The limit and extent of surface and subsurface water to be encountered during the performance of the work, and the requirement of drainage and pumping.
 - vii). The type of equipment and facilities needed, for and in the performance of the work;
 - viii). The extent of lead and lift required for the work in complete form over the entire duration of the contract, and
 - ix). All other information pertaining to and needed for the work including information as to the risks, contingencies and other circumstances which may influence or affect the work or the cost thereof under this contract.
- 1.10.2.3 The bidder should note that information, if any, in regard to the local conditions, as contained in these tender documents, has been given to tenderer merely for guidance and is not warranted to be complete.
- 1.10.2.4 A bidder shall be deemed to have full knowledge of the site, whether he inspects it or not, and no extra charges consequent on any misunderstanding or otherwise shall be allowed.
- 1.10.2.5 The bidder and any of his personnel or agents will be granted permission by the Site-In-Charge or his authorized nominee, on receipt of formal application in respect thereof a week in advance of the proposed date of inspection of site, to enter upon his premises and lands for purpose of such inspection, but only on the express condition that the tenderer (and his personnel and agents) will relieve and indemnify the Employer (and his personnel and agents) from and against all liability in respect thereof and will be responsible for personal injury (whether fatal or otherwise), loss of or damage to property and any other loss, damage, costs and expenses however caused which, but for the exercise of such permission, would not have arisen.

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- 1.10.2.6 The work covered under this specification is of highly sophisticated nature, requiring the best quality workmanship, engineering and construction management. The contractor must have adequate quantity of tools, construction aids, equipments etc., in his possession. He must also have on his rolls adequate trained, qualified and experienced supervisory staff and skilled personnel.
- 1.10.2.7 It is not the intent to specify herein all details of all material. Any item related this work not covered by this but necessary to complete the system will be deemed to have been included in the scope of the work.
- 1.10.2.8 All the necessary certificates and licenses required to carry out this scope of work are to be arranged by the contractor then and there at no extra cost.
- 1.10.2.9 Site testing wherever required shall be carried out for all items / materials installed by the contractor to ensure proper installation and functioning in accordance with drawings, specifications and manufacturer's recommendations.
- 1.10.2.10 The contractor shall carry out additional tests, if any, which the Engineer feels necessary because of site conditions and also to meet system specification.
- 1.10.2.11 The work shall be executed under the usual conditions without affecting power plant construction / operation and in conjunction with other operations and contracting agencies at site. The contractor and his personnel shall co-operate with the personnel of other agencies, co-ordinate his work with others and proceed in a manner that shall not delay or hinder the progress of work as a whole.
- 1.10.2.12 All the work shall be carried out as per instructions of BHEL engineer. BHEL engineer's decision regarding the correctness of the work and method of working shall be final and binding on the contractor.
- 1.10.2.13 Wherever Construction sequences are furnished by BHEL, the contractor shall follow the same sequence. Contractor shall execute the supply and works as per sequence prescribed by BHEL at site engineer. No claims for extra payment from the contractor will be entertained on the grounds of deviation from the methods of execution of similar job in any other site or for any reasons whatsoever.
- 1.10.2.14 If required by BHEL, the contractor shall change the sequence of his operation so that work on priority sectors can be completed within the projects schedule. The contractor shall afford maximum assistance to BHEL in this connection without causing delay to agreed completion date.
- 1.10.2.15 Contractor shall, transport all materials to site and unload at site / working area for inspection and checking. All material handling equipment required

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shall be arranged by the contractor.

- 1.10.2.16 Contractor shall retain all T&P / Testing instrument / Material handling equipment's etc. at site as per advice of BHEL engineer and same shall be taken out from site only after getting the clearances from engineer in charge.
- 1.10.2.17 The contractor at his cost shall arrange necessary security measures for adequate protection of his machinery, equipment, tools, materials etc. BHEL shall not be responsible for any loss or damage to the contractor's construction equipment and materials. The contractor may consult the Engineer-in-Charge on the arrangements made for general site security for protection of his machinery equipment tools etc.
- 1.10.2.18 The Contractor may have to execute work in such a place and condition where other agencies also will be under such circumstances. However, completion time for construction, agreed will be subject to the condition that contractor's work is not hampered by the agencies.
- 1.10.2.19 Contractor has to work in close co-ordination with other agency at site. BHEL engineer will co-ordinate area clearance. In a project of such magnitude, it is possible that the area clearance may be less / more at a particular given time. Activities and Construction program have to be planned in such a way that the milestones are achieved as per schedule/ plans. Contractor shall arrange & augment the resources accordingly.
- 1.10.2.20 The contractor must obtain the signature and permission of the security personnel of the customer / BHEL for bringing any of their materials inside the site premises. Without the Entry Gate Pass these materials will not be allowed to be taken outside. Surplus materials including steel item brought at site by the contractors with proper documentation and Gate pass, shall be allowed to taken out of the project premises after completion of relevant works, on certification by BHEL in charge.
- 1.10.2.21 Contractor shall remove all scrap materials periodically generated from his working area and collect the same at one place earmarked for the same. Load of scraps is to be shifted to a place earmarked by BHEL. Failure to collect the scrap is likely to lead to accidents and as such BHEL reserves the right to collect and remove the scrap at contractor's risk and cost if there is any failure on the part of contractor in this respect.
- 1.10.2.22 The contractor shall ensure that his premises are always kept clean and tidy to the extent possible. Any untidiness noted on the part of the contractor shall be brought to the attention of the contractor's site representative who shall take immediate action to clean the surroundings to the satisfaction of the Engineer-in-Charge.

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- 1.10.2.23 The contractor is strictly prohibited from using BHEL's regular components like angles, channels, beams, plates, pipe / tubes, and handrails etc. for any temporary supporting or scaffolding works. Contractor shall arrange himself all such materials. In case of such misuse of BHEL materials, a sum as determined by BHEL engineer will be recovered from the contractor's bill. The decision of BHEL engineer is final and binding on the contractor.
- 1.10.2.24 No member of the already erected structure / buildings, other component and auxiliaries should be removed / modified without specific approval of BHEL engineer.
- 1.10.2.25 Contractors shall ensure that all their Staff / Employees are exposed to periodical training programme conducted by qualified agencies/ personnel on latest ISO 9001 Standards.
- 1.10.2.26 Sometimes, it may be required to re-schedule the activities to enable other agencies to commence/ continue the work so as to keep the overall project schedule.
- 1.10.2.27 The terminal points decided by BHEL are final and binding on the contractor for deciding the scope of work and effecting the payment for the work done up to the terminals.
- 1.10.2.28 Crane operators deployed by the contractor shall be tested by BHEL before he is allowed to operate the cranes.
- 1.10.2.29 On Completion of work, all the temporary buildings, structures, pipe lines, cable etc. shall be dismantled and leveled and debris shall be removed as per instruction of BHEL by the contractor at his cost. In the event of his failure to do so, the expenditure towards clearance of the same will be recovered from the contractor. The decision of BHEL Engineer in this regard is final.
- 1.10.2.30 It is the responsibility of the contractor to do the checking, testing etc. if necessary, repeatedly to satisfy BHEL Engineer with all the necessary tools and tackles, manpower etc. without any extra cost. The testing will be completed only when jointly certified so, by the BHEL Engineer.
- 1.10.2.31 If any item not covered but requires being executed, same shall be carried out by the contractor. Equivalent or proportional unit rate shall be considered wherever possible from the BOQ. The rates quoted by the contractor shall be uniform as far as possible for similar items appearing in rate schedule.
- 1.10.2.32 The contractor's work shall not hinder other work, either underground or over ground, such as electrical, phone lines, water or sewage lines, etc. In areas of overlap, the contractor shall work in coordination with other related contractors. Any damage by the landscape contractor's team to such utilities

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will be penalized and contractor shall be responsible for cost for such damages.

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

1.10.2.34 Contractor has to clear the front, expeditiously and promptly as instructed by BHEL Engineer for other agencies, like Boiler, piping, Turbine, Generator erection, Cabling, instrumentation, insulation etc., to commence their work from / on the equipments coming under this scope.

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

1.10.2.36 RECORDS TO BE MAINTAINED AT SITE:

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

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

- (i) Hindrance Register
- (ii) Site Order Book.
- (iii) Test Check of measurements.
- (iv) Cement Supply and Consumption Daily Register
- (v) Records of Test reports of Field tests.
- (vi) Records of manufacture's test certificates.
- (vii) Records of disposal of scraps generated during and after the work completion.
- (viii) List of T&Ps and MMEs

1.10.2.37 SITE INSPECTION

1.10.2.37.1 The Owner or his authorized agents may inspect various stages of work during the currency of the contract awarded to him. The contractor shall make necessary arrangements for such inspection and carry out the rectification pointed out by the Owner or his authorized agents without any extra cost to the Owner or his authorized agents. No cost whatsoever such duplication of inspection of work be entertained.

1.10.2.37.2 BHEL / Owner will have full power and authority to inspect the works at any time, either on the site or at the contractor's premises. The contractor shall arrange every facility and assistance to carry out such inspection. On no

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account will the contractor be allowed to proceed with work of any type unless such work has been inspected and entries are made in the site inspection register by Owner / BHEL.

1.10.2.37.3 The contractor shall maintain at site a joint protocol for recording actual measurement of work carried out at site, inspection and witnessing of various tests conducted by the contractor.

1.10.2.37.4 Field Quality Assurance (FQA) Formats:-

It is the responsibility of the contractor to collect and fill up the relevant FQA log sheets of BHEL and present the same to BHEL after carrying out the necessary checks as per the log sheets and obtaining the signature of BHEL and Owner as token of their acceptance. Payment to the contractor will be inked with the submission of these FQA log sheets.

1.10.2.37.5 Site testing wherever required shall be carried out for all items / materials installed by the contractor to ensure proper installation and functioning in accordance with drawings, specifications and manufacturer's recommendations.

Contractor shall, transport all materials to site and unload at site / working area for inspection and checking. All material handling equipment required shall be arranged by the contractor

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VOLUME-IA PART – I CHAPTER - XI PROGRESS OF WORK

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

1.11 PROGRESS AND MONITORING OF WORK

1.11.1 Refer forms F -14 to F-15 of volume I D of volume -I book-II. Plan and review will be done as per the formats.

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

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

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

1.11.5 The monthly report at the end of every month shall be submitted as a booklet and shall contain the following details:

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- a) Colour Progress photographs to accompany the report should be submitted.
- b) Construction progress in terms of quantity, CUM, etc., completed as relevant to the respective work areas against planned.
- c) Site Organization chart of engineers & supervisors as on 24th of the month with further mobilization plan
- d) Category- wise man hours engaged during the previous month under the categories like fitters, electricians, welders, riggers, khalasis, grinder-men, gas-cutters, crane operators, store keepers, lab technicians, helpers, security etc. Data will be spilt up under the work area.
- e) Consumables report giving consumption of all types of gases and electrodes during the previous month (as applicable).
- f) Availability report of cranes/T&Ps
- g) Safety implementation report in the format
- h) Pending material and any other inputs required from BHEL for activities planned during the subsequent month.

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

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

TECHNICAL CONDITIONS OF CONTRACT (TCC)

- 1.11.8 It is the responsibility of the contractor to provide all relevant information on a regular basis regarding construction progress, laborer availability, equipment deployment, testing, etc.
- 1.11.9 The progress reports shall indicate the progress achieved against plan, indicating reasons for delays, if any. The report shall also give remedial actions which the contractor intends to make good the slippage or lost time so that further works can proceed as per the original plan the slippages do not accumulate and affect the overall programme.
- 1.11.10 The contractor to reflect actual progress achieved during the month and will be submitted to BHEL, so that slippages can be observed and necessary action taken in order to ensure that the situation does not get out of control will update the construction schedule forming part of this contract each month.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

VOLUME-IA PART –I CHAPTER -XII MATERIAL HANDLING

- 1.12.1 Open land as available shall be provided by BHEL on free of cost basis as provided by TANGEDCO. Contractor shall maintain one centralized fenced store cum bar bending yard at his own cost. Hard surfacing of this yard and all round drain shall be carried out by the contractor at his own cost within the quoted rate. The bidder shall make complete arrangement of necessary security personnel, to safeguard all such materials in his custody at his own cost. Materials issued will be used only for construction of permanent work. The contractor shall take care of material issued by BHEL and shall protect the same from theft, damage and weathering at his own cost.
- 1.12.2 The system for receipt, storage & issue of materials shall be available with vendors for easy traceability.
- 1.12.3 Periodic audit of system of purchasing, storing and issue, etc. will have to be carried out by the vendors. BHEL will also audit the same.
- 1.12.4 The contractor shall in no case be entitled for any compensation or damages on account of any delay in supply or non-supply thereof for all or any such material.
- 1.12.5 Excessive rusting of steel must be avoided. In case, due to any cause attributable to the contractor, rusting of steel for BHEL issued steel occur rendering the same unusable, then such quantity of steel shall be recovered from the interim payment at the penal rate specified in the tender.
- 1.12.6 The contractor shall maintain proper store account for all the BHEL issued materials and shall give three copies of computerized reconciliation statement of such account to the BHEL with each running bill.
- 1.12.7 All TMT shall be stacked over sleeper's diameter wise.
- 1.12.8 Materials shall not under any circumstances taken out of the project site unless otherwise permitted by BHEL.

TECHNICAL CONDITIONS OF CONTRACT (TCC)

VOLUME 1A PART-1 CHAPTER XIII

ACCOUNTING OF MATERIALS ISSUE

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

1.13.1 ISSUE OF REINFORCEMENT STEEL, CONSUMPTION, WASTAGE & RETURN OF MATERIALS

Please refer SPECIAL CONDITIONS OF CONTRACT (SCC)- Civil & Structural Chapter – VI: Material Handling, Storage & Preservation

1.13.2 SCRAP & SERVICEABLE MATERIALS

Please refer SPECIAL CONDITIONS OF CONTRACT (SCC)- Civil & Structural Chapter – VI: Material Handling, Storage & Preservation

1.13.3 RECONCILIATION OF MATERIALS

Please refer SPECIAL CONDITIONS OF CONTRACT (SCC)- Civil & Structural Chapter – VI: Material Handling, Storage & Preservation

1.13.4 RECOVERY OF MATERIAL

Recovery of wastages for reinforcement steel shall be made from the bills of contractor at the penal rate mentioned in the table below for the following cases:

- a) If wastage exceeds the specified limit
- b) If the wastage not exceeded specified limit, but not returned to BHEL store except invisible wastage
- c) For not returning the surplus serviceable materials.

13.2.1 PENAL RATE OF MATERIALS

A	EPOXY COATED REINFORCEMENT STEEL	Rs 76,000/- per MT + GST and/or other taxes & duties
B	READY MIX CONCRETE	
B.1	Ready Mix Concrete of grade M7.5	Rs. 4,980/- + GST and/or other taxes & duties

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B.2	Ready Mix Concrete of grade M10	Rs. 4,980/- + GST and/or other taxes & duties
B.3	Ready Mix Concrete of grade M 30 (for pedestals, Ring beam etc.)	Rs. 5,730/- + GST and/or other taxes & duties
B.4	Ready Mix Concrete of grade M 35 (for Grillage Columns etc.)	Rs. 5,850/- + GST and/or other taxes & duties
B.5	Ready Mix Concrete of grade M 40 (For shell, ring beam, corbel, platform, walkway etc.)	Rs. 5,930/- + GST and/or other taxes & duties



**TITLE: 2X660 MW ENNORE SEZ
SUPERCRITICAL TPP,
UNIT# 1 & 2**

SPECIFICATION NO. PE-TS-412-600-C002

VOLUME - II B

SECTION - C

REV.NO. 0

SHEET OF

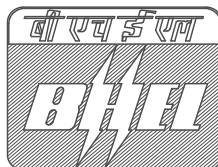
TAMILNADU GENERATION AND DISTRIBUTION CORPORATION

ENNORE SEZ SUPERCRITICAL TPP UNITS- 1 & 2 [2 x 660 MW]

VOLUME – II B CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-412-600-C002

SECTION – C *SPECIFIC TECHNICAL REQUIRMENTS*



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

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1 GENERAL

1.1 Intent of Specification

Contractor shall read the parts of specification relevant to contract and shall ignore other parts of specification. In case of ambiguity between BOQ, Part C and Part D of specification, the following priority for acceptance of items may be followed:

- a) BOQ
- b) Specific technical specification (Part C)
- c) General technical specification (Part D)

1.00.00 CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions / Technical Specifications as appropriate. The latest editions / revision of following codes and standards along with addendums / amendments, if any, shall be followed:

1.01.00 General

- a) Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to Indian Standards.
- b) National Building Code of India.
- c) “Accepted Standards” and “good Practice” listed in the appendix to National Building Code of India.
- d) IS:1200 : Method of measurement of Building and Civil Engineering Works.
- e) IS:1256 : Code of Practice for Building Byelaws.

1.02.00 Earthwork

a)	IS-1498	:	Classification and identification of soils for General Engineering purpose
b)	IS-3764	:	Safety code for excavation work
c)	IS:7293	:	Safety code for working with construction machinery

1.03.00 Concrete

a)	IS-269	:	Ordinary and low heat Portland cement
b)	IS-383	:	Coarse and fine aggregate from natural sources for concrete
c)	IS-432	:	Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
d)	IS-455	:	Portland slag cement
e)	IS-456	:	Code of practice for plain and reinforced concrete
f)	IS-460	:	Test Sieves (all parts)
g)	IS-516	:	Methods of test for strength of concrete
h)	IS-1199	:	Methods of sampling and analysis of concrete

i)	IS-1566	:	Hard drawn steel wire fabric for concrete reinforcement
j)	IS-1786	:	High strength deformed steel bars and wires for concrete reinforcement
k)	IS-1834	:	Hot applied sealing compounds for joints in concrete
l)	IS-2386	:	Methods of test for aggregates for concrete (all parts)
m)	IS:2502	:	Code of practice for bending and fixing of bars for concrete reinforcement
n)	IS:3370	:	Code of practice for concrete structures for storage of liquids (all parts)
o)	IS-3414	:	Code of practice for design and installation of joints in buildings
p)	IS-4948	:	Welded steel wire fabrics for general use.
q)	IS-6452	:	High alumina cement for structural use
r)	IS-7320	:	Concrete slump test apparatus
s)	IS-7861	:	Code of practice for extreme weather concreting (all parts)
t)	IS-8041	:	Rapid hardening Portland cement
u)	IS-8112	:	High strength ordinary Portland cement
v)	IS-10262	:	Recommended guidelines for concrete mix design.
w)	IS:13290	:	Ductile detailing of RCC structure subjected to seismic loads
x)	SP:34	:	Handbook on concrete reinforcement and detailing

1.04.00**Foundations**

a)	IS-1904	:	Code of practice for structural safety of building - Shallow foundations
b)	IS-2950	:	Code of practice for design and construction of raft foundations
c)	IS-2974	:	Code of practice for design and construction of Machine foundations (all parts)



- d) IS-2911 : Code of practice for design and construction of pile foundation.
- e) IS-9716 : Lateral dynamic load test on pile
- f) IS-6313 (Part-1 & Part-2) : Code of Practice for anti-termite measures and treatment.

1.05.00**Loading**

- a) IS-875 : Code of practice for design loads for buildings and structures
- b) IRS : Bridge Rules of Government of India, Ministry of Railways (Railway Board)

1.06.00**Masonry**

- a) IS-712 : Building limes
- b) IS-1077 : Common burnt clay building bricks
- c) IS-1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.
- d) IS-1528 : Methods of sampling and physical tests for refractory materials
- e) IS-1597 : Code of practice for construction of stone masonry (all parts)
- f) IS-2212 : Code of practice for brickwork
- g) IS-2116 : Sand for masonry mortars
- h) IS-2185 : Concrete masonry units. (all parts – Hollow and Solid concrete blocks)
- i) IS-2250 : Code of practice for preparation and use of masonry mortars
- j) IS:2572 : Code of practice for construction of hollow concrete block masonry
- k) IS-2691 : Burnt clay facing bricks



- l) IS-3414 : Code of practice for design and installation of joints in buildings
- m) IS-3495 : Methods of tests of burnt clay building bricks
- n) IS-4441 : Code of practice for use of silicate type chemical resistant mortars
- o) IS-4860 : Acid resistant bricks

1.07.00**Doors, Windows & Ventilators**

- a) IS-399 : Classification of commercial timbers and their zonal distribution
- b) IS-883 : Code of practice for design of structural timber in buildings
- c) IS-1003 : Timber paneled and glazed shutters (all parts)
- d) IS-1038 : Steel doors, windows and ventilators
- e) IS-1081 : Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators
- f) IS-1361 : Steel windows for industrial buildings
- g) IS-2835 : Transparent sheet glass for glazing and framing purposes
- h) IS-1948 : Aluminium doors, windows and ventilators
- i) IS-1949 : Aluminium windows for industrial building
- j) IS-2191 : Wooden flush door shutters (cellular and hollow core type)
- k) IS-2202 : Wooden flush door shutters (solid core type)
- l) IS-3103 : Code of practice for industrial ventilation
- m) IS-3548 : Code of practice for glazing in buildings
- n) IS-3614 : Fire check doors
- o) IS-4021 : Timber door, windows and ventilator frames
- p) IS-4351 : Steel door frames
- q) IS-6248 : Metal rolling shutters and rolling grills



1.08.00**Roof & Flooring**

- a) IS-2204 : Code of practice for construction of reinforced concrete shell roof
- b) IS-3201 : Criteria for the design and construction of precast concrete trusses
- c) IS-2210 : Criteria for design of RC shell structures and folded plates
- d) IS-809 : Rubber flooring materials for general purposes
- e) IS-1195 : Bitumen mastic for flooring
- f) IS-1196 : Code of practice for laying bitumen mastic flooring
- g) IS-1198 : Code of practice for laying, fixing and maintenance of linoleum floors
- h) IS-1237 : Cement concrete flooring tiles
- i) IS-1443 : Code of practice for laying and finishing of cement concrete flooring tiles
- j) IS-2114 : Code of practice for laying in situ terrazzo floor finish
- k) IS-2571 : Code of practice for laying in situ cement concrete flooring
- l) IS-5491 : Code of practice for laying in situ granolithic concrete floor topping
- m) IS-5766 : Code of practice for laying burnt clay brick flooring
- n) IS-1197 : Code of practice for laying of rubber floors
- o) IS:2441 : Code of practice for fixing ceiling coverings.

1.09.00**Waterproofing**

- a) IS-1322 : Bitumen felts for waterproofing and damp proofing
- b) IS-1346 : Code of practice for waterproofing of roofs with bitumen felts



- c) IS-1609 : Code of practice for laying damp proof treatment using bituminous felts.
- d) IS-3036 : Code of practice for laying lime concrete for a water proofed roof finish
- e) IS-3037 : Bitumen mastic for use in waterproofing of roofs.
- f) IS-3067 : Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings
- g) IS-3384 : Bitumen primer for use in water proofing and damp proofing
- h) IS-4365 : Code of practice for application of bitumen mastic for waterproofing of roofs.

1.10.00**Soil Engineering**

- a) IS-1498 : Classification and identification of soils for general engineering purposes
- b) IS-1892 : Code of practice for sub-structure investigation for foundations
- c) IS-2131 : Method for standard penetration test for soils
- d) IS-2720 : Methods of test for soils (all parts)

1.11.00**Water Supply, Drainage & Sewerage**

- a) IS-404 : Lead pipes
- b) IS-458 : Concrete pipes
- c) IS:651 : Salt glazed stoneware pipes and fittings
- d) IS-771 : Glazed fire-clay sanitary appliances (all parts)
- e) IS-774 : Flushing cisterns for water closets and urinals other than plastic cisterns
- f) IS-783 : Code of practice for laying of concrete pipes
- g) IS-1172 : Code of basic requirements for water supply, drainage and sanitation
- h) IS-1626 : Asbestos cement building pipes, gutters and fittings (all parts)



i)	IS-1742	: Code of practice for building drainage
j)	IS-2064	: Code of practice for selection, installation and maintenance of sanitary appliances
k)	IS-2065	: Code of practice for water supply in buildings
l)	IS-2470	: Code of practice for installation of septic tanks (all parts)
m)	IS-3114	: Code of practice for laying of cast iron pipes
n)	IS-4127	: Code of practice for laying of glazed stoneware pipes
o)	IS-12251	: Code of practice for drainage of building basement
p)	IS-1200	: Method of measurement : Laying of water and (Part-XVI) sewer lines including appurtenant items
q)	IS-1536	: Centrifugally cast (spun) iron pressure pipes for water, gas and sewage
r)	IS-1537	: Vertically cast iron pressure pipe for water, gas and sewage
s)	IS-3486	: Cast iron spigot and socket drain pipes
t)	IS-5329	: Code of practice for sanitary pipe work above ground for buildings
u)	IS-3076	: Low density polyethylene pipes for potable water supplies
v)	IS-1538	: Cast iron fittings for pressure pipes for potable water supplies
w)	IS-1230	: Cast iron rainwater pipes and fittings
x)	IS-1729	: Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
y)	IS-784	: Pre-stressed concrete pipes
z)	IS-1726	: Cast iron manhole covers and frames
aa)	IS-5961	: Cast iron grating for drainage purposes
bb)	IS-5219 [Part-I]	: “P” and “S” traps
cc)	IS-772	: General requirements for enameled cast iron sanitary



appliances

- dd) IS-775 : Cast iron brackets and supports for wash basins and sinks
- ee) IS-777 : Glazed earthenware wall tiles
- ff) IS-2548 : Plastic water closet seats and covers (all parts)
- gg) IS-2527 : Code of practice for fixing rainwater gutters and down pipes for roof drainage.

1.12.00 Paving & Road Works

- a) IS-73 : Paving bitumen
- b) IS-702 : Industrial bitumen
- c) IS:1201 : Method of testing tar and bituminous materials thru' 1220
- d) IRC-15 : Standard Specification and code of practice for construction of concrete roads.
- e) IRC-58 : Guidelines for the design of plain jointed rigid pavement for highways
- f) IRC-58 : Guidelines on cement fly ash concrete for rigid pavement.

1.13.00 Earthquake Resistant Design

- a) IS-1893 : Criteria for earthquake resistant design of structures
- b) IS-4326 : Code of practice for earthquake resistant design and construction of buildings

1.14.00 Chimney

- a) IS-4998 : Criteria for design of R.C. Chimneys (all parts)

1.15.00 Structural Steel Work

- a) IS-800 : Code of practice for general construction in steel
- b) IS-802 : Code of practice for use of structural steel in overhead transmission line

Part-I: Load and permissible stresses



Part-II: Fabrication, galvanizing, inspection and packing.

c)	IS-806	:	Code of practice for use of steel tubes in general building construction
d)	IS-808	:	Rolled steel beams, channels and angle sections
e)	IS-813	:	Scheme for symbols for welding
f)	IS-814	:	Covered electrodes for manual metal arc welding for carbon and carbon manganese steel
g)	IS-816	:	Code of practice for use of metal arc welding for general construction in mild steel
h)	IS-817	:	Code of practice for training and testing of metal arc welders
i)	IS-818	:	Code of practice for safety and health requirements in electric and gas welding and cutting operation
j)	IS-819	:	Code of practice for resistance spot welding for light assemblies in mild steel
k)	IS-919	:	Recommendations for limits and fits for engineering.
l)	IS-1024	:	Code of practice for use of welding in bridges and structures subjected to dynamic loading
m)	IS-1161	:	Steel tubes for structural purposes
n)	IS-1182	:	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
o)	IS-1200 [Part-VIII]	:	Method of measurement of steelwork and iron work
p)	IS-1239	:	Mild steel tubes, tubulars and other wrought steel fittings (all parts)
q)	IS-1363	:	Black hexagonal bolts, nuts and locknuts (dia. 6 to 39 mm) and black hexagon screws (dia. 6 to 24 mm) [all parts].
r)	IS-1364	:	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm) [all parts]
s)	IS-1365	:	Slotted counter sunk head screws (dia range 1.6 to 20 mm)
t)	IS-1367	:	Technical supply conditions for threaded steel



			fasteners
u)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
v)	IS-1608	:	Methods of tensile testing of steel products
w)	IS-1730	:	Dimensions for steel plate, sheet and strip for structural and general engineering purpose
x)	IS-1731	:	Dimensions for steel flats for structural and general engineering purposes
y)	IS-1852	:	Rolling and cutting tolerances for hot rolled steel products
z)	IS-1977	:	Structural steel (ordinary quality)
aa)	IS-2016	:	Plain washers
bb)	IS-2062	:	Steel for general structural purposes
cc)	IS-2074	:	Ready mixed paint, air drying, red oxide zinc-chrome, priming
dd)	IS-2633	:	Methods of testing uniformity of coating of zinc coated articles.
ee)	IS-3613	:	Acceptance test for wire-flux combinations for submerged arc welding of structural steel
ff)	IS-3664	:	Code of practice for ultrasonic pulse echo testing by contact and immersions methods
gg)	IS-3757	:	High strength structural bolts
hh)	IS-4000	:	High strength bolts in steel structures
ii)	IS-4759	:	Hot dip zinc coatings on structural steel and other allied products
jj)	IS-5334	:	Code of practice for magnetic particle flaw detection of welds
kk)	IS-7215	:	Tolerances for fabrication of steel structures
ll)	IS-7280	:	Base-wire electrodes for submerged arc welding of structural steel
mm)	IS-7318 [Part-I]	:	Approval test for welders when welding procedure approval is not required.



- nn) IS-8500 : Structural steel – micro-alloyed (medium and high strength qualities)
- oo) IS-9595 : Recommendation for metal arc welding of carbon and carbon manganese steel
- pp) AWS D.1.1 : Structural welding code.

1.16.00

Painting

- a) IS-348 : Specification for French polish
- b) IS-427 : Specification for distemper, dry colour as required
- c) IS-428 : Specification for distemper, oil emulsion, colour as required
- d) IS-1477 (I & II) : Code of practice for painting of ferrous metal in buildings
- e) IS-2338 (I & II) : Code of practice for finishing of wood and wood based materials
- f) IS-2339 : Specification for Aluminium Paints for general purposes in dual containers
- g) IS-2395 : Code of practice for painting concrete, masonry and plaster surface
- h) IS-2932 : Specification for enamel, synthetic, exterior - (a) undercoating , (b) finishing
- i) IS-2933 : Specification for enamel, exterior – (a) undercoating, (b) finishing.
- j) IS-5410 : Specification for cement paint.

1.17.00

- a) Indian Road Congress (IRC) Bridge codes
- b) Indian Railways Standard Bridge Rules

1.18.00

Environmental Protection

Charter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003.

1.19.00

Rules & Regulation of Local Authorities

1.20.00

Statutory Regulations of Tariff Regulation Commission (TAC)



6.00.00 GENERAL REQUIREMENT OF BUILDING / STRUCTURES

The CONTRACTOR shall obtain and be conversant with all laws, by-laws and 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.

EPC Contractor to ensure that all building layout has been finalized in such a way so that adequate space is available all-round the equipment for operation, repair & maintenance.

6.01.00 Roof Access

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

6.02.00 Platform and Walkways

Platforms shall be provided to all major equipment, not directly accessible from - the floors, for maintenance. Platforms and connecting walkway shall have a minimum width of 750 mm. Platforms in front of the entry shall be atleast 900 mm wide. Platforms located close to each other shall be connected with walkways.

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 consists of 8 mm thick Galvanised 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.

Continuous walkway with GI Hand rail at least 750 mm (Wherever occurs) 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 and staircase.

The plinth of powerhouse and its surrounding area is to be kept RL.10.0M. Top of finish of main approach road and internal road are to be kept be 250mm above surrounding Grade lvl. at RL.9.5M level.

Finished floor level boiler area / transformer yard area shall be kept 200mm lower than the finished floor level of power house building.

Finished ground floor level of all buildings and pump houses shall be minimum 500mm above the formation level / grade level.

6.03.00 Edge Protection

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

6.04.00 Anchor Bolts and Inserts Plates

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.

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

Insert plates required for the equipment supplied by BTG vendor will be supplied by BTG supplier and same shall be fixed in position under this contract and supply and fixing of all the balance inserts shall be under the scope of this contract.

6.05.00 Vertical Headroom

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
Above false ceiling	1000 mm
Safety cage for ladders	2500 mm
Access for fork lift trucks	2800 mm
Main roads / Railway crossings & crane access	7000 mm
Other plant roads and truck access	5000 mm
Cable & Pipe rack (except at road and rail crossings)	3000 mm

6.06.00 Anti Termite Treatment

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.

6.07.00 STAIRS AND LADDERS

6.07.01 Steel Stairs



All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000mm and maximum inclination with horizontal of 35.75°. However, in case of space restriction, minimum clear width upto 750mm and slope upto 45° may be provided. The vertical height between successive landings shall not exceed 5m. Channels (minimum MC200) shall be provided as stair stringers. Treads shall be minimum 250mm wide of grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 180mm.

6.07.02 Steel Ladders

Ladders shall be provided to platforms, walkways, instruments and equipments which do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 5°. Ladders shall be of minimum 450mm clear width with 35x35x3 angle diameter MS rungs spaced at 300mm (maximum). Ladders shall be provided with a safety cage of minimum 750mm diameter clear when the top of ladder is more than 4.5m above the landing level. However safety cages shall start at 2.5m above the lower landing level.

6.07.03 RCC Stairs

All stairs shall have maximum riser of 180mm and a minimum tread of 250mm. However, for Administration & Control room building riser shall be limited to 150mm and tread width of 300mm. Minimum width of stairs shall be 1200mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminium angle nosing with minimum 50x25x3 angle shall be provided for edge protection of RCC stairs.

6.08.00 Handrails

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

All handrails shall be of 32mm nominal bore MS pipes (medium class) as per IS:1161 galvanised using 750 gm/sq. m of zinc. Handrails for platforms, walkways and projections shall be a two-rail 450mm below the top rails. Handrail post spacing shall be limited to 1500mm as far as possible but can be proportioned to the length of the protected horizontal opening. In such a case spacing shall not exceed 1850mm center to center of posts. Handrails shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel. For platforms at elevation more than 30m, three rail system with top rail at 1500mm shall be adopted.

For RCC stairs, handrails with 20mm square MS bar balustrade with suitable MS flat & Teakwood handrail shall be provided, unless specifically mentioned otherwise.

6.09.00 Expansion/Construction Joints

Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made watertight 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 6mm and minimum width 225mm. At other joints these shall be 150mm wide.

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 conforming to IS:1834 shall be used. Dura board HD100 or its equivalent shall be used as joint filler.

6.10.00**Brick / Stone Masonry And Parapet Wall**

All masonry works shall be designed in accordance with IS:1905, IS:2212, IS:4326, IS:2185 and other relevant IS codes as applicable. Structural design of load bearing and non load bearing walls constructed with fly ash bricks shall be in accordance with criteria specified by section-4 of National Building Code of India, Part-VI and codal provisions.

All walls shall be non-load bearing in filled panel walls. External walls of all buildings shall be atleast one brick thick. All internal walls shall be atleast one brick thick except for internal partition walls for office area, canteen, change room, first aid rooms and toilets, which may be half brick thick. RCC bands (transoms and mullions) shall be provided wherever necessary to curtail the unsupported length / width of the wall.

50mm thick DPC (1:1.5:3) with water proofing admixture shall be provided at plinth level before starting masonry works.

Bricks having minimum 75 kg/sq.cm compressive strength shall be used for non-load bearing superstructure brick work. Cement and sand mortar 1:5 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. Transoms shall be provided at lintel / door height. The spacing of mullions shall not exceed 2000 mm centre to centre. The size of transoms / mullions shall be minimum 115mm square with four numbers, 8 mm dia bars and 6mm stirrups 150 mm centers.

Type, thickness and height of external wall, facing the transformer yard to take care of fire accidents in transformer yard shall be according to the requirements of Tariff Advisory Committee.

Even where metal cladding is specified, for initial 3m height from the ground level, minimum one brick thick masonry wall shall be provided.

All upstands and parapet walls on roof shall be of RCC construction, minimum height of parapet walls shall be 750mm and thickness 125 mm.

6.11.00**Waterproofing Of Underground Structures**

All underground structures like water retaining structures, track hoppers, transfer house, conveyor tunnel & other deep underground structures etc., shall have plasticizer cum water proofing cement additives conforming to IS:9103. In addition, limits on permeability as given in IS:2545 shall also be met with.



All water retaining structures shall be hydro tested as per IS 3370 for leakage & in case leakage is noticed pressure grouting or any other approved method shall be used to rectify the same.

The concrete surface of these structures in contact with soil shall be provided with water proofing treatment as stated below.

- i) For base slab, a layer of PCC 1:4:8 shall be laid. Over PCC layer, 25mm thk CM 1:3 mixed with approved water proofing compound at the rate specified by the manufacturer shall be applied. Over this two coats of acrylic polymer modified cement based flexible water proofing membrane of approved make laid as per manufacture's and instruction. Over water proofing membrane, 25mm thk CM 1:3 mixed with approved water proofing compound at the rate specified by the manufacturer shall be provided over which protective layer of 15mm thk kota / cuddapa or equivalent stone with joints sealed with C1:3 shall be laid. Over this stone layer, 25mm thk CM 1:3 mixed with approved water proofing compound at the rate specified by the manufacturer shall be applied before RCC base slab shall be casted.
- ii) For side walls, two coats of acrylic polymer modified cement based flexible water proofing membrane of approved make laid as per manufacture's specification and instruction shall be applied to the sides of RCC walls. 25mm thk CM 1:3 mixed with approved water proofing compound at the rate specified by the manufacturer shall be applied over it. Protective layer of 15mm thk kota / ciddapa or equivalent stone with joints sealed with CM 1:3 shall be laid. Finally 25mm thk CM 1:3 mixed with approved water proofing compound at the rate specified by the manufacturer shall be applied.

For all other foundation & pedestal work below ground coming in contact with soil, bituminous painting of grade 85/25 conforming IS 702@ 1.7 kg/ sqm.(min)

6.12.00

Miscellaneous Requirements

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 on sunshade from the wall shall be minimum 450 mm over window openings and 750 mm over door openings.

Doors and windows on the external walls of buildings with metal cladding shall be fixed by creating recesses in the cladding system.

No cable trenches shall be provided in TG hall, Boiler/ESP area, fuel oil pump house, Ash pump houses etc.

Duct banks consisting of MS/PVC conduits for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.

All floor openings for cables below electrical panel shall be sealed with fire sealing compound after cables are laid.



All openings in external walls provided for pipes, cables, duct etc. shall be effectively sealed to prevent water seepage, after the routing of the services are completed.

Natural lighting & Ventilation.

The area of windows shall be a minimum 15 % of the floor area to ensure adequate natural lighting. Fans shall be provided in general office areas as per standard norms. Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.

6.13.00

Statutory Requirements

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, Environmental requirements etc., and stipulations of other relevant statutory authorities shall be taken into consideration at the time of design and construction.

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 750 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.

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.

Obtaining statutory approval clearance/ license from relevant agency will be within the scope of EPC Contractor.

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.



7.00.00 MATERIAL**7.01.00 Structural Steel**

Steel will conform to Grade-A of IS:2062 (latest) for rolled steel members or plates upto 20 mm thickness. For plates above 20 mm thickness and welded construction steel conforming to Grade-B (killed and normalized) of IS: 2062(latest) shall be used except for crane girders where Grade-C (IS: 2062) steel shall be used. Steel shall be procured from SAIL or any other approved main producers.

Chequered plate shall conform to IS: 3502 (latest) and minimum thickness of chequered plate for floorings, covers etc shall be 8 mm O/P.

Bottom 1.0 M of cylindrical portion and entire conical portion of bunker in mill building shall be provided with lining of atleast 6mm thik SS plate grade SS 316L.

The electrodes classification as per AWS shall be as follows:-

- a) For welding of stainless steel to stainless steel : E308L
- b) For welding of stainless steel to mild steel : E309

7.02.00 Cement

Ordinary Portland Cement (OPC) shall be used for all structures except for foundations, under ground structures & structures coming in contact with sea water where in sulphate resistant cement with C3A content limited to 5% to 8% shall be used. Grade of cement shall be 43 conforming to IS: 8113.

7.03.00 Reinforcement

The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 415 / Fe 500 conforming to IS:1786 – latest.

Fusion bonded epoxy coated reinforcement steel with coating conforming to IS:13620 shall be used for the complete project.

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

Welding of reinforcement shall not be carried out without the permission of the Owner.

Projecting reinforcement or dowel bars for future connection of the structural works shall be protected by cement paint, if they are to be left exposed for a long time.



8.00.00 LOADING**8.01.00 Dead Loads**

Dead loads shall include the weight of structure complete with finishes, fixtures & partitions and shall be taken as per IS: 875 (Part-I)

8.02.00 Imposed Loads

Imposed loads in different areas shall include live loads, erection, operation and maintenance loads. Equipment loads (which constitute all loads of equipment to be supported on the building frame) are not included in the imposed loads furnished below and shall be considered in addition to imposed loads.

For consideration of imposed loads on structures, IS:875 (Part-2) "Code of practice for design loads (other than earthquake) for buildings & structure" shall be followed. The following minimum imposed loads as indicated for some of the important areas shall however be considered for the design. If actual expected load is more than the specified minimum load, then actual load is to be considered

Sl.No.	Location	Imposed Loads (T/Sq.m)
A)	Turbine Building	
i)	Ground floor (general)	2.50
ii)	Ground floor (Heavy equipment storage area)	5.00
iii)	Mezzanine Floor	1.50
iv)	Operating Floor	
	a) Rotor Removal area Rotor removal area beams shall also be checked for ½ the rotor load at the center of beam	5.00
	b) Equipment Laydown area	3.00
v)	Gratings, chequered floors, walkways, platforms, stairs etc.	0.75
vi)	Roof (Where no equipment are located and non-accessible)	0.15
	Roof (where equipment are located and accessible)	0.50
B)	Deaerator and Heater Bay	
i)	HP / LP heater floor	2.0



	ii)	Deaerator floor	1.5
	iii)	Cable gallery	0.50 (In addition to this actual cable load shall be considered)
	iv)	MCC & Control Building floors	1.00
	v)	AHU room battery room, air washer room	1.5
C)	Mill & Bunker Bay		
	i)	Ground Floor	2.5
	ii)	Feeder Floor	2.00
	iii)	Tripper Floor	2.00 Beams however shall be checked for feeder / tripper concentrated load
	iv)	Roof	0.15 (where no equipment are located) 0.50 (where equipment are located)
	v)	Dust Load	0.1
D)	Pump Houses operating floor		1.50
E)	Underground Structures such as Channels, Sumps, Underground Pump House, Tanks, Trenches, Reservoirs, Cooling Water Ducts etc. In addition to earth pressure and ground water pressure, the surcharge load of 2T/sqm. shall also be considered for design of all underground structures.		
F)	Road Culverts / Bridges and its allied structures including RCC Pipe Crossings & Road Crossing of Trenches. Design for class 'AA' loading (wheeled & tracked both) and checked for class 'A' loading as per IRC Standard.		
G)	Covers for Channels / trenches		Trench cover at entry to building and road



		crossings shall be designed for live load of 100 kN at centre. Trench cover at other location shall be designed with a surcharge of 100 kN/m ² or a concentrated load of 100 kN at center which is worst.
H)	Railway Supporting Structures, Rail Culverts	As per railway 'Bridge Rules'
I)	Boiler / ESP Support Structures	0.50
J)	General (Unless Specified Otherwise)	
i)	Stairs, Landings and Balconies	0.50
ii)	Toilets	0.20
iii)	Chequered plates, grating floors, etc.	0.50
iv)	RCC floors (General)	0.50
v)	a) Flat roofs (where no equipment are located)	0.15
	b) Flat Roofs (where equipment are located)	0.50
vi)	Inclined Roofs	As per IS:875 (Part-II)
vii)	Walkways (General).	0.50 T/sq.m or a concentrated load of 0.3 T/m which ever is greater
viii)	Walkways of conveyor galleries.	0.50
ix)	Floor of control room of switchyard control building	1.00
x)	Cable and pipe trestles	0.20 for walkway and in addition, friction loads as applicable.



NOTE :

1. Additional load for cable, piping / ducting, shall be considered as applicable.
2. Hung load shall be based on minimum loading equivalents of 1 kN/m^2 for piping and 0.5 kN/m^2 for electrical ventilation and air conditioning.
3. Loading resulting from concentrations of facilities in specific areas shall be substituted where listed base loadings are excluded
4. 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.
5. 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.
6. 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 1600 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)
7. Boiler supporting structures shall be so configured that the temperature of steel does not exceed 60°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.
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.

8.03.00 Equipment, Piping and Associated Loads

Equipment loads shall be considered over and above the imposed loads. Equipment loads shall be considered as given by equipment supplier.

8.04.00 Crane Loads

For crane loads, an impact factor of 25% and lateral crane surge of 10% (of lifted weight + trolley weight) shall be considered in the analysis of frame according to the provisions of IS:875. The longitudinal crane surge shall be 5% of the static wheel load. Longitudinal surge and lateral surge shall not be considered to act simultaneously.

8.05.00 Seismic Load

The project site is in Zone – III as per IS: 1893/Part I-2003 & IS:1893 – Part II – 2005.

Zone factor Z = 0.16

Importance factor = 1.75

Response reduction factor = 5.0 (for MRF) AND 3.0 (for OMRF)

8.06.00 Wind Load

Basic wind speed at project site is 50 m/sec. as per IS:875 -1987 Part-3

Probability factor, (k1 risk coefficient), terrain, height and structure size factor, k2 and topography factor, k3 shall be as per IS:875.

8.07.00 Damping in Structures

The damping factor to be adopted shall not be more than as indicated below:

Type of Structure	Wind Load	Seismic Load
a) Welded steel structure	1%	2%
b) Bolted steel structure	2%	2%
c) RCC structure	1.6%	5%

8.08.00 Temperature Load

For temperature loading, the total temperature variation shall be considered as 2/3 of the 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 ambient temperature during the coldest month of the year and mean of daily maximum ambient temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation.

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.

Systems and system component design criteria which require ambient temperature extremes shall use the range from 22C to 40C for dry-bulb temperatures.

8.09.00 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

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



8.10.00 Loading for Switch Yard

The loading for the design of switchyard structures shall be as per IS:802 Part 1/Sec 1:1995 (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
- (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 concading 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.

8.10.01 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.

8.10.02 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.



9.00.00 STEEL STRUCTURE**9.01.00 Framing**

All steel framed structures shall be either “rigid frame” or “simple space frame” or a combination of two.

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.

The power house building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction.

If RCC floor / roof is assumed to act as diaphragm transmitting lateral loads to braced bays, it shall be provided with shear connectors. However, whenever large / more number of cut-outs are provided in the floor slab, horizontal floor bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab.

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.

9.02.00 Design Concepts

Individual members of the frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion, etc. Criticality of erection / maintenance loads shall also be checked separately in combination with other simultaneously occurring loads for possible design loadings.

The different load combinations shall be taken as per IS:875 (Part-5) and other relevant IS Codes.

- a. Wind and seismic forces shall not be considered to act simultaneously.
- b. For the design of main plant structures during seismic condition, the deaerator feed water tank shall be considered full upto operating level. However, for other load combinations, deaerator feed water tank in flooded condition shall also be considered.
- c. In the analysis of main plant building & bunker building, the stresses arising due to temperature shall be considered.
- d. ‘Lifted load’ of crane shall not be considered during seismic condition.
- e. In case two cranes are 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.



- f. In case two cranes are provided and tandem operation is envisaged for some bays, then the load shall be taken as both the cranes fully loaded and standing side for these bays. For other bays, load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane.
- g. Permissible stresses for different load combinations shall be taken as per relevant IS codes.
- h. For the design of pipe / cable supporting structure, the soil weight shall be considered as backfilled upto grade level for the condition of pipe running full / cables in position.
- i. Frictional force between the pipes and supporting structure in longitudinal direction need not be considered along with seismic or wind forces.

The design of steel structures shall be done by working stress method. Design shall be as per provision of IS:800 (latest) and other relevant IS standards. For design of coal bins and loading hopper IS:9178 (Part I to III) shall be followed.

Roof decking sheets shall be designed as per IS:801 to carry the self load, dead load due to RCC slab and finishes and imposed load. The deflection of metal deck shall be limited as per BS:5950. In case composite action is considered in the design, suitable shear studs shall be provided as per BS: 5950.

Permissible stresses for different members shall be allowed to exceed upto 33.33% only under normal loads along with wind and seismic conditions. The members which are designed primarily to resist wind load such as bracing members, no increase in permissible stress will be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed up to 25 % only under wind and seismic conditions.

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 90% 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.

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 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 M20	5.0 N / sq.mm
Pedestal in concrete grade M25	6.25 N / sq.mm
Pedestal in concrete grade M30	7.5 N / sq.mm

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.

Welding shall be used for fabrication and erection. Site connections shall generally be with welding. However, high Strength Structural (HSS) bolts shall be used for all important connections to be decided during detail engineering stage. In few cases, for shear connections or removable beam connections, bolted joints with MS bolts may be adopted. For HSS bolt connection, IS:4000, IS:3757, IS:6623 and IS:6649 shall be followed. IS:814, IS:816, IS:1024, IS:4353 and IS:9595 shall be followed for welding of structures.

Trestles supporting coal conveyor galleries shall be so proportioned that the transverse deflection of trestles due to wind / seismic load shall not exceed trestle height / 1000 as stipulated in IS:11592.

In the case of galleries, temperature expansion joint shall be introduced at intervals less than 90 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.

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.

Anchor fasteners shall not be used for supporting equipment imparting dynamic forces.

Pedestals supporting gravity take-up shall be designed to resist 100% impact.

For calculation of coal load on moving conveyor, a multiplication factor of 1.6 shall be used to take care of inertia force.

- a) Conveyor gallery structure & trestles shall be designed considering both conveyors operating simultaneously.
 1. Dynamic analysis of conveyor galleries and conveyor supporting system shall be carried out for spans greater than 25m.
 2. All structures close to railway line shall have clearances conforming to Railway norms.

Transverse coal pressure on Bunker/ Silo / Hopper walls shall be calculated using Walker's theory and IS:9178. The Coal Bunker / Silo / Hopper shall be designed for the following conditions.



- i) The Bunker / Silo / Hopper is full up to its full capacity with top surface nearly horizontal.
- ii) The Bunker / Silo / Hopper is partially empty with the top surface of coal at an angle of repose of 37 degrees.

Design pressure on coal bunker / hopper walls shall take into account all possible flow regimes (core flow, mass flow, etc.), and different aeration regimes (radial, diametrical, radial and core, impulsive etc.)

9.03.00 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.

9.04.00 Vertical Deflection

- 9.04.01**
- a) For beams supporting dynamic equipment : Span / 500
 - b) For beams supporting floors / masonry : Span / 325
 - c) For beams supporting pipes : Span / 400
 - d) For roofing and cladding components : Span / 325
 - e) For gratings and chequered plates : Span / 200 subject to
a maximum of 6 mm
 - f) Coal/ Ash conveyor gallery bridges : Span / 450

9.04.02 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
- b) For electric overhead cranes
 - i) Up to 50 t capacity : Span / 750
 - ii) Over 50 t capacity : Span / 1000

9.05.00 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)	Crane gantry girder due to surge	:	Height/200
e)	Building main columns at crane rail level due to action of crane surge load only	:	Height / 2500 limited to maximum of 10 mm
f)	Open gantry columns at crane rail level due to action of crane surge load only	:	Height/4000 limited to maximum of 10 mm
g)	Open structures	:	Span / 2000 Limited to Maximum of 15mm
h)	Coal handling trestles	:	Height / 1000

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

9.07.00 MINIMUM THICKNESS OF STRUCTURAL STEEL ELEMENTS

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	6mm
b)	Columns and beams	8mm
c)	Gussets	8mm
d)	Stiffeners	8mm
e)	Base plates	10mm & above
e)	Chequered plates	8 mm o/p & above
f)	Grating flats	5 mm

Minimum thickness of structural members other than gratings directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

9.08.00 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.



9.09.00**Slenderness and Depth Ratio**

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

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

9.10.00**Joints / Connections in Steel Structures:****9.10.01**

Steel structures shall be detailed and connection and joints provided as per the provisions of IS:800, IS:9595, IS:1367, IS:9178 and IS:816 and as per following requirements:

- a. Connection of vertical bracings with connection members and diagonals of truss members shall be designed for full tensile capacity of the bracings unless actual loads are indicated on the drawings.
- b. Size of fillet weld for flange to web connection for built up section shall be as follows:
 - i) For box section weld size shall be designed for 60% of full shear capacity or actual shear whichever is more. Where fillet weld is not possible, full penetration but weld shall be provided.
 - ii) For built-up I section, weld size shall be designed for 80% of full shear capacity or actual shear, (if indicated in drawings) whichever is more. However, weld size shall not be less 0.5 times the web thickness. Weld shall be double fillet.
 - iii) All welds shall be continuous unless otherwise specifically approved. The minimum size of the fillet weld shall be 6 mm.
- c. Shear connections shall be designed for 70% of section strength for rolled sections and 80% of section strength of built-up section or rolled section with cover plates. However, if actual shear load is more than above, the connection shall be designed for actual load.
- d. Moment connection between beam and column shall be designed for 100% of moment capacity of the beam section. This can be achieved either by direct butt welding of the top flange of beam with column flange or by providing top moment plate with suitable notch for additional weld length.
- e. 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.

- f) 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.
- g) All butt welds shall be full penetration butt welds.
- h) The connection between top flange and web of crane girder shall be full penetration butt weld. Bottom flange, connection with web can be fillet weld or butt weld as directed by Purchaser. Bearing edges of crane girders shall be machine finished.
- i) Connection of base plate and associated stiffeners with the columns shall be designed considering the total load transferred through welds. However, minimum weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners.
- j) Splicing: All work shall be full strength. Field splicing shall be done with web and flange cover plates for full strength. In exceptional cases, the field splicing shall be designed for 50% of load carried by the cover plates and remaining 50% load through full penetration butt weld. Shop splicing for all sections other than rolled shall be carried out by full penetration butt welds with no cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plates.

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

9.10.03 Efficiency of site welds to be considered shall be as follows:

- a) Butt weld above 25 m from ground --- 50%
- b) Others --- 80%

9.11.00 Specification for Painting of Steel Structures / Material

Refer Volume-VI, Part-B



10.00.00 REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS**10.01.00 General**

All structures, building foundation, machines / equipment 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

10.02.00 Design Methodology

- a) The design and construction of RCC structures shall be carried out as per IS: 456-2000. Working stress method shall be adopted for the design wherever specifically mentioned in this specification.
- b) For all concrete structures, ductile detailing has to be done as per IS: 13920 and IS: 4326.
- c) For reinforcement detailing, IS: 5525 and SP34 shall be followed.
- d) Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150mm or more.

10.03.00 Foundation and Underground structures

- a) Foundation system to be adopted for structures shall be based on loading arrangement , load intensity and soil strata.
- b) All RCC liquid retaining / conveying structure / slurry pump house / underground structures, such as conveyor tunnel, reclaimer hooper pit, etc., shall be designed in accordance with IS:3370 (Part 1 to 4) . For under ground structures not in contact with liquid on inside face may be designed as cracked sections with crack width limited to 0.1mm for both faces.
- c) All liquid retaining / carrying structures shall be tested for water tightness as per the provisions of IS:3370 and IS:6494 and in case of leakage, the same shall be rectified by chemical injection grouting through nozzles.
- d) Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest. Co-efficient of passive earth pressure shall be used only in design of shear keys for stability against sliding.
- e) In all liquid retaining structures , pvc water bar shall be provided at each construction / expansion joint. No pressure relieving devices shall be permitted in underground structures except forebay.
- f) For design of all underground structures, including CW ducts, pump house and forebay etc. ground water table shall be assumed at the finished ground level unless specified otherwise. In addition to ground water pressure, minimum



surcharge load of 2 T/M² shall also be considered for design of all underground structures.

- g) All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of loads. Factor of safety for these cases shall be as per 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.
- h) In cases where dead load provides the restoring forces, only 0.9 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

10.04.00 Grouting

- i) 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.
- ii) 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.
- iii) Nominal thickness of grouting shall be at least 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.

10.05.00 Edge Distance For Bolts

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

- i) Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 50 mm.
- ii) Clear distance from the face of pocket to the outer edge of pedestal shall be 75 mm.
- iii) Clear distance from the face of pocket to the outer edge of pedestal shall be 75 mm.



10.06.00 Loading conditions for underground structures

Following loading conditions shall be considered in addition to the loading from super structure for the design of substructure of pump house, channels, sumps, tanks, trenches and other underground structures containing liquid.

- a. Water pressure from inside and no outside pressure, like earth pressure, ground water & surcharge pressure (applicable only to structures which are liable to be filled up with water or any other liquid.)
- b. Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.
- c. Design shall also be checked against buoyancy due to the ground water during construction as well as after construction stages. Minimum factor of safety against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loadings. Provision of pressure relief valves / flap valves, etc. may be considered only in forebay of CW Pump House to counter the buoyancy. When pressure relief valves are used, 60% of the hydrostatic pressure shall be considered for design of the base slab.
- d. Base slab of the pump houses shall also be designed for the condition of different combination of pump sump being empty during maintenance stages with maximum ground water level.
- e. Intermediate dividing pier of pump sumps and partition wall (if applicable) in channel shall be designed considering water on one side only and other side being empty for maintenance.
- f. All pump houses and other substructures (wherever applicable) shall be checked for stability against sliding and overturning during construction as well as operating conditions for various combinations of loads.

10.07.00 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.

10.07.01 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.

10.07.02 All block foundations resting on soil shall be designed using the elastic half space theory or Barkens theory. Block foundation resting on piles shall be designed using Novak's theory or Barken's theory. The mass of the RCC block shall not be less than three times mass of the machine and the CG of the combined mass of foundation and equipment should pass through the CG of the base area with tolerance not more than 5%. Dynamic analysis shall be carried out to calculate natural frequencies in all modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant codes or



machine manufacturers shall be satisfied. Minimum reinforcement shall be governed by IS: 2974 and IS: 456.

10.07.03

For the foundations supporting minor equipment weighing less than one ton or if 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 (VIS) shall be designed suitably.

10.07.04

- a) For the foundation of Turbo-generator, Boiler feed pumps, Fan (ID, FD and PA), Mills etc., detailed static and dynamic analysis shall be done. The static analysis shall include all operating conditions, load cases and abnormal loads like short circuit, loss of blade, unbalance and seismic forces. Unbalance loads for normal operating condition as given by machine manufacturer and / or VDI 2060 whichever is more conservative shall be used for calculating dynamic response. The dynamic analysis. Transient analysis shall be carried out for the short circuit condition with an appropriate force function. Frequency separation criteria and amplitude criteria as laid down in IS: 2974 and / or DIN 4024 and / or VDI 2056 and / or as required by the machine manufacturer, whichever is more stringent shall be satisfied. RCC design shall be done by working stress method for all machine foundations. A fatigue factor of 2.0 shall be considered for dynamic forces. Minimum reinforcement shall be governed by IS:2974 as well as IS:456. However minimum reinforcement in bottom face of the foundation raft resting on soil or pile shall not be less than 0.2% of effective cross sectional area of the raft.

The special requirements for concreting including grade, type of aggregate, use of admixture, temperature control, ultrasonic testing, etc. shall be as mentioned elsewhere in this specification.

- b) All block foundations supporting rotating equipment resting on soil or piles shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than three times the mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down in the relevant codes and / or by machine manufacturer whichever is more stringent shall be satisfied. Minimum reinforcement shall be governed by IS: 2974 and IS: 456. Minimum Reinforcement in base raft in either direction shall be as follows:-

i)	At bottom face	0.2% of gross cross-sectional area.
ii)	At top face	0.12% of gross cross-sectional area.

- c) For the foundations supporting minor rotating equipment weighing less than one tonne or if 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 structure, floors, etc. suitable vibration



isolation shall be provided by means of springs, neoprene pads, etc. and such vibration isolation system shall be designed suitably.

- d) BFP, Mill, PA, FD & ID fan foundations shall be supported on vibration isolation system. The vibration isolation system shall consist of steel helical spring units and viscous dampers supporting the RCC deck which would support the machine. The spring units shall conform to DIN 2089 and DIN 2096.
- e) GERB or equivalent manufacturer's vibration isolation system shall be supplied for supporting machines like TG, BFP, Mill, PA, FD & ID fan.
- f) Isolation efficiency of at least 90% shall be provided for the Turbo generator, ID fan foundations.
- g) All approved drawings of equipment foundations shall be vetted by execution agency of civil works in order to match between the equipment sizing and foundation.

10.08.00 Increase in Stresses

10.08.01 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.

10.08.02 Bearing capacity of the soil / pile capacity shall be allowed to increase by 25% under seismic / wind load condition except for chimney where increase in bearing capacity/pile capacity is not considered.

10.09.00 Minimum thickness of structural elements:

The following minimum thickness shall be followed:

Flat roof slab	:	125 mm
Suspended floor / slab / walkways / canopy slabs etc.	:	150 mm
Ground floor slab (non-suspended)	:	200 mm
Water retaining slabs / walls	:	200 mm
Cable / pipe trenches / underground pits / Launder walls and base slab	:	125 mm
All footings (including raft foundations)	:	200 mm
Parapets	:	125 mm
Sunshades at edge	:	75 mm
Pre-cast louvers / fins	:	50 mm



Pre-cast trench cover slabs / floor slabs / louvers	:	75 mm
Paving	:	200 mm
Basement walls and base slab	:	200 mm
Silo / bin walls	:	150 mm
Underground reservoir:		
Below ground	:	200 mm
Above ground	:	150 mm

10.10.00 From fire resistance point of view minimum thickness of reinforced concrete members shall be as per fig. 1 or table 16a of IS:456.

10.11.00 MINIMUM HEIGHT FOR PEDESTALS / ENCASEMENT OF STEEL COLUMNS

10.11.01 Pedestals to steel columns for building structures

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	:	500 mm above paved level
b.	Covered area		
	Internal Column	:	1000 mm above FFL
	Peripheral Column	:	500 mm above FFL

Stair and ladder pedestal shall be kept 500 mm above the finished floor level.

Boiler structure supporting steel columns will be encased upto scarper feeder top level.

10.11.02 Pedestals to steel columns for equipment structure:

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

Dense and durable concrete with controlled water cement ratio preferably 0.45 shall be used for all underground concrete structures such as foundations, basements, pump



houses, water retaining structures, cable and pipe trenches etc. for achieving water tightness and durability.

All foundation, embedments, inserts, block-outs etc. required for equipment shall be provided by the Bidder.

Fly ash bricks shall be used for masonry work. Bidder shall ascertain himself at site regarding the availability of fly ash bricks of minimum 75kg/cm² compressive strength before submitting his offer.

Aluminium nosing shall be provided for edge protection in RCC stairs.

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 corners expected shall be provided with angles of minimum size L 50x50x6 with lugs for edge protection e.g. all round the cut-outs I openings in floor slab, edges of drains supporting grating covers, edges of RCC cable I pipe trenches supporting covers, edges of manholes supporting covers and supporting edges of precast covers etc.

All cables & pipes in outlying area shall run above ground over steel trestles or other supporting structures for easy inspection & maintenance except in transformer yard area and some other localized area where the same can run in RCC trenches. However, for facilities for which buried pipe & cables are permitted by Purchaser, the same can be provided. In case of trestles, minimum 7.0 m head clearance shall be provided for road crossings. In other areas, the clear height shall be 3.0m minimum.

All cable and pipe trenches shall be of RCC of minimum M25 grade. Trenches located outside buildings shall project at least 200mm above the finished formation level so that no storm water shall enter into trench. The bottom of the trench shall be sloped suitably for draining out the collected water into sump pit. The pre-cast covers shall be of minimum M25 grade and shall not weigh more than 65kg. Lifting hooks shall be provided in the pre-cast covers. Pre-cast covers shall have edge protection angles at top and bottom on all the four sides along with lugs.

All construction drawing furnished by Bidder shall consist of total quantity of concrete (grade-wise), reinforcement steel (diameter wise) and structural steel (Section – wise).

Duct banks consisting of PVC / GI conduits for cables shall be sealed using approved fire retardant sealing compound.

All water retaining structures designed as un-cracked section shall also be tested for water tightness at full water level in accordance with IS:3370 (Part – I) and IS:6494.

10.12.00 Formwork Requirements

Refer Volume-VI, Part-B.

10.13.00 The number of construction joints in the columns of steam turbine foundation shall be restricted.

Construction joints at the following three locations shall be provided:

- a) At the meeting points of the columns and the raft.



- b) At the meeting points of the column and the top deck.

Additional reinforcement and shear keys shall be provided at the construction joints.

The base raft for steam turbine and GT foundation and table top for steam turbine shall be cast in single pour.

Mild steel bars required for earthing / grounding mat shall also be supplied and installed.

All cable vaults shall be located above ground level i.e. cable vaults shall not be provided as basements in the buildings. Minimum clear height below beam bottom shall be 2200mm in all cable vaults.

Connection work at terminal points is included in the scope of the Bidder.

All transformer / shunt reactor foundations shall be designed as per relevant IS Codes. This will include collection of oil, drainage of oil along with rainwater collected in such foundation.

Ground floor slab of all the building and RCC paving shall be of minimum 200mm thick of M-20 grade laid over minimum 75mm thick PCC and 230mm soling (minimum) course unless specifically mentioned otherwise. The reinforcement shall consist of minimum 8mm diameter bars at 200 mm c/c of grade Fe 415 at top and bottom in both directions.

10.14.00

Concrete Mix

The following minimum grades of concrete as per IS:456 shall generally be used for the type of structures noted against each grade.

a.	Grade M15	:	Fill concrete
b.	Mix (1:4:8)	:	Foundation below brick wall, blinding layer below foundations, trenches and underground structures, minimum thickness of the layer shall be 75 mm.
c.	Grade M20	:	Base plate encasement, pavement around building including plinth protection work, encasement of structural steel work, grade slab & grade beams etc.
d.	Grade M25 & M30	:	Chimney raft and all RCC members, e.g. foundation and superstructure, pedestals, roof slabs, cable and pipe trenches, water retaining structures, cooling water channel, CWPH forebay, raft & sump etc.



- e. Grade M35 : TG foundation, TG top deck, chimney shell etc. and for structures coming in contact with sea water.

For superstructure of RCC chimney and natural draft cooling towers richer mix may be used as per design requirement. However, requirement of Table-4 & 5 of IS:456 shall be satisfied as per the exposure condition. As per IS:456, exposure condition will be “severe” for all structures under the civil scope of work except for sea water intake well and pump house, cooling tower, CWPH forebay & sump etc. coming in contact with sea water, where in exposure condition shall be “very severe”.

Washing and screening of coarse and fine aggregates to remove fines, dirt or other deleterious materials shall be carried out by approved means, if desired by the Engineer-in-charge.

The water cement ratio by weight shall be 0.45 maximum including free moisture in the aggregate and slump should be suitably decided to provide good quality concrete work.

10.15.00 Special Painting For Sea Water Structures

All concrete surface coming in contact with sea water will be painted with 1.5 mm thick polyurea coating meeting ASTM D-16, Type V (two component, chemical cure). This will be applicable for pump house, Natural draught cooling tower and CW pump house forebay and sump, Clarified Water reservoir, Guard pond, Fire water sump, RO stage I Permeate Tank etc.

For NDCT inside surface special painting shall be provided upto 2.0m above drift eliminator level.

10.16.00 Allowable Settlement

The total permissible settlement and differential settlement of the foundations will be governed by IS:1904, IS:13063 and from functional requirements whichever is more stringent.

Maximum allowable total settlement should be restricted to 25 mm for foundations of all plant structures like cooling towers, CW pump house, DM plant, crusher house, transfer house etc.,

Maximum allowable total settlement should be restricted to 40 mm for all other foundations.

All foundations shall be so designed that the settlements are within permissible limits as per relevant Indian Standard or from consideration of safe equipment / machine operation whichever is critical. In case of open foundations without piles, Ground improvement methods opted by contractor, like sand drains / stone columns etc. to reduce settlement and increase the rate of settlement, detail methodology of such installation supported by calculation based on relevant field data shall be furnished for approval of Owner / Consultants before execution. In the event, the contractor adopts any patented method of ground improvement or retain any specialized agency for such purpose, the same can be done subject to prior approval of owner.



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.



13.00.00 NATURAL DRAUGHT COOLING TOWER**13.01.00 Scope**

This specification covers the general requirements of engineering by the Bidder, 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.

13.02.00 Codes and Standards

a.	IS:383	Coarse and fine aggregates from natural sources for concrete.
b.	IS:432	Mild steel and medium tensile steel and bars (parts 1 & 2) and hard drawn steel wire for concrete reinforcement.
c.	IS:702	Industrial bitumen.
d.	IS:780	Sluice valves for water works purposes (50-300mm size).
e.	IS:1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
f.	IS:1554	PVC insulated (Heavy duty) electric cables. (part 1)
g.	IS:1785 (parts 1&2)	Plain hard drawn steel wire for pre-stressed concrete.
h.	IS:1786	High strength deformed steel bars and wires for concrete reinforcement.
i.	IS:1834	Hot applied sealing compound for joint in concrete.
j.	IS:1838 (part 1)	Preformed fillers for expansion joint in concrete pavements and structures (non-extruding and resilient type: Part-1 bitumen impregnated fibre).
k.	IS:2062	Steel for general structural purposes.
l.	IS:2267	Polystyrene moulding and extrusion materials.
m.	IS:3042	Single faced sluice gates (200-1200 mm size)
n.	IS:3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3mm - 2032mm).
o.	IS:5620	Recommendations for structural design criteria for low head slide gates.
p.	IS:5666	Etch primer.
q.	IS:8112 (Part 1 to 4)	43 Grade Ordinary Portland Cement



r.	IS:9862	Ready mixed paint brushing, bituminous, black, lead free acid, alkali, water and chlorine resisting.
s.	IS 12330	Sulphate resistant Portland cement
t.	IS:456	Code of practice for plain and reinforced concrete.
u.	IS:800	Code of practice for general construction in steel.
v.	IS:875 (part 1 to part 5)	Code of practice for design loads (other than earthquakes for building and structures).
w.	IS:1080	Code of practice for design and construction of simple spread foundations.
x.	IS:1343	Code of practice for pre-stressed concrete.
y.	IS:1893	Criteria for earthquake resistant design of structures.
z.	IS:2210	Criteria for the design of reinforced concrete shell structures and folded plates.
aa.	IS:2309	Code of practice for the protection of buildings and allied structures against lightning.
bb.	IS:2395 (parts 1&2)	Code of practice for painting, concrete, masonry and plaster surfaces.
cc.	IS:2502	Code of practice for bending and fixing bars for concrete reinforcement.
dd.	IS:2629	Recommended practice for hot dip galvanising on iron and steel.
ee.	IS:2633	Methods of testing uniformity of coating of zinc coated articles.
ff.	IS:2751	Recommended practice for welding of mild steel bars for reinforced concrete construction.
gg.	IS:2950 (part 1)	Code for practice for design and construction of raft foundation.
hh.	IS:3043	Code of practice for earthing.
ii.	IS:3370	Code of practice for concrete structures for storage
jj.	IS:4558	Code of practice for under drainage of lined canals.
kk.	IS:11504	Criteria for structural design of reinforced concrete natural draft cooling towers.
ll.	IS:12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.
mm.	IS:1549 (2004)	Guide lines for improving the cyclonic resistance of low rise house and other buildings
nn.	BS:4485	Specification for water cooling towers. (All parts)



- oo. VGB Guidelines Structural design of cooling towers.
- pp. ATC - 105 Specification for Cooling Towers - Cooling Tower Institute - USA

13.02.01 Wherever the above Standards are in conflict with the stipulations of this specification, decision of the OWNER / OWNER CONSULTANT will dictate.

13.03.00 General

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 Mechanical section of this document.

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 associated hardware, etc., complete all as required to give satisfactory performance and as stipulated in various clauses in this document.

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

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.

For NDCT, three dimensional finite element analysis of the entire system consisting of tower shell, column supports, pedestal, pile cap, pile and soil mass shall be carried out in a single step so that effect of soil structure interaction can be taken care.

13.04.00 Grade of Concrete & Steel

Minimum grade of concrete to be used for all the structural elements shall be as specified below:

<u>STRUCTURAL CONCRETE</u>	<u>Minimum Grade</u>
a) Foundations	M30
b) Basin	M35
c) Shell	M35
d) Precast works (Fill Supporting Structure)	M35
e) Diagonal columns	M40



Minimum cement content of all RCC structures shall be 360 kg/cum.

Cement to be used for entire NDCT structure including pile cap is sulphate resistant cement with C_3A content between 5 to 8%.

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

Reinforcement shall conform to grade Fe 500/550 as per IS:1786 except noted otherwise.

Steel wires for prestressing shall conform to IS: 1785 (part 1&2).

Fusion bonded epoxy coated reinforcement steel, with coating conforming to IS : 13620 shall be used for entire NDCT structure including pile and pile cap.

Steel for all structural steel works shall conform to IS: 2062.

All exposed steel work shall be protected by hot dip galvanising. The minimum coating of zinc shall be 910 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.

As per IS 456, the environmental exposure condition of “very severe” shall be considered for entire NDCT structure below & above ground level including pile cap & Pile. Also, requirement of table 4 & 5 of IS 456 shall be satisfied depending on exposure condition.

13.05.00 Design Criteria

13.05.01 Wind Load

Basic wind speed as well as factors $K_1/K_2/K_3$ 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 1.43 or based on wind tunnel studies, whichever is higher. Further cyclonic risk factor as per IS:15498 shall also be considered.

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.

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.

13.05.02 Earthquake Load

The coefficient of horizontal acceleration shall be for the appropriate seismic



zone as per IS:1893. Earthquake forces in all the three directions (x,y,z) shall be considered in the analysis of NDCT.

13.05.03 Dead Load

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

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.

13.05.04 Constructional Loadings

Contractor shall be fully responsible for ensuring safety by checking the designs, for all the temporary construction loadings as applicable.

13.05.05 Miscellaneous Loads

Effect on account of the following loads shall also be investigated.

- a) Thermal restraint loads
- b) Subsoil deformation

13.05.06 Load Combinations and Permissible Stresses

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 following load / load combinations shall be followed in addition to codal requirement:

- 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. $0.9DL + 1.5EQ + 0.5 WL$

where DL = Dead Load
 WL = Wind Load
 EQ = Earthquake Load

While considering the above load combinations, the appropriate stress resultants shall be superimposed most unfavourable. Stress due to subsoil deformation, temperature and constructional loads shall also be added to arrive at the most unfavourable load



combination.

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.

13.0600

Foundations

The design and construction of cooling tower foundations shall be in accordance with the requirements stipulated in IS:1080/IS:2911/IS:2950 as applicable. Continuous foundations shall be provided for cooling towers more than 75 m in height.

The foundation structure shall be designed for loads and load combinations indicated above of this specification and shall in addition consider the following:

- a. Thermally induced local loading where supply culverts pass through the foundation structure without structural isolation.
- b. Cold water basin floor loading.
- c. Surcharge load of 25 KN per sq.metre at the ground / grade level.
- d. In case of subsoil with varying degrees of stiffness, non uniform settlements due to the varying stiffnesses have to be determined. The redistribution of stress resulting from interaction effects between the subsoil and the shell structure have to be taken into account.

For the load combination 0.9DL+1.5WL, uplift of the foundation, not exceeding a sector of 15 degrees is permitted, provided the foundation is a continuous annular raft foundation.

No pressure relief valve shall be provided in any part including foundation & basin slab of NDCT.

13.07.00

Basin and Cold Water Outlet

The basin shall be divided into two compartments to facilitate complete isolation of one half of the basin for the purpose of cleaning and maintenance, while the other half is in service.

The basin floor of each compartment shall be sloped with a slope not less than 1 in 120 towards a collecting sump for effectively draining the water to permit desilting/desludging. To minimise obstructions to the flow of water, only the columns supporting the Fill structure shall be projected above the basin floor. Water shall be drained from the sump into a drain chamber outside the basin by CI drain pipe embedded below the basin floor. Suitable sluice gates of the rising spindle type conforming to IS:3042 or sluice valve conforming to IS:780 shall be provided in the drain chamber. Drainage arrangement from drain chamber to suitable location shall also be made.

A minimum of 300mm free board shall be provided for the basin over the maximum design water level. The basin wall shall project a minimum of 500 mm over the surrounding grade level. Plinth protection of 1 m wide shall be provided all round the



building.

7 m wide paving around NDCT tower from racker column shall also be provided

Each compartment of the basin shall be provided with a concrete channel for outlet of cold water. Cold water outlet channels shall be provided with the stoplogs and screens.

Stoplogs shall be fabricated out of structural steel plate and rolled sections and provided with rubber seals to prevent leakage. Stoplogs shall be hot dip galvanised and provided with etch primer and bituminous paint.

Screens shall be out of 8 gauge 25mm clear opening SS crimped wire netting welded to frame of structural steel section/flats. Frame work shall be hot dip galvanised and provided with etch primer and bituminous painting. Two numbers of screens shall be supplied per tower.

Suitable arrangement of monorails with hoist shall be provided for handling stoplogs and screens.

The basin walls, floor slab and outlet channels shall be of reinforced concrete construction. The design and construction of these water retaining structures shall be in accordance with IS:3370 with provision of construction/contraction and expansion joints. Resistance to cracking shall be checked as per cl. 4.5.2 and cl. 4.5.3 of IS:3370 (PART 2): 2009. Minimum thickness of structural concrete elements shall be 230mm. Basin walls shall also be designed for condition of external surcharge load along with ground water table and basin being empty.

The basin and channel walls shall be designed for a minimum surcharge load of 25kN per sq.m. to allow for construction plant operating in the vicinity.

External pressure due to earth and ground water shall not be relied upon to reduce the effect of the internal water pressure, but account shall be taken of the ground water pressure when considering buoyancy or stresses in the empty water retaining structure.

Construction of the basin and channel shall be watertight with the provision of minimum 230mm wide approved quality PVC ribbed water stops with central bulb of minimum 10mm at all construction joints and expansion joints.

The water retaining structures shall be tested for water-tightness in accordance with IS:3370, without the backfill. Any rectification measures required to satisfy the test criteria shall be executed by the CONTRACTOR at his own cost all as per the directions of the OWNER.

All round Cold water basin, plinth protection in M20, 150 mm thick shall be provided for a width of 3000 mm, sloping away from the basin. Dry rubble soling of 150 mm thick shall be provided below the concrete paving. Suitable drain shall also be provided along plinth protection with a sum at appropriate location.

In any case, the basin slab shall not be used to give lateral resistant to piles below main tower shell structure.



13.08.00 Tower Shell**13.08.01 Shell Geometry**

The shape of the tower shall be hyperboloid in vertical section and circular in plan.

13.08.02 Thickness

The tower shell shall have a minimum thickness of 250mm.

A minimum factor of safety of five (5) against buckling shall be ensured at all levels.

13.08.03 Design

The tower shell shall be designed based on bending analysis and as per elastic theory for thin shells.

Consideration shall also be given to the following effects of temperature and moisture variations that occur in the shell :

- a) The strain resulting from a temperature gradient across the shell thickness.
- b) The strain resulting from moisture content variations through the shell thickness, and
- c) The strain resulting from variations of conditions (a) and (b) caused by rain and sunshine on one side of the tower or partial operation of the tower.

The effect of stress concentration due to any fixtures shall be taken into account.

13.08.04 Reinforcement and Cover

Reinforcement shall be provided on each face of the shell in both directions.

The shell reinforcement of high yield strength deformed bars, in either direction and on each face shall be not less than 0.15% of the concrete cross-sectional area. Further, the circumferential reinforcement on each face shall be not less than 0.20% of the concrete cross sectional area in the top one third height of the shell.

The maximum spacing of reinforcement in either direction on each face shall be restricted to twice the thickness of the shell or 200 mm whichever is less. Further, not more than one third of the reinforcement at any level or section shall be lapped.

Minimum lap lengths in shell shall be 1.3 times L_d where L_d is the development length as described in cl 26.2.1 of IS:456.

Column reinforcing bars shall be carefully anchored in the shell and in the foundations. The minimum anchorage length in the shell shall be $2L_d$ or 80 times the diameter of the bar.



Minimum size of deformed bars used shall be 8mm for circumferential reinforcement and 10mm for Meridional steel.

The concrete cover shall be 50 mm minimum. However, the clear cover shall not be less than 1.5 dia of bars. (for severe exposure condition)

13.08.05 Tolerances

The shell should be constructed within the dimensional tolerances stipulated in clause 7.3 of IS:11504. Permissible allowances for survey inaccuracies while checking of shell geometry shall be as per clause 7.4 of IS:11504.

13.09.00 Fill

PVC splash type bars fill arrangement shall be provided.

The fill shall be adequately supported to minimize sag, possibility of dislodgment and damage as a consequence of induced vibrations in the fill.

The supporting hanger rods/tubes shall be of stainless steel conforming to ASTM 316L.

Density of fill to be considered for the design of fill supporting structure shall be 100 kg/m³ minimum

13.10.00 Fill Supporting Structure

Fill supporting structure with its foundation shall be of reinforced concrete construction.

Fill supporting structure, where formed of precast concrete units, shall be made stable by the use of either bolted, cast-in-situ or glued joints. Members of precast concrete structure shall be either pre-stressed or reinforced concrete units. Where bolts are used for permanent connections, they shall be of a material highly resistant to corrosion or fully protected by embedment or coating.

The columns and beams supporting the Fill shall be adequately braced in all directions. The design of all members shall be checked for resistance to buckling.

The stability of the Fill support structure shall be checked for its capacity to resist a horizontal force of 2% of self-weight, the Fill and supporting structure, assumed to act horizontally in any direction. The structure shall also be checked for the appropriate earthquake loading as applicable.

During erection, care shall be taken to ensure the stability of the potentially unstable, partially completed structure.

The Fill support structure members shall be designed to cater for the likely loads to be imposed thereon, including:

- a) temporary loadings : they are subjected to during handling, transportation and erection at normal design stresses.



- b) loading due to scaffolding for the erection crew if so envisaged to be supported.
- c) loading of personnel during maintenance of pipe work and sprinkler system. The appropriate parts of the pack support structure shall be designed to support a point load of 1.5 kN at any position.

Reinforced concrete members shall be designed for self-weight and permanent loadings by working stress method with allowable stresses limited to 80% of those specified in IS:456.

13.11.00 Maintenance Access Facilities

All areas of the cooling tower requiring inspection, cleaning, repairs and/or adjustment shall be easily and safely accessible by suitable provision of stairs, platforms etc., as per the requirement described herein below :

13.11.01 Stairs

The tower shall be provided with two numbers external RC staircase, leading to a heavy duty door giving access to the distribution system. Staircase shall be minimum 1000 mm wide (clear), with landings of minimum width of 1000 mm at not more than 2500 mm height intervals unless approved otherwise. The steps shall have a rise of about 125 mm and tread of about 250 mm. Anti-skid nosing at each step shall be provided.

All access doors shall be of size minimum 1200 mm wide and 2100 mm height, minimum.

13.11.02 Platforms

Reinforced concrete platform of 1.2m clear width shall be provided around the circumference at the top of the cooling tower on the outside for fixing aviation warning beacons.

13.11.03 Walkways

RCC walkways having a minimum clear width of 1.50 m shall be provided around the circumference inside the cooling tower above the Fill to provide access for inspection and maintenance of all hot water distribution pipes/ducts and nozzles. Walkways shall be supported independent of the Fill structure.

13.11.04 Ladders

Four numbers of hot dip galvanised mild steel rung ladders with etch primer and bituminous painting shall be provided equally spaced around the circumference of the tower.

Safety cage for the ladder shall be provided for the ladders located on the external surface of the tower upto the throat level.



Ladders shall be continued along the inside surface of the tower upto the top of the tower and then on to the top platform. At the throat level a reinforced concrete landing of 1.2m minimum width shall be provided with a hot dip galvanised steel access door for the interchange.

Two of the ladders leading to the platform at the top of the tower shall have approach from the reinforced concrete stairs. Other two ladders shall be directly from the ground level itself.

13.11.05 Handrailings

Handrailing shall be provided on both sides at the edges of platforms, landing slabs, sides of stairs, walkways and cold water outlet channel.

Handrailing shall be of hot dip galvanised construction and shall be out of 32 mm NB pipes of medium class conforming to IS:1239 and provided with etch primer and bituminous painting.

Handrailing shall be 1300 mm high with two intermediate rails at 450mm and 900 mm with the top rail at 1300 mm above the surface of slab/steps. Handrail posts shall be spaced at not more than 1.5 m centres.

A toe plate of hot dip galvanised mild steel of size 65 mm x 8 mm shall be provided for all handrailing.

13.12.00 Painting To Concrete Surfaces

Painting to the concrete surfaces specified herein below shall be with 100% solid high build Polyurethane coating of 2000 microns over compatible primer as per manufacturer's requirement. The prior approval of manufacturer shall be obtained from OWNER for painting of cooling tower.

- a) Basin floor
- b) Internal surfaces of basin wall including the partition wall.
- c) Diagonal columns over complete height.
- d) Fill support columns and beams for the full height and length respectively.
- e) Internal and external surfaces of hot water duct.
- f) Internal and external surfaces of cold water channel upto the terminal point.
- g) Internal and external surfaces of the drain chamber.
- h) Complete internal surface of the shell. For external surface at least 1 metre on the shell at top.

The preparation of concrete surface for painting shall conform to IS:2395(Part-I). For new surface, it is preferable that the surface left unpainted for as long as possible to allow drying. Before painting, the surface shall be thoroughly brushed to



remove all dirt and remains of loose or powdered materials.

All other exposed concrete surfaces shall be given two coat of water proof cement paint of approved make and colour after the surfaces are rubbed down suitably and as approved by the OWNER. All concrete surfaces which are in contact with the earth shall be applied with anticorrosive coat system.

13.13.00 Water Distribution System

The arrangement of water distribution system shall permit a satisfactory distribution of water over the whole area of the tower at all reasonable loads.

Hot water Inlet pipe shall conform to the requirements of Class I of IS:3589 and steel shall conform to IS:2062.

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

13.14.00 Lightning Protection

The cooling tower shall be protected against damage by lightning. The installation work shall conform to the requirements of IS:2309.

CONTRACTOR's scope of work includes supply and installation of the complete system upto and including the earth electrodes.

For detailed specification of lightning protection system refer eletrical section of this document..

During the construction of tower, temporary lightning protection shall be maintained by connecting the reinforcement bars to two grounding conductors of size 50 mm x 6 mm.

Lighting protection requirement shall be provided as per mentioned specification of vol. IV 4.

13.15.00 Aviation Warning System, Lighting and Power Receptacles

Refer Volume-III (Mechanical Section)

TECHNICAL DATA SHEET- A

13.22.00 Specific Technical Requirements

a) Number of cooling towers 2 nos

13.22.01 1. Design & Operating Conditions

Refer Volume-III (Mechanical Section)



13.23.00	Features	
	Refer Volume-III (Mechanical Section)	
13.24.00	Elevations	
13.24.01	Grade level in m	To be decided during during detail engineering.
13.24.02	Sill level in m	-do-
13.24.03	Basin depth in m	-do-
13.25.00	Materials of Construction	
	Refer Volume-III (Mechanical Section)	
13.26.00	Structural Concrete (Minimum Grade)	
	a) Foundations	M30
	b) Basin	M35
	c) Diagonal Columns	M40
	d) Shell	M35
	e) Precast works (Fill Supporting Structure)	M35
13.27.00	Type of Cement	
	a) Below ground	
	(i) Sulphate Resisting Portland cement with C ₃ A content 5 to 8%conforming to IS:12330	
	b) Above ground	
	(i) Sulphate Resisting Portland cement with C ₃ A content 5 to 8%conforming to IS:12330	
13.28.00	Primary Loads	
13.28.01	Wind load (as per IS 875)	
	a) Basic wind speed	50 m /sec
	b) Factor K1	1.08
	c) Terrain category factor K2 Varies w.r.t. height	Category 1



	d)	Factor K3	1.0
	e)	Intensification factor	as per spec.
13.28.02		Earth quake load.	
	a)	Zone as per IS:1893	III
	b)	Importance factor	as per code
13.29.00		Foundation Criteria	
		Ground water table	At grade level.
		Type of foundation	Pile
		Safe bearing capacity of soil	As per soil report
		Type of pile	As per soil report
		Pile capacity and termination depth belowground level	As per soil report
		Minimum thickness of basin base slab	250mm
		Pressure relief valves in the basin floor slab	Not to be provided
13.30.00		Water Distribution Channel	
		Design Pressure	
13.31.00		Performance Test	
		Method	
		Instrumentation	



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2 x 660 MW Ennore SEZ Coal Based Supercritical Thermal Power
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19.00.00 SURVEYING WORKS

19.01.00 Site survey shall be carried out to establish the ground levels and to determine any existing structures, roads etc. The site survey shall be carried out before the commencement of the work and if required during the progress of the work. The site survey shall be carried out at a grid spacing of 5-10 meters and at every change of level of the existing ground to produce contour drawings at 0.25 meter intervals. Scale of the contour drawings shall be as directed by the Consultant. A specialized firm approved by the Consultant shall carry out the site survey.

A single grid pillar will be given by the client with coordinates in plant area. Necessary grids shall be made by EPC contractor including demarcating the structures, buildings and jungle clearance including Cutting, uprooting and removing of trees and dispose the same away from the site etc.

19.02.00 Survey points (reference points and bench marks) : The contractor shall construct adequate number of reference points and bench marks for marking the setting out lines and levels. The reference points shall consist of suitable metal plates set in 400 mm x 400 mm x 500 mm precast concrete plinth (grid pillars) and inscribed with the exact level. All levels of the benchmarks shall be related to the agreed datum. The exposed numbers, locations, co-ordinates and level of the reference points and bench marks shall be plotted on drawings and approved by the consultant prior to the commencement of the work. Survey points in solid walls shall be stainless steel plates or cast iron, fixed firmly and sufficiently deep in the walls.

19.03.00 Safeguard of survey points: The survey points shall not be removed from their position without the permission of the Consultant. If any of the survey points are damaged or lost due to any work carried out near their location, the contractor shall be responsible for replacing such survey points.

19.04.00 Surveying during the progress of work : The contractor shall assist the consultant at any time when checking survey points, setting out, checking construction items and erection parts. The contractor shall provide and arrange the following:

- i) Provision and maintenance of survey instruments and accessories.
- ii) Provision of skilled personnel, supply of all material required for the survey exposing covered survey points.
- iii) Shifting of any machinery used for construction out of the sight lines.
- iv) Stopping all drilling, blasting, driving and any other works.
- v) Causing soil vibrations and stopping during instrument observations.
- vi) Removing all obstructive accumulation of water.
- vii) Taking all necessary safety precautions.



- viii) Furnishing any marking material requested by the Consultant in connection with control surveys.
- ix) Providing additional survey points in accordance with the consultant's instruction.



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20.00.00 EXCAVATION AND FILLING

20.01.00 The works to be provided by the bidder in respect of excavation in all types of soils including shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations shall be as detailed below:

- a. Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, equipment, tools and plants, transportation etc. required for the work.
- b. Prepare and submit working drawings showing the approaches, slopes, beams, shoring, sumps for dewatering including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing etc. and all other details as may be required by the Engineer.
- c. To carryout sampling and testing and submit to the Engineer, results of soil compaction tests if required by the Engineer to assess the degree of compaction.

20.02.00 All works should conform to the requirements of the latest revision of relevant ISS.

IS: 3764 : Indian Standard for Safety Code for excavation work.

IS:1200 (PartI) : Indian Standard Methods of Measurement of Building and Civil Engineering work, Part-I: Earthwork.

20.03.00 The bidder should carryout the work as per the approved drawings. All materials required for the work shall be of best commercial variety. Borrow materials for back- filling shall be excavated from approved locations and shall consist of material, free from roots, vegetation, decayed organic matter, harmful salts and chemicals free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries, shall be used as fill material.

20.04.00 Quality Control: The bidder shall establish and maintain quality control for the various aspects of the work, method, material and equipment used. The quality control operation shall include but not be limited to the following items of work:

a.	Lines, Levels and Grades	:	i.	Periodic surveys.
		:	ii.	Establishment of markers, boards etc.
b.	Back-filling	:	i.	Checking the quality of fill material
			ii.	Checking moisture content



of

the backfill.

- iii. Checking the degree of compaction.

20.05.00**Excavation**

- a. **Setting out :** The contractor should submit to the Engineer, detailed drawings of the excavation work to be executed by him showing the dimensions as per drawings and specification adding his proposals of slopes, shoring, approaches, dewatering sumps, beams etc. Upon Engineer's approval the contractor should set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers shall be fixed at intervals prescribed by the Engineer. The contractor should proceed with the work after Engineer's approval. It should be noted that this checking by the Engineer prior to start of the work shall in no way absolve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if necessary, should be carried out by the contractor free of cost to the Purchaser.
- b. **Clearing and Grubbing etc.:** The area to be excavated shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush etc. and leveled up. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600mm below ground level or 150mm below formation level whichever is lower. After the tree is cut and roots taken out, the pit-holes formed shall be filled with good earth in 250 mm layers and consolidated. The trees shall be cut in suitable pieces as instructed by the Engineer.
Before earthwork is started, all the spoils/ unserviceable materials and rubbish shall be burned or removed from the site to approved disposal areas as specified. Useful materials, saleable timber, firewood etc. shall be the property of the Purchaser and shall be stacked properly at the work site in a manner as directed by the Engineer.
- c. **Excavation in all kinds of soil:** The excavation in all kinds of soil including old (from demolished structures) underground RCC / CC / brick masonry shall be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work shall be carried out in a workman like manner without endangering the safety of nearby structures/ services or works and without causing hindrances to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work shall be checked by the Engineer thoroughly and the balance work shall be carried out carefully to avoid any over-excavation. On completion, the work shall be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips etc. are expected, the Engineer may order to suspend the work at any stage and instruct the contractor to carryout the balance work just before the foundation work of the structure can be started.



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- d. Disposal: The excavated soils shall be disposed of within 5 km crow fly distance from site as directed by the Engineer-in-charge in any or all the following manners:
 - i) By using it for backfilling straightway.
 - ii) By stacking it temporarily for use in backfilling at a later date during execution.
 - iii) By either spreading or spreading and compacting at designated disposal areas.
 - iv) By selecting the useful material and stacking it nearly in areas designated by the Engineer for use in backfilling by some other agency.
- e. Disposal of Surplus: The surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer. All goods excavated from the pits and all assorted materials of dismantled structures shall be the property of the Purchaser.

20.06.00 Back-filling

- a. The backfilling material shall consist of materials, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc. In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.
- b. Filling and compaction in pits and trenches around structures: As soon as the work in foundations has been accepted and measured, the space around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc. and filled with earth in layers not exceeding 250 mm in loose thickness; each layer being watered, rammed and properly compacted to the satisfaction of the Engineer. Earth shall be rammed with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and leveled to proper profile as desired by the Engineer. Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimize the moisture content.

The backfilling shall be carried out at optimum moisture content to achieve 95% of Proctor's Maximum Dry Density.



- c. Plinth filling: The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slopes intended to be given to the floor.
- d. Filling in trenches for water pipes and drains: Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.
- e. Filling in disposal area: Surplus material from excavation which is not required for backfilling shall be disposed of in designated disposal areas within the lead for disposal as 5 km crow fly distance from the site. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas, rollers shall be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by the contractor.
In certain cases, the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

20.07.00 Approaches and Fencing : The contractor should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the plant. Sturdy and elegant fencing shall be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

20.08.00 Lighting: Full scale area lighting should be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the filling.

20.09.00 Testing and Acceptance Criteria

- a. Excavation: On „completion of excavation, the dimensions of the pits shall be checked as per the drawings. After the pits are completely dewatered, the



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work shall be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of M10 proportion and/ or richer and/ or by compacted earth, as directed by the Engineer. Over excavation of the sides shall be made good while carrying out the back-filling. The excavation work shall be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

- b. Back-filling: The degree of compaction required shall be as per IS standards and the actual method of measuring the compaction achieved shall be as decided by the Engineer. The work of back-filling shall be accepted after the Engineer is satisfied with the degree of compaction achieved.



21.00.00 CEMENT, CONCRETE & ALLIED WORKS

- 21.01.00**
- a. This part covers the requirements for general use of Plain and Reinforced Cement Concrete work in structures at all locations, cast-in-situ or precast, including all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. The special requirements of structures covered in latest IS:456 should also be complied with.
 - b. The works to be provided by Contractor:
 - i) Furnish all labour, supervision services including facilities as required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plant, transportation etc. required for the work.
 - ii) Prepare progressively detailed drawings and bar bending schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
 - iii) Submit shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedment, hangers, openings, frames etc.
 - iv) Submit detailed drawings of supports, templates, hangers etc. required for installation of various embedment like inserts, anchor bolts, pipe sleeves, joint seals, hangers, openings, frames etc.
 - v) Submit detailed schemes of all operations required for executing the work e.g. material handling, concrete mixing, placement of concrete, compaction, curing, services, approaches etc.
 - vi) Design and submit concrete mix designs required to be adopted on the job.
 - vii) Provide all incidental items necessary for successful completion of the work in accordance with the drawings, specifications and schedule of Items.
 - ix) Supply of specialized materials as directed by the Engineer with a guarantee in approved performa for satisfactory performance.
 - x) Furnish samples and submit for approval the results of various properties of the following materials :
 - a. The various ingredients of concrete including concrete
 - b. Embedments.
 - c. Joint seals

21.02.00 AFTER AWARD OF WORK ACTIVITIES

The following information and data including samples where necessary shall be submitted by the bidder progressively during the execution of contract:



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a) **Programme of execution and Requirement of Materials.**

Within 15 days of the award of contract ,the Contractor will submit a Master Programme for completion of the work giving month wise requirements of materials , particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms and conditions of the contract.

The master Programme may have to be reviewed and updated by the Contractor quarterly or at more frequent intervals as may be directed by the engineer depending on the emergency of the work.

b) **Samples**

Materials supplied by the Contractor have to be tested for physical, chemical and other properties in the reputed labs at their cost. If found unsuitable, the same shall be removed from the site. Samples of the following materials & any other materials proposed to be used, shall be submitted as directed by the Engineer in Charge, in sufficient quantities free of cost for approval. Approved samples will be preserved by the Engineer in Charge for future reference. The approval of the Engineer in Charge shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities :-

- i) Coarse and fine aggregates.
- ii) Cement.
- iii) Reinforcement.
- iv) Admixtures.
- v) Plywood for formwork.
- vi) Embedded & anchorage materials as may be desired by the Engineer in Charge.
- vii) Joint sealing strips and other waterproofing materials.
- viii) Joint filling compounds.
- ix) Foundation quality Rubber Pads.

c) **Design mix**

Design mix as per the specification giving proportions of the ingredients, sources of aggregates & cement, along with test results of trial mixes as per relevant I.S. is to be submitted to the Engineer in Charge for his approval before it can be used on the works.



- a. Detailed drawings & designs of formworks to be used.
- b. Detailed drawings for templates & temporary supports for embedments.
- c. Test reports for cement, reinforcement steel and formwork including inspection reports.
- d. Any other data as per specification.

d) Conformity with Design

The contractor should prepare check lists in approved performa which will be known as “Pour Cards” listing out all items of work involved. The contractor should inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help & assistance to the Engineer for checking required in the pour. On satisfying himself that all details are in accordance to the drawings & specifications, the Engineer will give written permission allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the contractor; deviations allowed by the Engineer and any other relevant information should be written on accompanying sheets attached to the Pour Cards. These sheets, termed as “Progress Cards” shall be prepared by the contractor on approved performa. The Pour Cards alongwith accompaniments shall be handed over to the Engineer before starting placement of concrete. One of mix designs developed by the contractor as per the I.S. specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete shall be to Engineer’s approval.

21.03.00 Materials to be Used / Supplied by Contractor

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

a) Cement

Ordinary Portland Cement (OPC) Grade 43 shall be used for all structures.

For mix design, water cement ratio would not exceed 0.45. Chloride free sulphonated melamine based super plasticizer conforming to IS:9103 shall be added as per mix design and manufacturer’s instructions to improve workability.

b) Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm & 150 mm shall be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries & conforming to IS: 383 shall be allowed to be used on the works. Aggregates shall be washed to make it free



from deleterious materials, if necessary.

c) **Fine Aggregate**

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification shall be allowed to be used on works.

In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading with prior approval of the Owner.

Crushed stone sand alone may be used only with the prior approval of the Engineer for filling and PCC works only.

d) **Water**

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts and other impurities. Normally potable water is found to be suitable. Generally, IS: 3550 shall be followed for routine tests. In case of doubt, the acceptance test for water shall be as per IS: 3025 and Table-I of IS: 456.

f) **Admixture**

Only admixtures of approved quality shall be used when directed or permitted by the Engineer in Charge. The admixture shall conform to IS: 9103.

g) **Reinforcement**

The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 415/Fe 500 conforming to IS:1786- latest.

21.04.00 Storage of Materials

a) All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately. The contractor shall maintain up-to-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

b) Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-house at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter. Sufficient space of storage with open passages should be arranged between stacks. Cement shall be stored in easily countable stacks with consignment identification marks arranged in the order



of their receipts at site. Sub standards or partly set cement shall not be used; and shall be removed from the site, as soon as it is detected.

- c) Aggregates shall be stored on planks or on steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in stockpiles stacks and sufficient care shall be taken to prevent the material at the edges of the stockpiles from getting intermixed. Stacks of fine & coarse aggregate shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths
- d) Reinforcing shall be stored consignment –wise and size wise off the ground & under cover. It shall be protected from rusting, oil, grease and distortions.

The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

21.05.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and material to assure compliance with spec requirements and submit to the Engineer. The quality control operation shall include but not be limited to the following items of work :-

- a) Admixture : Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete. For air entraining admixtures, doses to be adjusted to maintain air contents within desirable limits.
- b) Aggregates : Physical, chemical, mineralogical qualities, grading moisture contents and impurities.
- c) Water : Impurities test.
- d) Cement : Test to satisfy relevant IS: Specification
- e) Form work : Material shape, dimension, lines, elevation, surface finish, adequacy of form, ties, bracing and shoring & coating.
- f) Reinforcement : Shape, Dimension, Length of splices, clearances ties and supports. Quality & requirement of welded splices. Material test and certificates to satisfy relevant IS: Specification.
- g) Grade of concrete : Usage & Mixdesign. Testing of all



- h) Batching & Mixing : properties.
Types & capacities of Plant, concrete mixtures and transportation equipment.
- i) Joints : Location of joints, water stops and filler quality and materials. Dimension of joints, shape of joints material and splices.
- j) Embedments & anchorage items : Material, shape, location and setting.
- k) Placing : Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application mortar, slurry for proper bond, prevention of cold joints and type of chutes or conveyors.
- l) Compaction : Number of vibrators, their prime movers, frequency and amplitude of vibration, diameters and weight of vibrators, duration of vibrator, hands spreading and rodding and tamping.
- m) Setting of base : Lines, elevation and bedding mortar.
- n) Concrete finishes : Repair of surface defects, screening, floating, steel trowelling and brooming special finishes.
- o) Curing : Methods and length of time.

21.06.00 Concrete Mix Requirements

Concrete mix requirements shall be in accordance with IS:456 and as supplemented and modified herein or by other best possible standards.

- a) Washing & Screening of coarse and fine aggregates shall be carried out to remove fines, dirt and other deleterious material.
- b) Admixture: All concrete shall be designed for normal rate of setting and hardening at normal temperature and humidity under different climatic conditions. Admixtures shall be used in accordance with IS:456 to modify the rate of hardening, to improve workability or an aid to control quality. The Engineer reserves the right to order for laboratory test or use test data or



other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as desired by the Engineer.

- c) Concrete grades to be used in different parts of work shall be as shown on the drawings or as per the Engineer's instructions. In case of liquid retaining structures, IS:3370 shall be followed.
- d) Proportioning of ingredients of concrete shall be made either with preliminary test by designing the concrete mix ["Design Mix Concrete "] or without preliminary test adopting nominal concrete mix. Design mix concrete shall be used on all concrete works while nominal mix concrete, as per IS:456, may be used as shown on drawings and approved by the Engineer. In all cases, the proportioning of ingredients and works control shall be in accordance with IS:456 and its adequacy after obtaining Engineer's approval.

e) **Mix Design Concrete**

Concrete mixes shall be designed by the contractor to achieve the strength, durability and workability economically with various ingredients. In general the design will keep in view the following considerations :

- i) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
- ii) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- iii) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- iv) Chemical admixtures may be used to modify the rate of hardening and improve workability.
- v) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.
- vi) Concrete Mix Design and Strength requirements

Concrete mix design shall be as per IS: 10262 and SP: 23. The strength requirements of both design mix and nominal mix concrete where ordinary Portland cement or Portland slag cement is used shall be as per Table-2 of IS: 456. All other relevant clauses of IS: 456 shall also apply.



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f) **Minimum cement content**

The minimum cement content for each grade of concrete shall be as shown below:

TABLE – I
MINIMUM CEMENT CONTENT & MAX. W / C RATIO SPECIFIED
FOR
DIFFERENT GRADES OF CONCRETE

Sl no	Class	Conc Grade	Min cement content (kg/cum)	Water, Cement ratio	Slump (mm)
1	Plain concrete used for lean concrete.	M 10	-	-	-
2	Backfill	M 15	250	0.5	-
3	Pavement around buildings, Base plate encasement, etc.	M 20	320	0.55	80+/20
4	Precast concrete	M 25	365	0.50	Do
5	a) Reinforced concrete for structural work in foundation & superstructure	M 30	365 - 400	0.45	Do
	b) Reinforced concrete for Water retaining structure (not in contact with sea water)	M 30	365 - 400	0.45	Do
6	TG top deck, Chimney shell & structures coming in contact of sea water.	M 35	365-400	0.45	Do
7	Natural draft Cooling Tower	M 40	365-400	0.40	Do

The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

g) **Water-Cement Ratio**

The choice of water-cement ratio in designing a concrete mix will depend on

- i) The requirement of strength.
- ii) The requirement of durability.

i) **Strength Requirements of Concrete Mix**

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give



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acceptable test results as per IS: 456 will be selected by trial and error. The values of water- cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer.

Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-9 of IS: 456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS: 456.

ii) Durability

Tables 4 of IS:456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of Impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer / super- plasticizer.

h) Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedment's and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The limits of consistency for various types of structures as per Table – I With the permission of the Engineer. For any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS: 1199 and Clause 7 of IS: 456 shall be carried out.

i) Size of Coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows



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unless otherwise directed by the Engineer:

Reinforced concrete except foundation mm	-	20

Ordinary Plain concrete and Reinforced concrete foundations mm	-	40

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles 40 mm to 20 mm and 20 mm to 5 mm.

In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal

j) **Mixing of Concrete**

Concrete shall always be mixed in mechanical mixer for unimportant works & in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for atleast one minute. Mixing of each batch shall be continued for uniform distribution of the materials with uniform mass in colour and consistency, but in no case shall mixing be done for less than 2 minutes and at least 40 revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as needed. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

Controlled concrete only in batching plant shall be used for power house column foundation, TG, boiler foundation, ID, FD, PA, BFP foundations, chimney cooling tower & other important structure.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time, the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Purchaser to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as per IS: 4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances



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specified in IS: 1791 should be allowed to be employed. Batching Plant where used shall conform to IS: 4925.

Hand mixing if permitted shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the Purchaser.

Crushed ice shall be used in concrete mixing water so as to maintain temperature in the concrete in the top decks of the machine foundations. Arrangements for standby weight batching plant and equipment shall also be made available by the contractor for continuous pour of concrete.

k) **Conveying Concrete**

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means, concrete shall be placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way preventing segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design should be used. If, in spite of all precautions, segregation does occur during transport, the concrete shall be properly remixed before placement. During very hot weather, concrete shall be transported in deep container to reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container should be covered. Conveying equipment for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipment shall be kept free from set concrete.

l) **Placing and Compacting of Concrete**

- i) Relevant I.S. Code should be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. Concrete shall be placed against the surfaces of formwork or construction joint in concrete or masonry. The surface against which concrete is placed shall be cleaned thoroughly. Old construction joint has to be roughened by wire brushing, chipping sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. shall be removed by air water jetting or water at high pressure.

Concrete shall be placed in the formwork by approved means, and shall not be dropped from a height or handled in a manner which may cause segregation.

- ii) Construction joint shall be kept moist for at least 72 hours prior to placement. Concrete shall be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution shall be adopted. Formwork shall be cleaned thoroughly and smeared lightly with form oil or grease of approved quality



just prior to placement.

- iii) 12 mm thick mortar with less w/c ratio as that of the concrete being placed and cement slurry shall be spread thoroughly on the construction joint just prior to placement of concrete. The concrete shall be spread, and thoroughly compacted without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS. In thin members with heavy congestion of reinforcement of other embedments, where effective use of internal vibrator is, doubtful, in addition to immersion vibrators, the contractor should employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor should employ screed vibrator as per IS: 2506. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.
- iv) The rate of placement of concrete shall be such that no cold joint is formed; and fresh concrete is placed always against green, plastic and workable concrete. No concrete shall be placed in open during rains. During rainy season, no placement in the open should be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.
- v) Slabs, beams and similar members shall be poured in one operation. Moulding, throating, drip course, etc., shall be poured as per the drawings. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as per drawings. In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement. Once the concrete is deposited, consolidated and finished in its final position, it shall not be disturbed.

21.07.00

a) Construction Joints

Concrete structure shall be completed by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints shall be formed as per drawings. Vertical construction joints shall be made with rigid



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stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. For water retaining structures and leak proof buildings suitable and approved water stops shall be installed at the construction joints as per clause 12.4 of IS:456. Where the location of the joints are not specified, it shall be in accordance with the following :-

- i) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.
- ii) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.
- iii) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.
- iv) Feather-edges in concrete shall be avoided while forming a joint.
- v) A construction joint should preferably be placed in a low stress zone and at right angles to the direction of the principal stress.

b) Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The contractor should always remain vigilant to avoid cold joints. If however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it :-

- i) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete should be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible, and the joint thoroughly and systematically vibrated.
- ii) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, shall be placed on the cold joint, fresh concrete shall be placed on the mortar layer and the joint shall be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- iii) In case the concrete at the joint has become so stiff that it cannot be remolded and mortar or slurry does not rise inspite of extensive vibration, the



joint shall be left to harden for atleast 12 to 24 hrs. It shall then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as indicated above.

c) Expansion And Isolation Joints

i) Expansion and isolation joints in concrete structures shall be provided at specific places as shown on the drawings with materials and types of joints as specified. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as specified on the drawings. All materials should be procured from reliable manufacturers to the approval of the Engineer. Test certificates for the materials should be furnished. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval from concerned engineer of the method of forming the joints should be obtained.

ii) Duraboard HD or its equivalent of approved manufacturer shall be used as filler for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as recommended by the manufacturer.

Commercial quality of expanded polystyrene products commonly used for thermal insulation can also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material should be procured from reliable manufacturers as approved by the Engineer. The method of installation shall be similar to that recommended by the manufacturer for fixing on walls. A coat of bitumen paint shall be applied on the board against which concrete is placed.

iii) Joint sealing strips shall be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. General strips shall be of PVC or otherwise as specified. Sealing strips shall not have any longitudinal joint; and shall be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material shall be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations. The contractor should supply all labour and materials for installation including the material and tools required for jointing, testing, protection, etc. The joints in rubber seals shall be vulcanised as needed.



- iv) The minimum thickness of P.V.C. sealing strips shall be 3 mm and the minimum width 100mm. The actual size and shape shall be as shown in drawings. The material should be of good quality Polyvinyl Chloride highly resistant to tarring, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties shall generally be as follows:
- i) Specific Gravity : 1.3 to 1.35
 - ii) Shore Hardness : 60A to 80A
 - iii) Tensile Strength : 10 to 15 N/Sq.mm
 - iv) Maximum Safe Continuous Temperature : 70 Deg.C
 - v) Ultimate Elongation : Not less than 275%
 - vi) Bitumen Compound: When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per Manufacturer's recommendation. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.
 - vi) Isolation Joints: Strong and tough alkathene sheet or equivalent, about 1 mm in thickness shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.
 - vii) Rubber Pad: Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 kg/cum, shore hardness – 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.
 - viii) All foundation structures in contact with soil shall be coated with two coats of Bituminous coating.

21.08.00

Repairs, Finishes and Treatment of Concrete Surfaces

- a) Adequate and sound concrete surfaces, whether formed or unformed, should



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be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

- b) Unsound concrete resulting from improper mix design, incompetent methods, equipment and form work, poor workmanship and protection shall not be accepted and shall be dismantled, removed and replaced by sound concrete at the contractor's cost. All concrete work shall be inspected by the contractor immediately after the forms are removed and he should promptly report of occurrence of any defects to the Engineer. All repair works should be carried out as per the instructions and in the presence of the Engineer. Generally, repair work shall consist of any or all of the following operations :
- i) Sack rubbing with mortar and stoning with carborundum stone.
 - ii) Cutting away the defective concrete to the required depth and shape.
 - iii) Cleaning of reinforcement and embedments.
 - iv) Roughening by sand blasting or chipping.
 - v) Installing additional reinforcement/ welded mesh fabric.
 - vi) Dry packing with stiff mortar.
 - vii) Plastering, guniting, shotcreting etc.
 - viii) Placing and compacting concrete in the void left by cutting out defective concrete.
 - ix) Grouting with cement sand slurry of 1:1 mix.

c) Finishing Unformed Surface

The requirement of finishes of formed surfaces are specified hereunder separately. The contractor should include for concrete, the provision of normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below :

- i) Floor: For non-integral floor finish, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. The surface shall be scored and marked to provide better bond.



For monolithic finish, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type; and then floated with a wooden float. Steel trowelling should then started after the moisture film & shine disappeared from the surface; and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done should flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water should be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface. To provide a better grip, the floor should be marked in a regular geometric pattern after initial trowelling.

ii) Beams, Columns & Walls: If on any other concrete structure, it is intended to apply plaster or such concrete surfaces against which brick- work or other allied works are to be built, the contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop.

d) Protection and Curing of concrete: Newly placed concrete shall be protected from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days. Steps shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water shall be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the contractor.

The contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. In case any lapse on the part of the contractor is noticed, the Engineer will inform the contractor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the contractor within 3 hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the contractor.

21.09.00

a) **Reinforcement**

The reinforcement used shall be cold worked steel high strength deformed



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bars of grade Fe 415/ Fe 500 conforming to IS:1786 – latest.

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

b) Bar Bending Schedules

The contractor shall submit to the Engineer bar bending schedules with working drawings showing clearly the arrangements proposed by the contractor. Upon receipt of the Engineer's final approval of the bar bending schedule and drawings, the contractor shall submit the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings shall not relieve the contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contractor.

c) Bending

Reinforcing steel shall be bent in accordance with the procedure specified in IS:2502. Bends and shapes shall comply strictly with the dimensions corresponding to the approved bar bending schedules which shall be rechecked by the contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Re-bending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent.

d) Placing in position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings. Bars at crossing points, shall be securely tied together by # 20G annealed soft iron PVC coated wire or by tack welding in case of bar larger than 25 mm dia. binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained with FBEC spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases, he should not start placing any bar before obtaining clearance from the Engineer.

e) Welding

Normal bond laps in reinforcement should be placed by lap or butt welding reinforcement bars. The work should be done with suitable safe guards as per



IS for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. Welded mesh fabrics to IS:566 shall also be as per drawings.

f) **Control**

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be as per IS: 456. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1part cement to 2 parts sand by volume and cured in a pond for at least 14 days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

g) **Cold Weather Concreting**

When conditions are such that the ambient temperature may be expected to be 4.5 Deg.C or below during the placing and curing period, the work shall conform to the requirements of clause 13 of IS: 456 and IS: 7861.

h) **Hot Weather Concreting**

When depositing concrete in very hot weather, the contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38oC while placing.

21.10.00 Form Work

- a) The contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centering. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings. Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel.
- b) The centering shall be true to vertical, rigid and thoroughly braced both



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horizontally and diagonally. Rakes shall be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/ slabs for the purpose of securing and aligning the formwork shall not be used.

- c) The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 meters span. Bevelled forms 25 mm x 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places as necessary. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

d) Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/ or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork.



e) Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

f) Inspection of Forms

Casting of concrete shall start only after the formwork inspection and approval by the Engineer. The concreting shall start as early as possible within 3 days after the approval of the formwork; and during this period, the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

g) Removal of Forms

Before removing any formwork, the contractor must notify the Engineer well in advance to enable him to inspect the concrete if he so desires. The contractor shall record the date on which concrete is placed in each part of the work; and the date on which the formwork is removed there from. The contractor shall be responsible for the safe removal of the formwork; and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him. Forms for various types of structural components shall not be removed before the minimum periods as detailed below:

SCHEDULE OF REMOVAL OF FORM

Part of Structure	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
	Temperature ($^{\circ}\text{C}$)				Temperature ($^{\circ}\text{C}$)			
	Above 40°C	40°C to 20°C	20°C to 5°C	Below 5°C	Above 40°C	40°C to 20°C	20°C to 5°C	Below 5°C
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1	Do not remove	1	1	1	Do not remove
b) Beam sides	3	2	3	forms until	2	1	1	forms



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c) Slabs, 125 mm	10	7	8	site cured test specimen develop atleast 50% of the specified 28 days strength	7	4	5	until site cured test specimen develop atleast 50% of the specified 28 days strength
d) Slabs over 125 mm thick and soffit of minor beams	18	14	16		12	8	9	
e) Soffit of main beams	24	21	22		14	10	12	

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40oC can be reduced to those of the temperature range of 20oC to 40oC.

Construction joints in beams shall be located at the middle of span. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date.

h) Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances :-

i)	Sectional dimension	-	± 5 mm
ii)	Plumb	-	1 in 1000 of height
iii)	Levels	-	± 3 mm before any has taken

deflection
place

The above tolerance shall be for local aberrations in the finished concrete surface, and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible. Any error, within the above tolerance limits if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

i) Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired and inside surface treated as specified hereinbefore. Formwork shall not be used / re-used if declared unfit or unserviceable by the Engineer.

j) Generally, the “ordinary” class formwork shall be used in places where



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ordinary surface finish is required and shall be composed of steel and/ or approved good quality partially seasoned timber. Plywood formwork shall be used in exposed surfaces, where a specially good finish is required and shall

be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the “ordinary” class, if it is still in good condition. Ornamental formwork shall be used where ornamental and curved surfaces are required and shall be made of selected best quality well seasoned timber or plywood, which can be shaped correctly. The contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings.

21.11.00 **Anchor Bolts, Anchors, Sleeves, Inserts, Hangers / Conduits / Pipe and Other Misc.Embedded Fixtures**

The contractor shall build into concrete work all the items as noted below; and shall embed them partly or fully as directed and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant IS and of approved manufacture to the satisfaction of the Engineer. Exposed surfaces of embedded materials shall be painted with one coat of approved anti-corrosive paint and/or bituminous paint. If welding is to be done subsequently on the exposed surfaces of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line. Necessary templates, jigs, fixtures, supports etc. shall be used as required items to be embedded shall be as follows:

- i) Inserts, hangers, anchors, frames around openings, manhole covers, Frames, floor clips, sleeves conduits and pipes.
- ii) Anchor bolts and plates for machinery, equipment and for structural steel work.
- iii) Dowel bars, etc. for concrete work
- iv) Lugs or plugs for door and window frames occurring in concrete work. v) Flashing and jointing in concrete work.
- vi) Any misc. embedments and fixture as may be required.
- vii) Convextra-GP2, Sikka grout or equivalent grouting material shall be used as per manufacturer’s specification.



Correct location and alignment, as per drawings/instructions of all these embedded items shall be entirely the responsibility of the contractor.

21.12.00 Precast Concrete

The precast concrete shall be similar as for the cast-in-place concrete described herein. All precast work shall be carried out in a yard which shall be dry, properly levelled and having a hard and even surface. It shall be paved with concrete or masonry as needed; and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Casing shall be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 days of curing and can be removed for erection after 28 days of curing. The moulds shall be of steel or of timber lined with G.I. sheet metal.

Lifting hooks as necessary shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection. Precast concrete units, when ready, shall be transported to site by suitable means. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Engineer. The contractor shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

21.13.00 Sampling and Testing

The contractor shall carry out all sampling and testing as per IS for the following items:

a) Cement

Representative samples shall be taken from each consignment of cement received from the manufacturer / supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per IS:269. Soundness Tests shall also be carried out as required. No cement from a particular consignment / batch shall be used on the works unless satisfactory 3 days and 7 days test results for compressive strength are known. These tests shall be of great importance as their results shall have bearing on the acceptance of concrete or otherwise.

b) Aggregates

The contractor shall carry out any or all the tests of aggregates as required as per IS:2386 Parts-I to VIII. The acceptance criteria of the samples tested shall be as per the relevant IS.

c) Water



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Water for concrete works shall be tested as per IS: 3550 by the contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt shall be as per IS: 3025 & IS: 456.

d) Admixture

Air Entraining Agents (AEA): Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-à-vis quantity of A.E.A. used for all types of concrete shall be established by the contractor by carrying out sufficiently large number of tests. After than, at regular intervals and whenever directed by the Engineer, the contractor should check up, the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results. Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the contractor.

e) Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be as per IS:516 and IS:1199 with the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed apart from other tests as per IS:516. Sampling procedure, frequency of sampling and test specimen shall conform to clause 15 of IS: 456. To control the consistency of concrete from every mixing plant, slump tests and / or compacting factor tests in accordance with IS:1199 and as per clause 7.3.7(f) above shall be carried out by the contractor every 2 hours. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with clause 16 of IS:456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement shall be done as per specification by the contractor. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good by the contractor to the satisfaction of the Engineer.

f) Concrete for Equipment or Steel Structures Foundations

Concrete for equipment foundation, whether principal or auxiliary, shall be poured continuously so that the structure becomes monolithic, particular care being exercised to see that the base slabs, if any, are of compact impervious construction. Tunnels, passages apertures and so forth shall be provided in accordance with the drawings for the installation of mechanical and electrical equipment, pipes or cables. The top elevation of the equipment foundations or parts shall be accurately cast to 20/50 mm (or more as may be specified on the drawings) above the level required for grouting and it shall be pneumatically chiseled of and well roughened just prior to the erection of the equipment concerned. All embedded anchor bolts or bolt sleeves shall be accurately and firmly set with the aid of approved templates, steel supports



and / or other accessories. For holding the embedded bolts or sleeves in the correct position during concreting, template shall have to be of steel of suitable section approved by the Engineer in Charge. Two (2) sets of templates shall have to be provided, one to hold the bottom and the other the top of the bolts or sleeves. The bottom template shall be securely and rigidly fixed by providing anchorage arrangement and by welding to the lowest part of the steel reinforcement and other structural supports. The top templates shall be securely fixed by tying with guy wires and turn buckle arrangement to firm and rigid adjoining structures and stagings.

Bolt pockets, where required, shall be cast with wooden taper wedges. These shall be withdrawn at an appropriate time when the concrete has set, the pockets cleaned roughened and then covered or blocked thoroughly to prevent debris getting into these. The exposed portions of bolts and embedded parts shall be kept well greased and adequately protected from damage throughout construction. Any damages found shall have to be corrected at the contractor cost. The Purchaser shall have the right to use the foundations, pads, piers, slabs, floors and all concrete work as needed for other works or equipment erected prior to its "Taking over".

21.14.00 Acceptance Criteria

- a) Standard deviation shall be based on test results; and determination of standard deviation shall conform to clause 14.5 of IS:456. The strength requirements and acceptance criteria shall conform to clause 15 of IS:456. Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to clause 16 of IS:456.
- b) **Load Test**
 - i) Load tests of structural members as required, when the strength of test specimen results fall below the required strength, as per „Load Test on Parts of Structures”, clause 17.6 of IS:456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test shall be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.
 - ii) If the member shows evident failure, such changes as necessary to make the structure adequately strong, shall be made by the contractor, if permitted under Statutory Regulations to the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.
 - iii) A reinforced concrete beam, floor or roof shall be deemed to have passed the test, if the maximum deflection at the end of 24 hours does not exceed the deflection given in clause 17.6 of IS: 456. If a portion of the structure is



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found to be unacceptable, it shall be dismantled and replaced by a new structure as specified. If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same shall be made good, by the contractor to the satisfaction of the Engineer.

21.15.00 Tolerances

The permissible tolerances are as follows :-

- a) Tolerances for RC buildings
- b) Variation from the plumb
- c) In the lines and surfaces of columns, piers, walls and in arises 5mm per 2.5m but not more than 25mm.
- d) For exposed corner columns and other conspicuous lines:

In any bay upto 5m	=	5mm
In 10m or more	=	10mm
- e) Variation from the level or from the grades indicated on the drawings:
 - i. In slab soffits, ceilings, beam soffits and in arises:

In 2.5m	=	5mm
In any bay upto 5m	=	8mm
In 10m or more	=	15mm
 - ii. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines:

In any bay upto 5m	=	5mm
In 10m or more	=	10mm
 - i. Variation of the linear buildings lines from established position in plan and related position in plan and related position of columns, walls and partitions.

In any bay upto 5m	=	10mm



In 10m or more = 10mm

- ii. Variation in the sizes and locations of sleeves, openings in walls and floors = 5mm
(Except in the case of and for anchor bolts.)

- iii. Variation in cross-sectional dimensions of columns and beams the thickness of slabs and walls:-

Minus = 5mm
Plus = 10mm

- f) Footings

- g) Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50mm

- h) Reduction in thickness

Minus = 5% of specified thickness subject to a maximum of 50mm

- i) Variation in steps

In a flight of stairs

Rise = 3mm

Tread = 5mm

In consecutive steps

Rise = 1.5mm

Tread = 3mm

- j) Tolerances in other concrete structures

- i) Variation of the constructed linear outline from established position in plan.

In 5 m = 10mm
In 10m or more = 15mm



- ii. Variations of dimensions to individual structure features from established positions:

In 20m or more	=	25mm
In buried construction	=	50mm

- iii. Variation from plumb, from specified batter or from curved surfaces of all structures:

In 2.5 m	=	10mm
In 5m	=	15mm
In 10m or more	=	25mm
In buried – construction	=	Twice the above amounts

- iv. Variation from level or grade indicated on drawings in slab, beams, soffits, horizontal grooves and visible arises:

In 2.5 m	=	5mm
In 7.5m	=	10mm
In buried – construction	=	Twice the above amounts

- v. Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members:

Minus	=	5mm
Plus	=	10mm

- vi. Variation in the thickness of slabs, walls, arch section and similar members:

Minus	=	5mm
Plus	=	10mm

- vii. Misplacement of eccentricity:
2% of footing width in the direction of misplacement but not more than 50mm.

- viii. Reduction in thickness:

5% of specified thickness subject to a maximum of 50mm.



Tolerance in other types of structures shall generally conform to those given in clause 2.4 or recommended practice for concrete formwork (ACI347).

ix. Tolerance in fixing anchor bolts shall be as follows:

(i) Anchor bolts without sleeves +1.5mm in plan.

(ii) Anchor bolts with sleeves +5.0mm in elevation.

a) For bolts upto and including 25mm dia +mm in all directions.

b) For bolts 32mm dia and above +3mm in all directions.

(iii) Embedded parts +5mm in all directions.

21.16.00 Special Conditions For Construction of TG Foundation

a) Scope

i) The work to be performed under this contract consists of providing all materials except those supplied by the Purchaser, shuttering, staging, inserts, construction equipment, labour and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of the work, all in the strict accordance with the drawings, schedules and specifications and including revisions and amendments thereto and such detailed drawings as may be provided by the Consultant, during the execution of the work.

ii) It is not the intent to specify completely herein all the details of designs and construction of the structure. However, the structure shall conform in all respects to high standards of Engineering, design and workmanship and be capable of performing in continuous commercial operation upto contractors guarantee in the manner acceptable to the Purchaser / Consultant who will interpret the meaning of drawings and specifications and shall have the power to reject any work or materials which in his judgment are not in full accordance therewith.

b) Form Work

i) All forms shall be abundantly wetted on both sides before concrete is poured. The date of removing forms for each individual stage of construction shall be fixed by the Purchaser / Consultant.

ii) The minimum period for striking of formwork shall be as follows:-



- Vertical sides of beams and pedestals -7 days
- Bottom of beams / slabs -28 days

However, the vertical faces shall be loosened after 24 hours of completion of concreting the supports.

- iii) Concrete surface shall not normally be patched or otherwise treated after the removal of forms. Where the surfaces exposed on stripping is not of a satisfactory nature, owing to the contractors failure to take necessary precaution before, during or after the concrete placing, such surfaces shall be worked and finished in accordance with the instructions of the Purchaser / Consultant at the cost of the contractor. The pores shall be filled in with a neat solution of cement and water applied by brush and when dry the surface shall be rubbed down with carborundum stone. The cost of the above treatment shall be deemed to be included in the unit rate entered by Contractor. The top surface of the T.G. deck shall be float-finished, unless otherwise specified to the required levels. There must be no surface grouting or treating which might draw the “fines” to the top. All shuttered surfaces shall be left as they strip without removing boards or panel markings.

Any serious honey combing will render the concrete work liable to rejection and cutting out and re-concreting wholly or partly as the Engineer in Charge directs. All costs involved in repairing defect shall be borne by the Contractor.

- iv) The arrangement and method for movement of workers during TG construction to various levels of the TG foundations shall be submitted well in the advance to the Engineer- in – Charge for his approval far taking up the work.
- v) In addition to the above paras the contractor shall also satisfy all other requirements for formwork mentioned in elsewhere in the specification.

c) Staging

- i) The entire staging for supporting the formwork, walkways and platforms for placing concreting equipments such as vibrators, etc., shall be of structural steel. The staging shall be designed for the worst combination of loading as specified hereinafter.
- ii) The Contractor shall submit 6 copies of design calculations and drawing to prove adequacy of the staging for approval of the consultant. On receipt of final approval, the contractor shall supply 20 copies of approved drawings for distribution.



- iii) The staging shall be so designed that no load from platforms are passed on to the formwork at the top.
- iv) All platforms, walkways etc. shall be clear of the formwork and at least 200 mm above it. The width of platforms and walkways shall be at least 1.2 metres for easy movement of labour both ways.
- v) The platforms shall be of planks or bamboo mats (clamped with steel strips suitably stiffened to avoid springing).
- vi) The form work and staging shall be designed for a live load of 1000 Kg/m².
- vii) Unit weight of green concrete shall be considered as 2500kg/m³ for design of form work and staging.
- viii) The staging shall be braced in both the directions.
- ix) The staging shall be supported on rigid surfaces at ground level.
- x) The staging shall be sufficiently rigid to prevent any distortion in the form work.

d) Special Precautions

- i) The contractor shall take all precautions to ensure concreting of TG Raft, columns and TG Deck in one pour each. Concreting shall be continuous and no break in concreting shall be permitted.
- ii) The Contractor shall prepare a scheme for concreting giving details of number of mixers, labour, vibrators, pouring schedule and obtain prior approval of the same from the Engineer-in-Charge before starting of concreting.
- iii) The Contractor shall ensure that at no time the temperature of the green concrete exceeds 38 degree C by taking proper precautions. If required, ice shall be added to control the temperature at no additional cost to the Purchaser.
- vi) Approved “Retarders” shall be used by the contractor in the proportions specified by the manufacturer for total concreting work of the TG foundation. The cost of the admixture shall be included in unit rates quoted by the Bidders.



e) Test for Soundness of Concrete

- i) After completion of the construction of TG foundations and all major machine foundation like BFP, FANS, MILLS etc, the contractor shall get the Deck and column tested for soundness of concrete by “ultrasonic wave – non – destructive test method” from reputed research institutions like “SERC-CHENNAI” “CWPRI – POONA”, at no extra cost to the Purchaser.
- ii) If the test report calls for any rectification in the concrete works by way of pressure grouting or otherwise, the same shall be carried out by the contractor at no additional cost to the Purchaser to the satisfaction of the Purchaser / Consultant
- iii) If require, any additional test to establish the adequacy of the rectification works carried out shall be done by the contractor at no extra cost to the Purchaser

f) List of Codes and Standards

All work under this specification shall conform to the latest revisions of Indian Standard specifications and Codes of Practice:

IS : 216	-	Indian Standard Specification for Coal Tar Pitch
IS : 226	-	Indian Standard Specification for Structural Steel [Standard quality]
IS : 269	-	Indian Standard Specification for Ordinary, and Low Heat Portland Cement
IS : 383	-	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
IS : 432	-	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement
IS : 455	-	Indian Standard Specification for Slag Cement and Reinforced Concrete
IS : 456	-	Indian Standard Code of Practice for Plain and Reinforced Concrete
IS : 516	-	Indian Standard Specification for Methods of Test for Strength of Concrete.



IS : 1139	-	Indian Standard Specification for Hot Rolled Mild Steel and Medium Tensile Steel and High Yield Strength Steel Deformed Bars for concrete Reinforcement
IS : 1199	-	Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS : 1200	-	Indian Standard Specification for Method of measurement Cement Concrete Works. Part-II
IS : 1200	-	Indian Standard Specification for Method of Measurement of Part-V Formwork.
IS : 1332	-	Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing.
IS : 1489	-	Indian Standard Specification for Portland – Pozzolona Cement
IS : 1566	-	Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS : 1609	-	Code of Practice for Laying Damp proof Treatment using Bitumen felts
IS : 1786	-	Indian Standard Specification for Cold-twisted Steel Bars for Concrete Reinforcement
IS : 1791	-	Indian Standard Specification for Batch Type Concrete Mixers
IS: 2210	-	Indian Standard Specification FOR Design of Reinforced Concrete Shell Structures and Folded Plates.
IS : 2386	-	Indian Standard Specification for Methods of Test for Aggregates for Concrete – Part-I to VIII
IS : 2502	-	Indian Standard Code of Practice for Bending and Fixing of Bars for concrete reinforcement
IS : 2505	-	Indian Standard Specification for Concrete Vibrators, Immersion Type
IS: 2506	-	Indian Standard Specification for Screed Board Concrete Vibrators



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IS : 2514	-	Indian Standard Specification for Concrete Vibrating Tables
IS : 2722	-	Indian Standard Specification for Portable Swing weigh Batchers for Concrete (Single and Double Bucket type)
IS : 2770	-	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete.
IS : 3025	-	Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry.
IS : 3201	-	Indian Standard Specification for Design and for construction of Precast Concrete Trusses.
IS : 3370	-	Indian Standard Specification for Code of Practice Concrete Structures for Storage of Liquids.
IS : 3550	-	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry.
IS : 3558	-	Code of Practice for use of Immersion Vibrators for Consolidating Concrete
IS : 3590	-	Indian Standard Specification for Load Bearing Light Weight Concrete Blocks.
IS : 3696	-	Safety Code for Scaffolding and Ladders
IS : 3812	-	Indian Standard Specification for Fly Ash for use as Admixture for Concrete.
IS : 4031	-	Indian Standard Specification for Method of Tests for Hydraulic Cement.
IS : 4082	-	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site.
IS : 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes.
IS : 4656	-	Indian Standard Specification for Form Vibrators for Concrete.



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IS : 4925	-	Indian Standard Specification for Concrete Batching and Mixing Plant.
IS : 4926	-	Indian Standard Specification for Ready Mixed Concrete.
IS : 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work.
IS : 4995	-	Indian Standard Specification for Design of Part-I&II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials.
IS : 5512	-	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials.
IS : 5513	-	Indian Standard Specification for Vicat Apparatus.
IS : 5515	-	Indian Standard Specification for Compaction Factor Apparatus.
IS : 5751	-	Indian Standard Specification for Precast Concrete Coping Blocks.
IS : 5816	-	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders.
IS : 5891	-	Indian Standard Specification for Hand Operated Concrete Mixers.
IS : 6452	-	Indian Standard Specification for High Alumina Cement for Structural Use.
IS : 6909	-	Indian Standard Specification for Supersulphated Cement.
IS : 6923	-	Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.
IS : 6925	-	Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.
IS : 7242	-	Indian Standard Specification for Concrete Spreaders.



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IS : 7246	-	Indian Standard Specification for Table Vibrators for Consolidating Concrete.
IS : 7251	-	Indian Standard Specification for Concrete Finishers.
IS : 7320	-	Indian Standard Specification for Concrete Slump Test Apparatus.
IS : 7861 Part-I&II	-	Indian Standard Specification for Recommended Practice for Extreme Weather Concreting
IS : 7969	-	Safety Code for Storage and Handling of Building Materials.
IS : 8041E	-	Indian Standard Specification for Rapid Hardening Portland Cement.
IS : 8112	-	Indian Standard Specification for high strength Ordinary Portland Cement.
IS : 8142	-	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance.
IS : 8989	-	Safety Code for erection of Concrete Framed Structures.
IS : 9013	-	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated-cured Concrete Test Specimens.
IS : 9077	-	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction.
IS : 9103	-	Indian Standard Specification for Admixtures for Concrete.



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22.00.00 CONSTRUCTION OF SHELL BY SLIP-FORM METHOD

22.01.00 Shell construction has to be done by slip form shuttering technique. Type of slip form proposed should be indicated in the offer with sketches, drawings and construction statement as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress in mm/hour should also be indicated. The chosen scheme shall be of a past proven design. A certified performance record of the scheme should be submitted with the offer to guarantee workability of the scheme both from execution time and safety point of view.

22.02.00 The Contractor should furnish a brief but comprehensive statement indicating the planning & programme and method of work to be followed, for the approval of Purchaser at the time of submitting tender. This statement shall include the following items:

- i) Type and description of slip-form equipment and its accessories
- ii) Design of scaffolding and staging
- iii) Description of materials including admixtures to be used for construction.
- iv) Manpower planning, construction spaces required, standby arrangement.
- v) Rate of slip-forming
- vi) Proposed workability requirement of concrete and type of cement and admixture to be used
- vii) Quality assurance programme
- viii) Method of transportation of material
- ix) Method of curing and rectification of defects
- x) Planned interruption, if proposed, and activities during planned interruption. Treatment of construction joint.
- xi) Contingency solution for unplanned interruption
- xii) Time of completion

22.03.00 While selecting the Contractor, due consideration will be given to the merit of the above mentioned statement proposed by the Contractor and minimum time of completion, apart from his past experience in such types of work as also technical and



financial resources of the Contractor.

22.04.00

Notwithstanding what have been specified in earlier clauses, following guide lines are being presented which should be kept in view by intending Contractor, while quoting for slip form method of construction.

- a) Care to be taken to prevent dragging of concrete along with upward movement of the shuttering. For this purpose following steps are advisable.
 - i) Shutter plates have to be smooth and should be thoroughly Before fixing them in position all the surfaces which will be in contact with concrete to have a coat of epoxy paint.
 - ii) In areas where concrete thickness is 750 mm or more rate of should be such that minimum slipping of shuttering is 100 mm hour.
 - iii) Mix design should be so done that it will be self-lubricant at contact face of shutter and concrete and thus reduce friction cement of approved manufacturer (conforming to relevant specification) may be used for the purpose. An optimum ratio coarse / fine aggregate should be established to suit the depending on availability of aggregates.
 - iv) Mix design also should be so done that it has a slump of 50mm at the point where concrete is placed under an ambient temperature of around 40 Deg.C. This will also keep vibration by needle vibrators to required minimum. Slump should not drop down to zero in less than 45 min. Suitable retarding agent and plasticizer of approved manufacture may be added in mix to achieve this purpose. These admixtures to be properly identified by preliminary tests both for Performance and for compatibility with particular type of cement Proposed to be used.

Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40°C.

- b) Care must be taken to prevent twist, which predominantly occur in the initial stages because of low slipping rate, in the horizontal plane of slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person should exclusively be assigned to this work together with rectifying any defect.
- c) Every endeavor has to be made so as not to occur any tilt in the shutter assembly. To achieve this following steps need be taken:
 - i) Performance of jacks has to be closely observed and any defective one needs immediate replacement. Difference in levels of opposite aggregates offer better performance in slip form technique. These help to keep down water



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/ cement ratio and also offers better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates should be preferably be used unless reinforcement detailing calls for lesser size aggregates.

- d) From the creep point of view, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 400 kg per cum of concrete.
- e) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slip form proceeds should be between 0.1 to 0.2 Newton/sq.mm.
- f) Large diameter vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter – only in exceptional cases. Atleast two nos. standby vibrator units should always be maintained on top of working deck at all times during the entire period of slip form operation.
- g) It is preferable to have membrane curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curing at greater heights.

In case such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose. It is always advisable to have a standby pump for effective utilization of the system.

- h) If slip forming is carried out in summer, rate of slipping should be around 400 mm per hour. If lesser value is contemplated appropriate retarders should be specified.
- i) Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.

It is desirable that jacking system, based on which the entire slip form system works, should consist of jacks 3 tonne / 6 tonne capacity and a hydraulic pump with necessary pipe connections.

Spacing of yoke legs should preferably be kept within 2 meters to prevent overloading on jacks and consequent failure resulting in twist of the formwork.

Jacking rods should be of 25 mm diameter for 3 tonne jacks and 32 mm



diameter for 6 tonne jacks.

- j) Atleast 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump along with a set of loose pipes in perfect working condition on top of working deck.
- k) In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slip form yoke.
- l) For effective utility of this technique following areas need careful attention at the very conceptual stage:
 - i Detailed quality assurance programme
 - ii Advance planning and preparations
 - iii Arrangement for on site supervision and adequate access facilities.
- m) Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, descriptions and frequency of various checks and tests for slip form technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared before hand by executing agency and to be approved by Engineer before starting the actual work.
- n) Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.

Vertical reinforcements should be kept vertical by providing suitable holders within the slip form system.

- o) It is desirable to have a break of atleast one day for every two weeks of continuous operation. Such break should be utilized for various maintenance activities, removal of jacks rods etc.
- p) Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. It felt necessary one hoist may be exclusively earmarked for transporting concrete.

For movement of personnel supervising the work a separate hoist must be arranged for.



- q) The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system along with slip form.
- r) Winches for lifting men and material and mixers, if located within unsafe area around chimney, should be protected by adequate shelter from possible damage.
- s) Proper telecommunication system has to be established between the personnel working on top of chimney and control room below.
- t) A small laboratory should be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube testing machine may also be installed at site for getting quick feed back results.

Apart from using plumb bobs, level and theodolite instruments for survey purpose arrangement should also be kept for lasers.

- u) In case of interruption in the course of slipping of formwork following measures should be taken:
 - i Provision of a key and additional reinforcement at the junction of new and old concrete.
 - ii Slip form system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete.
 - iii Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout.
 - iv Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer.
 - v Neatly preferable the interface of old or new concrete as soon as it comes out of shutter panel.
- v) It is preferable to suspend the construction work under high wind condition.
- w) It is of utmost importance that for effective implementation of this system an Engineer fully conversant with slip form technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators.



- x) Operation of slip form method of construction is a continuous one and it demands continuous / intermediate inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.
- y) While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety engineer.

Safety measures as listed below must be adhered to but should not be limited to only these:

- i. Safety helmets and belts to be provided to all supervising staff and workers.
- ii. Safety nets to be provided below both inside and outside platforms as instructed by Engineer.
- iii. Hand railing and toe guard to be provided around all openings and platforms.
- iv. Regular maintenance of equipment, checking of hoists, scaffolding etc.
- v. Passenger hoist must have multiple ropes with adequate factor of safety.
- vi. Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the specification and to be operative in case of sudden power failure emergency standby generator must be kept ready during the entire period of slip form method or construction.
- vii) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

22.05.00 Construction tolerances

The following shall be the limit of construction tolerances to be strictly adhered to by the contractor:

- Wall thickness : (+) 10mm
- Shell diameter : (+) 10mm for every 3m diameter without any abrupt changes but in no case more than (+) 40mm.
- Verticality : 1 in 1000 subject to a maximum of 75 mm.

In addition, no two points 10m apart vertically shall be more than 20mm out



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of plumb w.r.t. each other

22.06.00

Although deviations in general will not be encouraged, the Contractor, however may mention in his offer, the additions to or deviations from drawings/ technical conditions/schedule of items issued with the tender papers and any other special requirement implied with the adoption of the slip form method, which may include but need not be limited to the following items as applicable.

- i. Particular requirement of type and brand of cement, if any.
- ii. Special admixture to be added to concrete
- iii. Any change required in the geometry of the chimney including the shell thickness or side slope from that shown in the NIT drawing.
- iv. Any change/special requirement in the arrangement of reinforcement.
- v. Implications if any of necessary in-situ bending of rebars for /brackets etc. and straightening/cleaning of the same prior to casting of brackets.
- vi. Any additional constructional opening in the shell required at ground level for concreting.

All deviations from specification must be justified and tender price shall include all such variation / deviation. Such deviation without assigning any reason will be rejected.



23.00.00 FABRICATION OF STRUCTURAL STEEL WORK

23.01.00 The details of fabrication, shop testing, painting and delivery to site of structural steel work including supply of all consumable stores, bolts, nuts, washers, electrodes and other materials as required including field connections are indicated below to be performed by the contractor:

- a) Preparation & submission of complete detailed fabrication drawings and erection marking drawings as required including design calculations.
- b) Furnish all materials, labour, tools & plant and all consumables required for fabrication and supply of all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections.
- c) Furnish shop painting of all fabricated steelwork as specified.
- d) Suitably mark, bundle and pack for transport all fabricated materials.
- e) Prepare and furnish detailed bill of materials, dispatch lists (including bought out items) as required for fabrication of structural steelwork.
- f) Load and transport all fabricated steelwork to site with field connection materials.
- g) Maintain a fully equipped fabrication shop at site for modification and repairs as required.

No work under this specification will be provided by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

23.02.00 Codes and standards

The work should conform to the requirements of the following latest relevant Indian standard specifications and codes of practice:

IS : 800	-	Code of practice for general construction in steel.
IS : 80	-	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS : 806	-	Code of practice for use of steel tubes in general building construction.
IS : 808	-	Dimensions for rolled steel beams, channels and angle sections.



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IS : 813	-	Scheme of symbols for welding.
IS : 814	-	Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS : 815	-	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
IS : 816	-	Code of practice for use of metal arc welding for general construction in mild steel.
IS: 228	-	Method of chemical analysis of pig Iron, cast Iron & plain carbon and low alloy steel
IS: 817	-	Code of practice for use of Structural steel in General building construction.
IS: 818	-	Code of practice for use of metal arc welding for general construction in mild steel.
IS: 819	-	Code of practice of resistance spot welding for light assemblies in mild steel.
IS:823	-	Code of practice for manual metal arc welding for mild steel.
IS: 919	-	Recommendations for limits and fits for engineering.
IS 1161	-	Specifications for steel tubes for structural purposes.
IS1181	-	Qualifying test for metal arc welders
IS1599	-	Method of bend tests for steel products other than sheet strip wire & tube.
IS 1731	-	Dimension for steel flats for structural & general engineering purposes.
IS 7205	-	Safety code for erection steel work.
IS2595	-	Code of practice for radiographic testing.
IS : 822	-	Code of practice for inspection of welds.
IS : 1182	-	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 1200 (Part - 8)	-	Method of measurement of steel work and iron work.



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IS : 1363 (Part - 1 to 3)	-	Hexagon head bolts, screws & nuts of product grade C.
IS : 1364 (Part - 1 to 5)	-	Hexagon head bolts, screws and nuts of product grade A&B.
IS : 1367 (Part - 1 to 18)	-	Technical supply conditions for threaded steel fasteners.
IS : 1608	-	Method for tensile testing of steel products.
IS : 1730	-	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS : 1852	-	Rolling and cutting tolerances for hot-rolled steel product.
IS : 1977	-	Structural steel (Ordinary quality)
IS : 2016	-	Plain washer
IS : 2062	-	Steel for general structural purposes.
IS : 3644 and	-	Code of practice for ultrasonic pulse echo testing by contact immersion method.
IS : 3757	-	High Strength Structural Bolt
IS : 4000	-	High strength bolts in steel structure
IS : 5369	-	General requirements for plain washers and lock washer.
IS : 6005	-	Code of practice for phosphating of iron and steel.
IS : 6649	-	Specification for hardened and tempered washers for high strength structural bolts and nuts.
IS : 6623	-	Specification for high strength structural nuts.
IS : 7215	-	Tolerances for fabrication of steel structures.
IS : 7280	-	Bare wire electrode for submerged arc welding
IS : 8500	-	Structural steel micro alloyed (medium & high strength quality).



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IS : 8629	-	Code of practice for protection of iron steel & structures (Part - I to III) from atmospheric corrosion.
IS : 9595	-	Recommendation for metal arc welding of carbon manganese steels.
IS : 117	-	Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
IS : 128	-	Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
IS : 1477	-	Code of practice for painting of ferrous metal in building (Part - I & II).
IS : 2074	-	Ready mixed paint, air-drying red-oxide zinc chrome priming.
IS : 2339	-	Specification for aluminum paints for general purposes in dual container.
IS : 2932	-	Specification for enamel, synthetic exterior type - I.
IS : 2933	-	Specification for enamel, synthetic exterior type - II.
BS 4465	-	Specification for water cooling towers.
ACI	-	Reinforced concrete cooling towers shall – practice & Commendatory

23.03.00 Conformity with designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings. The method of painting, marking, packing and delivery of all fabricated materials shall be as approved by the Engineer.

23.04.00 Materials to be used

Standard structural steel sections shall be used instead of fabricated steel sections as far as possible.

- a) All steel materials required for the work shall be supplied by the contractor. All steel materials shall comply with the following IS:-
- i) IS:801 - Cold formed light gauge steel structural member.



- ii) IS:2062 - Grade – A, Structural Steel for plate thickness upto 20mm
- iii) IS:2062 - Grade – B (Killed), Structural Steel for plate thickness above 20mm
- iv) IS:2062 - Grade – C, for crane gantry girder in turbine hall.
- v) IS:806 - Steel tubes in general building construction.

b) Electrodes

The arc welding electrodes shall conform to the relevant IS; and shall be of heavily coated type having uniform thickness. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (polarity in case of D.C. supply) for which the electrodes are suitable. All electrodes shall comply with the following IS:

- i) IS: 814 - Covered electrodes for metal arc welding structural steel.
- ii) IS:815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
- iii) IS:7280 - Base wire electrode for submerged arc welding.

c) Bolts and nuts

All bolts and nuts shall conform to the requirements of IS:1367 - Technical Supply Conditions for Threaded Fasteners. Materials for bolts and nuts shall comply with the following IS codes. Mild steel for bolts and nuts tested to following IS shall have a tensile strength of not less than 44 Kg/mm²; and minimum elongation of 23 per cent on a gauge length of 5.6 ÖA, where 'A' is the cross sectional area of the test specimen :

- i) IS:1367 - Technical supply conditions for threaded fasteners.
- ii) IS:1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.
- iii) High tensile steel material shall have the mechanical properties as per IS:1367 or as approved by the Engineer.



d Washers

Washers shall be made of steel conforming to the following IS:

- i) IS:1977 - Structural steel (Ordinary Quality) St-39-0
- ii) IS:2062 - Steel for general structural purpose
- iii) IS:6623 - High Strength Structural Nuts
- iv) IS:6649 - Hardened and tempered washers for high strength structural bolts & nuts.

Paints for shop coat of fabricated steel shall be of epoxy based paint to withstand severe corrosive conditions prevailing at site.

23.05.00 Painting

- a) 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.
- b) Steel surface which is to 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 abrasive blasted to Sa-2½ finish as per SIS05-5900. Primer paint shall be zinc silicate of approved brand . Dry film thickness of each primer coat shall be 50 microns.
- c) Finish paint shall be 2 coats of High built epoxy finish of approved brand. Dry film thickness of each finish coat shall be 90 microns. The undercoat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 300 microns . All paints shall be of approved brand and shade as per the OWNER's requirement.
- d) 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.
- e) 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.

23.06.00**Storage of Materials**

- a) All materials shall be stored to prevent deterioration ensuring the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately. The contractor shall maintain upto date account in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials shall be stacked separately with easily identifiable marks.
- b) The steel used for fabrication shall be stored in separate stacks off the ground section-wise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials should be stored under cover; and suitably painted for protection against weather.
- c) The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition [if necessary by resorting to heating].
- d) Bolts, nuts, washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.
- e) Paints shall be stored under cover in airtight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

23.07.00**Quality Control****23.07.01**

The contractor shall establish and maintain quality control procedures for different items of work and materials to ensure that all works are performed as per specification. As far as possible, all inspections by the Engineer shall be made at the contractor's fabrication shop. The contractor shall co-operate with the Engineer in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools & plant, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the contractor.



Materials or workmanship not in reasonable conformance with the provisions of this specification would be rejected at any time during the progress of the work. The quality control procedure shall cover but not be limited to the following items of work:

- i) Steel : Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- ii) Bolts, Nuts : Manufacturer's certificate, dimension & washers checks, material testing.
- iii) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
- iv) Welders : Qualifying tests
- v) Welding sets : Performance tests
- vi) Welds : Inspection, X-ray, Ultrasonic tests
- vii) Paints : Manufacturer's certificate, physical Inspection Reports.

23.07.02

- a) The dimensions, forms, weights and tolerances of all rolled shapes, bolts, nuts, studs, washers etc. and other members used in the fabrication shall, wherever applicable, conform to the requirements of the latest relevant IS.

b) **Fabrication Drawing**

The sequence of submission of fabrication drawings for approval shall match with the approved fabrication and erection schedule. It should be ensured that the correctness of general arrangement for centerline dimensions and levels, section sizes, and adequacy of connections including splice joints as to the number of bolts, weld length, size of gusset/end plates are maintained. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of spec.

The fabrication drawings shall include but not be limited to the following:

- i) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- ii) Dimensional drawings of base plates, foundation bolt location etc.
- iii) Details of all connections with supporting calculations.



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- iv) Any other drawings or calculations that may be required for the clarification of the works.

The fabrication drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between fabrication and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence; and technique of welding shall be carefully controlled to minimize the locked-up stresses and distortion. Welding symbols used shall be in accordance with the requirements of IS:813; and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

All steel structural wall beam/columns shall be encased with nominal reinforcement and chicken wire mesh fouling / connecting in brick masonry works. Also, chicken wire mesh shall be provided at the junction of RCC and brick work. The wall beam/tie beam shall be provided at every 2.5 meter height of the brick wall.

All columns shall be encased with RCC upto the height of 500 mm above zero level of STG power house building.

23.08.00 Workmanship

- a) All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of IS:800 and other relevant Indian standards or equivalent.
- b) Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by IS:1852. If straightening is necessary, it shall be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.
- c) Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch is permitted for mild steel only. Gas cutting of high tensile steel is permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically



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controlled torch shall be permitted if special care is taken and done under expert hand.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, subjected to substantial stress or which have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

- d) Finishing of sheared or cropped edges of plates or shapes of edges gas-cut with mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed.
- e) The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.
- f) **Bolted construction:**
 - i) Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching shall be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size; and reamed after assembly to the full diameter.

Holes for black bolts shall be not more than 1.5 mm or 2 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 to IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thicknesses in one operation shall be drilled to a smaller size and reamed out after assembly. Holes for bolts shall not be formed by gas cutting process.



- ii) Drifting to enlarge unmatched holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes to be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the drawings and is subjected to the limitation of particular connection as may be specified.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases, the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as indicated on the drawings.

g) Welded Construction

- i) Welding shall be in accordance with relevant IS. Welding shall be done by experienced and good welders qualified by tests in accordance with IS:817. Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.
- ii) Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected; and in making the correction, the parts shall not be drawn into a sharper slope than two degrees (2 Deg.). The work shall be positioned for flat welding whenever practicable.
- iii) In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is



welded to other parts of the member. Long girders or girder sections shall be made by shop splicing not more than 3 sub-sections, each made in accordance with this paragraph. Welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant IS.

- iv) All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of joint in a manner ensuring soundness. Where possible, this should be done by use of extension bars or run-off plates which need not be removed upon weld completion. To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall conform to the welds made, and the methods of correcting defective work shall conform to the relevant IS.

- v) If welding is to be undertaken at low temperature, adequate precautions as recommended in relevant IS shall be taken. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C, all requirements regarding preheating of the parent material shall be in accordance with the relevant IS.
- vi) Where required, intermediate layers of multiple-layer welds shall be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld is cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld & base metal from over peening.
- vii) The equipment shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of type and capacity as recommended by the electrode manufacturer.
- viii) Column splices and butt joints of compression members for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined



so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2 mm.

- ix) Bases and caps fabricated out of steel plates, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face. To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air. The ends of lacing bars shall be neat and free from burrs. Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used. Provision shall be made for all necessary steel bearing plates to take up reaction of beams & columns and the required stiffeners & gussets whether or not specified. Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.
- x) All shop connections shall be welded as specified. Certain shop connections, may be changed to field connections if desired by the Engineer for convenience of erection; and the contractor shall make the desired changes. The steelwork shall be temporarily shop-erected complete so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected facilitating the check of interchangeability.

23.09.00 Shop Painting

- a) The steelwork concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. All other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned as below, by brush, spray, roller coating, flow coating or dipping. Before leaving the shop, all steelwork to be painted shall be cleaned by hand- wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork having no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners; and shall be cleaned of dirt and other foreign material by through sweeping with a fiber brush. After completion of the pre- cleaning, the metal surface shall be immediately painted with epoxy based paint.
- b) Inaccessible surfaces after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections. Contact surfaces shall be cleaned as per para (a) above before assembly.



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Machine finished surfaces shall be protected against corrosion by a rust inhibitive coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection. Surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

- c) All the grills shall be galvanized

23.10.00 Testing, Acceptance Criteria and Delivery

- a) The contractor shall carry out testing as per IS. The contractor shall get the specimen tested in a laboratory approved by the Engineer and test results shall be submitted to the Engineer in triplicate within 3 days after completion of the test. All electrodes shall be procured with test certificates. The correct grade and size of electrodes not deteriorated in storage shall only be used. The testing of welding shall be performed as under with quantum of minimum non-destructive tests to be conducted during fabrication and after erection as below:
- i) Ultrasonic test should be performed on the columns; girders; Built-up beam fabricated with plates.
 - ii) Fillet welds at junction of flange & web of built-up beams, columns, all shear connections of main beams and all butt welds shall be 100% ultra sonic tested
 - iii) 100% radiographic test shall be performed for butt weld joints of crane girder & its supporting columns, deaerator supporting beams and columns. The minimum percentage of Radiographic test to be carried out at other locations shall be 25 percent.
 - iv) Dypenetration test, Ultrasonic test, Radiographic test shall be carried out at any other location also, if required as per Engineer's approval.

In cases, the test results shows deficiency, the Engineer shall have option to reject or instruct any remedial measures to be carried out by the contractor.

- b) All bolts, nuts and washers shall conform to the relevant IS. If desired by the Engineer, representative samples of these materials should be tested in an approved laboratory and in accordance with the procedures described in relevant IS. All paints and primers shall be of standard quality; and shall conform to the provisions of the relevant IS. The paint shall be epoxy based. The tolerances on the dimensions of individual rolled steel components shall be as per IS:1852. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures subjected to dynamic loading (like wind,



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seismic etc.) and thin walled construction (like box girders) shall be as per IS:7215.

- c) Should any structure or part of a structure be found not to complying to the provisions of the specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory.

When all tests to be performed in the contractor's shop have been successfully carried out, the steelwork will be accepted forthwith; upon receipt of which, the items shall be shop painted, packed and dispatched. No item should be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Purchaser to accept the work, should it, on further tests before or after erection, be found not in compliance with spec.

- d) The contractor should deliver the fabricated structural steel materials to site with all necessary field connection materials in a sequence permitting an efficient and economical performance of the erection work. The Purchaser may prescribe or control the sequence of delivery of materials, at his own discretion. Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings; and shall bear such other marks as will further facilitate identification and erection.

23.11.00 Inspection of Welding

The extent of quality control in respect of welds of structural elements shall be as follows:

a) Visual Examination

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

Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.

b) Dye penetration Test (DPT)

This test shall be carried out for all fillet welds and groove welds to check the following:

- i) Surface cracks
- ii) Surface porosities

c) Ultrasonic Testing

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 Purchaser to detect the following:

- i) Cracks
- ii) Lack of fusion
- iii) Slag inclusion
- iv) Gas porosity

Ultrasonic testing shall be carried out in accordance with American National Standard ANSI/AWS D1.1-92 Chapter 6 Part-C.

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.

d) Radiographic Testing (X-ray and Gamma-ray Examination)

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 Purchaser to detect the following defects:

- i) Gas porosity



- ii) Slag inclusion
- iii) Lack of penetration
- iv) Lack of fusion
- v) Cracks

Radiographic testing shall be conducted in accordance with American National Standard ANSI/AWSD1.1-92.

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 $0.75 \times$ focal distance. The width of the radiographic film shall be equal to width of the welded joint plus 20 mm on either side of the weld.

EPC Contractor shall provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the Purchaser.

e) Acceptable Limits of Defects of Weld

Limits of acceptability of welding defects shall be as follows:

i) Visual inspection and Dye penetration test

The limits of acceptability of weld defects detected during visual inspection and dye penetration test shall be in accordance with clause 8.15.1 and clauses 9.25.3 of American National Standard ANSI / AWS D1.1-92 respectively, for statically and dynamically loaded structures.

- ii) Ultrasonic testing The limits of acceptability of weld defects detected during ultrasonic testing shall be in accordance with clause 8.15.4 and clause 9.25.3 of American National Standard ANSI/AWS D1.1-92 respectively for statically and dynamically loaded structures.

iii) Radiographic testing:

The limits of acceptability of weld defects detected during Radiographic testing shall be in accordance with clause 8.15.3 and 9.25.2 of American National Standard ANSI/ AWS D1.1-92 respectively for statically and dynamically loaded structures.

f) Rectification of Defects in Welds

In case of detection of defects in welds, the rectification of the same shall be done as follows:



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- i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld
- ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.

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 wheel. Care shall be taken not to damage the adjacent material.



24.00.00 ERECTION OF STRUCTURAL STEELWORK

24.01.00 The works related to the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete are detailed below:

- a) Providing all construction & transport equipment, tools, tackles, consumables, materials, labour and supervision as required for the erection of the structural steelwork.
- b) Receiving, unloading, checking and moving to storage yard at site including prompt attendance to all insurance matters as necessary.
- c) Transportation of all fabricated structural steel materials from site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation in proper location as per approved erection drawings. If necessary suitable temporary approach roads should be built for transportation.
- d) Checking centerlines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be brought to the notice of the Engineer. The contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.
- e) Aligning, plumbing, leveling, bolting, welding and securely fixing the fabricated steel structures as per drawings.
- f) Painting of the erected steel structures.
- g) Minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:-
 - i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
 - ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.
 - iii) Reaming of holes for use of higher size bolt if required.
 - iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication.
 - v) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts which are incorrectly fabricated.



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- vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
- vii) Drilling of holes which are either not drilled at all or drilled in incorrect location during fabrication

24.02.00

- a) The work shall conform to the latest revisions of the following IS Codes:

IS-800	:	Code of Practice for general construction in Steel
IS-456	:	Code of Practice for plain or reinforced concrete
IS-7205	:	Safety Code for erection of Structural Steel work
IS-12840	:	Tolerance for erection of Steel Structures

- b) Conformity with designs: The contractor should erect the fabricated steel structures, align all the members, complete all field connections as per approved drawings. All works shall conform to the provisions of the relevant IS. The testing and acceptance of the erected structures shall be in accordance with the provisions of this specification.

24.03.00

- a) The contractor should take delivery of all the materials at site. He shall unload the materials and perform all formalities such as checking of materials and attend to insurance matters as specified above.

Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as may be directed by the Engineer at the contractor's own cost. All field connection materials such as bolts, nuts, washers and electrodes, other consumables such as oxygen and acetylene gas, paints, fuels, lubricants, oil, grease and any other material as required for the execution of the works shall be supplied by the contractor for erection work.

- b) All materials shall be stored preventing deterioration and ensuring the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site. The contractor should establish a suitable yard at site for storing the fabricated steel structures and other materials. The yard shall have proper facilities such as drainage, lighting, suitable access for large cranes, trailers and other heavy equipment. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding. All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building.
- c) The contractor shall establish and maintain quality control procedures for different items of work and materials; and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following:



- i) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
- ii) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

24.04.00 Workmanship

- a) The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition. The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange in most economical method; and sequence available to him consistent with the drawings.
- b) Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure during the course of the erection of the steel framing, arrangement for installation by the erector shall be made.

The responsibility of the contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, leveled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer. The temporary guys, braces, false work and cribbing shall be removed immediately upon completion of the erection

- c) Positioning and leveling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be as per approved drawings. Anchor bolts and other anchor steel shall be embedded. The contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, the contractor shall set proper screed bars to maintain proper level. Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable. No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.
- d) All relevant portions in respect of bolted construction for fabrication of



structural steelwork shall also be applicable for field bolting as below:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled; and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except light mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing. High tensile bolts shall be tightened to provide the required minimum bolt tension by any of the following methods:-

Turn-of-nut method: When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "Snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation as below with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation, there shall be no rotation of the part not turned by the wrench.

Bolts length not Bolt length exceeding 8 times dia or 200mm	Bolts length not Bolt length exceeding 8 times dia or 200mm	Remarks
½ turn	2/3 turn	Nut rotaion is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotaion – 30 over or under

Bolts shall be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks shall be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

Torque Wrench tightening: When torque wrenches are used to provide the



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bolt tensions, the bolts shall be tightened to the torques as below. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia; 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening shall be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be as per IS.

- e) Field Welding: All field assembly and welding shall be carried out as specified for fabrication work, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.
- f) Holes, cutting and fitting: No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done. The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified. Wherever such work is specified the contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work.

24.05.00

Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock shall be considered as permissible. For this, light drifting shall be used to draw holes together; and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.



Any shop work error which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

24.06.00**Testing and Acceptance Criteria**

- a) Loading tests shall be carried out on erected structures to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall be dismantled and replaced with suitable member. On the basis of the tests, the Engineer will decide and his decision will be final. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing; and the tests shall be conducted as indicated below:-

- i) **Stiffness Test:** In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.
- ii) **Strength Test:** The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.



b) Structure of same design:

Where several identical same design structures exists as a prototype, one structure shall be fully tested, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

- c)** Repair for subsequent test and use after strength tests: The structure passed the "Strength Test" as above and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in above.

24.07.00 Tolerances

Considering expected variation in the finished dimensions of structural steel frames, these shall be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabrication tolerances for the finished parts; and the rolling tolerances for the profile dimensions permitted under the specification for fabrication of structural steelwork shall be as indicated below:

	Component	Description	Variation Allowed
a	For Buildings Containing Cranes		
	i) Main Colomnn	a) Shifting of column axis at foundation level withrespect to building line	
		i) In longitudinal direction	(+/-) 3.0mm
		ii) In lateral direction	(+/-) 3.0mm
		b) Deviation of both major column axis from vertical between foundation and	



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Component	Description	Variation Allowed
	other member connection levels :	
	i) For a column upto including 10M	(+/-) 3.5 mm and from true height vertical
	ii) For a column greater than 10M but less than 40M height	(+/-) 3.5 mm from true vertical for length measured between connection levels, but not more than (+/-) 7.0 mm per 30 m length
	c) For adjacent pairs of columns across the width of the building prior to placing of truss.	(+/-) 9 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	(+/-) 3 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
ii) Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord	1/1500 of the span or not greater than 10 mm whichever is the least
	b) Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is the least.
iii) Cranes Girders & Tracks	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm
	b) Deviation to crane rail gauge	(+/-) 3 mm
	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm



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Component	Description	Variation Allowed
	d) Deviation of crane rail axis from centre line of web.	(+/-) 3.5 mm
iv) Setting of expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per Deg.C per unit length.	
b For Buildings without Cranes		
The maximum tolerances for line and level of the steel work shall be ± 3 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10 m section of height and not more than 7 mm per 30 m section. These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.		



29.00.00**GALVANIZING**

- a) Structural steel works and pipe supports wherever required other than that of fencing shall be hot double dip galvanized after fabrication as per relevant IS codes. Galvanising of the towers shall be as per IS:4759 and 2633 and as given in the following paras. Zinc required for galvanizing shall be arranged by the contractor. Purity of zinc to used for galvanizing shall be 99.5% as per IS:209. All burrs and irregular edges shall be ground smooth before galvanizing.
- b) After completion of all shop work, structural material shall be punched with the erection marks and be hot dip galvanized including the portion to be embedded in concrete. Each grillage member including stubs shall also be fully galvanized. Before galvanizing, the steel section shall be thoroughly cleaned of any paint, grease, rust, scale, acid, alkali or such other foreign matters likely to interfere with the galvanizing process or with the quality and durability of the zinc coating. Pickling shall be carefully done and shall be proper.
- c) The weight of the zinc coating shall be at least 0.9 kg/ sq.m including stub members. The galvanized surfaces 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, unevenness of coating, spelter which is loosely attached to the steel, 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.
- d) There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand in copper sulphate solution as per IS:2633. When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumpng'. The process known as 'wiping' or 'scrapping' shall not be used for this purpose.
- All bolts, nuts, washers etc. shall be hot dip galvanized. Excess spelter from bolts, nuts etc. shall be removed by centrifugal spinning of bolts and nuts. Threading after galvanizing, shall not be permitted. Nuts, however, may be tapped, but not to cause appreciable racking of the nuts on the bolts. Spring washers shall be electro-galvanised.
- e) Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specification or lack of quality control in any manner in the galvanizing plant shall render the entire production in the relevant shift liable to



rejection. All the towers, pipe supports and accessories shall be treated with sodium dichromate or an approved equivalent solution after galvanizing, so as to prevent white storage stains.

- f) Similar If the galvanizing of any member is damaged, the galvanizing shall be redone in the manner as stated above to Engineer's approval. The contractor shall also furnish sufficient quantity of appropriate paint, for repairing galvanized surfaces, damaged in transit.



30.00.00**PILING****30.01.00**

The detailed design, preparation of construction drawings, installation and testing of piles forming foundations to buildings and structures are detailed below conforming to the latest IS:2911 – Code of Practice for Design and Construction of Pile Foundations : Part I Concrete Piles and IS:2911 Part : IV Load test on piles and to this Specification. The contractor shall be responsible for all aspects of the pile performance installed including demonstration of the adequacy of his design by testing. During detailed design the contractor shall submit the proposed firm to undertake piling work with details piling system, method of installation, summary of design basis, number, type and size of construction plant items to be employed for the work including crane, piling equipment, concreting equipment and proposal for installation & testing of trial piles and tests on work piles.

30.02.00

Prior to installation of trial piles, the contractor shall submit final details of the trial piling installation including specifications, detailed design calculations and construction drawings for the trial piling together with associated equipment to be provided for construction and testing of the same. Design report discussing the overall results of the tests on trial piles and concluding with and justifying the proposed definition of reference piles; specification, with fully detailed construction drawings, supporting calculations for the final design of the working piles, and the field control procedures the contractor intends to use to verify that pile installation satisfies the requirements of his design should also be submitted.

30.03.00**Design Criteria**

The following shall be the design criteria for the working piles :

- a) Piles shall be designed in line with approved soil investigation report as single vertical piles acting under a design load as deemed fit.
- b) Driving formula (where relevant) may be adopted inter alia as a criteria for acceptance. But the minimum founding requirements shall be based on recognized methods of soil mechanics design, appropriate to the type of pile.
- c) The piles shall be designed for a minimum factor of safety of 2.5 against failure under the design load specified.
- d) Piles shall be designed for a limiting settlement of a single pile under vertical design load of 8 mm at the head.



- e) Piles shall be designed to resist a maximum force due to critical load combination in any direction applied to the head of the pile at cut-off level. For this design condition it shall be assumed that the pile head is effectively as a fixed-end by the pile-cap.

30.04.00**Tolerance**

Setting out shall be carried out from the main grid lines of the proposed structure. Immediately before installation of the pile, the pile position shall be marked with suitable identifiable pins or markers. For a pile head cut-off, at or above ground level, the maximum permitted deviation of the pile head cut off center from the center point, shown on the setting out drawing shall be 75 mm in any direction. For a pile head cut-off below ground level, an additional tolerance will be permitted as below on the assumption that the pile head would have been within tolerance if the cut-off had been at ground level. The maximum permitted deviation of the finished pile from the vertical is 1 in 75. Forcible corrections to concrete piles shall not be made.

30.05.00

The contractor shall carry out the work to minimize noise and disturbance.

If during the execution of the work, damage is likely to be, caused to mains, services or adjacent structures, the contractor shall submit proposal for repair or avoidance of such damage. The contractor shall ensure that damage does not occur to completed piles.

30.06.00**Records**

The contractor shall keep records as below of the installation of each pile and shall submit record to the Engineer.

Table 1.0

a)	Piles reference number (location)	*
b)	Piles cut off level	*
c)	Pile type	*
d)	Nominal cross-sectional dimensions or diameter	*
e)	Pile design capacity	*
f)	Standing groundwater level	*
g)	Date and time of driving, red riving or boring	*
h)	Date of concreting	*
i)	Ground level at commencement of installation of piles	*
j)	Working level	*
k)	Depth from working level to pile toe	*
l)	Toe level	*
m)	Depth from working level to pile head level	*
n)	Length of temporary / permanent casing	*
o)	Type weight, drop and mechanical condition of hammer	*



p)	Number of type of packings used and type and condition of	*
q)	Record of blows per 300 mm over complete drive	*
r)	Set of pile or pile tube in mm per 10 blows or number of	*
s)	Temporary compression of ground and pile from time of	*
t)	Length and details of reinforcement	*
u)	Grade and slump of Concrete mix and control test	*
v)	Volume of concrete installed in pile	*
w)	Method of placing concrete	*
x)	Number of blows to form bulb where appropriate	*
y)	Level of water or drilling fluid at commencement of	*
z)	All information regarding obstructions delays and other	*

30.07.00**Driven Cast-in-situ Concrete Piles**

- a)** Installation of piles shall be carried out as per layout construction drawings in accordance with latest IS codes as below:
- i) IS:456-2000 :Code of practice for plain and Reinforced Concrete
 - ii) IS:2911-Part I : Code of Practice for Design and Section-I Construction of pipe foundation
 - iii) IS:2911-Part IV : Test load on piles
- b)** The sequence of installation of piles shall be to the approval of the Engineer.
- c)** The equipment and accessories required for the pile driving shall be standard type. The capacity of the pile frame shall be selected after considering the size and weight of the casing to be handled, the location of the work and the hardness of driving. The steel casing used for installing the piles shall be straight and shall have sufficient wall thickness and strength to prevent damage, distortion etc. Detachable shoes used with the temporary steel casing shall be fabricated steel or cast iron, double rimmed and of requisite strength, and of the standard sizes used with the respective steel casing. The shoe shall be co-axial with the steel casing. Casings distorted from true uniform shape whether caused by driving or earth and water pressure resulting in a reduction of the cross sectional area of the pile in excess of 10 percent shall not be used in the works. The nominal casing size shall be 500 mm diameter.



- d) The pile shall be driven to a set proposed by the contractor. The final set values shall be repeated thrice before terminating the pile at that level. All relevant data with back up, computations pertaining to “set” shall be submitted before commencing piling work for Purchasers approval. Any sudden change in rate of penetration shall be brought to the notice of the Engineer.

e) **Control of Pile Driving**

Protection of pile heads and selection of pile hammer shall be as per IS:2911 Part I. The pile shall be driven as accurately as possible to the vertical. Piles shall be installed with due consideration for the safety of adjacent structures by a method leaving their strength unimpaired and which develops and retains the required load bearing capacity. In the case of piles close to existing plant and structures, the Engineer may specify suitable precautions which may call for additional working hours for the rig. The quipment and methods for installing piles shall be such that the loss of energy is limited to a minimum. Should the deviation of the installed pile be greater than the specified tolerances, the Engineer may at his discretion order the installation of additional piles after checking the design load on the pile group of which the particular pile forms part. Care shall be taken not to damage the piles by over driving. Any sudden change in the rate of penetration shall be noted and informed to the Engineer. Jetting of Pile by means of water shall not be permitted.

- f) After complete installation of the casing before concreting, the contractor shall inform the Engineer to inspect the casing for proper plumb location and other conditions. Only after approval concreting should proceed. Level readings shall be taken on each pile after driving and again after all the piles in a group are driven. Piles which are found to have resin shall be driven to the original depth and set.

- g) The main longitudinal reinforcing bars in piles shall be in one continuous length. In long piles, joints shall be permitted in main longitudinal bars but these shall be kept to a minimum. Joints in adjacent bars shall be staggered at least 1 meter part along the length of the pile. Joints in reinforcement shall be such that the full strength of the bar is effective across the joint.

Longitudinal reinforcement shall be provided for the full length of the pile extending above pile cut off level to provide adequate bond length into the pile cap. The minimum area of longitudinal reinforcement within the pile shaft shall be 0.4 percent of cross-sectional area of the pile on the basis of the nominal casing diameter. Longitudinal reinforcement shall be formed into a rigid cage to resist deformation during handling and installation by the use of links or helical reinforcement. The minimum diameter of links



and helical reinforcement shall be 6 mm spaced at 150 mm and not more than 300 mm. The longitudinal reinforcement shall project 52 times its diameter; above the cut off level of the pile to ensure adequate bond length inside the pipe cap. Minimum 6 Nos. of longitudinal reinforcement shall be provided. Reinforcement provided in pile shall be symmetrical about any axis on the pile cross section. The diameter of longitudinal reinforcement shall not be less than 12 mm. Lap or splice joints shall be provided with sufficient link bars to resist eccentric forces. Minimum cover to main reinforcement in the pile shall be 75mm.

h) The method of placing and the workability of the concrete shall be such that continuous monolithic concrete shaft of the full cross-section is formed. Mechanical vibrators shall not be used to compact concrete. Concrete in piles shall be of design- mix with minimum grade M25 with minimum cement of 400 kg/cum water cement ratio within 0.45 to 0.55 using super plasticized Sikament 170 or equivalent. Generally the slump of the concrete shall be within the range 100 to 150 mm. The contractor shall ensure the minimum specified strength in accordance with IS:456, IS:10262 & SP. 23 shall be followed as guidance for mix design. Compaction of test cubes shall be done under same condition as followed for concreting of piles.

i) In soft clays or loose sands ,or where there is likelihood of danger to green concrete due to driving of adjacent piles, the designed reinforcement should be provided up to the full pile depth, regardless of whether or not it is required from uplift and lateral load considerations. Refer clause 5.11.2 of IS : 2911 (Part I / Sec-1)

j) Cleaning out of casing

Before placement of concrete ,it shall be ensured that the inside of the casing is free from sludge or any foreign matter. The contractor shall ensure that water does not enter the casing tube/pile shoe at the end of driving & during the concreting operations. The existence of water inside casing tube after driving and before executing the concrete operation, if any shall be checked by the contractor by suitable probe & concreting of pile work shall be allowed to proceed if water level is less than 15 cm measured above the inner surface at the top of the shoe. If the water level is more than 15 cm, contractor shall take remedial measures viz. bailing or pumping to reduce the depth of water before concreting & if it is not possible to do so then the contractor shall re-drive the casing at no extra cost to the Purchaser.

k) Concrete Level – finishing of pile head

The cut-off level shall be as shown on the construction drawings. Concrete shall be cast to minimum of 500 mm above the cut-off level, or local ground water level, whichever is higher. Withdrawal of temporary casing



shall be carried out in stages during the concrete placing operation with utmost care maintaining an adequate head of concrete above the bottom of casing at each stage of withdrawal so as to prevent the inflow of soil and water into the bore. Section of empty hole remaining above the head of the pile shall be temporarily backfilled with sand or other approved material prior to excavation for pile cap construction.

l) Trimming of pile heads

Following excavation subsequently for pile cap construction, the contractor shall carefully remove excess concrete above specified cut-off level, without damaging the remainder of the pile including the projection reinforcement. Any cracked or defective concrete occurring below specified cut-off level shall be cut away and made good with new concrete properly bonded to the old. Piles that are defective shall be pulled out or left in place as judged by Engineer without affecting performance of adjacent piles. Also the contractor shall be bound to install additional piles to substitute the defective ones as per the directions of the Engineer.

- m)** The dynamic cone penetration tests shall be carried out for a depth of at least 2 meters from the termination depth. The number of such tests shall be as follows
- a. One number dynamic cone penetration test for each pile group consisting of more than four piles.
 - b. For TG and Chimney pile groups the number of dynamic cone penetration tests shall be one per cent of the total number of piles.

30.08.00

Load Tests on Piles

- a)** Load test shall be in accordance with IS:2911 Part IV (latest revision) Initial load tests on “Trial Piles” shall be executed in advance of works pile construction and shall comprise vertical load tests at locations as directed. Load test on trial piles shall also include lateral load test and uplift load tests as directed by the Engineer. 6 number of trial piles shall be tested from each capacity of the pile. Out of the six (6) nos. of piles to be tested for two (2) nos. each capacity shall be tested for vertical load, two (2) nos. for lateral load and two (2) nos. for uplift load.

Routine load tests on “Works Piles” shall be vertical load test and lateral load tests on piles as directed by the Engineer. Number of routine tests to be conducted on work piles shall be equal to one and half (1.5) percent of the total number of piles used in the work for vertical load tests as well as lateral load tests.



- b) Load tests shall not normally be undertaken by the contractor within 28 days after the installation of the piles in position. However, the contractor may be allowed by the Engineer to use rapid hardening cement or add necessary admixtures to enable him to conduct the tests within a lesser period. Before any load test is done, the proposed arrangement for carrying out the load tests including the preparation of the structure to receive the loads and the type of loading to be adopted shall be furnished by the contractor.

c) **Vertical Load Test on Trial Piles**

Load tests to verify the contractor's design shall be carried out on piles of different capacities proposed to be used. The contractor shall commence testing as early as possible after installing the piles. The test shall be carried out by applying series of loads on RC cap over single pile. The load shall be applied by means of standard hydraulic jack reacting against a loaded platform which shall be preloaded platform which shall be preloaded to three times the estimated safe load carrying capacity of the pile. Reading of settlement and rebound shall be recorded with four dial gauges of 0.01 mm sensitively and resting on diametrically opposite ends of the pile cap. The dial gauge shall be fixed to a datum bar whose ends rest-upon non-movable supports. The supports for datum bar with reference to which the settlement of the pile is measured shall be at least 5 times diameter of pile away from the pile.

The test shall be conducted by the cyclic loading method. The test load shall be applied in equal increments of about one-fifth of the estimated safe load. Each stage of loading or unloading shall be maintained till the rate of movement of the pile cap is not more than 0.02 mm per hour. However, load shall be maintained for longer periods at 1 to 1.5 times the assumed safe capacity, and at final loads as directed by Engineer. The safe load on pile shall be the least of the following :

- i Two third of the final load at which the total settlement attains the value of 12 mm.
- ii Two third of the final load at which the net settlement attains a value of 6 mm.
- iii 50 per cent of the final load at which the total settlement equals one-tenth of the pile diameter.

d) **Lateral Load Test on Trial Piles**

The test pile shall be decided by the Engineer. The test pile shall be cut off at the proper level and provided with a cap with vertical plane sides having



an adequate area for proper seating of the jack and dial gauge. The lateral load shall be applied on the pile at or approximately at cut off level and the deflection shall be measured at a point diametrically opposite to the point of load application. The loading shall be applied by the hydraulic jack of adequate capacity, abutting the pile horizontally and reacting against a suitable system. The reaction may be provided by the well of the excavated pit when the test is being conducted below ground level or by a neighbouring pile in which case thrust pieces shall be inserted on either end of the jack to make up the gap. Lateral load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack, having a least count of 500 kg. Deflection of the pile head shall be measured by four dial gauges, fixed to datum bars & having a least count of 0.01 mm. The datum bars shall be provided with rigid supports. Loading shall be applied in increments of 500 kg. Each stage shall be maintained for a period till the rate of movement of the pile head is not more than 0.02 mm/hour or 1 hour whichever is greater .

Loading shall be continued till one of the following occurs :

- i. Deflection of pile head exceeds 12 mm.
- ii. The applied load on the pile is three times the assumed lateral load capacity of the pile.

The safe load shall be smaller of the following :

- i. Half the final load for which the total deflection is 12 mm.
- ii. Load at which the total displacement corresponds to 5 mm.

e) Pull-out Test

The test piles shall be decided by the Engineer. The test pile shall be built upto the proper length and the head provided with suitable arrangements for anchoring the load applying system. Loads shall be applied using a approved reaction system, uplift forces on the pile shall be applied directly to the test pile or through a lever system. The reaction shall be provided by neighbouring piles or blocks may be constructed for the purpose. Hydraulic jacks shall be used for load application. Load applied by the hydraulic jack shall be measured by a calibrated gauge with a least count of 100 Kg. Movement of the pile shall be measured by dial gauges, fixed to datum bar and having a least count of 0.01 mm. Four dial gauges placed diametrically opposite shall be used. Datum bars shall be provided with rigid supports. The load shall be applied along the longitudinal axis of the pile using method approved by the Engineer. Loading shall be applied to the pile top in increment of one-fifth of the expected safe capacity. Each stage shall be



maintained for a period till the rate of movement of the pile head is not more than 0.02 mm per hour or four hours whichever is greater. Loading shall be continued till one of the following occurs :

- i. Yield of soil pile system occurs causing progressive movement of pile exceeding 12 mm.
- ii. The loading on the pile top equals three times the estimated safe load or as specified in the case of separate test pile.

The safe capacity of the pile should be least of the following :

- i. Two third of the load at which the total displacement is 12 mm or the load corresponding to a specified permissible uplift, and
- ii Half of the load at which the load displacement curve shows a clear break (downward trend)

f) Routine Test on Working Piles

Three tests shall be carried out on working piles upto one and half times the design load and the maximum settlement of test loading in position being not exceeding 12 mm as per IS:2911 (Part IV). In case a pile fails under or during the load test, the Engineer shall select two additional piles in lieu of each of such failed pile and the contractor shall carryout load tests on such additional piles.

30.09.00

Cast-In-Situ Piling Bored

The following specification deals with the requirements of materials, workmanship and installation of Bore Cast-in-situ reinforced concrete piles.

The materials and workmanship shall conform with the provision of the latest IS:456, IS:2911 (Part I, Section 2) & IS:2911 (Part 4).

Care shall be taken while boring piles so that no existing foundations / sub-structures are disturbed by providing suitable arrangements like shoring etc.

a) Sequence of Piling

The sequence of piles installed shall be such that the adjacent piles already installed are not disturbed nor their carrying capacity reduced by subsequent boring operation. In a group the installation of the piles shall normally proceed from the center of the group towards the periphery.

b) Control of Alignment



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Piles shall be installed as accurately as possible as per the designs and drawings either vertically or to the specified batter. Great care should be exercised in respect of installation of single pile or piles in two pile group. For vertical piles a deviation of 1.5 percent should not normally be exceeded. Piles should not deviate more than 75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm from their designed positions at the working level of the piling rig. In the case of a single pile in a column, positional tolerance should not be more than 50 mm (100 mm in case of piles having diameter more than 600 mm).

For piles carried to substantial depth, the design should provide for the worst combination of the above tolerance in position and inclination. In case of piles deviating beyond these limits and to such an extent that the resulting eccentricity cannot be taken care of by a redesign of the pile cap and ties, the piles shall be replaced or supplemented by one or more additional piles, as directed by the Engineer, at no extra cost.

Any deviation from the designed location, alignment or load capacity of any piles shall be noted and brought to the attention of the Engineer and rectification and supplemental works carried out to the satisfaction of the Engineer at no extra cost.

A minimum length of one meter of temporary casing shall be inserted in each bored pile unless otherwise specifically desired. Additional length of temporary casing may be used depending on the condition of the strata etc.

Drilling mud of suitable consistency may also be used instead of temporary casings for stabilizing sides of the holes.

In case, a bored pile is stabilized by drilling mud the bottom of the hole shall be cleaned very carefully before concreting work is taken upon. The cleaning of the hole shall be ensured by careful operation of boring tool and / or flushing of the drilling mud through the bottom of the hole. Flushing of bore holes before concreting with fresh drilling fluid/ mud is preferred.

In case a holes is bored by use of drilling mud, the specific gravity of the mud suspension near about the bottom of the hole shall, wherever practicable, be determined by suitable interval of piles and recorded. Consistency of the drilling mus suspension shall be controlled throughout the boring as well as concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with the thicker suspension of the mud.

The concreting operatings should not be taken up when the specific gravity of bottom slurry is more than 1.2. Concreting shall be done by tremie method in all such cases.



The top of concrete in a pile shall be brought above the cut-off level as per cl. 7.8 of IS: 2911 (Part 1/sec.2).

In case, defective piles are formed, they shall be removed or left in place, if so directed by the Engineer, if these do not affect the performance of the adjacent piles or the cap as a whole. Additional piles shall be provided to replace them as directed by the Engineer.

Any deviation from the designed location alignment or load capacity of any pile shall be noted and adequate measures taken well before the concreting, of the pile cap and plinth beam if the deviations are beyond the permissible limit.

During chipping of the pile top manual chipping may be permitted after three days of pile casting, pneumatic tools for chipping shall not be used before seven days after pile casting.

After concreting the actual quantity of concrete shall be compared with the average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures taken.

The bentonite suspension used for piling work shall satisfy the following requirements:

- i. The liquid limit of bentonite when tested in accordance with IS:2720 (Part V) shall be more than 300 percent and less than 450 percent.
- ii. The sand content of the bentonite powder shall not be greater than 7 percent.
- iii. Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared Bentonite solution should be between 1.034 and 1.10 gm/ml depending upon pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite solution after mixing with deleterious materials in the pile bore may be up to 1.25 gm/ml.
- iv. The marsh velocity when tested by a Marsh cone should be about 37 seconds.
- v. The differential free swell shall be more than 540 percent.
- vi. The PH value of the bentonite suspension shall be between 9 & 11.5.



30.10.00**Codes and Standards**

The following Indian Codes and Standards (Latest) shall be used for design of the structural elements:

IS:456 : Code of Practice for plain and Reinforced concrete

IS:875 : Code of Practice for Design loads (other than earthquake) for Buildings and structures.

IS:2911: Code of Practice for Design and Construction of Pile Foundations – Bored Cast-in-situ Piles (Part 1/sec. 2)

IS:2911 : Code of Practice for Design and Construction of Pile Foundation – Load Test on Piles (Part 4)

IS:1786 : Code of Practice for HYSD bars

IS:2751 : Code of Practice for welding of mild steel bars used for reinforced concrete construction

IS:2062 : Steel for general structural purposes

SP:16 : Design Aids for Reinforced Concrete to IS:456.



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SPECIFICATION NO. PE-TS-635-600-C001



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



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**STANDARD TECHNICAL SPECIFICATION FOR EARTHWORK IN
EXCAVATION AND BACKFILLING**

1.0.0 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision services, earth moving machineries, surveying instruments including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) To carry tests and submit to the Engineer, test results of fill materials and degree of soil compaction of fill whenever required by the Engineer to assess the quality of fill.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc. including procurement of necessary licenses from proper authorities.

2.2.0 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.



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2.3.0 Codes and Standards

All works shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS-1200	Method of measurement of building and civil engineering works, Part-I: Earthwork
IS-2720	Method of test for soils (Relevant parts)
IS-3764	Excavation work - Code of safety
IS-4081	Safety code for blasting and related drilling operations
IS-4701	Indian Standard Code of Practice for earthwork on Canals
IS:6922	Criteria for safety and design of structures subject to underground blasts
IS: 3764	Excavation work – code of safety

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.4.0 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.5.0 Materials

2.5.1 General

All materials required for the work shall be of the best commercial variety and approved by the engineer.

2.5.2 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, refer clause no. 3.4.0 for the classification of earth strata.

2.5.3 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following



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manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as far as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.6.0 Quality Control

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

2.7.0 Information regarding site conditions

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction



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likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.0.0 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms etc. for the approval of engineer.

3.1.0 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.2.0 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. All records of levels, measurements etc. and also any drawing, cross-section etc. made therefrom, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3.0 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the



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engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

3.4.0

Classification

All earthwork shall be classified under the following categories:

No distinction will be made whether the material is dry or wet.

a) Ordinary Soil

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) Hard Soil

This shall include :

- i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;
- ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;
- iii) soling of roads, paths, etc., and hard core ;
- iv) macadam surfaces such as water bound, and bitumen/tar bound;
- v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;
- vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and
- vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) Soft and Decomposed Rock

This shall include :

- i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;
- ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;
- iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded



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in river bed, soil, talus, slope wash and terrace material of dissimilar origin ;
and

iv) any rock which in dry state may be hard, requiring blasting, but which
when wet becomes soft and manageable by means other than blasting.

d) Hard Rock (requiring blasting)

This shall include :

- i) any rock or cement concrete for the excavation of which the use of
mechanical plant or blasting is required ;
- ii) reinforced cement concrete (reinforcement cut through but not separated
from the concrete) below ground level; and
- iii) boulders requiring blasting.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is
prohibited for any reason and excavation has to be carried out by chiselling,
wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the
Engineer shall be final.

3.5.0 Excavation for Foundations and Trenches

3.5.1 General

All excavation shall be done to the minimum dimensions as required for the
safety and working facility. In each individual case, the contractor shall obtain
prior approval of the engineer for the method he proposes to adopt for the
excavation including dimensions, side slopes, shoring, dewatering, drainage
and disposal etc. This approval however shall not in any way make the
engineer responsible for any consequent loss or damage. The excavation must
be carried out in the most expeditious and efficient manner. All excavation in
open cuts shall be made true to the line, slopes and grades as shown on the
drawings and/or as directed by the engineer. No material shall project within
the dimension of minimum excavation lines marked. Boulders (if any)
projecting out of the excavated surfaces shall be removed if they are likely to
be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the
engineer. The contractor shall ensure the stability and safety of the excavation,
adjacent structures, services and works etc including the safety of the
workmen. If any slip occurs, the contractor shall remove all the slipped
materials from the excavated pit without any extra cost to the engineer/owner.
All loose boulders and semi detached rocks which are not inside but so close
to the area to be excavated and may liable to fall or otherwise endanger the



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workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.5.2

Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades



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etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.5.3 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.5.4 Blasting

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.



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3.5.4.1 Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

3.5.4.2 Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be



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provided at the magazine for this purpose and should be careful

- * not to put their feet on the clean floor unless the magazine shoes on.
- * not to touch the magazine shoes on ground outside the clean floor.
- * not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

3.5.4.3 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his



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responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.



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Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

3.5.4.5 Restrictions in Blasting

- a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
- b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
- c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
- d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
- e) The last blast shall not be more than 0.50 m in depth.
- f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.5.5 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

- a) By using it straightway for backfilling.
- b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.
- c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.
- a) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.5.6 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer.



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All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.5.7 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.5.8 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.5.9 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer's prior approval on the method of pumping to be adopted shall be



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taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.5.10 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started from one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.5.10.2 Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.



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3.6.0 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.7.0 Backfilling

3.7.1 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.7.2 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.



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3.7.4 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.7.5 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.8.0 Approaches and Fencing

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.9.0 Lighting

Full scale area lighting is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.



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4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.2.0 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS:4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.0.0 RATES AND MEASUREMENTS

5.1.0 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.



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f) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.2.0 Measurements

Method of measurements are specified as below:

a) The length, breadth and depth shall be measured correct to the nearest centimeter if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

c) In case of open footings (rafts/ pilecaps/ drains/ cable trench/ pipe trench/ sub soil beams etc.) up to the depth of 2.0 metres, around excavation of 30 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for excavation, backfilling, carriage, dewatering etc. item of work in the schedule of quantities. (Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in item of work in the schedule of quantities).

d) In case of open footings (Rafts/ pilecaps / drains/ cable trench/ pipe trench/ sub soil beams etc.) at a depth of more than 2.0 metre, around excavation of 75 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for excavation, backfilling, carriage, dewatering etc. item of work in the schedule of quantities. (Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in item of work in the schedule of quantities).

e) IN TRENCHES FOR BURIED PIPES & CABLES

Width of Trench

i) Upto one metre depth the authorized width of trench for excavation



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shall be arrived at by adding 25 cm to the external diameter of pipe (not socket/ collar) cable, conduit etc. Where a pipe is laid on concrete bed/ cushioning layer, the authorized width shall be the external diameter of pipe (not socket/ collar) plus 25 cm or the width of concrete bed/ cushioning layer whichever is more.

ii) For depths exceeding one metre, an allowance of 5 cm per metre of depth for each side of the trench shall be added to the authorized width (that is external diameter of pipe plus 25 cm) for excavation. This allowance shall apply to the entire depth of the trench. In firm soils the sides of the trenches shall be kept vertical upto depth of 2 metres from the bottom. For depths greater than 2 metres, the excavation profiles shall be widened by allowing steps of 50 cm on either side after every two metres from bottom. Where the soil is soft, loose or slushy, width of trench shall be suitably increased or side sloped or the soil shored up as directed by the Engineer-in-Charge. However, any additional excavation beyond the limit specified for firm soil herein shall not be measured for payment for excavation, backfilling, carriage, dewatering etc. item of work in the schedule of quantities as these are deemed to be included in item of work in the schedule of quantities.

iii) Where more than one pipe, cable, conduit etc, are laid, the diameter shall be reckoned as the horizontal distance from outside to outside of the outermost pipes, cable, conduit etc.

f) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

g) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

h) The authorized quantity (calculated on the basis of authorized width/ working space under clause no. 5.2.0 c, 5.2.0 d & 5.2.0 e) or those actually excavated, whichever, are less, shall be measured for payment.



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i) Tree cutting having girth more than 300mm shall be measured in number and are separately payable as deemed not covered in excavation items of work in the schedule of quantities.

j) Special dewatering of ground water by well point method and side protection work by sheet piling are separately payable as deemed not covered in excavation items of work in the schedule of quantities.

6.0.0 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.1.0 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.2.0 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.



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GENERAL TECHNICAL SPECIFICATION

CEMENT CONCRETE (PLAIN & REINFORCED)



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



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CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

- a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.
- b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
- c) Prepare working drawings of formworks, scaffolds, supports, etc.
- d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
- e) Prepare detailed drawings of supports, templates, hangers, etc. required for



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installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

- f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.
- g) Design and submit for approval concrete mix designs required to be adopted on the job.

Furnish samples and submit for approval results of tests of various properties of the following:

- i) The various ingredients of concrete
- ii) Concrete
- iii) Embedments
- iv) Joint seals
- i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.
- j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

- a) Source and arrangement of processing of aggregates proposed to be adopted.



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- b) Type of plant and equipment proposed to be used.
- c) Names of firms with which association is sought for to execute the special items of work in the contract.
- d) Types of formwork proposed to be used.

2.03.02

After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

- i) Coarse and fine aggregates.
- ii) Admixtures.
- iii) Plywood for Formwork.
- iv) Embedded and anchorage materials as may be desired by the Engineer.
- v) Joint sealing strips and other*waterproofing materials.
- vi) Joint filling compounds.
- vii) Foundation quality Rubber Pads.



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c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.

d) Bar Bending Schedules

Bar Bending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00

Conformity with Design

The Contractor will prepare checklists in approved Form, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour



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Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

- a) TG foundation top deck and sub structures including raft.
- b) Spring Supporting decks of all machine foundations.
- c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.

For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as



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Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

- a) Accelerating admixture
- b) Retarding admixture
- c) Water reducing admixture
- d) Air entraining admixture
- e) Water proofing admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval



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of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTM C-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the



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edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture:	Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete.
	For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.
b) Aggregate:	Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
c) Water:	Impurities tests.
d) Cement:	Tests to satisfy relevant IS Specifications.
e) Formwork:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f) Reinforcement:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.



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Material tests or Certificates to satisfy relevant IS Specification.

- g) Grades of Concrete: Usage and mix design, testing of all properties.
- h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.
- i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.
- j) Embedded and Anchorage Items: Material, shape, location, setting.
- k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
- l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
- m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.
- n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
- o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00

INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not



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cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

"Design Mix Concrete" and "Nominal Mix Design" is defined as follows for use in this specification:

- a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".
- b) Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be



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adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

- a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
- b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.
- e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at



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site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

- a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.
- b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.
- c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on:-

- a) The requirement of strength.
- b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement



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Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00

Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V

LIMITS OF CONSISTENCY

Degree of	Slump in mm with Standard Cone as	Use for which concrete is suitable



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workability

per IS: 1199

Min.

Max.

Very low

0

25

Large Mass concrete structure with heavy compaction equipments, roads

Low

25

50

Uncongested wide and shallow R.C.C. structures

Medium

50

100

Deep but wide R.C.C. structures with congestion of reinforcement and inserts

High

100

150

Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00

Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space - 12 mm

Reinforced concrete
Except foundation - 20 mm

Ordinary Plain concrete and Reinforced
concrete foundations - 40 mm

Mass concrete - 80 mm



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Lean concrete

- 40 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.09.01

Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills) as extra payable over RCC item of BOQ:

The temperature of fresh concrete shall not exceed 23°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 23°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 23°C.

3.09.02

Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00

Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.



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The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregations does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be



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adopted. Concrete may have to be placed against the following types of surfaces:

- a) Earth foundation
- b) Rock foundation
- c) Formwork
- d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of



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Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints



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It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

- a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.
- b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.
- c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.
- d) Feather-edges in concrete shall be avoided while forming a joint.
- e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.
- f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

- a) If the concrete is so green that it can be removed manually and if vibrators



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can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01

Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

- a) Sack rubbing with mortar and stoning with carborundum stone.
- b) Cutting away the defective concrete to the required depth shape.
- c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.
- d) Roughening by sand blasting or chipping.



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- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- g) Plastering, guniting, shotcreting etc.
- h) Placing and compacting concrete in the void left by cutting out defective concrete.
- i) Grouting with cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortars.
- k) Polymer modified patching and adhesive repair & mortar for beams & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.



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To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.



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The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the



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final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 **Placing in Position**

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 **Welding / Coupler for Splicing**

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. For High yield strength deformed bars, lap welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards as per IS: 9417. Welding of High yield strength deformed bar shall not be allowed.

Splicing of reinforcement using mechanical coupler may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian standards for "Reinforcement couplers for mechanical splices of bars in concrete" as per IS: 16172. Corrosion test in the coupler-bar connections exposed to marine or



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severe environmental conditions to rule out any risk of galvanic corrosion will be done by the contractor at no extra cost. Proper fitting & fixing of mechanical coupler to rebar shall be ensured at site for each coupled joint as per inspection testing plan developed at site in consultation with manufacturer of coupler. If so required at site, coupler/ threading on rebar shall be such that two bars can be coupled by moving couplers not rebar (as being heavy reinforcement weight and L shaped, it is not feasible to rotate the rebar for fixing up the coupler) at no extra cost.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.



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3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned



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not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.



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3.20.05

Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06

Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

- For -
- a) Sectional dimension - ± 5 mm
 - b) Plumb - 1 in 1000 of height
 - c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface & should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07

Re-use of Forms



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Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

- a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.
- b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.
- c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti-corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be



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required or directed by the Engineer.

Items to be embedded

- a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.
- b) Anchor bolts and plates for machinery, equipment and for structural steel work.
- c) Steel structurals to be left embedded for future extension, special connection etc.
- d) Dowel bars, etc. for concrete work falling under the scope of other contractors.
- e) Lugs or plugs for door and window frames occurring in concrete work.
- f) Flashing and jointing in concrete work.
- g) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

- a) Bitumen Board



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Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03

Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to



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establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the



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central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to SOA
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04

Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be



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thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.

3.25.00 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard,



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lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown



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on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting. In case of walls, the above bonding agent will be mixed with water, which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two-component epoxy resin-bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.



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3.26.03

Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasticizer will be preferable.

- a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.
- b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04

Structural waterproofing

- a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

- b) External Treatment

Two layers of (1:4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer



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surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well-known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder

- i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.
- ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum
- iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having



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three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,
- v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250-micron polyethylene film as second layer similar to (iii)above.
- viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.
- x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.



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4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete



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The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to IS: 456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.

5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required strength.

If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items



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and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

- a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall include the cost of curing by regular wetting or by using curing compound.
- b) The unit rates shall include for all working conditions including at locations under water, liquid, mud, in or under foul positions and extreme weather conditions.
- c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.
- d) The unit rates shall include all arrangement for maintaining stability of structure during execution.
- e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.
- f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity (UPV) tests or other relevant tests to ascertain grade and quality, etc. of the concrete in case the concrete quality is in doubt and contractor has to establish the quality by further tests. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.

However, mandatory UPV test as specified in the drawings shall be carried out including arrangement of all its facilities, staging, etc. and shall be payable to the contractor as per BOQ item.

- g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.
- h) The quoted rate shall include the cost of MIX design, making of all trial mixes using admixtures and mixing in concrete etc. complete.

6.01.02 Measurements



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- a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres to the nearest two decimals.
- b) No deductions shall be made for the following:
 - i) Ends of dissimilar materials embedded inside for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm in cross section;
 - ii) Opening upto 0.1 sq.m.
 - iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.
 - iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.
- c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.
- d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 23⁰C.

6.02.00 Reinforcement

6.02.01 Rates

- a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.
- b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc.
- c) However, lap welding of reinforcement steel if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour



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and binding wire saved for not providing lap length shall be made. Similarly, splicing of reinforcement bars using mechanical couplers if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made.

- d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).
- e) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

- a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.
- b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

- a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.
- b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.
- c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.
- d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.



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- e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.
- f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02 Measurements

- a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.
- b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

- d) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.
- e) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.
- e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

- a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.
- b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.
- c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.



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6.04.02

Measurements

- a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.
- b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.
- c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.
- d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.
- e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.
- f) The expansion fasteners shall be measured in number according to tension capacity.
- g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00

Groutings

6.05.01

Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02

Measurements:

- a) Measurement shall be in cubic decimeters.
- b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.
- c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.



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d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

f) Pressure injection grouting with cement based grout if required as per drawing shall be applied at appropriate spacing to cover the desired surface area and measurement shall be made for the surface area grouted in sqm as per BOQ item. However in water retaining structures, the structural grouting if required to ensure water tightness shall not be payable separately as deemed to be covered in water retaining concrete item of BOQ.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete



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6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

If the serviceable material including reinforcement steel from dismantled structure is allowed to be used/taken out by bidder, suitable rebate shall be given by bidder.

6.07.02 Measurements

- a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be done on the same basis as that applied for construction work.
- b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).
- c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

- a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of



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volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00

LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

IS: 73 -	Indian Standard Specification for Paving Bitumen
IS: 216 -	Indian Standard Specification for Coal Tar Pitch
IS: 383 -	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
IS: 432 -	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement
IS: 455 -	Indian Standard Specification for Slag Cement
IS: 456 -	Indian Standard Code of Practice for Plain and Reinforced Concrete
IS: 457 -	Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
IS: 516 -	Indian Standard Specification for Methods of Test for Strength



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of Concrete

- IS: 702 - Indian Standard specification for industrial bitumen.
- IS: 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete
- IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing
- IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement
- IS: 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
- IS: 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts
- IS: 1786 - Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.
- IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.
- IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
- IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks
- IS: 2210 - Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates
- IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
- IS: 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
- IS: 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type
- IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators
- IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables



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IS: 2571 -	Code of practice for laying in-situ cement concrete floors.
IS: 2645 -	Integral cement water proofing compound
IS: 2722 -	Indian Standard Specification for Portable Swing Weigh Batcher for Concrete (Single and Double Bucket type)
IS: 2750 -	Indian Standard Specification for steel scaffoldings.
IS: 2751 -	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
IS: 2770 -	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete
IS: 3025 -	Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry
IS: 3067 -	Code of practice for general design details and preparatory work for damp proofing and water proofing of building.
IS: 3201 -	Indian Standard Specification for Design and Construction of Precast Concrete Trusses
IS: 3370 -	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids
IS: 3414 -	Code of practice for design and installation of joints in buildings.
IS: 3550 -	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
IS: 3558 -	Code of Practice for use of Immersion vibrators for Consolidating Concrete
IS: 3696 -	Safety Code for Scaffolding and Ladders
IS: 3812 -	Indian Standard Specification for Fly Ash for Use as Admixture for Concrete
IS: 4014 -	Code of practice for steel tubular scaffolding.
IS: 4031 -	Indian Standard Specification for Method of Tests for Hydraulic Cement
IS: 4082 -	Indian Standard Specification for Recommendation on



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Stacking and Storage of Construction Materials at site

- IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches
- IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes
- IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete
- IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant
- IS: 4926 - Indian Standard Specification for Ready Mixed Concrete
- IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work
- IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground
- IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials
- IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.
- IS: 5256 - Code of practice for sealing joints in concrete lining on canals.
- IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials
- IS: 5513 - Indian Standard Specification for vacate Apparatus.
- IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.
- IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.
- IS: 5624 - Indian Standard Specification for foundation bolts.
- IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks.
- IS: 5816 - Indian Standard Specification for Method of Test for Splitting



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Tensile strength of Concrete Cylinders.

- IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.
- IS: 5892 - Indian Standard Specification for transit mixer and agitators.
- IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use
- IS: 6909 - Indian Standard Specification for Super sulphated Cement
- IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.
- IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.
- IS: 7242 - Indian Standard Specification for Concrete Spreaders.
- IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.
- IS: 7251 - Indian Standard Specification for Concrete Finishers.
- IS: 7293 - Safety code for working with construction machinery.
- IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.
- IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.
- IS: 7969 - Safety Code for Storage and Handling of Building Materials.
- IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.
- IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.
- IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.
- IS: 8989 - Safety Code for Erection of Concrete Framed Structures.



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- IS: 9012 - Recommended method for shortcreting.
- IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.
- IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.
- IS: 9103 - Indian Standard Specification for Admixtures for Concrete.
- IS: 10262 - Recommended Guidelines for Concrete Mix Design.
- IS: 13311 - Non-destructive testing of concrete.
- SP: 34 - Handbook of concrete, reinforcement and detailing.



**TECHNICAL SPECIFICATION FOR
ROOF AND UNDERGROUND
STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-635-600-C001

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**ROOF AND UNDERGROUND STRUCTURES WATER
PROOFING, INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-635-600-C001



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



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**ROOF AND UNDERGROUND WATER PROOFING,
INSULATION AND ALLIED WORKS**

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 GRADING UNDERBED

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix



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by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expanded Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.



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The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.



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Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Hessian base self-finished felt, type 3, grade I.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fibre base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)



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- 3) Fibre base self-finished felt, type 2, grade 2.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Fibre base self-finished felt, type 2, grade 2.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fibre based felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Fibre-base self-finished felt type 2, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)
- 5) Fibre base self-finished felt type 2, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 7) Fibre base self-finished felt type 2, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Hessian base self-finished felt, type 3, grade 1.



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- 4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 5) Hessian base self-finished felt, type 3, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.
- 7) Hessian base self-finished felt, type 3, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.
- 9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02

Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTM C 836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70°C minimum, 300%



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elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkali and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.

b) Primer coat

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane is applied.

c) Finishing coats:

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish:

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using 12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh



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and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03 Waterproofing by Epoxy Resin Based Application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:



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- a) 2 layers - for depths up to 5m below ground level
- b) 3 layers - for depths beyond 5m below ground level

2.05.01

Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose, drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

- i) Primer (For vertical faces only), as per I.S. 3384.
- ii) Hot applied blown bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base, bitumen felt type 3 grades 2
- iv) Hot applied blown bitumen @ 1.2 Kg/m²
- v) Hessian base, bitumen felt type 3 grade 2
- vi) Hot applied blown bitumen @ 1.2 Kg/m²

B) Extra Heavy treatment (Three layers of felt)

- i) Primer (for vertical faces only) as per I.S. 3384



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ii) Hot applied bitumen at the rate of 1.2 Kg/m²

iii) Hessian base bitumen felt type 3 grades 2

iv) Hot applied bitumen at the rate 1.2 Kg/m²

v) Hessian base bitumen felt type 3 grades 2

vi) Hot applied bitumen at the rate of 1.2 Kg/m²

vii) Hessian base bitumen felt type 3 grades 2

viii) Hot applied bitumen at the rate of 1.2 Kg/m²

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.



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3.00.00

ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship as under:

For Bitumen Felt Treatment under clause no. 2.04.01: 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment.

For Elastomeric Membrane under clause no. 2.04.02: 10 (ten) years.

In case guarantee is more stringent in owner specification, more stringent guarantee shall be applicable. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.



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4.00.00

I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- a) IS: 73 - Paving Bitumen
- b) IS: 702 - Industrial Bitumen
- c) IS: 1203 - Methods of testing tar and bitumen
- d) IS: 1322 - Bitumen felts for waterproofing and damp proofing.
- e) IS: 1346 - Code of practice for waterproofing of roofs with bitumen felts.
- f) IS: 1609 - Damp-proofing Treatment using Bitumen Felts – Code of Practice
- g) IS: 3067 - Code of practice for General design details and preparatory work for Damp-proofing and waterproofing of buildings
- h) IS: 3384 - Bitumen primer for use in waterproofing and damp proofing.



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5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labor, as detailed in the specification unless any portion is specifically excluded in the "Schedule of Items".

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.



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MISCELLANEOUS METAL

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



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MISCELLANEOUS METAL

1.00.00 SCOPE

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S. & galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 Shop Connections

- a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
- b) Welding of steel shall be done in accordance with IS: 816.
- c) Welding of aluminium shall be done accordance with IS: 2812, "Arc welding of Aluminium and Alloys." Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.



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2.02.00 Erection

2.02.01 Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.

2.02.02 Temporary Bolting-Up

As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 Welding

Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

2.02.05 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, then those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 Drifting

Correction minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.



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Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturer's instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

- a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
- b) Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.



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- c) The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.
- d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as nut version are acceptable. The bolt version anchors consist of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.
- e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5-micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5-micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING

2.03.01 Chain Link Fencing

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more than ± 0.05 mm. all steel wire shall be hot dipped galvanised wire. The Dia. shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wires for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild



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steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:

Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02

Barbed Wire Fencing

The barbed wire shall be conforming to IS:278 latest editions. The barbed wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two-line wire and two-point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one-line wire (Type A - around both line wire, Type B - around one-line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. The distance between two barbs shall be 75 ± 12 mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four



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evenly spaced row of line wire in all. The top line wire shall be doubled, making five-line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less than 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

- a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.
- b) For installed items, the tolerances shall be as follows
 - i) Permissible deviation from, straightness – 1 in 1000.
 - ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.
- c) All castings shall be free from blowholes, cracks, and other blemishes.
- d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

- IS:278 Specification for Galvanized Steel Barbed wire for fencing.
- IS:816 Code of practice for use of Metal Arc welding for general construction in mild steel.
- IS:1367 Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
- IS:2721 Specification for Galvanized Steel Chain Link fence fabric.
- IS:2812 Arc welding of Aluminum and Alloy



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5.00.00 RATES AND MEASUREMENTS

5.01.0 Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items.

Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.

5.02.0 Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.



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FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items, the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.



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2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.

For sand cement plaster, sand and cement in the specified proportion shall be

mixed dry, on a watertight platform and minimum water added to achieve working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.



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2.02.03

Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1-part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the



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Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) Textured Finish

Mortar consisting of 1-part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.



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2.02.04

Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00

Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1-part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00

Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1-part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00

Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the



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lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1-part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.



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3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall be measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.



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Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
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PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of Paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer's test certificate. All paint shall be subject to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.



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a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 litres of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and shall conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.



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f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not be yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well-known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pre-treated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02

Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00

Preparation of surface

Before starting the work, the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.



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2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477 (Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc. and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.



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2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.



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2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1-part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers, the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.



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2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conforming to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primed surface. Sub sequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flattening varnish. This shall be allowed to dry hard and be flattened down, before applying the next coat. Sufficient time must be allowed between coats to get a



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hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.



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3.00.00

ACCEPTANCE CRITERIA AND TESTING

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) All varnished surfaces shall be of uniform texture and high glossy finish.
- c) The colour, texture etc. shall match exactly with those of approved samples.
- d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.



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Testing

- a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.
- b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.
- c) Material/workmanship unsuitable for acceptance shall be removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00

I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348 Specification for French polish

IS: 427 Specification for Distemper, dry colour as required.

IS: 428 Specification for Distemper oil emulsion, colour as required.

IS: 1477 Code of Practice for painting of ferrous metal in buildings.
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- IS: 2338 (I & II) Code of Practice for finishing of wood and wood based materials.
- IS: 2339 Specification for Aluminium, Paints for general purposes in dual containers.
- IS: 2395 Code of Practice for painting concrete, masonry, and Plaster surface.
- IS: 2932 Specification for enamel, exterior type-1.
- IS: 5410 Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the “Schedule of Items”.

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. of fabricated steel (as per section D-17 clause 6.02.00 i.e. Mode of measurement of technical specification for fabrication of structural steel works) unless specified otherwise.



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**SECTION - D
(PART I)**

SUB-SECTION – D 17

FABRICATION OF STRUCTURAL STEEL WORK



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



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SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

- a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.
- b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.
- c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.
- d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,
- e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.
- f) Suitably mark, bundle, and pack for transport all fabricated materials.
- g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.
- h) Insure, load and transport all fabricated steelwork field connection materials to site.

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		i) Maintain a fully equipped workshop at site for fabrication, modification and repairs of steelwork at site as may be required to complete the works in accordance with the Contract. 2.02.00 Work by others No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract. 2.03.00 Codes and standards All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed: IS: 226 - Structural steel (Standard Quality) IS: 800 - Code of Practice for general construction in steel. IS: 806 - Code of practice for use of steel tubes in general building construction. IS: 808 - Rolled steel beams, channels, and angle sections IS: 813 - Scheme of symbols for welding IS: 814 - Covered electrodes for metal arc welding of structural steel IS: 815 - Classification and coding of covered electrodes for metal arc welding of structural steels. IS: 816 - Code of practice for use of metal arc welding for general construction in mild steel IS: 817 - Code of practice for training and testing metal arc welders IS: 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations IS: 822 - Code of practice for inspection of welds IS: 919 - Recommendations for limits and fits for Engineering	

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IS: 961 - Structural Steel (High Tensile) IS: 1148 - Rivet bars for structural purposes IS: 1149 - High tensile rivet bars for structural purposes IS: 1161 - Steel Tubes for structural purposes IS: 1200 - Method of measurement of steelwork and ironwork (Part 8) IS: 1239 - Mild Steel Tubes IS: 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (Dia 6 to 24 mm) IS: 1364 - Precision and semi-precision hexagon bolts, screws, nuts and 1 locknuts (Dia, range 6 to 39 mm) IS: 1367 - Technical supply conditions for threaded fasteners IS: 1442 - Covered electrodes for the metal are welding of high tensile structural steel IS: 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube IS: 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes. IS: 1731 - Dimensions for steel flats for structural and general engineering purposes IS: 1852 - Rolling and cutting tolerances for hot-rolled steel products IS: 1977 - Structural steel (ordinary quality) St-42-0 IS: 2062 - Steel for General Structural Purposes IS: 2074 - Ready mixed paint, red oxide Zinc chromate priming IS: 2595 - Code of Practice for Radiographic Testing IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles					

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	IS: 3757 - High strength structural bolts IS: 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products IS: 7205 - Safety Code for Erection of Structural Steelwork IS: 7215 - Tolerances for fabrication of steel structures IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels. IS: 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels. 2.04.00 Conformity with Designs The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract. 2.05.00 Materials to be used 2.05.01 General All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section. The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and	



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amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02

Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

- a) IS: 2062 - Steel for general structural purposes
- b) IS: 961 - Structural steel High Tensile
- c) IS: 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03

Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

- a) IS: 1148 - Rivet Bars for structural purpose
- b) IS: 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04

Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable

- a) IS: 814 - Covered electrodes for metal arc welding of structural steel
- b) IS: 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel
- c) IS: 1442 - Covered electrodes for the metal arc welding of high tensile structural steel



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d) IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels

2.05.05

Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06

Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

a) IS: 2062 - Steel for general structural purposes

b) IS: 961 - Structural Steel (High Tensile Quality)

c) IS: 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS: 6649 - Hardened washers

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2.05.07	Paints
	Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS: 2074 - Ready Mixed Paint, Red oxide Zinc Chromate Priming.
2.06.00	Coal Bin
2.06.01	Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have been conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.
2.06.02	For general requirements, fabrication and construction details IS: 9178 (Pt. I & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.
2.06.03	The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.
2.06.04	Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.
2.06.05	Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.
2.07.00	New Erection Marks
2.07.01	Additional structures involving new erection marks may be required to be added at any stage of work.
2.07.02	All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.
2.07.03	All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

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2.08.00	ELECTRO FORGED STEEL GRATINGS	
2.08.01	Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.	
2.08.02	All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.	
2.08.03	The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.	
2.08.04	The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.	
2.08.05	Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.	
2.08.06	The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.	
2.08.07	Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.	
2.08.08	Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.	
2.08.09	Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.	

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2.08.10	Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.
2.08.11	The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.
2.08.12	Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.
2.08.13	All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two: (a)Two coats of red lead primer and two coats of black enamel finish paint. (b) Hot dipped galvanization at 610 gm/sq.m. in the shop prior to erection at site, as the approved drawing.
2.08.14	Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.
2.08.15	Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.
2.09.00	GALVANIZATION OF GRATINGS
2.09.01	Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15
2.09.02	After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).
2.09.03	The weight of the zinc coating shall be at least 610 gm/m ² - unless noted otherwise.
2.09.04	The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter that is loosely attached to

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	the steel, 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. 2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633. 2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose. 2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection. 2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains. 2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to be redone in the similar manner as stated above at no extra cost to the Owner. 2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item) 2.10.01 Material In case SS Hopper is to be fabricated & erected as per BOQ item with SS415M, following specification shall be followed. Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used. <table> <tr> <th>Material</th><th>%</th><th>Remarks</th></tr> <tr> <td>Carbon</td><td>10.03%</td><td>Max.</td></tr> <tr> <td>Silicon</td><td>1.60%</td><td>Max.</td></tr> <tr> <td>Manganese</td><td>0.80% to 1.50%</td><td></td></tr> <tr> <td>Phosphorous</td><td>0.03%</td><td>Max.</td></tr> <tr> <td>Sulphur</td><td>0.03%</td><td>Max.</td></tr> <tr> <td>Chromium</td><td>10.80% to 12.50%</td><td></td></tr> </table>		Material	%	Remarks	Carbon	10.03%	Max.	Silicon	1.60%	Max.	Manganese	0.80% to 1.50%		Phosphorous	0.03%	Max.	Sulphur	0.03%	Max.	Chromium	10.80% to 12.50%	
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Nickel 1.50% Max. Titanium 0.75% Max. Nitrogen 0.03% Max.																					
The mechanical properties shall be as follows:																					
<table><tr><th>Description</th><th>Value</th><th>Remarks</th></tr><tr><td>Hardness Rock Well B Scale</td><td>90</td><td>Max.</td></tr><tr><td>Tensile Strength</td><td>450 MPa</td><td>Min.</td></tr><tr><td>Yield Strength</td><td>300 MPa</td><td>Min.</td></tr><tr><td>Elongation</td><td>25%</td><td>Min.</td></tr></table>							Description	Value	Remarks	Hardness Rock Well B Scale	90	Max.	Tensile Strength	450 MPa	Min.	Yield Strength	300 MPa	Min.	Elongation	25%	Min.
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2.10.02	Fabrication																				
The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.																					
2.10.03	Fabrication Drawings																				
a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly, the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also require adjustment in the size of each element of hopper plate and also additional weld joints. b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner’s store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner’s store																					



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will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the store.

- c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory



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results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the

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	beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed. 2.12.00 Storage of material 2.12.01 General All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks. 2.12.02 Steel The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather. 2.12.03 Electrodes The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating. 2.12.04 Bolts, Nuts and Washers Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality. 2.12.05 Paints Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.	



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2.13.00

Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

- a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- b) Rivets, Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.
- c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
- d) Welders : Qualifying Tests
- e) Welding sets : Performance Tests
- f) Welds : Inspection, X-ray, Ultrasonic tests
- g) Paints : Manufacturer's certificate, physical inspection reports
- h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

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2.14.00	Standard dimensions, forms and weights The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.	
2.15.00	Fabrication Drawings The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval. The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents. The fabrication drawings shall include but not limited to the following: - Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections. - Dimensional drawings of base plates, foundation bolts location etc. - Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings. - Complete Bill of Materials and detailed drawings of all sections as also their billing weights. - Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof. These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information	



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necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under



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expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as



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specified in IS. 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02

Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with the holes. Rivets shall be heated uniformly to a temperature not exceeding 1125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular



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section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.



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3.03.04

Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05

Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03.12

Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate



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precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03. 13 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03. 14 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butt over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

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3.12.00	Lacing bars
	The ends of lacing bars shall be neat and free from burns.
3.13.00	Separators
	Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.
3.14.00	Bearing Plates
	Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.
3.15.00	Floor Grating
	All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively, diamond pattern grating if approved may be used.
	The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.
	The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.
	Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.
3.10.00	Chequered Plates
	Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

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3.11.00	Architectural Clearances Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances. 3.11.00 Shop connections a) All shop connections shall be otherwise riveted or welded as specified on the Drawings. b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection. c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer. 3.13.00 Castings Steel castings shall be annealed. 3.14.00 Shop erection The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.	



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not to injure the skin on galvanized surfaces during transport, handling, and erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.



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4.02.02

Welding

- a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.
- b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:
 - i) 10% at random on fillet-joints.
 - ii) 100% on all butt-joints.
- c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.
- d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

4.02.04

Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05

Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

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4.02. 12	Galvanizing All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.	
4.03.00	Tolerance The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.	
4.04.00	Acceptance Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost. When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.	
4.05.00	Delivery of materials	
4.05.01	General The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.	

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4.05.02	Marking Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection. 4.05.03 Shipping Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit. Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following: a) Name and address of the consignee b) Name and address of the consignor c) Gross weight of the package in tonnes and its dimensions d) Identification marks and/or number of the package e) Custom registration number, if required All markings shall be carried out with such materials as would ensure quick drying and indelibility. Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers. Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially - a) Name of the Contractor b) Number and date of the Contract c) Name of the office placing the contract d) Nomenclature of stores	

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	e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each. The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads. After delivery of the materials at site, all packing materials shall automatically become the property of the Owner. Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor. The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges. If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor. Necessary advice regarding the shipment with relevant details shall reach the Engineer at least a week in advance. 5.00.00 INFORMATION TO BE SUBMITTED 5.01.00 With Tender The following information is required to be submitted with the Tender: a) Progress Schedule The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work. i) Preparation and approval of fabrication drawing ii) Procurement of Materials iii) Fabrication and shipping of all anchor bolts iv) Fabrication and shipping of main steelwork.	



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v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.

vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.

vii) Final date of completion of all shipments.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00

After Award

After award of the Contract the successful Tenderer is to submit the following:

- a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.
- b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.
- c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.
- d) Results of any test as and when conducted and as require by the engineer.
- e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

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6.00.00	RATES AND MEASUREMENT	
6.01.00	Rates	
6.01.01	The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary operations described in the Specifications.	
6.01.02	The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.	
6.01.03	The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.	
6.01.04	No claims shall be entertained, if the details shown on the 'Released for Construction' drawings differ from those shown on the bid/tender drawings.	
6.01.05	Rates shall be inclusive of all leads and lifts/elevation.	
6.01.06	The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces'/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.	

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	The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site. Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ. 6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC. 6.01.08 The bidder's rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the primer specified. 6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint. 6.01.10 The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint. 6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration. 6.01.12 The bidder's rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification. 6.01.13 The bidder's rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.	

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6.01.14	The bidder's rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unutilized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member. The bidder should prepare an optimised cutting plan as per fabrication drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/contract specifications. 6.01.15 The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight. 6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc. 6.01.17 The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.	

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	from assumed minimum circumscribing rectangular area for the purpose of payment. 6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m. 6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment. 6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment. 6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting. 6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds. 6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works. 6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works. 6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units. 6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.	



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The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.



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ERECTION OF STRUCTURAL STEELWORK



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



TITLE:

**TECHNICAL SPECIFICATION FOR
ERECTION OF STRUCTURAL
STEELWORK**

SPECIFICATION NO. PE-TS-635-600-C001

VOLUME -

SECTION - D SUBSECTION - D18

REV.NO. 0 DATE 13/02/2018

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SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

- a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.
- b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.
- c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.
- d) Checking centre lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.
- e) Aligning, plumbing, levelling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.
- f) Painting of the erected steel structures.



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- g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:
- i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.
 - ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.
 - iii) Reaming of holes for use of higher size rivet or bolt if required.
 - iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.
 - v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.
 - vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.
 - vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions of the Engineer.

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2.05.00	Material		
2.05.01	General		
	All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.		
2.05.02	Materials to conform to Indian standards		
	All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.		
2.06.00	Storage of Materials		
2.06.01	General		
	All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.		
2.06.02	Yard		
	The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.		
	The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.		



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2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work:

- i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.
- ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.
- iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.



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3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.



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Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.

No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight' is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation



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there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times Dia or 200 mm	Bolt length exceeding 8 times Dia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30° over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) (Kg.M) of IS:1367	Torque to be applied for bolt class 8.8
20	59.94
22	81.63
24	103.73



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Note: The above torque values are approximate for providing tensions of 14.7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge



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holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00

Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, "ironite" or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00

Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance



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with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable



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and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.



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When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and	



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other member connection
levels:

i) For a column upto and
including 10M height

i) ± 3.5 mm from true
vertical

ii) For a column greater
than 10M but less
than 40M height

ii) ± 3.5 mm from
true vertical for any
10 M length measured
between connection
levels, but not more
than ± 7 mm per 30m
length.

c) For adjacent pairs of columns
across the width of the building
prior to placing of truss

± 9.0 mm on true
span.

d) For any individual column
deviation of any bearing or
resting level from levels shown
on drawings.

± 3.0 mm

e) For adjacent pairs of columns
either across the width of building
or longitudinally level difference
allowed between bearing or seating

3.0 mm

Trusses

least.

a) Deviation at centre of span
of upper chord member from
vertical plane running through

centre of bottom chord.

1/1500 of the span or
greater than 10mm
whichever is the

Trusses

b) Lateral displacement of
top chord at center of
span from vertical plane
running through center of
supports.

1/250 of depth
of truss or 20 mm
which ever is the -
least.

Crane Cirders

a) Difference in levels of
crane rail measured between
adjacent columns.

2.0 mm.

b) Deviation to crane rail-
gauge

± 3.0 mm



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c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding. 1.0 mm.

d) Deviation of crane rail axis from centre line of web. ± 3.5 mm

Setting of
Expansion
gaps

At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.



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5.01.02

Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03

Erection Yard

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00

After award of the Contract

After award of the contract, the Contractor shall submit the following:

5.02.01

Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02

Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

TANGEDCO
2X660 MW ENNORE SEZ STPP
AT ASH DYKE OF NCTPS, CHENNAI

VOLUME -IIB

**TECHNICAL SPECIFICATION
FOR
COOLING TOWER**

Specification No. : PE-TS-412-165-N001 (REV. 0)



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



TITLE:	SPEC. NO.: PE-TS-412-165-N001	
	VOLUME: IIB	
	SECTION:	
	REV. NO. 0	DATE: 11.12.14
	SHEET 1	OF 1

PREAMBLE

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**

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CONTENTS

SECTION	TITLE
A	Scope of Inquiry
B	Project Information (as per NIT)
C	Specific Technical Requirements
C1	Specific Technical Requirements (Mechanical).
C2	Specific Technical Requirements (Elec.)
C3	Specific Technical Requirements (Civil)
C4	Specific Technical Requirements (C&I)
D	Standard Technical Specifications
D1	Standard Technical Specifications (Mechanical) including Data Sheet – A.
D2	Standard Technical Specifications (Elec.)



TITLE:

**TECHNICAL SPECIFICATION
COOLING TOWERS**

SCOPE OF ENQUIRY

SPEC. NO.: **PE-TS-412-165-N001**

VOLUME: **IIB**

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SECTION - A

SCOPE OF ENQUIRY



TITLE:

**TECHNICAL SPECIFICATION
COOLING TOWERS****SCOPE OF ENQUIRY**SPEC. NO.: **PE-TS-412-165-N001**VOLUME: **IIB**SECTION: **A**REV. NO. **0** DATE 11.12.14SHEET **1** OF **2****1.00.00 SCOPE**

1.01.01 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 **2x660 MW Ennore SEZ STPP at Ash Dyke of NCTPS, Chennai.**

The Structural and reinforced Steels for CT and Cement are included in Bidder's scope.

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-412-165-N001**

VOLUME: **IIB**

SECTION: **B**

REV. NO. **0** DATE 11.12.14

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SECTION – B

PROJECT INFORMATION

SPECIFICATION FOR EPC CUM DEBT FINANCING CONTRACT VOLUME II – GENERAL & SCHEDULES

CHAPTER 1

PROJECT SYNOPSIS

1.0 GENERAL BACKGROUND AND SALIENT FEATURES

1.1 Introduction

Tamilnadu Generation and Distribution Corporation owns the proposed green-field 1320 MW (2 units of 660 MW each) Coal Based Thermal Power Station at Katupalli. This is an expansion of North Chennai Thermal Power Station (NCTPS) and located on some portion of the ashdyke of NCTPS.

1.2 Location

The proposed site for main power plant is located near Ennore port (approx 5 kms).

The nearest Railway station is at Athipattu Pudunagar (approx 5 kms)

All weather road from Pattamandri on the Thiruvottiyur-Ponneri district highway is the nearest road access.

The nearest airport is at Chennai at a distance of 60 km.

1.3 Type of Plant

The proposed 2x660 MW Super-Critical Power Project consists of coal fired steam generator connected to a reheat type steam turbine generator along with all the required auxiliaries. Circulating cooling water system is envisaged for condenser cooling.

The description and salient technical data of the Steam Generator, Steam Turbine Generator, Auxiliary systems, Electrical, Control & Instrumentation, Civil etc. are explained elsewhere in the specification:

1.4 PROJECT INFORMATION

Project Title : **2 x 660 MW Ennore SEZ Coal Based Supercritical Thermal Power Project at Ash Dyke of NCTPS**



2 x 660 MW Ennore SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03 /2013-14

Vol. II: 1



Owner : **TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)**

LOCATION

The site is located near Vayalur Village, Ennore

Latitude : 13⁰17' N to 13⁰18' N

Longitude : 80⁰18' E to 80⁰19' E

Distance from Chennai City : 35 km

Nearest Airport is at Chennai at a

Distance of : 60 km

Nearest Seaport is : Ennore

Nearest Railway Station is : Athipattu Pudunagar (approx 5 kms)

Meteorological Condition

Climate : Tropical ,very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind.

Climatological data : Ambient temp. (°C)
Annual Maximum Mean Temp 41.5(°C)
Annual Minimum Mean Temp 24(°C)
Design Ambient temperature 35(°C)

Relative Humidity

Maximum 100%

Minimum 36%

Design 75%

Annual Rainfall

Maximum 2540 mm

Average 1600 mm

Minimum 1175 mm

Prevailing Wind Direction

Nov to Jan – From NW & NE



2 x 660 MW Ennore SEZ Supercritical Thermal Power
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Feb to Mar – From East & SE
 Apr to May – From South & SE
 June – From SW
 July to Aug – From NW
 Sept to Oct – From SE & SW
 Wind Speed 11.8 kmph (avg)
 50 kmph (max)
 Seismic Zone III as per
 IS:1893-2002

1.5 Access to Site

Site is well connected to all weather road from Pattamandri on the Thiruvottiyur – Ponneri district highway. Site is located adjacent to the Chennai – Howrah broad gauge line and thus well connected by rail also.

1.6 Plant Rating, Capacity, Availability, PLF

Each of the two units shall have a Turbine maximum continuous rating (TMCR) of 660 MW at generator terminals based on the following site conditions.

- Ambient air temperature
- Condenser cooling water inlet temperature of 33°C and 9°C temperature rise across the condenser.
- Generator power factor of 0.85.
- Fuel specification as given elsewhere.
- Design temperature for electrical equipment is 50°C.

The VVO capacity of the steam turbine shall not be less than 105% of TMCR flow at rated parameters. Boiler maximum Continuous Rating (BMCR) will be established to match the steam flow at VVO conditions, but BMCR flow shall not less than 108% of TMCR flow.

The capacity of the unit is selected so as to deliver the rated output even after ageing that will occur between overhauls, as a result of deposition of salts in turbine blades, wear and tear etc.

The plant load factor (PLF) being considered is 85%.

1.7 Power Evacuation

Power will be evacuated from the proposed thermal power station at 400 KV voltage level through 400 KV transmission lines. The power evacuation lines would be double circuit 400 KV lines which will act as Line in & Line out circuit.



2 x 660 MW Ennore SEZ Supercritical Thermal Power
 Project at Ash Dyke of NCTPS
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1.8 Site Selection

The following factors which influence the project site selection have been found very favourable to establish and operate the project.

- a. Availability of fuel.
- b. Existing power plant
- c. Availability of adequate cooling water.
- d. Availability of adequate land for locating the power plant with approach roads.
- e. Suitability of land from topographical and geological aspects
- f. Proximity of National Highways, Ports & Transport of fuel & heavy equipment.
- g. Facility for interconnection with transmission and distribution system for evacuation of power.
- h. Environmental aspects.

Total land required for the project is 500 acres which is under the possession of TANGEDCO.

1.9 Fuel

1.9.1 Source of Fuel

Domestic coal requirement for the power plant will be sourced from Kalinga block of Talcher coal fields, Mahanadi and IB valley coal fields in the state of Orissa. Coal will be transported by sea. The port of dispatch and port of receipt for domestic coal would be Paradip port and Ennore port respectively. Imported coal shall be sourced from foreign countries through sea to Ennore port.

Coal can be transported from coal mines to Ennore port by sea and unloaded at proposed coal berth-III. Further the coal can be transported to the proposed power plant through pipe conveyor which shall have a system capacity of 2 x 2000TPH.

The steam generator shall be designed for the following conditions :

- **Best Coal** – 100% Imported Coal
- **Design Coal** – 70% Imported & 30% Domestic Coal
- **Worst Coal** – 50% Imported & 50% Domestic Coal

The analysis of fuel is given below :

1.9.2 Coal Analysis:

Coal Quality Parameters

SL.NO	DESCRIPTION	DOMESTIC COAL	IMPORTED COAL
1.	HIGHER HEATING	2800 (GCV as	6250 (GCV Air



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	VALUE -As Fired basis given Kcal/kg	received basis)	dried basis) 5642 (as received basis)
2.	TOTAL MOISTURE %	During rainy season 20% (inherent + surface)	16.5%
3.	HGI Abrasive ness expected YGP Shale and sand stone content Feed coal size	45 to 55 Average 52 50 to 70 mg/kg 20% max. upto 50 mm.	51

DOMESTIC COAL

Sr. No.	Particulars	Units	Parameters
A.	Proximate Analysis		
1.	Moisture	%	16.00
2.	Volatile Matter	%	19.00
3.	Ash	%	45.00
4.	Fixed carbon	%	20.00
	Total	%	100
B.	ULTIMATE ANALYSIS, % (As received)		
1.	Carbon	%	27.70
2.	Hydrogen	%	2.60
3.	Nitrogen	%	0.52
4.	Oxygen	%	7.26
5.	Sulphur	%	0.50
6.	Ash	%	45.00
7.	Moisture	%	16.00
8.	Carbonates	%	0.38
9.	Phosphorous	%	0.04
10.	Others	%	-
	Total	%	100.00
C.	Ash fusion temperature	deg C	
1.	Initial deformation, IT	deg C	1100
2.	Spherical, ST	deg C	1200
3.	Hemispherical, HT	deg C	1300
4.	Fluid, FT	deg C	-
D.	Ash Analysis, %		
1.	Sio2	%	59.54
2.	Al 2 O3	%	29.00
3.	Fe2O3	%	6.42
4.	CaO	%	1.50
5.	Na2O	%	0.08



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Sr. No.	Particulars	Units	Parameters
6.	K ₂ O	%	-
7.	TiO ₂	%	1.60
8.	SO ₃	%	0.25
9.	P ₂ O ₅	%	0.51
10.	MgO	%	0.50
11.	Others	%	0.60
12.	Total		100.00
E	Resistivity of fly ash	Ohm - cm	1.73x 10 ¹²

IMPORTED COAL

Sr. No.	Particulars	Units	Parameters
A.	Proximate Analysis (As received)		
1.	Moisture	%	16.50
2.	Volatile Matter	%	36.45
3.	Ash	%	6.62
4.	Fixed carbon	%	40.43
5.	Total	%	100.00
B.	ULTIMATE ANALYSIS, % (As received)		
1.	Carbon	%	60.12
2.	Hydrogen	%	4.38
3.	Nitrogen	%	1.48
4.	Oxygen	%	10.37
5.	Sulphur	%	0.53
6.	Ash	%	6.62
7.	Moisture	%	16.5
8.	Carbonates	%	-
9.	Phosphorous	%	-
10.	Others	%	-
	Total	%	100.00
C.	Ash fusion temperature	deg C	
1.	Initial deformation, IT	deg C	1230
2.	Spherical, ST	deg C	1270
3.	Hemispherical, HT	deg C	1320
4.	Fluid, FT	deg C	-
D.	Ash Analysis, %		
1.	SiO ₂	%	36.00
2.	Al ₂ O ₃	%	13.90
3.	Fe ₂ O ₃	%	14.80
4.	CaO	%	12.70
5.	Na ₂ O	%	0.70
6.	K ₂ O	%	1.70
7.	TiO ₂	%	0.80



2 x 660 MW Ennore SEZ Supercritical Thermal Power
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Sr. No.	Particulars	Units	Parameters
8.	SO ₃	%	10.60
9.	P ₂ O ₅	%	0.20
10.	MgO	%	8.60
11.	Others	%	-
12.	Total	%	100.00

The plant should be suitable to accept imported coal sourced from any country. The limiting parameters of imported coal are furnished below :

S. No.	Particulars	Unit	Parameter
1	Total Moisture (ARB)	%	Up to 23 (Max)
2	Ash (ADB)	%	Up to 20 (Max)
3	Gross Calorific Value (ADB)	Kcal / Kg	5800 - 6500
4	Sulphur (ADB)	%	Up to 1 (Max)
5	Fixed Carbon (ADB)	%	30-50
6	Volatile Matter (ADB)	%	25-45
7	HGI		45-60
8	IDT (Under Reducing Atmosphere)	Deg C	1100-1250
9	Size	mm	< 50

Note: ADB stands for “As dried Basis” and ARB for “As Received Basis”

1.9.3 Specification of LDO

Specific gravity @ 15° C	0.8348
Gross calorific value, Kcal/kg	10400
Pour point “°C” max.	12
Flash point “°C” min.	66
Sulphur % “T” max.	0.5
K. Viscosity in Centistokes @ 50° C max.	7.5
Ash by wt. %	0.01
Water & sediment Vol. Max. %	0.25

1.9.4 Specification of HFO

Flash point “°C” min.	66
K. Viscosity in Centistokes @ 50° C max.	370



Ash by wt. %	0.1
Water content by volume % max	1
Sediment by weight % max	0.25
Total Sulphur by weight % max	4.5
Gross calorific value, Kcal/kg	10800

1.9.5 Fuel Linkage

TANGEDCO has approached Ministry of Coal through Ministry of Power for the long term linkage of Coal from the coal sources of Talcher or Mahanadi in Orissa.

The coal requirement has been worked as under:-

Coal required at MCR per hr. (Blended) 872 tonnes

Per day 20928 tonnes.

Annual 6.5 MTPA for 85% PLF

1.9.6 Fuel Transportation

The coal shall be received at Ennore port. The coal will be transported by pipe conveyor from coal berth 3 in Ennore Port and then through 2 x 2000 TPH pipe conveyor to the bunker directly or to stockyard.

1.10 Source Of Water

1.10.1 Source

The raw water intake shall be from the existing cooling water forebay of NCTPS PHASE-II.

1.10.2 Chemical analysis of Sea Water:

As given in Annexure-1, Volume III, Chapter- 3.

1.10.3 Requirement

The requirement of water for the plant will be for meeting the requirement of make up for the re-circulating cooling water system, dust suppression system in coal handling plants, ash disposal system and the RO/ D.M. water plant which will be supplying the power cycle make up requirements, etc. In addition the water requirements will be for drinking and service purposes. Water requirement is estimated as approx. 15523 m³/hr.



1.11 Source of Equipment

The proposed plant will be supplied, erected and commissioned on Single EPC basis.

1.12 Power Evacuation Plan

Power will be evacuated from the proposed thermal power station at 400 KV voltage level through 400 KV transmission lines. The power evacuation lines would be double circuit 400 KV lines.

1.13 400 KV GIS Switchyard

The 400 KV Switchyard is proposed to have one and a half bus arrangement and will comprise following bays/circuits :

- ◆ 2 – Generator transformer bays
- ◆ 1– Start up transformer bay
- ◆ 4 – Line Bays
- ◆ 2 – Bus VT's
- ◆ 2 – Bus Reactor Bays
- ◆ 2 – Spare bay (Equipped)
- ◆ 1 – Equipped bay for future GT
- ◆ 2 – Equipped bays for future lines

The switchyard will be complete with galvanized steel structures, lightning surge arrestors, OPGW Equipment, CTs, PTs of suitable VA burden and accuracy class as required for measurement protection and communication, insulators, bus-bars clamps & hard wares etc. The switchyard will be controlled by computerized control and data acquisition (SCADA) system.

1.14 Average Yearly Generation

The average yearly generation is calculated considering the following.

- The expected plant load factor is 85 %. With this PLF the average yearly generation will be around 11914 Million units.

1.15 INFORMATION FOR ENVIRONMENTAL APPRAISAL**1.0 GENERAL INFORMATION ABOUT THE PROJECT**

1.1	Name / Title of the Project	:	2 x 660 MW Ennore SEZ Coal Based Supercritical Thermal Power Project at Ash Dyke of NCTPS
1.2	Name of Owner	:	Tamilnadu Generation and Distribution Corporation (TANGEDCO)



2 x 660 MW Ennore SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
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- 1.3 Location of the Project : Near Vayalur Village, Ennore, Tamil Nadu
- 1.4 Site where proposed plant is to be located : Ash dyke of NCTPS
- 1.5 Capacity of the project under consideration : 2x 660MW
- 1.5.1 Govt. land / Private land / others : TANGEDCO land
- 1.5.2 Topographical feature, demographic profile & physiography : Site has differential levels and require filling to maintain the desired grade level of +10.00 meter above MSL
- 1.5.3 Nature of soil : Clayey soil
- 1.5.4 Distance from the nearest town / city / major human settlements : Chennai -35 km
- 1.5.5 Population to be displaced : Nil
- 1.5.6 Distance from water source : Approx. 5 km (from Cooling Water Forebay of NCTPS Stage II)
- 1.5.7 Area of forest land, if involved : Nil
- 1.5.8 Distance of forest from the site : N.A
- 1.6 Is this an extension? If so indicate capacity of existing plant : No
- 1.7 What is the ultimate capacity envisaged : 2x660 MW

2.0 GENERAL ENVIRONMENTAL INFORMATION

- 2.1 Area of the land proposed to be acquired : Refer Plot Plan Land already acquired
- i. Area required for plant : 500 Acres
- ii. Ash disposal : 100 % dry fly ash disposal and



- 100% wet bottom ash disposal is envisaged to existing ash pond.
- iii. Plant facilities : The area is adequate for locating all the required systems for 2x660 MW.
- 2.2 Area proposed to be built-up or developed : Power station will be built-up in the proposed site as indicated in the plot plan.
- 2.3 Specify site characteristics River basin/ estuarine / coastal / others : Site is close to Buckingham Canal
- 2.4 Is the site situated in the forest area? Give following details : No
- 2.4.1 Area : N.A
- 2.4.2 Type of forests : N.A
- 2.5 Is site situated near to the forests? Give the distance from the site. : N.A.
- 2.6 Give a description of the flora within 25 km of your plant site under the following heads :
- a. Crops :
 - b. Forest :
 - c. Grass land :
 - d. Endangered species :
 - e. Others (Specify) :
- } Refer details in the specification elsewhere.
- 2.6.2 Give details of the following features, if they exist, within a radius of 25 km of the proposed site? :
- i. Fisheries :
 - ii. Sanctuary / natural park biosphere reserve :
 - iii. Lakes / ponds / reservoir :
 - iv. Stream / river : Buckingham canal is close to the site
 - v. Estuary / sea : Bay of Bengal is 5 km from site



- vi. Hills / mountains :
- vii. Historic / cultural / tourist / archaeological scenic sites / defence installations :
- 2.7 Human settlement :
- 2.7.1 Total number of persons proposed to be employed :
- i. During construction : 2500
450(0.75person/MW) TANGEDCO
- ii. During operation : direct employees





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

SPEC. NO.: **PE-TS-412-165-N001**
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SECTION - C

SPECIFIC TECHNICAL REQUIREMENTS

SECTION C1 - Specific Technical Requirements (Mech.)

SECTION C2 - Specific Technical Requirements (Electrical)

SECTION C3 - Specific Technical Requirements (Civil)

SECTION C4 - Specific Technical Requirements (C&I)

SECTION – C1

SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)



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

SPEC. NO.: **PE-TS-412-165-N001**
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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 **2x660 MW Ennore SEZ STPP at Ash Dyke of NCTPS, Chennai** including complete Electrical, C&I and Civil Works as specified and as necessary.

The Structural and reinforced Steels for CT and Cement are included in Bidder's scope.

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

2x660 MW Ennore SEZ STPP at Ash Dyke of NCTPS, Chennai - 2 (Two) Nos. Cooling Tower

The performance parameters and other particulars of Cooling Tower are 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 water distribution level & Top of CT and all other equipments and accessories as mentioned herein after. It is not the intent to list all details herein; scope of supply listed is in brief.

2.01.00 Each Cooling Tower shall be complete with following:

2.01.01 Scope (Mechanical):

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



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- 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 100 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 (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.

2.01.03 Scope (C & I):

- a) Removable type Pitot Tube at each hot water inlet- piping header to measure the flow (during performance Guarantee test only). The Pitot Tube shall be left with customer after the completion of the test .
- b) One no. Pressure Gauge and One no. Temp Gauge at Hot Water pipe header at T.P.
- c) One no. of Anemometer for measurement of wind velocity.
- d) One no. of Psychrometer.
- e) Local Control Panel for sludge pumps (submersible type).

2.01.04 Scope (Civil):

- a) Complete civil works as detailed in Section – C3 including excavation, shoring, dewatering, backfilling, concrete work including shuttering, sand filling, disposal of surplus soil outside plant boundary, formwork including automatic climb form, laser beam survey instruments, fabrication, galvanizing and erection of steel structures and inserts, finishing anchor bolts, RCC sump/duct,



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laying and testing of hot water pipe line, water proofing, providing PVC water stops and joint fillers, drainage and other ancillary items connected with cooling towers. All faces of concrete structures and steel structures coming directly in contact with water shall be coated with corrosion resistant coating system as approved. The surfaces that would include are inner face of hyperbolic shell, raker column faces, inner faces of cold water basin, fill support structures, hot water distribution ducts & channels, cold water channel etc.

The scope of this work shall consist of , but not limited to, the 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 painting at site.

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

- One set of special tools & tackles required for maintenance of equipments & accessories in the cooling towers.
- Various drawings, datasheets, calculations, test reports/ certificates, operation & maintenance manuals including "As built drawings" etc. as specified & as necessary.
- 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.
- Supply of commissioning spares on as required basis.
- Scope of services shall include but not limited to erection/ testing/ commissioning/ trial run/ performance testing & handing over of cooling towers. Transportation of equipments, material to site, local clearance, storage at site etc. & supply of all labor including supervision personnel, materials, erection tools & tackles etc. as necessary for expeditious execution of works etc. are also included in bidder's scope. It shall be the responsibility of the bidder to arrange all T & P required for the execution of complete job including erection & civil works.

3.00.00 Equipment & Services to be provided by Purchaser:

- Supply and erection of incoming hot water piping up to bidder's terminal point.
- Supply & erection of sludge discharge piping beyond the bidder's terminal point, if applicable.
- Cold-water outlet channels for cooling tower beyond the bidder's terminal point.
- 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. Customer specification for cooling tower is enclosed at Annexure 'A' and it shall prevail in the event of conflict.

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.



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

Where

- L = Water flow rate in Kg/hr.
T₁ = Water inlet temperature to the tower in Deg.C
T₂ = 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.



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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 sea water with analysis as given in data sheet-A of Section. D.

- a) The COC in CW System shall be '1.3'.
- b) Control of biological / algae 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 Splash bars Type 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 0.005 % 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 & aviation warning lamp etc.

6.09.00 Four external cage/rung 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 and Aviation Warning Lamp etc.

6.11.00 All steel parts in direct contact with water or humid air shall be of SS 316L. All other steel parts not in direct contact with water/ humid air shall be galvanized steel with painting of Epoxy Coal tar. 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 1.9 m/sec.

- a) Piping for sizes above 150 Nb Carbon steel plates to IS 2062 internally lined with CorroCoat or Poly Urea Coating of 1500 Microns DFT, rolled and welded as per IS 3589.
- b) Piping up to and including 150 Nb shall be IS 1239 (Heavy Grade) internally lined with CorroCoat or Poly Urea Coating of 1500 Microns DFT.

Required wall thickness for Hot Water riser and Distribution piping shall be as follows:



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NB	OD	Min. THK
1400	1422.00	14.0
1800	1829.00	16.0
2500	2540.00	20.0
2600	2640.00	20.0
2800	2840.00	20.0

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

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

6.15.00 Motor 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 1:120) 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 of one no. CT 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.

The balance three (3) Cooling Towers shall be tested by bidder himself in presence of Employer/Purchaser.

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.

- Code ATC-105: Acceptance test code for water cooling towers. (latest Version).
- BS-4485: Specification for Water Cooling Tower.
- BS-1042: Methods for the measurement of fluid flow in pipes.
- BS-3435: Measurement of electrical power and energy in acceptance testing.
- ASME 19.5: Supplements on instruments and apparatus.

8.03.00 Conductance of tests:



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Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by the bidder for the design conditions of CW flow, range, ambient WBT as specified

- 8.03.01** The bidder shall submit cooling tower performance test procedure as per ATC 105 in consultation with CTI approved testing agency for approval & conduct the test as per the approved procedure, in the event of order.
- 8.03.02** The bidder shall be given permission to inspect the Cooling Tower in advance and ready it for the test.
- 8.03.03** **One Cooling Tower performance shall be tested jointly by CTI approved testing agency in presence of the bidder, BHEL and Owner. All the representatives shall jointly record data of test.**
- i. The responsibility for conducting the test will be with the bidder.
 - 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).



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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 notwithstanding anything else stated elsewhere in the offer, data sheets etc. **The hidden deviations or stated/ implied deviations in the offer shall not be acceptable and binding on the purchaser.**

11.00.00 PERFORMANCE GUARANTEES AND LIQUIDATED DAMAGES

- a) Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by bidder for the design conditions of CW flow, range, ambient WBT as specified.

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

0.1°C over the guaranteed value	=	215 lacs
0.2°C over the guaranteed value	=	430 lacs
0.3°C over the guaranteed value	=	645 lacs
0.4°C over the guaranteed value	=	860 lacs
0.5°C over the guaranteed value	=	1075 lacs
0.6°C over the guaranteed value	=	1290 lacs
0.7°C over the guaranteed value	=	1505 lacs
0.8°C over the guaranteed value	=	1720 lacs
0.9°C over the guaranteed value	=	1935 lacs
1.0°C over the guaranteed value	=	2150 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: $V = 0.85 \times C \times (i)^{0.54} \times (d/4)^{0.63}$.



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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.

- 12.01.00** The contractor/ manufacturer shall conduct the following minimum specific tests to ensure that the equipment shall conform to the requirements of this section and in full compliance with the requirements spelt out in applicable codes and standards.

- 12.02.00** Material identification and testing of regulating valve assemblies, screen assemblies, all supporting structural assemblies, fills, all nuts and bolts, sluice valves, nozzles and all other applicable components constituting each cooling tower.

- 12.03.00** Hydrostatic testing of hot water distribution piping regulating valves and all other pressure parts at a pressure and duration as spelt out in this specification.

- 12.04.00** Visual, dimensional checking of all components of each cooling tower.

- 12.05.00** Material testing of all components, hydrostatic testing of all pressure parts at a pressure and duration in compliance with this specification, static and dynamic balancing tests of all rotating components such as pump shaft, line shaft, impeller etc. and complete performance testing as minimum for each sludge pump in each cooling tower.

- 12.06.00** Tests for hoists, chain pulley blocks and all other lifting tackle shall be carried out as per relevant Indian/ equivalent international standards.

- 12.07.00** Any other tests deemed necessary for safe, reliable and satisfactory operation of the equipment.

13.00.00 QUALITY PLAN:

- 13.01.00** The inspection & testing of the cooling towers & its various components shall be as per quality plans approved by the purchaser/ Customer. Bidder shall submit the quality plans based on the guidelines given in specification & quality plans enclosed herein. The customer hold points of BHEL/ Customer/Customer nominated agency shall be marked in the QP at the contract stage, in the event of order & inspection/ testing shall be carried out as per same apart from various test certificates/ inspection records etc.

Following standard QP are enclosed for bidder's guidance:

- Cooling tower
- Pipes, fittings & pipe work
- BF Valves
- Chain Pulley Blocks
- Gate/ Globe Valves
- Submersible Pumps

- 13.02.00** The quality plans for various electrical, C&I and Civil works are enclosed in respective sections for bidder's compliance.



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13.03.00 For equipments not covered above, bidder shall submit QP's for same on the basis of similar guidelines & submit for approval in the event of order.

14.00.00 Tests at Site:

14.01.00 After completion of erection and commissioning of the cooling tower, supplier in accordance with cooling tower Institute Bulletin No ATC-105 "Acceptance Test Procedure for Industrial Cooling Tower" shall carry out performance tests of each cooling tower.

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

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

15.00.00 DRAWINGS, CURVES AND INFORMATION REQUIRED:

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

- Compliance certificate duly signed and stamped (enclosed herein).
- 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.
- Pumping head calculations.
- 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). However diameter and height of CT during contract stage shall not be less than the proposed dimensions as offered in the bid.

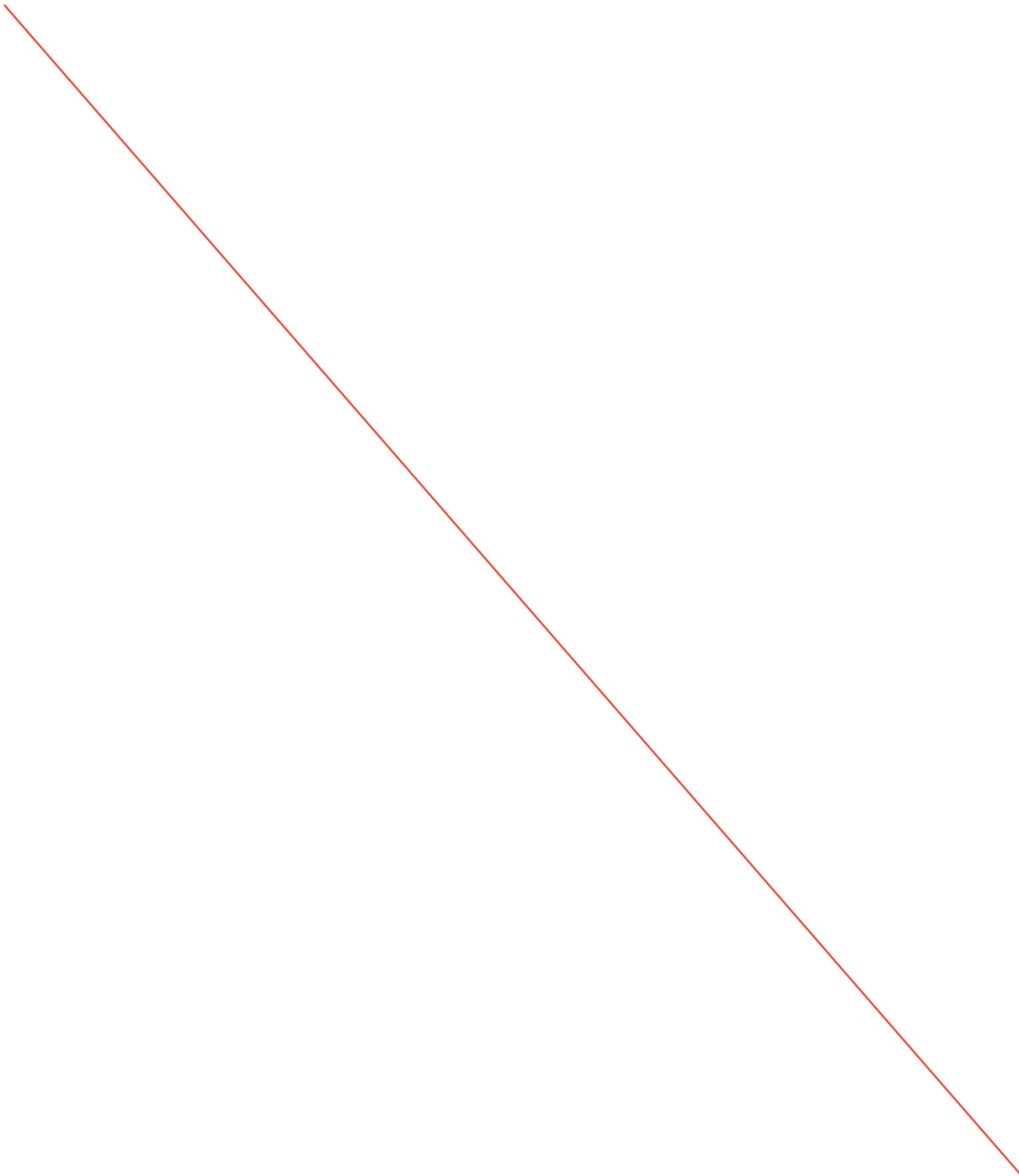
- Tower performance curves.
- Guarantee Schedule duly signed and stamped (enclosed herein)
- Technical deviation schedule (if reqd.) (enclosed herein)

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:

CHAPTER 9

9.0 NATURAL DRAUGHT COOLING TOWER



9.5 The Structure

The cooling tower shell shall be hyperbolic paraboloid.



The shell of the cooling tower shall be supported by a set of diagonal columns, which shall be supported by raker piles and a peripheral pile cap.
Hot water inlet shall be through a pair of concrete ducts/steel pipes.

To control the hydraulic forces at the change of alignment of the hot water (HW) inlet pipe, at ground level near the cooling tower RCC thrust block shall be provided.

The hot water distribution shall be by RCC main and secondary ducts finally through PVC pipes fitted with nozzles for uniform distribution through the fill, which shall be film type

When selecting the spray equipment and its position, it must be ensured that maximum heat transfer is achieved above the parts installed with the system chosen. Optimum cascading is to be attained using spray equipment with staggered nozzle sizes.

The concrete main distribution ducts shall be accessible and are to be provided with non-corroding, pressure-sealed inspection openings. Cleaning and sludge-removal openings are to be included on each run at the end of the duct in the main distributor pipes.

The fill packing is to consist of tried and tested plastic packing arranged crosswise over a number of storeys and which guarantees the exchange of heat and mass.

The profile of the drift eliminators is to be selected to ensure a maximum degree of precipitation and a minimum of air pressure loss.

The HW distribution arrangement shall be supported independent of the shell by internal columns finally supported on the floor of the cold water basin.

Access to the hot water distribution platform and further access to the shell top is provided with two Galvanised Steel ladders, mainly for the maintenance of aviation warning lights.

The material used for access facilities including steel components for steps, ladders, platforms, catwalks, railings, doors, base frames, mountings, etc must be resistant to corrosion.

All bolted connections and attachments to concrete must be made out of suitable stainless steel.

The basin shall be designed for a water depth of 1.0 m from normal water level with a free board of at least 0.3 m above maximum water level. The cooling tower basin shall be divided into two equal parts by watertight RCC partition for the cleaning and maintenance of one half while the other half is in service. Arrangements for water drainage shall also be provided.

The cold water from the basin shall be conducted through an opening in the cold water basin and connected to the fore-bay of the CW sump. The cold water from the basin shall flow by gravity to open approach channel leading to the fore-bay. The cold water channel shall be provided with a stop log. Suitable handling arrangements with a monorail and a chain-operated hoist with a travelling trolley shall be provided for handling of the stop log. In front of the outlet structure, provision shall be made for de-sludging facilities, so that sediments can be withdrawn near the basin. In order to clean the cooling tower basin, sludge sumps are to be distributed along its perimeter (approximately every 45°), from where the sludge can be pumped out.

The water collection basin, consisting of base slab and basin wall, shall also serve as a water reservoir. The basin wall shall be inside the diagonals.



Structural Design Concepts shall be designed as described in Volume VI.

9.6 **Fill Supporting Arrangement**

The supporting of the fill is to be achieved by a series of precast RCC columns arranged in suitable grid spacing and precast beams in orthogonal directions. Loads from fills, hot water ducts, pipes including water load, wall blocks etc shall be considered for column design. To take care of horizontal loads due to seismic and thrust from hot water header, a suitable system of vertical bracings is to be designed and provided in either direction.

Concrete which is impermeable to water is to be used for all components, including reinforced concrete components. The composition of the concrete and the cement are to be chosen depending on the chemical analysis of the cooling tower water/cooling tower make-up water.

9.7 **Aviation warning lights**

In accordance with official regulations, aviation warning lights are to be installed along the perimeter of the NDCT structure. Operating and reserve aviation warning lights are to be positioned next to each other. They are to be connected to completely separate power circuits and to be monitored by relays.

The obstruction lighting shall be done as per Appendix 6 figure 6.2 of ICAO i.e combination of low intensity (Multi LED type-B) & medium intensity (Multi LED Type). The life of the fittings shall be 20 years maintenance free. Total low intensity fittings 12 nos. (1/4 level & 3/4 level) & medium intensity fittings (1/2 & tope level). The aviation lighting shall meet the recommendations of ICAQ and Director General of Civil Aviation, India. The Aviation warning lighting system shall also conform to the latest Indian Standard IS :4998.

Lights should be installed in a manner to ensure an unobstructed view of at least two lights by a pilot approaching from any direction.

The minimum number of lights shall be as indicated below depending on the diameter:

- 20 feet (6 m) or less : 3 lights per level
- Exceeding 20 feet (6m) but not more than 100 feet (31 m) : 4 lights per level
- Exceeding 100 feet (31 m) but not more than 200 feet (61m) : 6 lights per level.
- Exceeding 200 feet (61m) : 8 lights per level.

Structures exceeding 600 feet (183 m) should have a second level of light units installed approximately at midpoint of the structure and in a vertical line with the top level of lights.

The technical requirements of aviation warning lighting, lightning protection system, earthing, lighting, and cabling etc. shall be as described in Volume-IV.

9.8 **Guaranteed Particulars**

The contractor shall guarantee the following parameters.

9.8.1 **Cold water temperature**

At the design point of the cooling tower, the cold water temperature guaranteed by the Contractor in accordance with the guarantee curve (cooling tower characteristic diagram) shall be achieved. The fundamental parameter for the design value of the cold water temperature during acceptance measurement shall be the measured across the cooling zone width.



9.8.2 Drift loss

At the design point, the total water mass flow entrained in the air shall not exceed 0.005% of the mass of water circulating.

9.8.3 Material resistance

All materials (including building materials) are to be chosen and geared to each other such that no damage will be occurred as a result of operational exposure to cooling water.

9.9 Performance Guarantee tests

9.9.1 Performance tests shall be conducted by the Contractor on the cooling tower on site to establish the performance of the Cooling tower. The tests shall cover thermal capability and performance parameters of the cooling tower. The Contractor guarantees that the cooling tower shall cool a certain mass flow of cooling water at the given ambient conditions from a certain hot water temperature down to a certain cold water temperature.

9.9.2 Latest versions of the following codes and standards shall be used for conducting the performance tests:

DIN 1947 – VDI - Acceptance test code for water cooling towers (latest version)

BS – 4485 Specification for Water Cooling towers

BS – 1042 Methods for the measurement of fluid flow in pipes

BS – 3435 Measurement of electrical power and energy in acceptance testing

ASME – 19.5 supplements on Instruments and Apparatus

9.9.3 Contractor shall arrange for all the test instrumentation required for conducting the performance guarantee tests. All instruments used in the testing shall be calibrated before and after the tests as per the relevant codes. Should the acceptance tests not produce the guaranteed values, the Contractor shall be granted the right to make improvements. The repeated acceptance measurements shall then be carried out at the Contractor's expense.



ACCESSORIES REQUIRED WITH EACH COOLING TOWER		
1	COLD WATER SUMP AT EACH COMPARTMENT	
2	2X100%, SUMP PUMPS, COMPLETE WITH PIPINGS, FITTINGS, VALVES & ACCESSORIES (PUMPS SIZED TO EMPTY EACH BASIN PARTITION IN 10 HRS)	
3	COLD WATER OVERFLOW, DRAIN, QUICK FILL, MAKE UP PIPING, FITTINGS, VALVES	
4	AVIATION WARNING LIGHTS	
5	SCREENS & STOP LOGS	
6	CHAIN PULLEY BLOCK WITH TRAVELLING TROLLEY	
9	ILLUMINATION	
10	LIGHTNING & EARTHING PROTECTION	
11	MONORAILS & HOISTS FOR STOP LOGS & SCREENS	
13	LADDERS, STAIRCASES, WALKWAYS & HANDRAILS	
14	TEMPERATURE & PRESSURE GAUGES ON HOT WATER INLET	
15	INSTRUMENTS REQUIRED FOR PG TEST (AS PER CTI / BS/ ASME)	
PERFORMANCE GUARANTEE		
1	COOLING TOWER CAPACITY	CT Capacity m ³ /hr ± 10%
2	COOLING RANGE	10 ⁰ C ± 20%
3	DESIGN AMBIENT WET BULB TEMPERATURE	27 ± 8.5 ⁰ C
4	PUMPING HEAD	BY BIDDER



SECTION C2

SPECIFIC TECHNICAL SPECIFICATION (ELECTRICAL)

ELECTRICAL EQUIPMENT SPECIFICATION FOR NATURAL DRAFT COOLING TOWER 2X660 MW ENNORE TPS	SPECIFICATION NO.
	VOLUME NO. :
	SECTION : C
	REV NO. : 00 DATE : 08.12.14
	SHEET : 2 OF 3

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

- a) Services and equipment as per “Electrical Scope between BHEL and Vendor”.
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Erection and Commissioning spares.
- e) Erection & Maintenance tools & tackles.
- f) Electrical load requirement for NATURAL DRAFT COOLING TOWER.
- g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL
- i) Various drawings, data 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.
- j) Motor shall meet minimum requirement of motor specification.
- k) LT power & control cables shall meet minimum requirement of LT power & control cables specification.
- l) Cabling, earthing & lightning protection shall meet minimum requirement of cabling, earthing & lightning protection specification.

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

Refer “Electrical Scope between BHEL and Vendor”.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/quality assurance requirements stipulated. In line with this two signed and stamped copies of the following shall be furnished by the bidder as technical offer:
 - a) A copy of this sheet ”Electrical equipment Specification for NATURAL DRAFT COOLING TOWER” and sheet “Electrical Scope between BHEL and Vendor” with bidder’s signature and company stamp.
 - b) Electrical load requirement
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.
- 4.0 List of enclosures :
 - a) Electrical scope between BHEL & vendor.
 - b) Technical datasheets & quality plans for LT motors.
 - c) Technical datasheets & quality plans for cabling, earthing & lightning protection.
 - d) Technical datasheets & quality plans for lighting system.
 - e) Electrical Load data format.

**ELECTRICAL EQUIPMENT SPECIFICATION
FOR
NATURAL DRAFT COOLING TOWER
2X660 MW ENNORE TPS**

SPECIFICATION NO.

VOLUME NO. :

SECTION : C

REV NO. : 00 DATE : 08.12.14

SHEET : 3 OF 3

- f) Typical SLD for ACDB
- g) Customer specification for Motor, Cabling, earthing, lighting, aviation, cables, switchgear

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE : COOLING TOWER (NATURAL DRAFT) SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT :

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V ACDB	Vendor L	Vendor	415 V AC, 3 phase, 4 wire supply/ 240 V AC, 1 phase supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor. Refer SLD. Makes shall be subject to customer/ BHEL approval at contract stage.
2	Local starter panel/ Push Button Station (for motors)	BHEL	BHEL	Located near the motor . Makes shall be subject to customer/ BHEL approval at contract stage.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL Vendor Vendor	BHEL Vendor Vendor	1. Termination at BHEL equipment terminals by BHEL. 2 Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	
5	Any special type of cable like compensating, co-axial, prefab, MICC, fibre Optic cables etc.	Vendor	Vendor	Refer scope/ C&I portion of specification for scope of fibre Optic cables if used between PLC/ micro processor & DCS.
6	Cabling material (Cable trays, accessories & cable tray supporting system, conduits)	Vendor	Vendor	1. Layout details between vendors supplied equipment & installation drawing by vendor. 2. BHEL will provide cable trench along with cabling material up to the terminal point approx. 10 m away from cooling tower. Further cabling (supply and E&C) shall be in vendor's scope.
7	Cable glands ,lugs, and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Equipment grounding & lightning protection	Vendor	Vendor	Material and sizes shall be as per specification and subject to BHEL approval during detailed engineering stage.
9	Below grade grounding	BHEL	Vendor	MS rod material shall be provided by BHEL. All other materials/ consumables are in vendor's scope.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE : COOLING TOWER (NATURAL DRAFT) SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
10	LV Motors with base plate and foundation hardware (in case applicable for NDCT)	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
11	Lighting System	Vendor	Vendor	In addition to other lighting system items, vendor shall consider aviation lights & their control as per statutory requirement and Lighting panels (LP) & timer control as per requirement. Further wires, any other material required for lighting system shall also be considered by vendor in their scope. BHEL will provide the power supply for LP, from LDB at one location near Cooling Tower. Further, distribution from LP including material is in vendor scope.
12	Aviation Lighting	Vendor	Vendor	Make shall be subject to customer/BHEL approval at contract stage
13	Receptacles/Industrial switch-sockets	Vendor	Vendor	Make shall be subject to customer/BHEL approval at contract stage
14	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	Engineering activities during detailed engineering stage, including those listed below: a. Electrical load data submission in PEM format b. Electrical equipment GA drawings and layout drawings c. Cable trench/ tray layout drawings d. Control cable schedules showing routing details [including cables supplied by PEM for CT equipment]. e. Grounding and lightning protection system layouts f. Cable termination/ interconnection details (diagram)/ Cable block diagram	Vendor	--	1. Documentation shall be submitted as per project schedule for BHEL/ customer approval. 2. Vendor shall be responsible for necessary coordination with BHEL for required engineering interfacing during contract stage. 3. Any approval required from electrical inspection authority for electrical equipment shall be arranged by vendor.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE : COOLING TOWER (NATURAL DRAFT) SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Wherever BHEL is indicated above, if the scope of supply and E&C of any of the above listed items is in BHEL's Customer scope, then the respective items shall be supplied, erected and commissioned by BHEL's Customer. For such items, BHEL as indicated in SUPPLY and E&C column above shall be read as "BHEL's CUSTOMER".



TITLE

LV MOTORS

DATA SHEET-A1

2X660MW ENNORE THERMAL POWER PLANT

SPECIFICATION NO.

VOLUME II B

SECTION D

REV NO. DATE 08.12.2014

SHEET 1 OF 2

1.0	Design ambient temperature	:	50 °C
2.0	Maximum acceptable kW rating of LV motor	:	160KW *
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V $\pm$ 10%
	b) Rated frequency (with variation)	:	50 Hz + 3 % to - 5%
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes		
	o 110 kW and above (Breaker Controlled)	:	50 KA for 0.20 sec..
	o Below 110 kW (Contactor Controlled)	:	50 KA protected by HRC fuse
	f) LV System grounding	:	Solidly
5.0	Class of insulation	:	Class 'F', with temp rise limited to class B.
6.0	Minimum voltage for starting (As percentage of rated voltage)	:	(a) 85% below 110KW (b) 80% from 110KW to 160KW (c) 85% above 160KW to 1000KW (d) 80% from 1001 KW to 4000KW (e) 75% > 4000KW
7.0	Power cables data	:	Shall be given during detailed engg.
8.0	Earth Conductor Size & Material	:	As per attached Datasheet of Earthing.
9.0	Space heater supply	:	240 V, 1 ϕ , 50 Hz (for motors above 30 Kw)
10.0	Rating up to which Single phase motor	:	Acceptable below 0.20 kW
11.0	Locked rotor current		
	a) Limit as percentage of FLC	:	As per IS 12615*
12.0	Flame-proof motor		
	a) Enclosure suitable (As per IS: 2148)	:	As per requirement
	b) Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement
13.0	Makes	:	BHEL/ Customer approval
14.0	Paint shade	:	Shall be given during detailed engg



TITLE

LV MOTORS**DATA SHEET-A1****2X660MW ENNORE THERMAL POWER
PLANT**

SPECIFICATION NO.

VOLUME

II B

SECTION

D

REV NO.

DATE

08.12.2014

SHEET

1

OF

2

15.0 Degree Of protection for motor/ terminal box : IP 54/ IP 55

All LV motors above 10 kW with S1 duty shall be compulsorily of Energy efficient level IE 2 as per IS 12615: 2011.

16.0 TESTING**16.1 Type Tests**

For LT Motors above 55kW, type test reports for type tests as per IS: 325/ IS: 12615 conducted on equipment similar to those proposed to be supplied and carried out within last five years from the date of bid opening shall be submitted. However, if such reports are not available, one motor of each type shall be subjected to type tests for free of cost.

16.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 325/ IS: 12615 in the presence of customer or customer representative.

2X660W ENNORE THERMAL POWER PLANT
DATA SHEET-A2

13.0 CABLING

S.NO.	DESCRIPTION	VALUE
1.0	Cable Trays & Support System	
1.1	Cable trays & accessories	
(a)	Type of cable tray & accessories	Ladder Type & Perforated type, Hot dipped galvanised
(b)	Material	Hot Rolled Mild Steel
(c)	Standard Length of Straight Length of Cable Trays	2.5 metre
(d)	Rung spacing for ladder type tray	250 mm
(e))	Standard Width (mm) of cable trays	600, 450, 300 ,150
(f)	Depth of cable trays & acc.	100 mm
(g)	Bending Radius of Accessories(in mm)	600 mm
(h)	Tolerance in length/width / height	+ /- 2 mm
(i)	SHEET THICKNESS	
	• For cable trays & Accessories	2 mm
	• For Coupler plate	3 mm
(j)	Tolerance in Thickness	(+/-0.2 mm)
(k)	Horizontal runs of cable trays supported at	1.5 metre
(l)	Vertical runs of cable trays supported at	1 metre
1.2	Cable tray support system	
(a)	Type of cable support system	Site fabricated & bolted type, Painted
(b)	Material:	Hot Rolled Mild Steel
(c)	Length	Standard length of 5.5m to 6.5m
(d)	Type:	Hot-dip galvanised
(e)	Sizes:	ISA 50X50X6/ISA 75X75X6 ISMC – 100/ISMC – 150 (As per requirement)
1.3	Surface Treatment of cable tray & support system	
(a)	Pre-treatment	IS 2629 before galvanisation
(b)	Type	Hot dip galvanisation
(c)	Applicable Standard	IS 2629

2X660W ENNORE THERMAL POWER PLANT
DATA SHEET-A2

(d)	Minimum thickness	75 microns (minimum)
(e)	Min. weight of Zinc deposit	610 grams per square meter
2.0	Rigid Conduits and Pipes	
2.1	Material	Galvanised steel
2.2	Type	Medium duty
2.3	Applicable Standard	IS: 9537 (upto 63mm OD) and IS:1239 (above 63mm OD)
3.0	Flexible Conduits and Pipes	
3.1	Material	Strip steel cold rolled & annealed
3.2	Type	Electro galvanised
3.3	Applicable Standard	IS:3480
4.0	Cable Glands	
4.1	Type of cable gland	Double compression, Brass
4.2	Applicable Standard	BS:6121 / Eqvt.
5.0	6.6kV Cable Jointing / Termination Kits	
5.1	Type	Tapex / Heat Shrinkable/ Push On/ Elastimold
5.2	Application	Indoor
5.3	Type of cable lugs/ferrule	Aluminium solderless crimping type
5.4	Applicable Standard	Type test reports as per IS:13573 will be submitted
6.0	Cable lugs	
6.1	Type	Aluminium (solderless crimping type) for Al conductor Tinned Copper (solderless crimping type) for Cu conductor
6.2	Applicable Standard	IS: 8309 / Eqvt.
7.0	TREFOIL CLAMPS(For single core power cables)	
7.1	Material	Nylon-6/ Aluminium alloy
7.2	Hardware	Hot Dip Galvanised/Zinc passivated / Cadmium Plated
7.3	Short circuit current values	105 kA (peak)
7.4	Spacing between trefoil clamps	1000 mm

2X660W ENNORE THERMAL POWER PLANT
DATA SHEET-A2

8.0	Fire Sealing	
7.1	Fire rating of the system	Two (2) Hour
7.2	Type	Heat resistant panel / powder or mortar
7.3	Type tests are to be conducted or Reports of previously conducted type tests shall be submitted	Reports of previously conducted following type tests shall be submitted a) Accelerated ageing test b) Water absorption test c) Fire rating test d) Hose stream test
7.4	Testing standards	ASTM-E-814, ASTM-E-119, UL-1479 ,BS: 476
7.5	Shelf life	12 months

2X660W ENNORE THERMAL POWER PLANT
DATA SHEET-A3

14.0 EARTHING AND LIGHTNING PROTECTION

S.NO.	DESCRIPTION	UNITS	VALUE
1.0	Earthing System		
1.1	Buried earth mat		
1.1.1	Applicable standard		IEEE: 80 & IEEE:665
1.1.2	Material		MS
1.1.3	Size		40 mm dia rod
1.2	Equipment Earthing		
1.2.1	Material		MS flat / GS wire
1.2.2	No. of leads		Generally two
1.3	Lightning Protection System		
1.3.1	Applicable Standard		IS:2309 & NFPA 78
1.3.2	Size & material for Horizontal Air termination		Min 50x6mm galvanised MS strip
1.3.3	Size & material for Vertical Air termination		Min 20mm dia, 1000mm long galvanised MS rod
1.3.4	Size & material for Vertical Air termination for chimney		Min 20mm dia, 1000mm long, Min 2mm thick copper rod
1.3.5	Size & material for down conductor		Min 50x6mm galvanised MS strip

2X660MW ENNORE THERMAL POWER PLANT - DATA SHEET A4

15.0 LIGHTING SYSTEM

S.NO.	DESCRIPTION	UNITS	VALUE
A	Lighting distribution board		
1.0	AC Lighting distribution board (AC LDB)		
1.1	LDB type		Single front, Fixed type
1.2	Sheet thickness	mm	2.0
1.3	Degree of protection		
	a) Main Panel		IP:52
	b) Transformer Cubicle (where provided)		IP:42
1.4	Lighting transformer rating	kVA	100/ 50 kVA
1.5	No. of incomer		One
1.6	Incomer type		TPN SFU
1.6	Incomer rating	A	As per lighting transformer rating
1.7	Outgoing type		TPN SFU
1.8	No. of outgoing feeders	Nos.	12 or 8
1.9	Outgoing feeder rating	A	63
1.10	Metering on LDB		Ammeter & Voltmeter with selector switch
1.0	DC Lighting distribution board (DC LDB)		
1.1	LDB type		Single front, Fixed type
1.2	Sheet thickness	mm	2.0
1.3	Degree of protection		IP:52
1.4	No. of incomer		One
1.5	Incomer type		DP SFU with contactor
1.6	Incomer rating	A	125 A
1.7	Outgoing type		DP SFU
1.8	No. of outgoing feeders	Nos.	12 or 6
1.9	Outgoing feeder rating	A	32
B	Lighting Panel		
1.0	AC Lighting Panel		
1.1	Sheet thickness	mm	2.0
1.2	Degree of protection		
	a) Indoor		IP:54

2 X660MW ENNORE THERMAL POWER PLANT

	b) Outdoor		IP:55 (with canopy)
1.3	Incomer type		TPN SFU
1.4	Incomer rating	A	63A
1.5	Timer provided for ON/OFF control		
	a) Indoor panel		No
	b) Outdoor panel		Yes
1.6	Outgoing type		SPN MCB
1.7	No. of outgoing feeders	Nos.	18, 12, 6
1.8	Outgoing feeder rating	A	20A
1.0	Street Lighting Panel		
1.1	Sheet thickness	mm	2.0
1.2	Degree of protection		IP:55 (with canopy)
1.3	Incomer type		TPN SFU
1.4	Incomer rating	A	63A
1.5	Timer provided for ON/OFF control		Yes
1.6	Outgoing type		TPN MCB
1.7	No. of outgoing feeders	Nos.	6
1.8	Outgoing feeder rating	A	20A
1.0	DC Lighting Panel		
1.1	Sheet thickness	mm	2.0
1.2	Degree of protection		
	a) Indoor		IP:54
	b) Outdoor		IP:55 (with canopy)
1.3	Incomer type		DP SFU
1.4	Incomer rating	A	32A
1.6	Outgoing type		DP MCB
1.7	No. of outgoing feeders	Nos.	6
1.8	Outgoing feeder rating	A	20A
C	LDBs & LPs COMPONENT DETAILS		
3.0	Miniature Circuit Breaker		
3.1	Applicable standard		IS:8828
3.2	Short time rating	kA	9
4.0	Isolator		
4.1	Type		Air-break

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5.0	Fuses		
5.1	Type		HRC
5.2	Applicable standard		IS:9224
6.0	Contactor		
6.1	Type		Air-break
6.2	Applicable standard		IS:2959
D	OTHER LIGHTING EQUIPMENTS		
1.0	Emergency Lighting Unit (ELU)		
1.1	Application		Off-site indoor areas for safe personal movement
1.2	Battery backup time		2 Hours
1.3	Battery type		Ni-Cd
1.4	Fluorescent Lamp		2x10 W
1.0	24V supply module		
1.1	Application		For maintenance purpose in TG Hall, Deaerator, Boiler platforms, ESP
1.2	Type		Fixed/ Portable
1.0	24V Hand lamp unit		
1.1	Lamp wattage		40W
1.2	Cable size & length		1.5 sq. mm, 15 meter
1.0	Exit Lamp		
1.1	Application		For safe exit of personal
1.2	Battery backup time		30 Minutes
1.3	Battery type		Ni-Cd
E	LIGHTING FIXTURE DETAILS		
	Applicable standard		Indian Standards
1.0	Fluorescent fixture		
1.1	Fluorescent fixture type		Energy Efficient T5 type
1.2	Fluorescent amp		28W
1.3	Fluorescent fixture application		CCR, CER, Switchgear/ Charger/ UPS rooms, cable vault, office area, Conference rooms, Battery rooms, AC

2 X660MW ENNORE THERMAL POWER PLANT

			plant, Air washer rooms, Labs, Corridor & passage etc.
1.0	HPSV fixtures		
1.1	HPSV fixtures type		As per requirement
1.2	HPSV lamp	Watt	70, 150, 250, 400 Watt
1.3	HPSV fixture application		TG Hall, Boiler/ESP platforms, Boiler area, Mill area, ID fan area, DG room, Compressor house, Pump houses, Outdoor lighting, street lighting etc.
1.0	HPMV fixtures		
1.1	HPMV fixtures type		As per requirement
1.2	HPMV lamp	Watt	125 Watt
1.3	HPMV fixture application		Only in hazardous area
1.0	CFL fixture		
1.6	CFL fixture		As per requirement
1.2	CFL lamp	Watt	As per requirement
1.3	CFL fixture application		DC emergency lighting, Corridor & passage etc.
F	Receptacles		
1.1	Material		Sheet steel
1.2	Thickness	mm	1.6
1.3	Type		Hot dipped galvanised
1.4	Degree of Protection		IP:55
1.5	Receptacles type & rating		
	RA Type (Industrial type)		20A, 240V
	RB Type (Decorative type)		5/15A, 240V
	RC Type (Welding Receptacle)		63A, 415V
G	Junction Boxes		
1.1	Material		Sheet steel
1.2	Thickness	mm	2
1.3	Type		Hot dipped galvanised
1.4	Degree of Protection		IP:55
H	Rigid steel Conduits		
1.1	Material		Hot dipped galvanized
1.2	Type		Medium duty
1.3	Minimum dia	mm	20
1.4	Size	mm	20, 25, 40, 50 mm

2 X660MW ENNORE THERMAL POWER PLANT

1.5	Conduit Thickness	mm	1.6mm upto 25 mm dia 2.0 mm above 25 dia
I	Flexible Conduits		
1.1	Material		Cold rolled annealed and electro galvanized mild steel strips coated with PVC
1.2	Type		electro galvanized
1.3	Size	mm	20
J	Lighting wires		
1.1	Voltage grade	V	1100
1.2	Size	mm sq.	1.5, 2.5, 4.0 sq. mm Lighting panel to Fixtures-1.5 sq. mm Lighting panel to JB's/ Switches-2.5 sq. mm JB's/ Switches to Fixtures-1.5 sq.mm Lighting panels to receptacles- 4.0 sq. mm First receptacles to looping other receptacles-4.0 sq.mm
1.3	Conductor material		Copper
1.4	Insulation		PVC
K	Lighting poles		
1.1	Type		Tubular, Painted
1.2	Pole height	M	11/13 meter as per IS:2713

	2X660 MW ENNORE THERMAL POWER PLANT		Document Number: PE-DC-K27-558-E001
	<u>ANNEXURE OF DATASHEET</u>		Revision: 00
			Date:08-12-2014

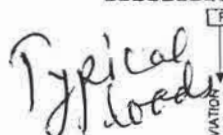
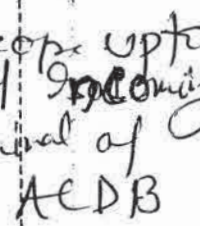
ANNEXURE-II

LIGHTING & LV POWER SERVICES IN DIFFERENT AREAS

S. No.	AREA	ACN	ACE	DCE	5/15A Socket	20A Socket	63/125A Socket	ELU \$
01	TG building	Y	Y	Y	Y*	Y	Y	-
02	Boiler platforms & boiler area	Y	Y	Y	-	Y	Y	-
03	ESP platforms & Mill area	Y	Y	Y	-	Y	Y	-
04	ID, FD & PA FAN area	Y	Y	Y	-	Y	Y	-
05	Transformer Yard	Y	Y	Y	-	Y	Y	-
06	ESP control room	Y	Y	Y	Y*	Y	Y	-
07	DG room	-	Y	Y	Y*	Y	Y	-
08	Compressor house	Y	Y	Y	Y*	Y	Y	-
09	Fuel oil area	Y	-	-	Y*	Y	Y	Y
10	Outdoor area	Y	-	-	-	-	-	-
10	Administrative building	Y	-	-	Y*	Y	Y	Y
12	Service building	Y	-	-	Y*	Y	Y	Y

LEGEND:

ACN:	AC Normal Lighting
ACE:	AC Emergency Lighting
DCE:	DC Emergency Lighting
Y:	YES
Y*:	YES, Only in control room, offices & toilets
\$:	Emergency Lighting Unit (ELU) & 5/15A Switch socket for ELU



TYPICAL LIGHTING PANEL

CHAPTER – 16

LV CABLES

1.00.00 CODES AND STANDARD

1.01.00 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS : 3961	Recommended current ratings for cables
IS : 3975	Low carbon galvanised steel wires, formed wires and tapes for armouring of cables.
IS : 4905	Methods for random sampling.
IS : 5831	PVC insulation and sheath of electrical cables.
IS:7098 (Part -I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100V.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Specification for drums for electric cables.
IS : 10810	Methods of tests for cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.
IEC-60754 (Part-I)	Test on gases evolved during combustion of electric cables.
IEEE-383	Standard for type test of Class IE Electric Cables.
IEC -60332	Tests on Electric cables under fire conditions.



	Part-3 : Tests on bunched wires or cables (category -B)
SS-4241475 classF3	Swedish Chimney test
NES-715-1	Temperature index

2.00.00 TECHNICAL REQUIREMENTS

- 2.01.01 The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground buried installation with chances of flooding by water.
- 2.01.02 Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.
- 2.01.03 Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.
- 2.01.04 XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250°C.
- 2.01.05 The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.
- 2.01.06 For single core armoured cables, armouring shall be of aluminium wires/ formed wires. For multicore armoured cables armouring shall be of galvanised steel as follows : -

Calculated nominal dia of cable under armour	Size and Type of armour
i) Up to 13 mm	1.4mm dia GS wire
ii) Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
iii) Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
iv) Above 40 & upto 55mm	1.4 mm thick GS formed wire / 2.5mm dia GS wire
v) Above 55 & upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
vi) Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire



2.01.07 The aluminium used for armouring shall be of H4 grade as per IS:8130 with maximum resistivity of 0.028264 ohm mm² per meter at 20 deg C. Aluminium armouring shall be same as indicated above for galvanized steel.

2.01.08 The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of G.S.wire/ formed wire

2.01.09 Cable Identification

1. Outer sheath shall be of PVC (of suitable grade) & black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

- (a.) Oxygen index of min. 21 (As per NES-715-1)
- (b.) Acid gas emission of max. 20% (As per IEC-60754-I).
- (c.) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTM D-2843.

2. Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:

- 1 core - Red, Black, Yellow or Blue
- 2 core - Red & Black
- 3 core - Red, Yellow & Blue
- 4 core - Red, Yellow, Blue and Black

3. For reduced neutral conductors the core shall be black.

4. In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.

- (a.) Cable size and voltage grade - To be embossed



(b.) Word 'FRLS' at every 5 metre - To be embossed

(c.) Sequential marking of length of the cable in metres at every one metre-
To be embossed / printed

The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.

5. Cores of the cables of upto 5 cores shall be identified by colouring of insulation. Following colour scheme shall be adopted.

1 core - Red, Black, Yellow, Blue

2 core - Red & Black

3 core - Red, Yellow & Blue

2.01.10 All cables shall meet the fire resistance requirement of IEEE - 383 with cable installations made in accordance with clause "Flammability test" and as per Category-B of IEC 60332 Part -3.

2.01.11 Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum over the declared value in the technical data sheets.

2.01.12 In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc, are not acceptable.

3.00.00 Cable selection & sizing

3.01.00 Cables shall be sized based on the following considerations:

- i. Rated current of equipment.
- ii. Maximum voltage drop limits under steady state and during starting for motor being fed from 415V switchgear restricted to 5% and 15% respectively.

Maximum voltage drop limits under steady state and during starting for motor being fed from 415V MCC restricted to 3% and 15% respectively.



Maximum voltage drop limits under steady state for feeder (i.e. Outgoing feeders being fed from 415V switchgear) restricted to 3%.

- iii. For cables to motors and feeders protected by MCCBs the cross section will be chosen according to the tripping time of MCCBs.

3.02.00 Derating Factors

Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:

- i. Variation in ambient temperature for cables laid in air
- ii. Grouping of cables
- iii. Variation In ground temperature and soil resistivity for buried cables.

3.03.00 Cable lengths shall be considered in such ways that straight through cable joints are avoided.

3.04.00 Cables shall be armoured type if laid in switchyard area, coal handling area or directly buried.

3.05.00 All LV power cables except trailing cables shall be XLPE insulated FRLS.

3.06.00 All control cables shall be 2.5 Sq mm copper cable.

3.07.00 Multicore control cables will generally have spare conductor (s) in accordance with the following chart and cores of a single cable will not be split for different auxiliary/equipment:

Conductors	required Cables
1 or 2	1-3/C
3 or 4	1-5/C
5 or 6	1-7/C
7 or 8	1-10/C
9 or 10	1-12/C
11 or 12	1-16/C
13 or 14	1-18/C
Above 14 core	Two or more of above cables



4.00.00 CONSTRUCTIONAL FEATURES**04.01.00 1.1 KV Grade Power Cables**

- (d.) 1.1 KV grade XLPE power cables shall have compacted aluminium conductor for cables including 10 sq. mm and above and copper conductor for cables below 10 sq.mm, XLPE insulated, PVC inner-sheathed (as applicable), armoured, FRLS PVC outer-sheathed conforming to IS: 7098. (Part-I).
- (e.) 1.1 KV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber (EPR) suitable for withstanding 90°C continuous conductor temperature and 250 deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968

4.02.00 1.1 kV Grade Copper Conductor Fire Survival Power Cables

- 4.02.01 1100 volt grade, 90 Deg.C rating, Power cables with stranded Copper conductor, heat resistance elastomeric insulation generally conforming to Type IE-2 of IS: 6380-1984, extruded Halogen free or very low Halogen elastomeric inner sheath, generally conforming to Type SE-3 of IS-6380-1984, round wire/strip armour and extruded outer sheath of elastomeric material generally conforming to Type SE-3 of IS: 6380-1984.
- 4.02.02 The cables shall be generally manufactured in conformity to IS-9968 Part-1/1988.
- 4.02.03 The cables shall be rated for 3 hours fire rating.
- 4.02.04 Conductor shall be of stranded construction, consisting of high conductivity annealed plain copper wires conforming to Class-II of IS 8130.
A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.
- 4.02.05 The insulation shall consist of heat resisting elastomeric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS:6380/1984 amended up to date.



4.02.06 The suitable fire retardant material fillers shall be used for filling in the interstices. Two layers of plain glass fiber binder tape shall be applied over the laid up cores.

4.02.07 Fire Survival Power & Control cables shall be provided for the following services:

- (a.) DC emergency lube oil pump.
- (b.) Turbine lube oil pump/barring gear.
- (c.) Jacking oil pump.
- (d.) Scanner air fan.
- (e.) Incoming & outgoing cables for DC lighting distribution board.
- (f.) Fire /smoke detection system.
- (g.) DC seal oil pump.
- (h.) DC emergency lighting cables for Main Plant Building.
- (i.) Batteries to charger and DC distribution board.
- (j.) Emergency turbine trip by push button in control room.
- (k.) Boiler turbine: Generator inter-trip which includes the interconnecting cables between
 - 1. Boiler master fuel trip and turbine trip relays
 - 2. Generator trip relays and turbine trip relays
 - 3. Generator trip relays and 400 kV circuit breaker
 - 4. Generator trip relays and generator field breaker.
 - 5. Generator trip relays and UAT breaker.

4.03.00 1.1 KV Grade Control Cable

Control cable shall be multi core, minimum 2.5 sq.mm cross section, stranded copper conductor, PVC insulated, inner PVC sheathed / galvanized steel wire armored and outer sheath made of FRLS PVC compound. In situation where accuracy of measurement or voltage drop in control circuit, warrant, higher cross sections as required shall be used. 4 sq.mm copper conductors shall be used for CT circuits, all other specification remaining same. In 4 sq.mm conductor impose unacceptable high burden on CTs, higher cross section of conductor shall be used.

Voltage Transformer leads shall be checked for voltage drop, which shall be limited to within 1 % for all cases other than tariff metering, for which the voltage drop shall be limited to 0.2 %. In case the voltage drop with 4 sq.mm Cu conductors exceeds this value, higher conductor sizes shall be used.



4.04.00 1.1 kV Copper Conductor Fire Survival Control Cables

- 4.04.01 Conductor shall be of stranded construction, consisting of high conductivity annealed tinned copper conductors conforming to IS 8130/1984 amended up to date.
- 4.04.02 A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.
- 4.04.03 The conductor insulation shall consist of heat resisting elastomeric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS:6380/1984 amended up to date.
- 4.04.04 An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour or any other natural colour with prior approval from Owner conforming to Type SE-3 of IS-6380/1984, amended up to date, shall be provided over the laid up cores.
- 4.04.05 The armouring over inner sheath shall consist of single layer of wire/round galvanized steel wire as per IS 3975 amended up to date.
- 4.04.06 The outer sheath shall be of special low smoke and very low Halogen content (Acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS: 6380 latest revision.
- 4.04.07 The colour of outer sheath shall be black or any other natural colour agreed mutually between Owner and Contractor.
- 4.04.08 The minimum sizes of L.T. cable to be chosen are as below:
AL-16 mm² (3 core) & Cu – 2.5 mm² (3 core)

In power cables maximum conductor size to be used will be 300 sq. mm & 630 sq.mm for multi core and single core cables. In case of multi core cables not more than 3 runs to be used or otherwise single core cable to be used.



4.05.00 Cable Drums

Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.

5.00.00 TESTS**5.01.00 Type Tests:**

5.01.01 The reports for the following type tests shall be submitted on one size each of LV Power cables :

S.No.	Type Tests	Remarks
a)	For Conductor	
1.	Annealing test	For copper conductor only.
2.	Tensile test	For aluminium conductor only.
3.	Wrapping test	For aluminium conductor only.
4.	Resistance test	
b)	For Armour Wires/ Formed Wires	
1.	Measurement of Dimensions	
2.	Tensile Test	
3.	Elongation test	
4.	Torsion test	For round wires only
5.	Winding test	For Formed wires only
6.	Resistance test	
7(a)	Zinc Coating test	For G.S. Formed wires /wires only.



7(b)	Wrapping test	For Al. Formed wires /wires
c)	For XLPE insulation & PVC Sheath	
1.	Test for thickness	
2.	Tensile strength & elongation tests before ageing and after ageing	
3.	Ageing in air oven	
4.	Loss of mass test	For PVC sheath only
5.	Hot deformation test	For PVC sheath only
6.	Heat shock test	For PVC sheath only
7.	Shrinkage test	
8.	Thermal stability test	For PVC sheath only
9.	Hot set test	For XLPE insulation only
10.	Water absorption test	For XLPE insulation only
11.	Oxygen index test	For outer sheath only
12.	Smoke density test	For outer sheath only
13.	Acid gas generation test	For outer sheath only
d)	For completed cables	
1.	Insulation resistance test (Volume resistivity method)	
2.	High voltage test	
3.	Flammability test as per clause "Flammability test"	
4.	Flammability test as per IEC - 332 Part-3 (Category -B)	



5.01.02 Flammability Test

- (f.) This test shall generally be carried out as per IEEE 383. The cable installation to be tested shall consist of as many cables as are necessary to give atleast 10 kg of organic material per metre run.
- (g.) The following cable installation shall be tested :
- (1.) Installation with single / multi core cables in touching formation.
- (h.) Size of cables, number of cables, number of layers and laying arrangements for each installation shall be subject to Owner's approval.
- (i.) The size of the cables selected (measured by total cross sectional area of the conductor) shall have maximum organic material per sq. mm of total cross sectional area of all the conductors.

5.01.03 Acceptance Tests

Acceptance tests shall be carried out on each type and size of the cables on the cable drums selected at random as per following sampling plan:

S. No.	No. of drums in the lot	No. of drums to be taken as sample
1.	Upto 100	10% (Subject to minimum of 1 drum)
2.	101 to 300	13
3.	301 to 500	20
4.	Above 500	32

The following shall constitute acceptance tests :

- Item No. 1 to 14, 16, 19, 20, 22, 23, 24, 25 of list of type tests specified in 9.03.01 of chapter 15.
- Fire resistance test as per SS 4241475 (F3 category)
- One length per size / lot for surface finish and length measurement
- Lay length / sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Band marking.

5.01.04 Routine Tests

Routine tests shall be carried out as per relevant standard for each drum of cables of all types and sizes.



CHAPTER - 11

LV SWITCHGEAR

1.00.00 CODES AND STANDARDS

IEC: 60947 - Low-Voltage Switchgear and Control gear

IS: 13947 (parts 1 TO 5) - General Requirements of Switchgear and Control gear For Voltage Not Exceeding 1000 V AC.

2.00.00 DESIGN CRITERIA

2.01.00 Power from Unit / Station LV service transformers will be supplied to 415 V switchgears. Power from 415 switchgears to the various PMCCs, ACDBs, MCCs, Emergency MCCs, etc. shall be supplied from redundant incomers. These switchgears will distribute power to LV auxiliary motors and also to other auxiliary loads viz. MCCs / ACDBs, etc. LV switchgears will be of metal enclosed indoor type. Incomers / bus-couplers, outgoing tie feeders rated above 400 amps and motor feeders rated 90 kW and higher, will be equipped with air circuit breakers of fault interrupting capacity of 50 KA rms. Lower rated feeders will be equipped with fully-rated MCCBs.

2.02.00 System Parameters

1)	Nominal system voltage	415 V AC	220 V DC
2)	Highest system Voltage	433 V	240 V DC
3)	Voltage variation	$\pm 10\%$	190 - 240
4)	Rated frequency	50 HZ	-
5)	Frequency variation	+3% to (-)5%	-
6)	One minute Power frequency withstand voltage		
	Main circuit	2.5 kV	2.5 kV
	Auxiliary Circuit	2.0 KV	2.0 KV
6)	System Earthing	Solidly Grounded	Unearthed



7)	Maximum system fault level	50 KA for 3 secs	25 KA for 1 sec
4.	Molded Case Circuit Breaker		
a)	No. of poles	TPN/TP	
b)	Short time current for 1 sec.	50 kA rms	
c)	Rated short circuit breaking current	50 kA rms	
d)	Rated short circuit making current	105 kA peak	
e)	Overload release setting	Yes	
f)	Short circuit release setting	Yes	
g)	Undervoltage release	Yes	
h)	Shunt trip	Yes	

2.03.00

Type

Circuit Breakers	Shall be air break, three pole, spring charged, and horizontal draw out type, suitable for electrical operation.
Switchgear	Fully draw out type single front
MCC	Fully draw out type single front/Double front.
ACDB/DCDB	Fixed type single front

2.04.00

List of minimum required LV switchgears**S.No Name of LV Switchboard**

1. UNIT PMCC
2. WT PMCC
3. P.H. ACDB
4. BUNKER FLOOR MCC
5. P.H.B. MLDB
6. VENTILATION MCC
7. AC MCC



8. BOILER MCC
9. SOOT BLOWER MCC
10. BOILER VALVE DAMPER MCC
11. MILL SYSTEM MCC
12. TURBINE AUX. MCC
13. TURBINE VALVE DB
14. BOILER ACDB
15. ESP # 1A PMCC
16. ESP # 1B PMCC
17. ESP # 1C PMCC
18. ESP # 1D PMCC
19. ESP ACDB
20. ASH SILO PMCC
21. HYDROGEN GEN PLANT MCC
22. SEA WATER PUMP HOUSE PMCC
23. WATER TREATMENT MCC
24. SWPH MLDB
25. SERVICE BLDG MCC
26. WORKSHOP ACDB
27. AIR CDM MCC
28. CHLORINATION MCC
29. CHP MCC
30. MLDB CHP
31. AHP PMCC
32. ASH SLURRY MCC
33. AHP WATER SYSTEM MCC
34. AHP MLDB
35. FIRE WATER PMCC
36. MLDB RFWF PHASE
37. DG SWGR1 AMF PANEL
38. UNIT NORMAL EMERGENCY PMCC
39. 415 AC ELDB
40. 415MLDB AWR PMCC
41. ADMIN BLDG. PMCC
42. MLDB ADMIN BLDG AREA
43. FUEL OIL UNLOADING PH PMCC
44. MLDB FOHS AREA



45. WATER SERVICE PMCC
46. DM PLANT MCC
47. ETP MCC
48. PRETREATMENT PLANT MCC
49. MLDB WATER SERVICE S/S
50. INTAKE RAW WATER MCC
51. CLARIFIED WATER PUMP HOUSE MCC
52. FD PRESSURISING AREA MCC
53. ESP STANDBY PMCC
54. RO Plant SWGR
55. ICHS Stage I SWGR
56. PIPE CONVEYOR END SWGR
57. Any other LV Switchgear not mentioned herein but required for safe and reliable functioning of the plant.
- 58.

3.00.00 TEMPERATURE RISE

The temperature rise of the horizontal and vertical busbars and main bus link including all power draw out contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg. C with silver plated joints and 40 deg. C with all other types of joints and busbars over an ambient of 50 deg C.

4.00.00 OPERATIONAL REQUIREMENTS

4.01.00 Automatic Reverse Closure

Automatic Reverse Closure (ARC) to the reserve supply source shall be provided for 415V unit essential service and other critical switchgears.

4.02.00 Breakers

- 4.02.01 Breakers shall have anti-pumping feature.
- 4.02.02 The incomer and bus coupler breakers for switchgear shall be electrically operated with over current releases or relays.
- 4.02.03 Breakers shall have inherent fault making and breaking capacities. They shall have shunt trip coils. In case releases are offered, the same shall have contact for energization of lockout relay. All breakers shall have built in interlocks for equipment and personnel safety.



- 4.02.04 Paralleling of two supplies shall be avoided by interlocking except for switchgear where auto-changeover is provided. Breaker contact multiplication, if required, shall be through latch relay.
- 4.02.05 Mechanical tripping shall be through red 'Trip' push button outside the panels for breakers, and through control switches for other circuits.
- 4.02.06 Provision of mechanical closing of breaker only in 'Test' and 'Withdrawn' position shall be made. Alternatively, mechanical closing facility should be normally inaccessible, accessibility rendered only after deliberate removal of shrouds. It shall be possible to close the door with breaker in test position.
- 4.02.07 Clear status indication for each circuit shall be provided through lamps, switch positions or other mechanical means.
- 4.02.08 Supervision relay shall be provided for trip coil monitoring.
- 4.02.09 All air circuit breakers (ACBs) and moulded case circuit breakers shall be of short circuit performance category as per IS: 13947.
- 4.02.10 The MCCBs shall be of current limiting type. When MCCBs are used as short circuit protection devices for motor modules they shall provide type 2 coordination with associated contactor and thermal overload relay as per IS: 8544 under all operating conditions for the all currents up to the design fault current. The MCCBs on upstream and downstream shall be coordinated. Test reports to prove the requirements of type-2 coordination shall be obtained.
- 4.02.11 The local start push button shall be connected to the DCS so that the drive can be started on checking the process permissive through DCS.
- First contact of STOP PB shall be hardwired directly to switch gear for tripping the drive. Another contact of local push button (Stop) shall be connected to DCS for alarming LPB latched condition in DCS.

4.03.00 Switches and Contactors

- 4.03.01 Motor starter contactors shall be of air break, electromagnetic type suitable for DOL starting of motor, and shall be of utilisation category AC-3 for ordinary and AC-4 for reversing starters. DC contactor shall be of DC-3 utilization category.
- 4.03.02 MCCBs shall be provided for short circuit protection. Isolating switches shall be of AC 23A category when used in motor circuit, and AC 22A category for other applications.
- 4.03.03 Isolating switches and MCCBs shall have door interlocks and padlocking facility.



4.03.04

Moulded case Circuit Breakers (MCCB) / Motor Protection Circuit Breakers (MPCB)

MCCBs shall be of three / four pole construction for panel mounting. The MCCBs shall be provided with front operating handles and mechanical ON / OFF indicators.

MCCB shall be provided with spring assisted quick-make, quick-break, current limiting type manually operated trip free mechanism, mechanical ON/OFF/TRIP position indicators, thermal tripping devices of inverse characteristics, instantaneous short circuit tripping devices and necessary auxiliary and alarm contacts. The MCCB module shall be provided with service, test and isolated position. The thermal and short circuit tripping device shall be adjustable type.

The MPCB's shall be in general similar to that of MCCB's in all the features mentioned above.

MCCBs/MPCBs shall be provided with overload thermal release setting range of 50% to 100% of rated current and adjustable short circuit magnetic release of 5 to 10 times rated current.

MCCBs/MPCBs shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relay settings of the motor starting equipment and the mechanical stress caused by the peak short circuit current of value associated with the switchgear rating. The maximum tripping time under short circuit shall not exceed 20 m.second. When used for motor circuit, shunt trip devices shall be provided and the let through power of controlling MCCB/MPCB shall be lower than the respective contactor, Contactor and overload relays shall be selected so as to withstand the let-through energy of the connected MCCB/MPCB in the feeder and consequent thermal and dynamic effects. All power feeder module MCCBs shall be equipped with earth fault release.

The DC circuits shall be provided with DC rated MCCB / MCBs.

MCCBs/MPCBs shall have following accessories and features:

- a) Shunt trip release
- b) Under voltage release
- c) Auxiliary contact for ON/OFF/ trip position
- d) Fault signaling contact
- e) Insulation shields to isolate the connection between each pole
- f) Finger protection plate to prevent accidental contact



g) The compartment door shall be interlocked with handle of MCCB/MPCB.

4.04.00 Panels

4.04.01 All switchgears, MCCs, DBs, panels, modules, local starters and push buttons shall have prominent engraved identification plates.

4.04.02 Local push button stations shall have metal enclosure of die cast aluminium or rolled sheet steel of 1.6mm thickness & shall be of Degree of Protection IP55. Push buttons shall be of latch type with mushroom knobs.

4.04.03 Operating height of the panels shall be maximum 1800 mm and minimum 300 mm from finished floor level.

4.04.04 Wherever breaker/starter module front serves as compartment cover, suitable blanking covers, one for each size of modules per switchboard shall be supplied for use when carriage is withdrawn.

4.04.05 All non-current carrying metal work of boards/panels shall be effectively bonded to earth bus of galvanized steel, extending throughout the switchboard/MCC/DB. Positive earthing shall be maintained for all positions of chassis and breaker frame.

4.04.06 Suitable trolley arrangement shall be provided for breaker/starter modules. Two trolleys per switchgear room shall be provided so that top most breaker module of all types, sizes and rating can be withdrawn on trolley and lowered for maintenance purpose.

4.04.07 The incoming connection to transformer of more than 1000 KVA and inter-connecting sections between switchboards shall be of busducts. The busduct enclosure shall be made of minimum 3mm thick aluminium alloy. The section of the busduct should have adequate strength to withstand internal and external forces resulting from the various operating conditions. Aluminium sheet hood shall be provided for outdoor busduct enclosure joints to provide additional protection against water ingress. The busduct top shall be sloped to prevent retention of water. The bus duct shall have DOP of IP55.

4.04.08 It should be possible to carryout maintenance on a feeder with adjacent feeders alive.

4.05.00 Control, Protection & Metering Requirements



- 4.05.01 Control circuits shall operate at suitable voltage of 110V AC. Necessary control supply transformers of 415/110 volts shall be provided for each module of MCC, with its connection after MCCB. However the breakers shall operate on 220V DC.
- 4.05.02 Contractor shall fully co-ordinate overload and short circuit tripping of breaker with upstream and downstream breakers/MCCBs motor starters. Various equipments shall meet requirement of Type-II class of coordination as per relevant IEC.
- 4.05.03 All relays shall be numerical and timers shall operate on available DC supply and not have any inbuilt batteries. They shall be provided with hand-reset operation indicator (flags) or LEDs with pushbuttons for resetting.

The relays shall have provision of both current and voltage inputs. The current operated relay shall have provision for 5 sets of CT inputs, 3 nos. for phase fault and 1 CT input for earth fault & 1 CT input for CBCT. Relay shall be suitable for both residually connected CT input as well as CBCT input. Relays shall be suitable for CT secondary current of 1 A / 5 A selectable at site. The voltage-operated relay shall have provision for 3 PT inputs. Relays shall be rated for operation on 110 V, VT secondary voltage. Relays used in Incomers and bus couplers shall have provision of two sets of voltage signal inputs for the purpose of synchronization.

All CT and PT terminals shall be provided as fixed type terminals on the relay to avoid any hazard due to loose connection leading to CT opening or any other loose connection. In no circumstances Plug In type connectors shall be used for CT/ PT connections.

All numerical relays shall have key pad / keys to allow relay settings from relay front. All hand reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote. Relays shall have suitable output contact for breaker failure protection.

Relays shall have self-diagnostic feature with self-check for power failure, programmable routines, memory and main CPU failures.

The numerical relay shall be able to provide supervisory functions such as, circuit breaker state monitoring, PT and CT supervisions and recording facilities with Post fault analysis



The numerical processor shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided.

Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping.

Numerical relays shall be capable of storing Minimum of 150 time tagged events/ records with time stamping. The numerical relays shall be able to store last 5 faults including the indication, waveforms, protection operated, fault location relay and operating time, currents, voltage and time. All Setting parameters, Fault data, waveforms & event logs shall be stored in Non-volatile memory only.

Sequence of events shall have 1 ms resolution at device level.

Measurement accuracy shall be 1 % for RMS Current and voltage.

Relay shall be immune to capacitance effect due to long length of connected control cables. Any external hardware, if required for avoiding mal operation of the relay due to cable capacitance shall be included as a standard feature. All IOs shall have optical isolation. Analog inputs shall be protected against switching surges, harmonics etc.

The alarm/status of each individual protection function and trip operation shall be communicated to DCS/Respective control system. The numerical relay system shall have built-in features/hardware interface to provide such inputs to Respective control system for analog/digital values.

Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC/ ANSI programmable characteristics.

Numerical relays shall have two level pass word protections, one for read only and other for authorization for modifying the setting etc.

Timer functions shall be programmable for on/off delays.



The protective relays shall have at least 10 nos. potential free contacts (Programmable) Auxiliary relays shall have contacts as required. Relay output contacts shall be suitable for directly wiring in the breaker closing and trip circuit operating from 220 V DC control voltage.

Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Interrogation voltage for the binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages.

No separate earth bus shall be required for the relays. It shall be possible to connect the relay earth to the common earth bus in the switchgear panel which shall be connected to the plant earth mat.

All protective relays shall be latest numerical type, having following features/functions:

- Protection functions as required
- IEC IDMT characteristics
- Measurements
- Event/fault/disturbance recording
- Binary input/output relays as required
- LEDs to indicate status of the relay
- LCD display for measurements, settings, faults etc.
- Key pad on the front of the relay
- Communication ports for transmitting settings, measurements, alarms, faults, events, disturbance records to DCS/Respective control system/SAS (Substation Automation System)
- Communication port for software setting/access measurements/maintenance/fault analysis
- Self-monitoring

All protective relays shall be latest numerical type with one USB port at the front for connecting to Laptop and one port (RJ45/FO port) at rear suitable for communication on IEC 61850 protocols.

The Numerical relays shall be networked through Ethernet switch, Gateway/Data Concentrators and shall be further integrated with SCADA based electrical monitoring system (for monitoring, measuring, fault data analysis & relay parameterization).



All necessary hardware including Managed Ethernet switches, accessories and licensed software shall be supplied by the vendor.

Ethernet switches shall be 'substation hardened' and shall comply with IEC61850-3 for communications and environment requirements. The Ethernet switches shall be of managed type with two (2) no. of fibre optic cable ports for ring network and Fourteen/Sixteen of Copper ports to achieve the LAN configuration. These switches shall be mounted inside the switchgear Panel.

The switchgear shall be provided with DC fail relay and DC fail indication lamp.

Breaker auxiliary contacts used for interlocking purposes shall be multiplied using electrically latched relay.

4.05.04 All equipments shall have necessary protections. However, following minimum protections shall be provided:

- 1) MCCB controlled motor feeders (all motors up to 90 kW)
 - a) Instantaneous short circuit protection on all phases through MCCBs rated for 80 kA rms (prospective breaking capacity at 415V).
 - b) Thermal overload relay in all the three phases with inbuilt protection against single phasing.
 - c) Instantaneous over current protection on all outgoing feeders.
- 2) ACB controlled motors feeders (motors rated above 90 kW) (protection relays shall be of numerical type)
 - a) Instantaneous short circuit protection on all phases
 - b) Overload protection on two phases
 - c) Over load alarm on third phase
 - d) Earth fault protection (sensitive earth fault detectors shall be provided in DC system to annunciator earth fault)
 - e) Under voltage protection
 - f) hand reset lockout relay
- 3) Incomers/bus coupler/outgoing breaker feeders other than motor feeders.
 - a) Definite time delay short circuit protection
 - b) Hand reset lockout relay



- 4) Incomer From DG Set.
- Differential Protection (87) - Three Pole
 - Reverse Power Protection.
 - Overload Alarm on one phase
 - Earth Fault Detection Relay (64) definite time delayed earth fault protection connected to transformer LV neutral CT (for Transformer Incomer feeder).
 - Voltage controlled over current relay
 - Generator under/over voltage Protection
 - Hand Reset Lockout Relay
 - 3-phase Digital Multifunction meter.

4.06.00 Meters / instruments

Plant electrical parameters shall be metered to the extent required for proper operation and monitoring of plant conditions. Current, voltage and watt-hours measured on each incomer and for each bus. Currents measured on each feeder. Voltage measured on each bus

All meters/ instrument shall be flush mounted on front panel, at least 96 sq.mm. size with 240 degree scales and accuracy class of 1.0. It shall have cramped scale above 2 times to 8 times the rated current for indicating the starting current.

4.06.01 All motors of 15 kW and above shall have an Ammeter. Bus-section shall have bus VT, voltmeter with selector switch, and other relay and timers required for protection. Ammeters shall also be provided for all critical drives such as AOP, jack oil pump, seal oil pumps etc., irrespective of ratings and can be decided during detailed engineering. Adequate control and selector switches, push buttons and indicating lamps shall be provided. Thermostatically controlled space heaters with switches shall be provided to prevent condensation.

4.06.02 Breaker controlled panel shall also be of remote controlled with following features:

Each feeder shall have local/remote selector switch. Closing from local shall be possible only in test position whereas closing from remote shall be possible in either service or test position. Tripping from local shall be possible only when local/remote selector switch is in local position. Tripping from remote shall be either breaker in service position or selector switch being in remote position.

4.06.03 Meters and Transducers for 415 Volts MCCs



For incomers feeders following Meters and transducers shall be provided:

- Current transducer on 'Y' phase
- Voltage transducer on 'Y-B' phase
- 1.0 class digital multi-function Meter.

For Bus Coupler following Meters and transducers shall be provided:

- Current transducer on 'Y' phase
- 1.0 class digital multi-function Meter.

For Bus PT following Meters and transducers shall be provided:

- Digital Voltmeter measuring all three phases
- Voltage transducer on three phases

For contactor motor feeders 15 kW & above following Meters and transducers shall be provided:

- Current transducer on 'Y' phase
- 1.0 class Analog meter on 'Y' phase
- Electronic overload relay with current display in switchgear.

For contactor motor feeders less than 15 kW following Meters and transducers shall be provided:

- Electronic overload relay with current display in switchgear.

Meters and Transducers for 415 Volts DBs

For incomers feeders following Meters shall be provided:

- Digital voltmeter measuring all three phases
- Digital ammeter measuring all three phases

For Bus PT following Meters shall be provided:

- Digital Voltmeter measuring all three phases

Energy accounting and audit meters shall meet CEA regulation. For details refer cl.7.00.00, chapter 1.

Transducers shall be of dual output type, class 0.5, 4-20 mA DC linear output & 750 ohm load.

Transducers shall be provided in all the buses so that algebraic summation in electrical system shall be Zero.

4.07.00

Control from Remote



Closing/ opening of the incomer and bus coupler breakers and starting/ Stopping of all motors/ outgoing feeders shall be from DCS/EDMS based control system through interposing relays only. The status (ON/OFF/TRIP), voltage and current of incomers & bus couplers shall be indicated in DCS/PLC. The required transducers shall be provided.

Necessary hardware shall be provided in the switchgear panel like coupling relays (24V DC, with max. burden of 2.5VA), auxiliary relays, current/voltage transducers (4-20 mA, dual output) etc. to effect interlocks, exchange information / status and exercise control from remote.

4.08.00 Normal/ Emergency (N/E) Switchgear

4.08.01 During auto changeover of the supply, the contactors in the affected bus would have dropped off. The services, which shall be restarted immediately and automatically without time lapse to keep unit running, are considered essential service. (For e.g. seal oil pumps, lube oil pumps, auxiliary cooling water pumps etc.). Such auxiliaries shall restart automatically after an auto changeover. These modules shall have additional hardware like timer, auxiliary contactors & associative circuitry in the module. Such essential services shall be identified during the detailed engineering stage & suitable module/Scheme shall be provided.

The modules of some of the critical application motors like baring gear motor, air heater motor, lube oil pump, jacking oil pump etc irrespective of their KW rating shall be provided with a CT, ammeter & a current transducer with remote metering in DCS.

Normal / emergency switchgear (N/E) shall be normally fed by 415V unit service switchgear & incomer from DG set will remain open. A bus coupler shall be provided in the N/E bus so that either DG set can feed the emergency loads.

The N/E switchgear shall be located adjacent to CCR.

5.00.00 DESIGN AND CONSTRUCTIONAL FEATURES

5.01.00 All 415V switchgear motor control centers (MCCs), ACDB, etc shall have following features:

- 1) Shall be of metal enclosed, fully draw out, indoor, floor mounted and free standing type.
- 2) Incomer modules and bus coupler modules of all the switchgear shall be fully draw out air circuit breaker type, controlled from local/ DCS/EDMS.



- 3) All frames and load bearing members shall be fabricated using mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 2 mm.
- 4) Frame shall be enclosed in cold rolled sheet steel of thickness not less than 1.6mm. Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary. Removable gland plates of thickness 3mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material) shall be provided for all panels.
- 5) All switchboards/panels shall be of dust and vermin proof. All cutouts shall have synthetic rubber gaskets.
- 6) For motors above 90 kW, remote controlled electrical circuit breakers (ACB), and for smaller motors and all other feeders, MCCBs shall be provided.
- 7) All switchboards, MCCs and DBs shall have following distinct vertical sections.
 - a) Completely enclosed bus bar compartment for horizontal and vertical bus bars.
 - b) Completely enclosed switchgear compartments (one for each circuit housing circuit breakers, motor starter or MCCB feeders).
 - c) Compartment for cable alley or cable box for power and control cables. In case of cable box, they shall be segregated with complete shrouding for individual feeders at the rear for direct termination of cables.
 - d) For cable connection to circuit breaker, a separately enclosed cable compartment shall also be acceptable.
 - e) Compartment for relays and other control devices associated with a circuit breaker, wherever necessary.
 - f) All 415 V switchgears, MCC's, AC & DC distribution boards etc. shall be painted by powder coating process. Paint shade for complete panels excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards.
- 8) Busbars shall be of high conductivity aluminium alloy suitable for required current ratings with maximum temperature rise of 40°C over design ambient



temperature for plain joints and 55°C for silver plated joints. The Busbars shall be provided with Double decker Lyra type contacts for better connection.

- 9) Minimum air clearance in air between phases and phase-earth shall be 25 mm for busbars and cable terminations. For all other components, the Clearances shall be at least 10mm. Wherever above is not possible except for horizontal and vertical busbars, insulation shall be provided by anti tracking sleeving or barriers. However for horizontal and vertical busbars, clearances specified above shall be maintained even when busbars are insulated/ sleeved.
- 10) Busbar insulators shall be of track-resistant high strength non-hydro- scopic, non-combustible type and suitable to withstand stresses due to over-voltages and short circuit current. Insulators and barrier of inflammable material such as Hylam shall not be accepted.
- 11) All numerical relays and timer shall be subject to Owner's approval. They shall be flush mounted with connections from inside, and shall have transparent & dust tight cover, removable from front, draw out construction for easy replacement and testing facility. The auxiliary relays and timer may be provided in fixed cases.
- 12) Maxi terminal /cage clamp type terminal blocks shall be provided for signals to be interfaced with DDCMIS. The details of interfacing with DCS/EDMS shall be referred in Annexure B, Volume V (C&I).
- 13) The switchgears/MCC shall be designed to offer adequate level of safety to operating/ maintenance personnel. Means shall be provided to prevent access to the live part to avoid accidents during service as well as maintenance period. Contractor shall bring out the safety means provided to achieve above. A detailed instruction plate suitable for wall mounting shall be provided for each switchgear/MCC room describing various safe operating procedure/safety precautions for safe operation and maintenance of switchgear/MCC.
- 14) All current and voltage transformers as required for metering & protection specified shall be completely encapsulated cast resin insulated type. Incomers from transformers shall have CTs for transformer REF protection. All current and voltage transformers as required for metering and protection specified shall



be completely encapsulated cast resin insulated type. Incomers from transformers shall have CTs for transformer restricted earth fault protection.

The accuracy shall be as follows:

	CTs	PTs
Protection	5P20	3P
Metering	1.0	1.0
REF	PS	

- 15) Indicating lamps shall be cluster LED type.
- 16) 20% spare feeders of each type used in the MCC with a minimum one (1) number on each bus section shall be provided.

5.02.00 **DC Distribution Board (DCDB)**

For feeding the DC loads, following DC switchboards shall be provided.

- a) 220VDC Main plant and Station Switch Board (one for each unit)
- b) 220VDC Coal Handling Plant Switch Board
- c) 220V DC 400 kV Switchyard Switch Board
- d) 220VDC Ash Handling Plant Switch Board
- e) 220VDC Raw water plant and RO Plant Switch Board
- f) 220VDC ECHS Switch Board

The switch board shall be provided with suitably rated incomers & bus couplers, required quantity and type of outgoing feeders for the auxiliaries, control supply to various panels / systems in accordance with the number of 220 VDC supplies enumerated in the respective equipment specification. For Each load and auxiliaries separate feeders shall be provided. In addition, the following feeders shall be provided in each switchboard.

- (a) Minimum of two nos. feeders of each type and rating as spare and the same is the minimum quantity at the time of handing over the plant. Any additional quantity required for increase/adjustment during detailed



engineering stage shall also be duly considered.

- (b) 1 No. switchboard for 230V single phase space heating modules.
- (c) 1 No. alarm module for common alarm of outgoing feeder fault.

05.02.01 Current Rating

The short circuit current rating of the switchboard shall be arrived considering the contribution from charger and battery with 5% margin, with minimum 25 kA

The continuous current rating of the bus bars, incomers, ties for 220V DC switchboards shall be the maximum DC load (excluding the momentary load) on the bus due to any operating condition, when unit system additionally feeds station system or vice-versa plus 20% margin rounded off to the next higher standard rating.

5.02.02 Specific Requirements

The constructional features of all DC switchboards shall comply with the requirements of 415V AC switchgear as applicable. DCDB shall be sectionalized and loads are to be distributed for easy maintenance and isolation during earth leakages.

Positive and negative bus bars in the DC switchgear shall be completely segregated from each other by sheet steel partitions.

5.02.03 Module details

(a) Incomer

The incomer modules shall be breaker controlled. Each incomer shall be provided with:

- Ammeter & voltmeter
- Earth fault relay with contact for remote indication (only for 220V DC switchboards)
- Under voltage relay with timer
- Indicating lamps for ON, OFF, earth fault, under voltage conditions
- One no. each of current and voltage transducers for remote indication
- Necessary hardware and circuitry for fault alarm, lamp test and reset.



(b) Outgoing feeders and tie Feeders/bus coupler

These feeders shall be provided with suitably rated DC MCBs with feeder on and fault indicating lamps.

The feeders rated 200 Amps and above shall be provided with a shunt and ammeter.

(c) Motor modules

(i) The motor starters shall be housed within DC switch boards. Separate DC starter panels are to be provided near the Motors. The starting current of the motor shall be limited to 200 % of full load current.

(ii) The motor modules shall be provided with:

- Switch, fuses, air break contactors
- Thermal overload relays
- Starting resistors with associated timers
- ON, OFF, FAULT indicating lamps.
- Necessary auxiliary contactors for fault alarm circuit
- 230V space heating circuit
- ON, OFF PBs for testing purposes
- One shunt with ammeter and one shunt for remote indication (if required)
- Appropriate circuitry for receiving the ON, OFF commands from remote panels/systems, interlocks, etc.
- MCB for space heating circuit

(d) Space Heating Module

230V, 1 space heating module shall be provided with incoming side switch fuse, suitably rated 415/230V cast resin type transformer (expected heating loads of the switchgear and the connected motors + 30% margin), secondary fuse, supply indicating lamp and connection to space heating buses. The 415V power supply for these modules shall be obtained from the unit service switchgear.

5.02.04

Technical Requirements Table

(a) DCDB Details



- (i) Ref ambient temperature : 50 deg C
- (ii) Degree of protection for enclosure IP54 enclosure
- (iii) Type of construction Indoor, single/ double front, non draw out type

(b) Alarm module

- (i) Alarm module for outgoing feeder faults shall be provided with switch fuse, alarm accept, reset PBs, 'supply ON' lamp, 'fault detected' lamp, hooter, necessary auxiliary contactors, control circuit for detecting, annunciating, accepting, resetting the fault in any module of the particular bus section. Contacts from this module for common feeder fault and its own module supply failure shall be provided and used for annunciation in control desk.
- (ii) Alarm module for incomers/bus coupler faults shall be similar to the above except that it shall work on 230V AC supply.

5.02.05 Control room alarms/indications/SER points

(a) Following indications /alarms shall be available in the control room OWSSs.

- Incomer, bus coupler, ties – ON & OFF
- Incomer current
- Alarm module supply failed
- Outgoing feeder fault
- Incomer alarm supply fail
- Bus under voltage
- Bus earth fault
- Bus voltage

- (b) For the annunciation in control desk, alarms of a particular bus shall be grouped as one window. The requirement of contacts to SER shall be duly considered and provided.



- 5.02.06 Metering
1. All meters / shunts / transducers in DC system shall be class 1.00 only
 2. Ammeters shall be provided on all incomer to DCDB with remote indication at UCR / DCS
 3. Center Zero Voltmeters with Earth fault detection relay shall be provided in Bus PT of DCDB with remote indication at UCR / DCS.
 4. Center zero ammeters shall be provided on bus coupler and ties
 5. Charger DC output ammeter and voltmeter shall be provided with remote indication at UCR /DCS.

6.00.00 INSTALLATION

- 6.01.00 This shall be applicable to all LV switchgear panels, MCCs and other power & lighting distribution boards, DCDB, etc.
- 6.02.00 Manufacturer's instructions, drawings and instructions of the Site Engineer shall be strictly followed during handling, erection, testing and commissioning of the switchgear. The switchgear shall be handled with care, avoiding impact to the equipment by using experienced riggers under the guidance of a competent supervisor. Dragging of the panels shall be avoided and use of a crane and trailer shall be made for handling purposes while transporting to various sites. The switchboard shall be properly supported on the truck or trailer by means of ropes to avoid any chances of damage or tilting due to heavy vibration. The switchboards should be lifted by making use of lifting eyebolts only, fully tightened after ensuring that panel supports, nuts and bolts are all intact and tightened. When panels are to be lifted in packed conditions, utmost care shall be taken to avoid any damage to insulators, bushings, metering and protective equipment. The panels shall preferably be kept inside the packing cases till foundations are ready.
- 6.03.00 Base channels shall be grouted, leveled, in cement concrete pad for 415 V switchgear panels and other cubicle panels. Pedestal type panels and MCCs shall be erected by grouting base channels by bolts. A proper bonding surface should be made by chipping the floor while making cement concreting. All foundations, grouted bolts shall be cured for a minimum period of 48 hours.
- 6.04.00 The switchboard panels should be taken out from the packed cases and moved one by one to a proper place. All the panels should be assembled aligned leveled and it



should be ensured that panel to panel coupling bolts, bus bars links fit properly without any strain on any part. It should also be checked up that lowering, lifting, racking in and out operation of the breaker and all other motions are free from any obstruction. The fixing bolts should be grouted only after satisfying all these requirements.

- 6.05.00 LV switchgear panels can be tack welded at suitable intervals for each shipping section.
- 6.06.00 After completion of the panel erection, all the cubicles should be cleaned and checked for tightness of all the components. All loosely supplied items shall be fitted up. All the wiring connections should also be checked with drawings and tightened. Metering and protection C.Ts. alarm, indications and protective relays should be fitted up. Phase sequence & polarity of PTs and CTs should be checked. Contact resistance of all busbar joints should be checked up. Every part or insulator should be checked for any possible damage. All the starters, switches, contacts should be cleaned using carbon tetrachloride. Silver tipped contacts should be checked for easy and free movement. Hinges of panel doors should be lightly lubricated to give free and noiseless movement. All openings shall be kept completely closed to avoid ingress of any foreign particles inside the panel.
- 6.07.00 Individual feeder functional scheme verification should be carried out and minor wiring modifications in the panel wirings, as per requirement at site, should be done as per the directions of TANGEDCO Site Engineer.
- 6.08.00 In case the switchgear is wet or having a low IR value due to bad wiring, insulators, bushings or any other insulated parts, the entire switchgear should be dried-up according to the instructions of the Site Engineer and the IR value should improve to a safe level for commissioning the same. Care should be taken to protect the surrounding insulation from direct local heating during the drying up process.
- 6.09.00 All the control wiring, PTs, bushings, busbars, other live parts of switchgear, and incoming and outgoing cables should be meggered with 500/1000V megger.
- 6.10.00 Electrical simulation tests should be carried out for all the protective, alarm and annunciation relays along with the manual operation of the circuit breaker.
- 6.11.00 Panels must be cleaned with vacuum cleaner.
- 6.12.00 All switchgear rooms shall be located on same floor (as far as possible) and shall have epoxy flooring.
- 6.13.00 Provision of store room shall be given in all switchgear rooms.



7.00.00 LIST OF TESTS TO BE CONDUCTED**7.01.00 ROUTINE TESTS**

The switchgear panel shall be subjected to routine tests in accordance with the relevant IS/IEC standards. The tests shall include the following:

- Power frequency voltage dry test on the main circuit
- Voltage test on control and auxiliary circuits
- Measurement of resistance of the main circuit
- Mechanical operating tests

The circuit breakers, contactors, switches, local push buttons, local motor starters, VTs, CTs and control transformers shall be subjected to routine tests in accordance with the relevant IS/IEC standards. Routine test reports shall be furnished by the Vendor for Owner's review.

For circuit breaker, the list of routine tests shall include the following:

- Dielectric tests on the main circuit
- Dielectric tests on the control circuit & auxiliary circuit
- Measurement of the resistance of the main circuit
- Mechanical operating tests
- Design and visual checks

7.02.00 TYPE TESTS

The following type test certificates on each type & rating of L.V. switchgear, MCC panel and distribution boards shall be submitted.

- (a.) Short time withstand test with circuit breaker mounted inside the switchgear panel.
- (b.) Temperature rise test.
- (c.) Type II - Short circuit co-ordination test for any three ratings of MCC module as selected by the Purchaser.
- (d.) Test sequence -1 & combined test sequence shall be carried out on each rating of circuit breaker mounted inside the panel.



7.03.00

(e.) Degree of protection tests

Site Tests

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

a) General

- Check name plate details according to specification
- Check for physical damage
- Check tightness of all bolts, clamps and connecting terminals
- Check earth connections
- Check cleanliness of insulators and bushings
- Check heaters are provided
- HV test on complete switchgear with CT and breaker/ contactor in position
- Check all moving parts are properly lubricated
- Check for alignment of busbar with the insulators to ensure alignment and fitness of insulators
- Check for interchange ability of breakers/ contactors
- Check continuity and IR value of space heater
- Check earth continuity for the complete switchgear board

b) Circuit Breaker/ Contactors

- Check alignment of trucks for free movement
- Check correct operation of shutters
- Check slow closing operation (if provided)
- Check control wiring for correctness of connections, continuity and IR values
- Manual operation of breakers completely assembled
- Power closing/ opening operation, manually and electrically at extreme condition of control supply voltage
- Closing and tripping time
- Trip free and anti-pumping operation
- IR values, resistance and minimum pick up voltage of coils
- Simultaneous closing of all the three phases
- Check electrical and mechanical interlocks provided



- Checks on spring charging motor, correct operation of limit switches and time of charging
- Check SF6 pressure/ vacuum (as applicable)
- All functional checks

c) Current Transformers

- Insulation resistance between windings and winding terminals to body
- Polarity tests
- Ratio identification checking of all ratios on all cores by primary
- injection of current
- Magnetisation characteristics and secondary winding resistance
- Spare CT cores, if any to be shorted and earthed

d) Voltage Transformers

- Insulation resistance test
- Ratio test on all cores
- Polarity test
- Line connections as per connection diagram

e) Cubicle Wiring

- Check all switch developments
- It should be made sure that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked
- Insulation resistance of all wires with respect to earth
- Functional checking of all control circuit e.g. closing, tripping interlock, supervision and alarm circuit including proper functioning of component/ equipment
- Check terminations and connections
- Wire ducting
- Gap sealing and cable bunching



f) Relays

- Check internal wiring
- Insulation resistance between all terminals and body
- Insulation resistance between AC and DC terminals
- Check operating characteristics by secondary injection
- Check minimum pick up voltage of DC coils
- Check operation of electrical/ mechanical targets
- Check CT connections with particular reference to their polarities for differential type relays
- Relay settings

g) Meters

- Insulation resistance of all insulated portions
- Check CT and VT connections with particular reference to their polarities for power type meter



Structural Design Concepts shall be designed as described in Volume VI.

9.6 **Fill Supporting Arrangement**

The supporting of the fill is to be achieved by a series of precast RCC columns arranged in suitable grid spacing and precast beams in orthogonal directions. Loads from fills, hot water ducts, pipes including water load, wall blocks etc shall be considered for column design. To take care of horizontal loads due to seismic and thrust from hot water header, a suitable system of vertical bracings is to be designed and provided in either direction.

Concrete which is impermeable to water is to be used for all components, including reinforced concrete components. The composition of the concrete and the cement are to be chosen depending on the chemical analysis of the cooling tower water/cooling tower make-up water.

9.7 **Aviation warning lights**

In accordance with official regulations, aviation warning lights are to be installed along the perimeter of the NDCT structure. Operating and reserve aviation warning lights are to be positioned next to each other. They are to be connected to completely separate power circuits and to be monitored by relays.

The obstruction lighting shall be done as per Appendix 6 figure 6.2 of ICAO i.e combination of low intensity (Multi LED type-B) & medium intensity (Multi LED Type). The life of the fittings shall be 20 years maintenance free. Total low intensity fittings 12 nos. (1/4 level & 3/4 level) & medium intensity fittings (1/2 & tope level). The aviation lighting shall meet the recommendations of ICAQ and Director General of Civil Aviation, India. The Aviation warning lighting system shall also conform to the latest Indian Standard IS :4998.

Lights should be installed in a manner to ensure an unobstructed view of at least two lights by a pilot approaching from any direction.

The minimum number of lights shall be as indicated below depending on the diameter:

- 20 feet (6 m) or less : 3 lights per level
- Exceeding 20 feet (6m) but not more than 100 feet (31 m) : 4 lights per level
- Exceeding 100 feet (31 m) but not more than 200 feet (61m) : 6 lights per level.
- Exceeding 200 feet (61m) : 8 lights per level.

Structures exceeding 600 feet (183 m) should have a second level of light units installed approximately at midpoint of the structure and in a vertical line with the top level of lights.

The technical requirements of aviation warning lighting, lightning protection system, earthing, lighting, and cabling etc. shall be as described in Volume-IV.

9.8 **Guaranteed Particulars**

The contractor shall guarantee the following parameters.

9.8.1 **Cold water temperature**

At the design point of the cooling tower, the cold water temperature guaranteed by the Contractor in accordance with the guarantee curve (cooling tower characteristic diagram) shall be achieved. The fundamental parameter for the design value of the cold water temperature during acceptance measurement shall be the measured across the cooling zone width.



CHAPTER-19

ILLUMINATION SYSTEM

1.00.00 SCOPE OF WORK

The scope of work shall include complete supply, installation, testing, commissioning and putting into successful commercial operation of the lighting system for the entire plant covering all indoor & outdoor areas including street, area, periphery and yard lighting and offsite buildings like ICHS Stage I, Sea water intake plant at NCTPP Stage II etc.

The equipment and materials within the scope of supply shall include but not limited to:

- a) Lighting transformer.
- b) Lighting fixtures with lamps and accessories/LED type fixtures.
- c) Lighting panels/boards: Main lighting distribution boards, emergency lighting distribution boards, emergency DC lighting panels, lighting panels, street lighting panels etc. All panels shall be provided with Energy Saving System.
- d) Street lighting poles, flood lighting towers and high masts.
- e) Receptacles, switches, switchboards, portable emergency lighting unit, maintenance equipment etc.
- f) Cables, wires, splicing/termination kits/connection accessories.
- g) Conduit and accessories, junction and pull boxes, terminal blocks.
- h) Grounding materials and connections.
- i) All fittings, supports, brackets, anchors, clamps and connections.
- j) Steel for field fabrication of supports and brackets

Carrying out of detail engineering including detail design calculations, preparation of lighting layouts showing location of fixtures, cable wires and conduit, preparation of cable schedule, and other related drawings as detailed in subsequent clauses and also consider the Energy Saving System.

Furnishing of all labour, skilled and unskilled, supervisory personnel, erection tools and tackles, testing equipments, implements, supplies, consumables & hardware, and transportation for timely and efficient execution of the contract work.



Preparation of **AS-BUILT** drawings showing field modifications (if any).

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture and testing of equipment shall be carried out as per the latest Indian/International Standards, Indian Electricity Rules, Relevant Code of Practices and requirements of Govt. of Tamil Nadu.

2.02.00 Equipment/components conforming to the latest editions of Standards of the International Standard Institutions, Institution of Electrical & Electronic Engineers, USA (IEEE), National Elect. Manufactures Association, USA (NEMA) or International Electro-Technical Commission (IEC) will also be acceptable provided these are either equivalent or more stringent.

IS-1913	IS-1977	IS-10322	IS-8623	IS-6064
IS-8828	IEC-598	IS-9224	IS-2959	IS-1248
IS-2705	IS-4160	IS-2713	IS-800	IS-2026
IS-2099	IS-694	IS-1554	IS-9537	IS-5133

3.00.00 DESIGN CRITERIA

3.01.00 The lighting layout shall be designed to provide uniform illumination with minimum glare. The layout design shall meet all the statutory requirements, etc.

3.02.00 The system provides lighting and electric power supply to all plant areas covering both BTG, BOP, Outdoor areas (also including lighting of all main streets, approach roads to various buildings) and Offsite buildings and areas. In addition, it also provides lighting to selected areas during plant emergency conditions.

3.03.00 The system will be installed in an adverse industrial environment. Equipment in some areas will be subject to vibration, coal-dust and oil / water vapour's as prevalent in a thermal power generating plant.

3.04.00 The circuit loading on each circuit shall be restricted to 80% of the MCB rating.

3.05.00 All A.C. Normal and Emergency A.C. lighting shall be provided with Energy Saving System



3.06.00 The lighting system shall comprise of following sub-systems:-

i) Normal A.C. Lighting

- a) This will be provided by A.C. lighting fixtures distributed throughout the plant. These lights will be ON as long as the A.C. supply is available.
- b) A.C. lighting fixtures will be fed from respective area lighting panels, which in turn will be connected to main lighting distribution board. The main lighting distribution boards will be fed through respective lighting transformer, which forms a part of the MLDB. Normal A.C. supply thus made available by the MLDB is 415V-3ph-4W-50HZ effectively grounded. Both the MLDB and the lighting panels shall be provided with at least 20% spare outlets.

ii) Emergency A.C. Lighting

- a) On failure of normal A.C. Supply, emergency A.C. lighting will be provided in service building, areas of the powerhouse, boiler area, boiler galleries etc for general visibility, safe movements and operation of important auxiliaries.
- b) The emergency LDBs (ELDB) are similar to the MLDB except that lighting transformers in this case are fed from station A.C. Emergency bus having D.G. System backup. Thus power for A.C. emergency lighting is 415V-3ph-4W, 50HZ, effectively grounded.
- c) At least 20% of the fixtures shall be fed from AC emergency source.

iii) Emergency D.C. Lighting

- a) This will be provided by emergency A.C. /D.C. lighting fixtures located strategically in critical operating areas and emergency exits. About 10% of the fixtures that are fed from normal AC supply and upon its failure, be fed from 220 V DC supply. Emergency DC lighting will be catered by DC emergency lighting distribution (DCELDB) boards. These DCELDBs will feed the DC emergency lighting fixtures directly and through a numbers of DC emergency lighting panels (DCELP) located suitably in respective areas.



b) The DC Emergency Lighting Distribution Boards will be fed from two power sources, namely –

1. Emergency Main Lighting Distribution Board (EMLDB)
2. 220V DC distribution boards (DCDB)

c) These lights will be ON all the time – normally from A.C. supply, but on its failure from D.C. supply through automatic switching.

iv) Remote Emergency Lighting

This will be provided in isolated building/area/mobile equipments viz. Stacker-Reclaimer where AC emergency/D.C. supply is not available by self-contained battery/ automatic charger/inverter/flood light units. These portable emergency light units will energize automatically on loss of normal A.C. supply.

v) Street/Area Lighting

Time switch and photocell will be used for controlling streetlights with provision for manual override and also have the provision of latest Energy Saving Systems. Same arrangement will also be used for controlling coal yard.

vi) Receptacles

To cater to welding and other low voltage power requirement of the plant 63A TPN welding socket fed from MCC/A.C. distribution board of respective area shall be provided. For other services 15A, 3pin socket shall be provided.

4.00.00 SYSTEM PARTICULARS

System particulars are as follows:

		415V AC System Incoming	415V AC System Outgoing	240V AC System	220VDC System
4.01.00	Nominal Voltage	415V	415 V	240V	220V



4.02.00	Highest system Voltage	457V	457 V	264V	242 V
4.03.00	Number of phases	Three (3)	Three (3)	Single	NA
4.04.00	Frequency	50 Hertz	50 Hertz	50 Hertz	NA
4.05.00	Voltage variation	±10%	±10%	±10%	-15% to +10%
4.06.00	Frequency variation	±5%	±5%	±5%	NA
4.07.00	Combined voltage & frequency variation	10%	10%	10%	NA
4.08.00	Neutral earthing	Effectively	Solidly grounded	Solidly grounded	Un grounded grounded
4.09.00	Fault level	50 kA	9 kA	9 kA	25 kA

5.00.00 METHOD OF CALCULATION

- a) Standard Lumen method shall be adopted for interior & exterior lighting in order to determine the number of lighting fixtures for obtaining the desired average level of illumination.
- b) The coefficient of utilization shall be considered to take care of Lumen loss due to:
 1. Effect of room dimensions
 2. Absorption of light in luminaries
 3. Absorption of light at various room surfaces in ceiling, wall etc.
 4. Floor cavity, ceiling cavity
 5. Mounting height
- c) Additionally, a maintenance factor shall also be considered to account for the fall of illumination due to ageing, pollution like dust deposit etc. Maintenance factors to be considered for various areas shall be as follows :



<u>Area</u>	<u>Maintenance factor</u>
Air conditioned offices/control rooms : with false ceiling	0.75
Switchgear/MCC Rooms in TG : Building/Service Building	0.65
Other indoor areas :	0.6
Boiler area and other areas : prone to chemical/dust pollution	0.55

d) Utilization Factor

1. Dusty area such as conveyor galleries/tunnels, TPs/ Crusher House etc.
= 50% ceiling, 30% wall, 10% floor.
2. Clear areas such as switchgear room / control room etc. = 70% ceiling,
50% wall, 10% floor.
3. Working plain = a) At conveyor walkway level. B) At building floor level.

e) Lux levels and types of fittings to be considered for various areas are given in Annexure-1.

f) Voltage drop at the fixture from the LDB bus shall not exceed 3%.

g) Circuit loading of each lighting panel shall be done in such a way that almost balanced loading in all the phases i.e. R, Y and B is achieved.

h) At least two phases shall be used for illumination of a particular area. All control rooms & power house area like operating floor, Switchgear room, boiler area etc.

i) Sub circuit loading of each lighting panel shall be restricted to 2000W or 12 Nos. fixtures whichever is lower.

j) The working plane shall be considered at 0.85m from the floor level.

k) The suspension height for suspended fixtures shall not exceed 1 m.



6.00.00 GENERAL REQUIREMENTS

- 6.00.01 Equipment and material shall comply with description, rating, type and size as detailed in this Specification. All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards.
- 6.00.02 Equipment and materials furnished shall be complete and operative in all details.
- 6.00.03 All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.
- 6.00.04 All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.
- 6.00.05 All equipment and accessories shall have proper enclosure to suit the site conditions. Hazardous areas shall have flame-proof enclosure

6.01.00 Lighting Transformers

- a) Lighting transformers shall be dry type, indoor type dust and vermin proof having single phase, 415 V/433 V, off load tap-changer with $\pm 2 \times 2.5\%$ on primary side. The vector-group shall be Dyn11. (The secondary side shall be solidly grounded through an additional neutral bushing exclusively used for grounding.) Rating of each lighting transformer shall be selected to cater to the maximum connected lighting and receptacle load on that transformer. The casing of the transformer shall be grounded at least at two (2) points. Rating of each transformer shall be decided to limit the fault level within 9kA.
- b) Lighting Transformer shall be 2 x 100% for TG Building , Service building , Water treatment plant, ESP and Fuel oil pump house
- c) If necessary, apart from the main lighting transformers, separate small additional lighting transformers may be used at distance lighting points.

6.02.00 Lighting Fixtures

- a) Lighting fixtures shall be designed for minimum glare. The surface finish shall be smooth, unobtrusive and scratch resistant.
- b) Reflector shall be of sheet steel or aluminium, minimum 20 SWG thick, securely fixed by fastening device of captive type.
- c) Fixture shall be suitable for 20 mm conduit entry and 16 SWG G.I. earth-wire connections. Fixture shall also be suitable for case coupling entry wherever required.
- d) High bay fixtures shall have provision for vibration damper to ensure rated lamp life.
- e) Fixture shall be furnished complete with lamps and integrally/non-integrally or separately mounted control gear & accessories or applicable for different types of fixtures. These shall include holders, ballast, capacitor, starter, igniters (separate type) etc.
- f) Fixtures shall be fully wired up to respective terminal blocks, suitable for loop in and loop one connection of PVC wires of following sizes:-
 - 1. Lighting fixture : 2.5 Sq.mm Copper
 - 2. Flood Light fixture : 2x2.5 Sq.mm Copper
- g) The distribution of lighting fixtures/receptacles shall be such that the loading on each phase of the LDB is approx. equal.
- h) In indoor areas fixtures with suitable mounting accessories shall be used and shall not be directly mounted on walls.
- i) Search lights having adequate coverage shall be provided in watch towers

6.03.00**Lamps**

- a) General lighting service (GLS) lamps shall be with clear glass and screwed caps.
- b) All fluorescent lamp shall be bi-pin rotary type and cool daylight.
- c) Lamps shall be suitable for use in position and capable of withstanding small vibrations. Restrictions and special features, if any, shall be clearly indicated in the bid.
- d) CFL and T5 fluorescent tube with electronic ballast or tri phosphorous tube.



- e) Latest energy saving LED type lighting fixture/ lamps
- f) Light Emitting Plasma (LEP)

6.04.00 Ballast

- a) Ballasts shall be heavy duty, low loss, and polyester-filled type with copper winding.
- b) Ballasts shall be free from hum. Ballasts which produce humming sound shall be replaced without any implication.
- c) In multi-lamp fixture, each lamp shall be provided with individual ballast.
- d) Ballast windings shall have maximum operating temperature of 120 Deg.C without rated temperature rise marking.
- e) Ballast for Control Room Area shall be heavy duty, low loss, high-grade silicon steel stampings; vacuum impregnated polyester resin filled with copper winding. Ballast for other area shall be electronic type, flicker free pre heat lamp start type having power consumption less than 3-watts per ballast, power factor less than 0.98 and THD less than 10%. Ballast shall operate at operating frequency of more than 40 kHz. Power consumption of ballast for 36W Fluorescent Tube shall be less than 9.5W.

6.05.00 Lighting Panel/Distribution Boards

- a) Lighting Distribution Boards/panels shall be Fibre reinforced plastic (FRP) type, suitable for either wall/column mounting on brackets or floor mounting on channel sills.
- b) Indoor Lighting Distribution Boards & Lighting Panels shall be dust and vermin-proof, IP-54. Outdoor panels shall be weather-proof with canopy, IPW-55 or better. The cubicle housing transformer shall be minimum IP-42.
- c) Lighting Distribution Boards and Lighting Panels shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements.



- d) Lighting Distribution Boards shall have provision of cable entry from bottom and, panels shall have provision of cable entry from top and bottom, as required, with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminium cable lugs are to be furnished.
- e) Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Distribution Board and Lighting Panel for connection to 25 x 3 mm G.I. flat.
- f) Each Lighting Distribution Board shall be complete with designation and caution notice plates fixed on front cover and a directory plate fixed on inside of the front cover. This directory Plate shall contain details of the Lighting Panels being fed from the Distribution Board including their designation, location, loading etc. Each Lighting Panel shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of each circuit. The plates shall be of anodized aluminium with inscriptions indelibly etched on it.
- g) Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85°C. Minimum size shall be 25 x 6 mm.
- h) Board / Panel shall be fitted with phase barriers such that it is not readily possible for personnel to touch the phase busbars. Insulation barriers shall preferably be fitted around the circuit breakers such that only the surface and the toggle of the circuit breaker are available on the front.
- i) Incoming and outgoing circuits shall be terminated in suitable terminal blocks.
- j) In lighting and receptacle panel 3-phase and 1-phase MCB should not be mixed.

6.06.00**Receptacles**

- a) Receptacles shall be heavy duty, complete with individual plug and switch.
- b) The conduit box of the receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding with 16 SWG G.I. wire.



Arrangement shall be provided inside the conduit box for grounding of third pin.

- c) Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.
- d) Receptacles shall be of following types:
 1. Type RA-5A, 240V, 2 pole, 3 pin type with third pin grounded, suitable for flush mounting in MCC Room, office areas, control rooms, store rooms, cabins etc. The switch shall be of piano-key type, also flush mounted and decorative non-industrial type.

In service building and administration building all the occupants shall be provided with 4 nos. of 5A, switches and telephone point in the modular furniture.

2. Type RB-15A, 240V, 2 pole, 3 pin Industrial type with third pin grounded, metal clad with gasket having 19mm conduit entry and a metallic screwed cover tied to it with a metallic chain and suitable for installation in clean/dusty areas. The receptacles located in switchgear rooms, MCC rooms and control room shall have IP-42 degree of protection and those located in other dusty areas shall have IP-62 degree of protection. These receptacles shall be located at an interval of 50M along length of conveyor gallery/tunnel starting from one end and both sides of Track Hopper. Minimum one (1) no shall be provided in all equipment floor, feeder floor, boiler drum level, TPs Crusher House, Sub-station, Control Room, Pump House, Transformer Room, various levels of service building, RO plant, and at suitable location in all other areas as required. In fuel oil area receptacles will be of flameproof type.
3. Type RC-63A, 415V, 3 phase, 4 pin Industrial type interlocked plug and switch with earthing contact. Other requirements shall be same as Type RB. Interlocking shall be so selected that the switch can be put to 'ON' position only when all the four (4) pins of the plug are housed with complete alignment. In 'OFF' position of the switch the socket outlet shall be completely dead and outgoing terminals isolated. Welding receptacles shall be connected with each other in loop-in loop-out connection to the extent of 4 Nos., located at an interval of 50 M. along the length of conveyor gallery/tunnel starting from one end and both sides of Track Hopper and minimum one (1) no. shall be provided in all equipment floor, T.Ps, crusher house (2 nos. on each floor of crusher house) , wagon tippler, stacker



reclaimer machines, pump houses, substation buildings & Cable spreader room, transformer room, boiler platform, switchgear/ MCC rooms, Transformer yard, cooling tower, etc. Separate distribution boards with isolating transformers shall be used to feed these welding receptacles. At least one (1) no. shall also be provided in each offsite building, which will be fed from 415V MCC. In hazardous areas these receptacle shall be located in MCC rooms.

4. 400A, 415 V, 3 phase, 4 wire receptacles for Transformer filtration unit shall also be provided with MCCB and earthing arrangement.

6.07.00**Fans & Regulators**

- a) Ceiling fans shall be provided in non-air conditioned cabins and in various areas inside the administration building canteen, security building etc. The number of such fans shall be decided based on room size.
- b) The fan shall have three well balanced blades and shall be reasonably free from noise. Pedestal fans shall also be provided as per Owner's requirement.
- c) Fan motor shall be totally enclosed type with copper winding & class E insulation.
- d) Regulator shall have minimum five steps. Electronic regulator with smooth control is preferred.
- e) Fans and accessories shall be provided for the Local control rooms in addition to the Air Conditioning

6.08.00**Switch & Switch Board**

- a) Modular Switches, miniature circuit breakers (MCB), bus bars shall be fully rated for short circuit level at the point of application. MCB shall have back-up HRC fuse if its rating is less than the available short circuit current.
- b) All switch boards/boxes shall be of bent steel construction, fabricated of 14 SWG M.S. sheet with 6 mm thick Bakelite cover.
- c) Switch boards/boxes located in control room and office areas shall be flush mounted type on brick wall with only the switch knob projecting outside.



- d) Switch boards / boxes shall have conduit knock outs on the sides. Adequate provision shall be made for ventilation of these boxes.
- e) Flush type receptacles where provided shall be so located that only the plug projects outside.
- f) Switches shall have quick-make and quick-break mechanism operated by a suitable external handle complete with position indicator.
- g) Occupancy switches shall be provided in service building.

6.09.00 Maintenance Equipment

- a) The Contractor shall supply one (1) no. mini truck mounted adjustable hydraulic lift for the maintenance of street lights.
- b) For the maintenance of lighting fixtures within the high bay areas, the contractor shall also supply four (4) nos. free standing adjustable aluminium ladder, adjustable from 5m. To 10m.
- c) Three (3) nos. portable aluminium ladders of various sizes suitable for main control room, switchyard control room, etc

6.10.00 Special Requirement

- a) All outdoor illumination fixtures, unless it is fed from photo cell time switch controlled lighting panel, has to be provided with outdoor type local switches.
- b) In all the air filtration units and air handling units, one marine type lamp (of 100 Watt approx.) shall be supplied the wiring and fixing of the same has to be done by the contractor.

6.11.00 Conduits and Accessories

- a) Conduits shall be rigid steel, hot-dip galvanized, furnished in standard length of 3 metres, threaded at both ends.
- b) Conduits upto and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.
- c) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.



- d) Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanized mild steel strips and coated with PVC.

6.12.00 Junction Box

- a) Junction boxes shall be of 16 SWG sheet steel hot-dip galvanized, dust and damp proof, generally conforming to IP-66.
- b) Junction boxes shall be complete with gasket inspection cover, conduit knock out/threaded hub and terminal blocks.
- c) Junction boxes for outdoor use shall be FRP weatherproof IPW-66 and those for hazardous location shall be flame-proof type.
- d) Junction boxes shall have following indelible markings :
1. Circuit nos. on top
 2. Circuit nos. with ferrules (inside) as per drawing
 3. DANGER sign in case of 415V circuit

6.13.00 Lighting Cables & Wires

6.13.01 All wiring from lighting panels to fixtures and receptacles shall be carried out by PVC wires in G.I. Conduits.

6.13.02 Heavy duty AYWY FRLS cables will be used only for connections:

1. From main lighting distribution boards to area lighting panels
2. From street/area lighting panel to street light poles/towers.
3. From 415V MCCs to receptacles of 63A and above.

6.13.03 Lighting Cable shall be heavy duty, 1100 Volt grade, multi-core stranded aluminium conductor, PVC insulated, extruded PVC inner sheath, single round G.I. wire armoured and overall PVC sheathed conforming to IS 1554.

6.13.04 Lighting wires shall be 1100 Volt grade, PVC insulated, stranded conductor, single core cable conforming to IS 694, colour coded as below :

RED for R-Phase

BLACK for Neutral

YELLOW for Y-Phase

WHITE for +Ve D.C.



BLUE for B-Phase

GREY for -'Ve D.C.

6.13.05 Wire size shall be as follows:

For point wiring beyond lighting panel : 10 Sq.mm. Aluminium.
i.e. from lighting Panel to junction Stranded conductor
box (main run)

From Junction box to lighting fixture : 2.5 Sq.mm. Copper.
Stranded conductor.

6.14.00 Terminals

6.14.01 Multi way terminal blocks of approved type, complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires.

6.14.02 Each terminal shall be suitable for connection upto 2 nos. 10 Sq.mm stranded aluminium conductors without any damage to the conductor or looseness of connectors.

7.00.00 ENERGY SAVING SYSTEM**7.01.00 Panels**

The energy saving system panel shall consists of loss less reactance coils with voltage tapping, contactor to select the tap, Micro-processor based TIMER along with real time clock for activating the contactor at a pre-set time. The unit shall be programmable so that at a pre-set time contactor on the lower voltage tap can be selected and reduced voltage can be applied across the circuit. It shall also be possible to modify the setting at site, if required. The capacity of panels shall be 25/30 kVA or more as required. This system shall be incorporated in normal AC panels and Emergency AC panels.

7.02.00 Lamps

Latest energy saving LED type lighting fixture/ lamps and/or CFL and T5 fluorescent tubes with electronic ballast or tri-phosphorous tubes or Light Emitting Plasma.

7.03.00 Board/Panel Equipment

- a) Each board shall consist of 2 x 100% dry type transformer housed in the different cubicles voltmeter with selector switch, C.T. operated ammeter and incoming triple pole switch. Outgoing feeder from the Lighting Distribution Board shall have MCCB.
- b) Each lighting panel shall have an incoming triple pole switch with neutral link and a number of outgoing miniature circuit breakers (MCB).
- c) Board/Panel access door shall be interlocked with incoming switch unit such that the door can be opened only when the switch is in OFF position. Means shall be provided to defeat this interlock.
- d) Contactors shall be air-break electromagnetic type. Push buttons shall be push to actuate type.
- e) MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.
- f) Time switch in street lighting panels shall be photocell type with automatic voltage stabilizer and necessary electronic unit with provision for sensitivity adjustment depending on external light intensity. When the exterior illumination level shall fall below a preset value for a considerable period of time (adjustable 30 sec. to 180 secs.) the electronic unit shall generate signal for the output relay to pick-up and potential-free contact of the same shall be used for control of contactor for lighting system. Sustained normal illumination level being restored (adjustable 30 sec. to 180 sec.) the lights shall switch off.
- g) Voltmeter / Ammeter shall be of accuracy class 2.0 or better as per IS: 1248 Voltmeter / Ammeter selector switch shall be of reputed make.
- h) Each lighting panel shall be provided with adequate number of outgoing LCBs/MCBs for controlling fixtures. 5A, 3Pin sockets shall be fed from the lighting panel through separate circuits.

8.00.00**LIGHTING POLES/TOWERS**

Suitable number of Flood Lighting Towers / Lighting Masts with adequate metal halide Flood Light or LEP (Light Emitting Plasma) will be provided for crushed coal



pile, and other necessary outdoor areas.

The fixtures shall not be fixed to gantry structures in outdoor areas.

8.01.00 Street Light Poles

a) Street light poles shall be swaged and welded steel pole, complete with fixing brackets, weather-proof junction box and all other accessories.

b) The pole shall be coated with bituminous preservative paint on inside as well as embedded outside surface. Exposed surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in synthetic medium).

8.02.00 Flood Light Tower

a) Flood light tower shall be a lattice structure with maintenance platform and approach ladder. All structural members and hardware shall be hot-dip galvanized.

b) Structures shall be designed for an additional load of 1500kg for maintenance crew. Deflection under maximum wind pressure shall not exceed 1 in 360. Structural design shall be as per IS-800 and subject to Owner's approval.

8.03.00 Lighting High Masts

a) Applicable standards

1. IS-875 (Part-III) 1987	-	Code and practice for design loads for Structures.
2. BSEN 10025/DIN 17100	-	Grade of M.S. Plates.
3. BS-5135/AWS	-	Welding
4. BS.ISO 1461	-	Galvanizing
a) TR. No. 7200 of ILE	-	UK Specification for Mast and foundation.

b) Structure

- Lighting High Mast shall be of continuously tapered polygonal cross section, at least 20 sided, hot dip galvanized and presenting a good and pleasing



appearance and shall be based on proven In-Tension design confirming to the standards referred to above, to give an assured performance, and reliable service. The structure shall be suitable for wind loading as per IS-875 Part-III, 1987. The masts dimensions shall be as per standards.

2. The Mast shall be of 30M height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless steel wire rope, in built power tool, luminaries, suitable aviation warning light, lightning along with necessary power cables within the mast. The mast shall be delivered only in three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast.

9.00.00 CHIMNEY LIGHTING

9.01.00 Electrical System

415V, normal and emergency AC power supply for chimney shall be derived from main plant power supply system. Emergency supply shall feed 20% of platform lighting, 50% of staircase lighting, aviation obstruction lighting and elevator load. All other loads shall be connected on normal power supply.

Ambient temperature for design of all equipment shall be considered as 55°C, which is likely to be encountered inside the chimney.

The distribution boards of chimney shall comprise switch fuse units of appropriate ratings. Emergency board shall have two incomers, one from emergency supply and other from normal AC distribution board itself. Auto changeover scheme shall be provided in emergency board to enable changeover to healthy source on failure of any source.

Dry type isolating transformer of Dyn11 connection shall be provided in emergency board to obtain neutral lead, in case 3 – phase 3- wire, emergency supply is derived from main plant.

9.02.00 Lighting system

Various platforms shall be illuminated by 70/150W metal halide well glass lighting fixtures. Staircase lighting shall be with 70W metal halide well glass fixtures. Average



illuminations level of 150 lux shall be maintained on equipment and 50 lux on platforms/staircases. Lighting system shall be controlled through MCB provided in lighting panel. Six numbers of metal halide flood lights focused towards chimney shall be provided on each external platform for aesthetics view during night times.

Lighting and power panel each shall be located at grade level and at other in between levels as required. All distribution boards, aviation lighting controls, etc. shall be located at grade level only. At each platform, 1 No. 63A, 415V welding receptacle and 1 No. 15A, 240V receptacle shall be provided and shall be fed from power panel. Wiring installation for lighting fixture shall be of PVC insulated copper/aluminum wires through galvanized steel conduits. a

Aviations obstruction lighting system shall conform to the requirements of the latest rules and regulations of the International Civil Aviation Organization (ICAO), National Airports Authority (NAA) and Directorate of Air Routes and Aerodromes (DARA) or any other statutory body and also to conform to IS: 4998. The obstruction lighting shall be done as per Appendix 6 figure 6.2 of ICAO i.e. Combination of Low intensity (Multi LED type- B) & Medium intensity (Multi LED type- B). The life of light fittings shall be 20 years maintenance free. Minimum Low intensity fittings 12 nos. (1/6, 1/2 & 5/6 level) & Medium intensity fittings 12 nos. (1/3, 2/3 & top level) and marking/painting shall be done as per ICAO. A minimum of six levels will be provided with aviation obstruction lights and there will be four light units per level. Each aviation warning light shall be of neon type having two lamps. Only one (1) lamp in a given fitting would be ON at a time and if the lamp fails, its failure would initiate an alarm and the next lamp in that particular fitting would be switched on automatically. Necessary control panel for control and annunciation shall be supplied. The control scheme of the control panel shall be to the approved of OWNER/Consultant.

One (1) photo controller along with suitable controller arrangement to be supplied by the contractor to switch ON and OFF the aviation warning light automatically based on the intensity of natural light during day/night.

The top light or lights shall be so arranged as to mark the point or edge of the obstruction marking surface. The lights shall be placed between 1.5 meter and 3 meter below the top. The number and arrangements of lights at each level or platform be such that the obstruction is indicated from every angle in azimuths.



Aviation obstruction lighting shall be complete with lights, photocell, controller, special cables, etc. and IP65 shall be followed for all panels.

The warning lights shall be adequately secured to the chimney against the wind forces. The low intensity shall be of fixed red colour, medium intensity shall be flashing red and high intensity shall be of flashing white. Temporary aviation lights with infrared bulbs shall be installed at each of the levels as instructed by OWNER as the construction work progresses and also above the top most point of the obstruction as construction progresses. These lights need to be installed only after the level of obstruction is greater than 45 meter above grade level. The lights shall continue to exist till permanent arrangement to provide such lights are completed.

10.00.00 Portable Emergency Lighting Unit

The portable emergency lighting unit shall be complete with storage battery (rechargeable), inverter, automatic charger, twin 9W CFL lamp and test switch. Contractor shall furnish make, type and catalogue.

11.00.00 24V AC Maintenance Lighting System

11.01.00 Each 24V A.C. supply module for maintenance purposes (for hand lamps and for hand operated tools) shall have one(1) no. double wound dry types, 1-phase, 50HZ, 240/24V transformer with HRC fuse in primary and secondary side and necessary 240V and 24V terminals for incoming and outgoing connections. The 240V terminals of 24V AC supply module shall be fed from respective lighting panels.

11.02.00 The 24V A.C. supply modules shall be sheet steel enclosed with louvers and shall be suitable for outdoor use. The 24V A.C. supply modules shall be suitable for wall/steel structure/column mounting. Switches shall be mounted at the front on sheet steel enclosure.

12.00.00 Nameplate

Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to their functions.



13.00.00 Painting

All sheet steel enclosures shall be chemically cleaned, rinsed, phosphated, rinsed and dried. After the treatment, steel surfaces shall be given undercoats of primer and finished with two coats of sprayed-on enamel or lacquer of approved shade.

Street light poles shall be given two coats of aluminium paints after installation.

All steel fabrication shall be given two coats of red-oxide primer followed by two coats of Siemens gray (RAL-7032).

All equipment shall be given touch-up paint as required after installation

14.00.00 Samples

Owner reserves the right to call for samples if considered necessary and the same shall be submitted by the Contractor free and without any obligation.

15.00.00 SPECIFIC REQUIREMENTS-SERVICES**15.01.00 Consumables and Hardware**

15.01.01 The Contractor shall furnish all erection materials, hardware and consumables required for the completed installation.

15.01.02 The materials shall include but not limited to the following:-

- a. Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.
- b. Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.
- c. Materials : Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.



15.01.03 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.

15.02.00 Erection Tools & Tackles

15.02.01 The Contractor shall provide all tools, tackle, implements, scaffoldings, ladders, etc. which are required for handling and erection of the equipment and materials.

15.03.00 Street Lighting Poles

Erection of Street Lighting poles together with all its accessories including civil foundation work, installing lighting fixture, wiring and cabling work are included within scope of contractor.

15.04.00 Flood Lighting Tower

15.04.01 Erection of Flood Lighting Towers including civil foundation work shall be done by Contractor.

15.04.02 Contractor shall also mount assembled fixtures, outdoor & lockable type isolating switch cubicle install necessary cabling and wiring make connections.

15. 05.00 Lighting High Masts (winch operated)

Erection of Lighting Masts together with all its accessories including civil foundation work, installing lighting fixture, wiring and cabling work are included within scope of contractor. Min. 30 Nos. shall be provided, locations shall be decided during detailed engineering.

15.06.00 Wiring

15.06.01 Wiring shall be generally carried out by PVC wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.

15.06.02 Wire shall not be pulled through more than two equivalent 90° bends in a single conduit run.



- 15.06.03 Wiring shall be spliced only at junction boxes with approved type connections or terminal strips. Maximum two wires can be connected to each way of the terminal block. Splicing of only one phase shall be done in a junction box.
- 15.06.04 For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.
- 15.06.05 For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/ junction box.
- 15.06.06 A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers shall be run through different conduits and Junction boxes.
- 15.06.07 Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.
- 15.06.08 Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in form of switch or fuse.
- 15.06.09 Wires of different phases shall run in separate conduits wires of lighting and power receptacles shall be run in separate conduits and on separate circuits.
- 15.07.00 Cabling**
- 15.07.01 In outdoor areas, main runs from lighting panels shall be by means of cables, directly buried in ground or laid in trenches for the underground portion and through conduit for the above ground portion.
- 15.07.02 Buried cables shall be laid and covered with sand/riddled earth, and protected from damage by bricks at sides and precast concrete slab at top. Buried cables shall have cable markers at 50M interval and projecting 150 mm above ground. At cable bends and joints markers shall be provided.
- 15.07.03 When buried cables cross road/railway track, additional protection to be provided in form of G.I. pipe.
- 15.08.00 Grounding**



- 15.08.01 All lighting panels, junction boxes, receptacles, fixtures, conduit etc. shall be grounded in compliance with the provision of I.E. Rules.
- 15.08.02 Ground connections shall be made from nearest available ground grid. All connections to ground grid shall be done by arc welding.
- 15.08.03 Panels/Boards shall be directly connected to ground grid by two nos.35 x 6 mm G.I. flats. (for panels/two nos. 50x6 mm G.I. flats (for distribution boards).
- 15.08.04 All junction boxes, receptacles, lighting fixtures etc. shall be grounded with 8 SWG G.I. wire.
- 15.08.05 Each street lighting Pole shall be grounded at two points by two nos. 50x6 mm G.I flat risers from two (2) nos. earthing spike 40 mm dia & 3m long directly driven into ground at a depth of 1m from ground level. The junction box at each lighting pole is grounded at two (2) points from two (2) nos. earthing terminals by 16 SWG GI wire. One 16 SWG G.I wire shall be taken upto the junction box from lighting fixtures and connected to grounding point.
- 15.08.06 Two (2) nos. earthing spike 3m long & 40 mm dia directly driven into ground at a depth of 1m from ground level shall be provided for each flood lighting tower.
- The sheet steel cubicle housing the power supply Isolator at base of flood lighting tower shall be connected at two (2) points from these earthing risers by 16 SWG G.I. wire – The flood lighting fixtures shall be grounded by one (1) 16 SWG G.I wire running through the lighting conduct upto the distribution box.
- Two (2) nos. separate spike of 3m long & 40 mm dia directly driven into ground at a depth of one (1) m from ground level shall be provided for connection of the lighting must on top of flood lighting tower through two (2) nos. 50x6 mm G. I. flat down conductor.
- 15.08.07 A continuous ground conductor of 12 SWG G.I. wire shall be run all along each conduit run and bonded to it every 600 mm by not less than two turns of the same size of wire. This conductor shall be connected to each panel ground bus.

All junction boxes, receptacles, fixtures etc. shall be connected to this 12 SWG ground conductor.

15.09.00 Foundation & Civil Works

15.09.01 Equipment foundations panel foundations and all other civil work will be provided by the Contractor.

15.09.02 Concrete trenches, cable trays and other civil work will be provided by the Contractor. The Contractor can make use of those trenches, cable trays etc. for conduit installation.

15.10.00 Excavation and Back Filling

15.10.01 The Contractor shall perform all excavation and backfilling as required for buried cable and ground connections.

15.10.02 Excavation shall be performed upto the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.

15.10.03 The Contractor shall make use his own arrangements for pumping out any water that may be accumulated in the excavation.

15.10.04 All excavation shall be backfilled to the original level with good consolidation.

15.11.00 Steel Fabrication

15.11.01 All supports, hangers & brackets shall be fabricated by the Contractor. Necessary steel shall be supplied by the Contractor.

15.11.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge.

15.11.03 Every effort shall be made to minimize the wastage of steel as far as practicable during fabrication. The wastage in no case shall exceed 3% of the total quantity of steel fabricated

15.12.00 Cleaning up of Work Site

15.12.01 The Contractor shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.

15.12.02 Upon completion of work, the Contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

16.00.00 INSPECTION & TESTING

16.01.00 The Engineer shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor.

16.02.00 The installation shall be then tested and commissioned in presence of the Engineer and put on trial run for stipulated contract period.

16.03.00 All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Contractor without any extra cost.

17.00.00 LIST OF TESTS TO BE CONDUCTED

17.01.00 Shop Tests

17.01.01 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works and in the presence of Owner's representatives.

17.01.02 Tests on Control gear / Lighting Distribution Boards / Lighting Panels shall include:

- a) Wiring continuity tests.
- b) High voltage and insulation tests.
- c) Operational tests.

17.01.03 The tests on lighting fixtures shall include:

- a) All routine tests as per relevant I.S.



- b) Rain-proof test for outdoor type luminaries and respective control gearbox as type test.
- c) Temperature rise test on ballast/choke as type test. Dust proof test as type test.

17.02.00 Site Tests

- 17.02.01 Contractor shall thoroughly test and meggar all cables, wires and equipment to prove the same are free from ground and short circuit.
- 17.02.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.
- 17.02.03 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.
- 17.02.04 Illumination in different areas are as per designed lux level generally confirming with Indian Standards. The lux level shall be verified by photometer at site location.

18.00.00 DRAWINGS, DATA & MANUALS

18.01.00 To be submitted with the Bid

- 18.01.01 Make, type and catalogue number of lighting fixtures, lamps and accessories along with technical leaflets, data sheets, polar curves etc.
- 18.01.02 Typical outline drawings, showing constructional features, cable / conduit entry, fixing arrangements etc. of:
 - a) General Arrangement Drawing of Lighting Transformer.
 - b) Lighting Distribution Board & Panel/receptacles/junction boxes.
 - c) Street light pole.
 - d) Flood light towers.



- 18.01.03 Technical leaflets and data sheet on each piece of equipment/device such as M.C.B., switch fuse, receptacle etc.
- 18.01.04 Technical Particulars Sheets.
- 18.01.05 Type test certificates on lighting fixtures and lighting panels, transformer, ballast, power cables.
- 18.02.00 To be submitted for Approval and Distribution**
- 18.02.01 Detail dimensional drawing showing constructional features, cable/ conduit entry, grounding, fixing arrangement etc. of :
- a) Lighting Transformer.
 - b) Lighting panels & distribution boards.
 - c) Receptacles & Junction boxes.
 - d) Street light poles & towers.
 - e) Lighting fixture complete with lamps and accessories.
 - f) Non-integral/separate type control gear box for lighting fixtures, as applicable.
- 18.02.02 Data sheets for lighting fixture, lamps, accessories with light distribution curves, coefficient of utilization charts etc. Type and routine test certificates of transformer, cables, lighting fixture, lighting panels, ballast, etc.
- 18.02.03 Control schematic and wiring diagram of 415V AC/220V DC lighting panel with automatic changeover from AC to DC and vice-versa, 415V normal AC Street/area lighting panel with automatic ON/OFF feature.
- 18.02.04 Technical Particulars Sheets and Calculations
- 18.02.05 Technical leaflets and data sheet on each piece of equipment/ device such as MCB, switch, fuse, receptacle etc. Type and routine test certificates of transformer and cables.
- 18.02.06 Lighting layouts showing the disposition of fixtures, lighting panels/boards, circuit distributions, conduit & wire rolling.



- 18.02.07 Key Single Line Diagram for lighting distribution, board-wise single line diagram with feeder loading, cable schedule and interconnection chart, design calculation for lighting.
- 18.02.08 AS-BUILT lighting layout and erection drawings, properly incorporating the changes/alterations/field modifications, if any, as carried out at field alongwith circuit distribution schemes of all lighting panels, conduit and cable routing and as acceptable to the Owner.
- 18.02.09 Any other relevant drawings, data and manuals necessary for satisfactory installation, operation and maintenance.
- 18.02.10 The Contractor may note that the drawings, data and manuals listed are minimum requirement only. The Contractor shall ensure that all other necessary write-ups, curves and information required to fully describe the equipment offered are submitted with his bid.



ANNEXURE – 1

ILLUMINATION LEVELS

Lighting System will provide the following illumination levels. The lighting fixture/clamp type and quantity will be selected to achieve the illumination level at different condition of the plant.

S.No.	Area/Structure	Average Illumination in Lux	Type of Luminaire	Type of lamp
1.0	Turbine Generator Building			
1.1	General Auxiliary Equipment Areas	200	Industrial Well Glass	70W/150W metal halide /125W metal halide Lamp
1.2	Cable Spreader Room	100	Industrial type fluorescent lamp with vitreous enamel reflectors	T5 fluorescent tube with electronic ballast or tri phosphorous tube.
1.3	All Switchgear Room Area	200	Industrial type fluorescent lamp with vitreous enamel reflectors	LED Lamp Fixtures
1.4	TG Building Operating Floor	200	Industrial integral high bay	250W/400W metal halide Lamp
1.5	Main Control Rooms, Computer Rooms	400	Decorative recessed mounted with mirror optic (Dark Lighter)	LED Lamp Fixtures
1.6	Battery Rooms	200	Industrial Corrosion proof luminaire	2 x 40W/36W FTL
1.7	Unloading and Maintenance bay	250	Industrial integral high bay	250 W/400 W HPMV Lamp
1.8	Service Building	300	Industrial type fluorescent lamp with vitreous enamel reflectors/ Industrial integral high bay	2 x 36W FTL/250W metal halide Lamp
2.0	Boiler Area			



2.1	Boiler area and platforms	100	Dust proof/dust tight integral well glass luminaire.	70W metal halide / 125 W metal halide lamp
2.2	Coal Bunker and Mill bay area, feeder floor, trippler floor	150	Dust proof/dust tight integral well glass luminaire	1 x80 W/125 W metal halide Lamp
2.3	ESP areas and Platforms	120	Dust proof/dust tight integral well glass luminaire	70 W metal halide /125 W metal halide Lamp
2.4	ESP Control room	400	Decorative recessed mounted with mirror optic for clean room areas	LED Lamp Fixtures
3.0	Transformer Yard			
3.1	General	50	General purpose flood light	250W/ 400 W metal halide Lamp or LEP
3.2	Near equipment	70	Dust proof/dust light integral well glass	1 x 70 W metal halide Lamp
4.0	Various Off-site building			
4.1	Equipment / Switchgear Room	200	Industrial type fluorescent lamp with vitreous enamel reflectors upto mounting height of 3.5M or industrial medium bay integral luminaire for mounting heights between 3.5 to 8.0 M	LED Lamp Fixtures.
4.2	Pump House	200	Industrial Well glass	70 W metal halide /125 W metal halide Lamp
5.0	Cooling Water Pump House area.			
5.1	Cooling tower area.	50	Industrial well glass.	70W metal halide /125W metal



				halide lamp.
5.2	CWPH	200	Industrial medium bay integral luminaire for mounting heights between 3.5 to 8M.	70/150W metal halide or 150/250W metal halide lamp.
6.0	DM Plant area.			
6.1	Control room.	300	Decorative recessed mounted with mirror optic for clean room areas.	LED Lamp Fixtures.
6.2	Pump House.	200	Industrial well glass.	70W metal halide /125W metal halide lamp.
7.0	Chemical House.			
7.1	Control room.	300	Decorative recessed mounted with mirror optic for clean room areas.	LED Lamp Fixtures.
7.2	Equipment rooms and Pump rooms.	150	Industrial Corrosion proof luminaire.	2x40W /36 FTL.
8.0	Ash Handling System.			
8.1	AH Pump Houses.	200	Industrial well glass.	70W metal halide /125W metal halide lamp.
8.2	Control room.	300	Decorative recessed mounted with mirror optic for clean room areas.	LED Lamp Fixtures
9.0	Coal Handling Plant			
9.1	Conveyors open/enclosed	70/100	Dust proof / dust tight integral well glass luminaire	1 x 80 W / 125 W metal halide Lamp
9.2	Crusher house, Junction towers	100	Dust proof / dust tight integral well glass luminaire	1 x 80 W/125 W metal halide Lamp
9.3	Coal Stock yard	50	Non-integral flood light	250 W/400 W metal halide Lamp



9.4	SWGR Room	200	Industrial type fluorescent lamp with vitreous enamel reflectors	LED Lamp Fixtures
9.5	Control Room	300	Decorative recessed mounted with mirror optic for clean room areas	LED Lamp Fixtures
9.6	Underground conveyor	100	Flame proof and dust proof well glass	1 x 80 W/125 W metal halide Lamp.
9.7	Pipe Conveyor (ECHS)	70	Dust proof / dust tight integral well glass luminaire	1 x 80 W metal halide Lamp
10.0	Fuel Oil Tank Area			
10.1	Tank Area	50	Non-integral flood light	LEP or 250 W/400 W metal halide Lamp.
10.2	Fuel oil area pump house	100	Flame proof well glass	1 x 80 W/125 W metal halide Lamp.
11.0	Road & Yard Lighting			
11.1	Main Roads	25	Integral type street lighting luminaire with aluminium reflector	LED Lamp Fixtures.
11.2	Secondary roads	15	-do-	LED Lamp Fixtures
11.3	Perimeter (compound lighting)	15	-do-	LED Lamp Fixtures
11.4	Yard Lighting	20	Flood light	LEP or 250 W metal halide
12.0	Diesel Generator			
12.1	DG Room	150	Industrial trough type	1 x 80 W/125 W metal halide Lamp
12.2	Compressor Room	150	-do-	-do-
13.0	Stores			
13.1	Cement stores	100	Industrial trough type fluorescent dust proof	1 x 80 W/125 W metal halide Lamp



13.2	Chemical stores	150	Corrosion proof	
13.3	Permanent stores	150	Industrial trough type/ metal halide	1 x 80 W/125 W HPMV Lamp
14.0	Hydrogen Plant			
14.1	Hydrogen Plant Building	150	Explosion proof metal halide / Fluorescent fittings suitable for class-I and Division –II	1 x 80 W/125 W metal halide Lamp
15.0	Laboratory			
15.1	Electrical Laboratory	250	Mirror optics fluorescent	LED Lamp Fixtures
15.2	Chemical laboratory	300	Corrosion resistant, fluorescent	CFL
16.0	Cable Galleries			
16.1	Cable galleries	100	Industrial trough type fluorescent	
17.0	General			
17.1	Offices, conference rooms, etc.	300	Decorative mirror optics type	LED Lamp Fixtures
17.2	Corridors, Walkways, Staircase, Lockers etc.	70	Industrial Type CFL with vitreous enamel reflectors	LED Lamp Fixtures
17.3	Toilet Wash room etc.	70	Industrial Type CFL with vitreous enamel reflectors	LED Lamp Fixtures
17.4	Garage/Car Parking	50	Industrial trough type fluorescent	LED Lamp Fixtures
17.5	Facility building, canteen	150	Industrial trough type fluorescent	LED Lamp Fixtures



18.0	Administration Building			
18.1	Main office areas (air conditioned)	300	Decorative recessed type with mirror optic reflector	LED Lamp Fixtures
18.2	Main office areas (non A/c)	300	Decorative with wide mirror optic reflector	LED Lamp Fixtures
19.0	DC Lights Fittings			
19.1	Control Room (with false ceiling)	50	Recess mounted Down lighter	1 x 100 W GLS lamp
19.2	Other areas (without false ceiling)	20	Industrial bulk head	1 x 100 W GLS Lamp.

Note:

1. The lux level and type of fitting for any area not specified shall be finalized during detailed engineering without any price implication.
2. N/E AC lighting and DC lighting shall be identified with suitable colour code.

CONTRACTOR may change the type of fixture to be used in different area against indicated above, provided minimum illumination level as indicated above is maintained. Lighting shall appear aesthetically good. CONTRACTOR shall measure the lux levels in the above areas (measured at the working plane) using suitable devices/meters as per relevant standards to prove the specified values.

ANNEXURE B: FITTINGS AND ACCESSORIES OF LIGHTING TRANSFORMER

Each transformer shall be equipped with fittings and accessories as listed below:

1. 150 mm dia. winding temperature indicator with maximum reading pointer and electrically separate sets of contacts for trip and alarm.
2. Handling and lifting lugs both for enclosure and core-coil assembly.
3. Jacking pad for core-coil assembly.



4. Inspection covers for cable and box.
5. Door handle operated safety limit switch with 1NO + 1NC contact.
6. Ground bus.
7. IP-55 junction box.
8. Rating and terminal marking plates.

Note: All indication, alarm, trip contacts provided shall be rated for 0.5A at 220 V D.C. and 5A at 240 V A.C.



CHAPTER 18

EARTHING AND LIGHTNING PROTECTION

A. EARTHING SYSTEM

1.00.00 SCOPE

The Contractor shall provide all required material and carry out main earth grid, treated earth pits, raisers and inter connections, equipment earthing etc for the following areas and all areas/buildings/structures in both units including but not limited to:

- a) 400 kV Switchyard (Outdoor and Indoor GIS)
- b) Main Plant Building (TG building)
- c) Boiler area, ESP, Chimney, NDCT & other electrical systems
- d) FOPH
- f) Coal / Ash Handling plant etc.
- g) Sea Water PH, RO-DM Plant
- h) All other miscellaneous buildings not mentioned herein.

For Transformer yard, separate earth grid shall be suitably formed and treated earth pits including raisers shall be provided for transformer neutral & body earthing, bus duct support structures and LAs.

Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons. The earthing system shall conform to IS 3043 and Indian Electricity Act/rules.

The Contractor shall furnish the detailed design, layout and calculations for Owner's approval. Contractor shall obtain all necessary statutory approvals for the system.

2.00.00 CODES AND STANDARDS

- 2.01.00 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening



of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

2.02.00 Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed below. In such a case, the Contractor shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

1.	IS:513	Cold rolled low carbon steel sheets and strips.
2.	IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
3.	IS:1079	Hot Rolled carbon steel sheet & strips
4.	IS:1239	Mild steel tubes, tubular and other wrought steel fittings
5.	IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
6.	IS:2309	Code of Practice for the protection of building and allied structures against lightning.
7.	IS:2629	Recommended practice for hot dip galvanising of iron & steel
8.	IS:2633	Method for testing uniformity of coating on zinc coated articles.
9.	IS:3043	Code of practice for Earthing
10.	IS:6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.



11.	IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
12.	IEEE:80	IEEE guide for safety in AC substation grounding
13.	IEEE:142	Grounding of Industrial & commercial power systems
14.		Indian Electricity Act.
15.		Indian Electricity Rules.

3.00.00 DESIGN CRITERIA**3.01.00 Fault Current & Duration**

Earthing system network/earth mat shall be interconnected mesh of mild steel rods buried in ground in the plant. For earth mat design, the size of earthing conductor shall be calculated considering maximum fault current 56 kA for duration of 1 second and corrosion factor. The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80.

3.02.00 Conductor Material

3.02.01 The earthing system conductors and accessories as proposed are to be as

(a) Conductors above ground level and in trenches:	Galvanized steel
(b) Conductors buried in ground or embedded in concrete:	Mild Steel
(c) Electrodes:	GS Pipe / Rod

3.02.02 The contractor shall undertake the soil resistivity measurements at site and shall select suitable type of conductors.

3.02.03 The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects.



3.03.00 Size of Conductors**3.03.01 Main Conductors**

The minimum sizes of earthing conductors for various electrical equipments shall be as below:

Equipment		Earth conductor buried in earth	Earth conductor above ground level & in built-up trenches
a)	Main earth grid	40 mm dia.MS rod	65x8mm GS flat
b)	Switchyard	---	75x12 mm GS Flat and 50x6 mm GS flat
b)	11/3.3KV/415V Switchgear/equipment	---	65x8mm GS flat
c)	415 V MCC/ Distribution boards / Transformers	---	50x6mm GS flat
d)	LV Motors above 125 KW	---	50 x 6mm GS flat
	25 KW to 125 KW	---	25 x 6mm GS flat
	1KW to 25 KW	---	25 x 3mm GS flat
	Fractional HP LV Motors	---	8 SWG GS wire
e)	Control panel & control desk	---	25 x 3 mm GS flat
f)	Push button station / Junction Box	---	8 SWG GI wire
g)	Columns, structures, cable trays and busducts enclosures	---	50x6mm GS flat
h)	Crane, rails, rail tracks & other non-current carrying metal parts		25x6mm GS flat



3.03.02 Soil Treatment to Lower Resistivity

The soil resistivity study shall be carried out by the contractor.

In order to reduce the resistivity of the soil the earth pits shall be treated with high purity electrically conductive material having ultra low resistance value (typically, 0.001 ohm-m). The properties of the material shall be such that it does not require periodic re-watering or recharge of salt or earth enhancing compound during the life of the power plant. The material should be such that it does not reach chemicals into the adjacent soil or underground water channels and should be PH neutral. Earth enhancing material should permanently protect the encased metal components of the earthing systems. Earthing electrodes encased in high strength concrete mixed with the conductive material shall be preferred instead of electrode buried directly in the earth.

3.03.03 Rod Electrodes

Galvanized steel rod electrodes of suitable diameter and length shall be used as per the recommendation of IS-3043. For test pits electrodes shall be heavy duty type (Class – C) GI pipe of suitable diameter with perforations. For treated earth pits, GI pipe shall be provided as per IS 3043 including charcoal, salt etc. Necessary number of treated earth pits shall be provided for LAs, GTs, UTs, ST, UATs in the transformer yard and other UATs in coal and ash handling plants, ant UATs at raw water pump house and for all LT transformer Neutral & body earthing. Electrodes installed in the test pits will have disconnecting facilities.

3.03.04 Earthing of Electrical equipment on cranes and travelling machines:

Every electrical equipment shall have double earthing. A ring earthing system shall be provided within the crane/machine to which electrical equipment shall be connected at least at two places. The earth ring on the crane/machine shall be connected to the plant earthing system through gantry rails. Two sets of earth collector brushes shall be provided on each side of crane/machine to connect its earth ring to the gantry rails. Each end of each gantry rail shall be bonded to the plant earthing system. In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks. Flexible copper bonds shall be provided across any gap in the running



gantry rails. For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

3.03.05 Equipment Earthing Leads

The size of the earthing leads shall be decided based on the type of equipment and structure to be earthed and shall be provided generally as per IS-3043.

4.00.00 EARTHING SYSTEM LAYOUT

4.01.00 General

Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, structures in contact with switchyard earth, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system.

All the offsite areas shall be interconnected together by minimum two parallel conductors.

Crane rails, tracks, metal pipes and conduits shall be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing lead ensured by bonding the different sections of hand rails and metallic stairs.

For all other equipments, two earthing leads shall be used if rated voltage of equipment is above 250V. In case the rated voltage is 250 V or below, one earth lead can be used. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead.

Earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm.

All cable trays in the plant buildings as well as inside the trenches shall be connected to earth grid at an interval of about 10 m.

Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable



4.02.00 Earthing Conductor Layout in Switchyard

Main earthing conductors shall be laid in the form of a grid. Spacing between conductors, number of parallel conductors, etc., shall be decided such that step and touch potential are within safe limits.

The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80.

Earthing conductors shall be provided around the outside edge of fence at a distance of approximately 6000 mm. This shall be connected to the switchyard earthing grid.

Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post.

An earthing mat comprising closely spaced (about 150 mm) conductors shall be provided below the operating handles of disconnecting switches and breaker operating kiosk for the additional safety of the operating personnel.

Each of the earth leads of transformer neutral, lightning arrester shall be directly connected to two separate electrodes. Neutral points of HV transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors. Lightning protection down conductor shall be directly connected to a separate earth electrode.

All earth electrodes in turn shall be connected to main earthing system. The earth grids of different areas of the plant shall be interconnected through, test pits to enable measurement of earth resistance for each area separately.

Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.

Earth pit shall be constructed as per IS: 3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600 mm.



4.03.00 Earthing Conductors Inside Building

Main earthing conductors shall be buried in earth around the building. Minimum two taps-off from this earthing loop shall be taken inside the building and connected to the earthing grid embedded in the floor slab with approximately 50 mm concrete cover. The requirement of electrodes around the building shall be specified.

In case the building has more than one floor, each floor shall be provided with separate earth grid. These floor earthing grids shall be interconnected.

Each RCC / Steel column of the building shall be interconnected to the floor earthing grid in the ground floor.

Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment. Separate electronic earthing for the PLC equipments, SAS panels and all other equipments wherever necessary shall also be provided

Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.

Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.

Suitable earth risers as approved by Owner shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.

5.00.00 EARTHING SYSTEM INSTALLATION

The spacing between two electrodes shall be at least equivalent to twice the length of the electrode.

Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively. 8 SWG earth wire should be run along with lighting conduits and shall be earthed at both ends. The wire should be suitable clamped with conduit at equal interval at not more than 500 mm.

The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.



When earth conductor passes through floors, walls, etc., suitable pipe sleeves shall be provided and the same shall be sealed after installation.

The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.

Cable trays, metal pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.

Street lighting poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.

Flexible earth conductors shall be provided at expansion joints for earthing the gates, operating handles, etc.

Equipment bolted connection after being checked and tested shall be painted with anti-corrosive paint / compound be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.

Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise instructed by the Owner.

All bimetallic connections shall be treated with suitable compound to prevent moisture ingress.

The contractor shall demonstrate the effectiveness of earthing system by measurement of earth resistance, step and touch potential at different locations. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. All equipment required for testing shall be furnished by contractor.

Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.



Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding. The overlapping of earthing conductor in welded joints should be 6 times diameter. Cleats should be provided at both sides to increase contact area. Angles/ cleats should be welded at the point of crossing of longitudinal and transverse earthing conductors.

Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.

Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm. Trenches after laying earth rods should be closed with approved filling materials in layers and not with debris.

6.00.00**OTHER REQUIREMENTS OF EARTHING SYSTEM:**

Life expectancy	40 Years
System Fault Level	56KA for one second
Min. Steel corrosion	0.12mm/year

Depth of burial of main earth conductor	600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.

Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor.

Surface resistivity	- Gravel : 3000 ohm-meter
	- Concrete : 500 ohm-meter

B. LIGHTNING PROTECTION SYSTEM

Lightning protection system shall be in strict accordance with IS: 2309 and NFPA 78 as applicable.



7.00.00 CONDUCTOR MATERIALS

- a) Lightning protection air termination, down conductors, test links for buildings: GS flat
- b) Exposed lightning protection air termination on chimney top: lead coated copper
- c) Earth conductors buried in ground/concrete: MS rod

8.00.00 LIGHTNING SYSTEM LAYOUT

8.00.01 Lightning conductors shall be connected through test link with earth electrode/earthing system

8.00.02 Suitable lightning protection shall be provided to protect

- a) Main Power House building and other structure as per IS requirement.
- b) Main transformers and other equipments.
- c) 400 KV GIS switchyard & building
- d) Chimney, Cooling Tower and CHP
- e) Other off site buildings & structures as applicable.

8.01.00 Down Conductors

1. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.
2. Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.
3. All joints in the down conductors shall be welded type.
4. Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.
5. Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor



fixing at an interval of 1500 mm.

6. All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.
7. Lightning conductors shall not pass through or run inside GI Conduits.
8. Testing link shall be made of galvanized steel of size 25x 6mm.
9. Pulser system for lightning shall not be accepted.
10. Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.
11. Lightning protection conductors/ air termination rods and circumferential band provided at the top position of chimney stack shall be lead coated in order to avoid melting by exposure to hot flue gases.
12. For tall buildings and structures, early streamer emission (ESE) type, air terminal system such as marketed by Heary Brothers (USA) or any other reputed make are preferred.
13. Horizontal air termination flats provided on top of boilers, main plant building, pump houses & other buildings shall be laid such that no part of the roof shall be more than 9 metres.
14. Conductors of lightning protection system shall not be connected with conductors of earthing system above ground level
15. Lightning protection shall have as few joint as possible and avoid sharp bends. Down conductors shall have as far as possible, no joint except at test point and end termination.
16. Termination at the metallic equipments on roof should be made by suitable nuts, bolts, pressure washer and bitumen washers with good electrical conductivity.
17. All lightning protection conductors shall be exposed to atmosphere unless specifically mentioned.



9.00.00 QUALITY ASSURANCE PROGRAMME

Contractor shall furnish detailed Quality Assurance Programme and Quality Plans for all materials and accessories to be supplied and installed under the scope of the specification as per General Technical Conditions of technical specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.

10.00.00 INSPECTION AND TESTING

- 1) Earth continuity checks.
- 2) Earth resistance of the complete system as well as sub-system.
- 3) The earthing and lightning conductors should be type tested as per IS 2629. Following minimum tests shall be conducted:
 - i. Freedom from defects
 - ii. Uniformity in thickness
 - iii. Mass of coating
 - iv. Adhesion tests

Any other applicable tests not mentioned in the specification but required



CHAPTER – 17

CABLING SYSTEM

1.00.00 SCOPE OF SUPPLY

1.01.00 The scope of work shall include complete supply, installation, testing, commissioning and putting into successful commercial operation of the cabling system for the entire plant covering all indoor & outdoor areas and offsite buildings like ICHS Stage I, Sea water intake plant, etc.

1.02.00 The equipments and materials within the scope of supply shall include but not limited to

- i. Power & control cabling works (including that of special cables):
Supply and installation of cable and cable trays/raceways, supports, conduits, duct bank, cable accessories such as jointing/termination kits, cable glands, lugs, ferrules, etc. as required for all the systems & equipments.
- ii. Supply and installation (including laying & termination) of control cables, special cables, instrumentation cables for all equipments and systems.
- iii. Supply and installation (including laying & termination) of all power cables (HV and LV) of all power cables (HV and LV) for all equipments and systems.
- iv. Cable routing has to be planned such that it shall not cross the steam lines, oil lines.
- v. Fire Sealing Arrangement: All cable entries into the panel (HV & MV & LV SWGR panels) should be provided with fire sealing arrangements.
- vi. Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire



2.00.00

CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

IS:513	Cold rolled low carbon steel sheets and strips.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubular and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:9537	Conduits for electrical installation.
IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 3.3kv up to and including 33kv performance requirements and type tests.
BS:476	Fire tests on building materials and structures
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.



- 2.01.00 Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Contractor shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

3.00.00 DESIGN AND CONSTRUCTIONAL FEATURES

3.01.01 Inter Plant Cabling

Interplant cabling for main routes shall be laid along overhead trestles/duct banks. However, from tap-offs, same can be through shallow trenches. All the switchgear room shall be provided with cable spreader room at ground floor. The cable trenches are allowed between switchyard control room and transformer yard only.

3.02.00 Transformer yard

In transformer yard cables shall be laid in RCC concrete trenches with RCC covers. The main cable routes coming out from Main plant building and crossing the Transformer yard shall be laid in overhead trestles/duct banks. Minimum clear height of trestle shall be 3 m and for Rail/road crossing, it shall be as per rail/road crossing norms.

False floors are not to be provided for cabling purpose.

3.03.00 Cable entry

Cable entry from outdoor underground/cable routes to the buildings, if any, shall be above the finished floor level of the building.

- 3.04.00 All Buildings shall have suitable cable spreader rooms /cable vaults.

3.05.00 Trenches

- 3.05.01 PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

- 3.05.02 No sub zero level cable vault/trenches shall be provided below control building/switchgear rooms in main plant areas.

- 3.05.03 All field switches for equipments corresponding to a stream located within a radius of 4-5 m shall be wired out to a field junction box and from field junction box to control panel/Input – Output cabinet by screened instrumentation cables.



- 3.05.04 For CHP following shall also be applicable.
- a) All cable routes shall be overhead along the route of the conveyor gallery by separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600 mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 3.0 M above the grade level except for rail/road crossings where it shall be at 8.0 M above grade level. However in bunker area the bottom of the cable trestle shall be 10 to 14 M depending on boiler/bunker layout.
 - b) Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches receptacles etc.
 - c) Cables for Pull cord switches and belt sway switches shall be taken in cable trays. The trailing cables of the mobile machines shall also be laid in cable trays.
- 3.05.05 Cable trench shall be allowed only between switchyard control room and 'A' row column of TG building.
- 4.00.00 EQUIPMENT DESCRIPTION**
- 4.01.00 Cable trays, Fittings & Accessories**
- 4.01.01 Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, etc.) and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.
- 4.01.02 These shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.
- 4.01.03 Cable trays shall have standard width of 150 mm, 300 mm & 600 mm and standard lengths of 2.5 metre. Minimum thickness of mild steel sheets used for fabrication of



4.02.00	Support System for Cable Trays
4.02.01	Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".
4.02.02	Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types: (i) C1:- having provision of supporting cable trays on one side and (ii) C2:- having provision of supporting cable trays on both sides. The support system shall be the type described hereunder



- a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.
- b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware's fittings and accessories shall be prefabricated factory galvanised.
- c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied.
- d. All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.
- e. The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheets conforming to IS.
- f. Cantilever arms of 300 mm, 600 mm and 750 mm in length are required. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
- g. Cable trays in areas subjected to excessive coal dust or mechanical damage shall have hot dip galvanized sheet steel metal trays cover installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run with consideration for ventilation.
- h. FRP Cable trays shall be used for areas like intake raw water pump house, Desalination plant, CHP, Battery room, NDCT and chemical house.

4.02.03

The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above are indicative only. Nevertheless, the support system shall be designed by the contractor to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Contractor without any



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additional cost. The contractor shall submit the detailed drawings of the system offered by him along with the bid.

4.03.00 Pipes, Fittings & Accessories

4.03.01 Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria

4.03.02 GI Pipes shall be of medium duty as per IS: 1239

4.03.03 Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

4.04.00 Junction Boxes

4.04.01 Junction Boxes shall comprise of a case with hinged door constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3 mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.

4.04.02 Glass Fibre Reinforced Junction Boxes

No. of Ways: 12/24/36/48 with 20% spares terminals.

4.04.03 Junction boxes shall be Glass Fibre Reinforced with saturated polyester conforming to standards like DIN 16911 type 803/16913 type 834, 5 self extinguishing in accordance with ASTM D635/UL 94 VO.

Junction boxes for use in outdoor or damp locations shall be sturdy construction. Temperature resistance shall be between – 10 to 100°C. Impact resistance shall be greater than 7 Nm, (EN 50014). Protective insulation shall be in line with VDE 0100, dielectric strength shall be greater than 10 KV/mm, halogen free toxicity, the enclosure and door cover shall be painted and electro statically power coated (preferably in RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door.



- 4.04.04 Doors
With integrated viewing window of 3mm resistant plexi glass or equivalent. The doors shall be industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.
- 4.04.05 Protection Class

Protection Category shall be IP 66 to EN 60529. There shall be guaranteed perfect seal to meet Protection class IP 66 providing arrangement like highly elastic foamed in special type seal like polyurethane/chloroprene. The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).
- 4.04.06 Mounting clamps and accessories

Junction boxes shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. The accessories like mounting plates etc. of steel shall be powder coated. The support rails for terminal box shall be zinc coated.
- 4.04.07 General

 1. JBs shall have small canopy at the top.
 2. There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage into the junction box shall be avoided and it shall fall outside.
 3. Cable entry shall be from bottom side only.
 4. Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.
- 4.04.08 Steel Junction Boxes
- 4.04.09 No. of Ways

12/24/36/48 with 20% spares terminals.



4.04.10 Junction boxes shall be designed in accordance with NEC, article 370, paragraph 18, 19 & 20 or equivalent standards.

4.04.11 Enclosure

Junction boxes for use in outdoor or damp locations shall be sturdy steel construction. The enclosure and door cover shall be surface finished clean, degreased, phosphated, deep coated primed (preferably in RAL 7044) and electro-statically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M6) shall be provided on the cover as well as door. The sheath steel thickness shall be more than 2 mm.

4.04.12 Doors

The doors shall be hinged and lockable. The doors shall have industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

4.04.13 Protection Class

Protection Category shall be IP 66 to EN60529/1091 complies with NEMA 4. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane. There shall be an arrangement like multifold protection channel for additional stability and prevention of ingress of dust and water when the enclosure is open.

The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

4.04.14 Mounting clamps and accessories

The mounting clamps and accessories shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass.

4.04.15 General

i) JB's shall have small canopy at the top.



- ii) There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage in to the junction box shall be avoided and it shall fall outside.
- iii) Cable entry shall be from bottom side only.
- iv) Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

4.04.16 Junction boxes shall be provided with two nos. earthing terminals (externally available) suitable for connection of 8 SWG G.I. wire. Knockouts shall be provided at bottom and both sides. These shall be provided by fixing plates in order to make them detachable type with suitable neoprene gaskets. Bottom and side plates for cable/conduit connection shall be provided. All unused holes shall be sealed with suitable grommets.

4.04.17 Junction boxes shall be provided with external designation label. The label inscriptions shall be informed to the Contractor by the Owner. Junction boxes shall be provided with danger sign in case of 415V circuit.

4.04.18 Junction boxes shall be of two types, viz. One suitable for control cabling and the other suitable for power cabling.

Junction boxes for control cabling shall have 24 way/ 48 way terminal blocks suitable for up to 2.5 sq.mm. Cu. Cable. However, for instrumentation junction boxes there shall be 24/48 ways suitable for terminating cable of 0.5 sq.mm. Cu. Cable.

4.04.19 Junction boxes for power circuit cabling shall be suitable for 1 no. 3 core 16 sq.mm. Al. Incoming cable and 1 no. 3 core 2.5 sq.mm Cu. Outgoing cable.

4.05.00 Terminal blocks

Terminal blocks shall be 650 volts grade, rated for 10 Amps and in one piece, rigid, Bakelite moulded, with disconnecting /shorting link. It shall be complete with insulating barriers, Klip-on-type terminals and identification strips, terminal studs, washers, nuts, lock nuts, marking strips etc.

Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be Elmex type CSLT-1 with insulating material of Melamine conforming to ESI Standard 12.1 or equivalent. Cage clamp type terminal block suitable for terminating 2 wires of 2.5 sq mm. on both sides arranged to facilitate easy termination shall be provided.

20% spare terminals shall be provided.



4.06.00 Terminations & Straight through Joints

- 4.06.01 Termination and jointing kits for 33/11/3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 33/11/3.3 kV grade joints and terminations shall be type tested as per IS: 13573. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solder less crimping type cable lugs & ferrule as per DIN standard.
- 4.06.02 Straight through joint and termination shall be capable of withstanding the fault level for 33kV, 11 kV and 3.3 kV systems.
- 4.06.03 1.1 KV grade straight through joints shall be of proven design.

4.07.00 Cable glands

- 4.07.01 Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful contractor.
- 4.07.02 Cable glands shall be single compression for indoor use, double compression type for outdoor use. Glands for classified hazardous areas shall be double compression type flameproof and weather proof duly certified by CMRS and approved by CCE.

4.08.00 Cable lugs/ferrules

- 4.08.01 The cables lugs shall be conforming to IS: 8309.
- 4.08.02 Machine ferruling shall be adopted.
- 4.08.03 Cable lugs for power cables shall be Aluminium solder less crimping type suitable for aluminium compacted conductor cables.
- 4.08.04 The cable lugs for control/instrumentation/ telephone cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments.



Cable lugs shall be suitable for termination of different cross-sections of control/instrumentation /telephone cables and shall be of following types.

- i) Copper tubular terminal end for solder less crimping to copper conductors.
- ii) Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the pan
- iii) Pin type lugs shall not used.
- iv) Aluminium tubular terminal ends for solder less crimping of to Aluminium conductor.

Solder less crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.

4.09.00 Cable Clamps & Straps

- 4.09.01 The cable clamps required to clamp multicore cables on vertical runs shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables on horizontal trays, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment.
- 4.09.02 Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the system short circuit current of 105 KA peak.

4.10.00 Galvanizing

- 4.10.01 Galvanizing of steel components and accessories shall conform to IS: 2629 & IS: 2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots
- 4.10.02 The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS: 1367. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.



4.11.00 Welding

4.11.01 The welding shall be carried out in accordance with IS: 9595. All welding procedures and welders qualification shall also be followed strictly in line with IS: 9595

5.00.00 INSTALLATION**5.01.00 Cable tray and Support System Installation**

5.01.01 Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures. All cable trays shall be in vertical configuration in boiler, CHP & ESP areas.

5.01.02 Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 1500 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000mm. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per relevant Standard. The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated in the relevant approved tray layout drawings.

5.01.03 All cable way sections shall have identification, designations as per approved cable way layout as and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stenciled with identification numbers at every floor.

5.01.04 In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. In such cases the Contractor shall fabricate at site suitable sections of trays, supports and accessories to make the installation complete for the specific purpose after obtaining owner's prior approval, which shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.



5.02.00 Conduits/Pipes/Ducts Installation

5.02.01 The Contractor shall be fully responsible for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.

5.02.02 GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.

5.02.03 Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material.

5.02.04 Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 150 to the trench wall. In case of larger dia cables i.e. 50mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Site Engineer.

5.02.05 Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit /pipe size (dia).	Spacing
Up to 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm	3.0 M

5.02.06 In areas like WTP, chemical handling, battery room etc. exterior surface of the conduits shall be further coated with chromate or polymer for better resistance to corrosion.

5.02.07 All G.I. pipes shall be laid as per approved layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. The bends formed shall be smooth. GI Pipes with bends shall be buried



in oil/concrete in such way that that the bends shall be totally concealed. For GI pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. plugs after they are laid in final position. G.I. plugs shall be supplied by the contractor at no extra cost.

5.03.00 Junction Boxes Installation

5.03.01 Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the approved drawings or as decided by Owner and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

5.04.00 Cable Laying and Installation

5.04.01 Cable network shall include power, control, lighting, communication and fire alarm system cables, which shall be laid in trenches, cables trays/conduits as detailed in the approved drawings and cable schedules. Erection of cable trays and aligning and leveling as required shall be the responsibility of the contractor.

5.04.02 Cable installation shall be carried out as per IS: 1255 and other applicable standards. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

5.04.03 Laying of cables directly buried in ground is not acceptable.

5.04.04 For coal handling plant the cables shall not be routed along conveyor galleries. The cables shall be routed on independent cable trestles.



- 5.04.05 All tray levels shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings. The contractor shall have to secure rack/tray supports by welding to those inserts or other available building steel surfaces. Outdoor trays shall be installed by welding on the steel/concrete structure with inserts by the contractor. As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.
- 5.04.06 While laying cable, ground rollers shall be used at every 2 metre interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables.
- 5.04.07 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted.
- 5.04.08 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls columns. Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.
- 5.05.00 Laying of cables in cable trays**
- 5.05.01 Cables shall be laid on cable trays strictly in line with cable schedule furnished. Where specific cable layouts are not shown on approved drawings, contractor shall route these as directed by the Owner.
- 5.05.02 Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.V. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil



formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two metre. All multicore cables shall be laid in touching formation. LT power cables above 95 sq.mm size shall be laid in single layer touching formation in trays while cables upto & including 95 sq.mm shall be laid in maximum of 2 layers. Control and Instrumentation cables can be laid upto a maximum of three layers in each tray.

- 5.05.03 All communication cables (telephone, P.A. System) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench/trays with a minimum clearance of 600mm away from electrical trench/trays as per the direction of Site Engineer and Communication cables shall cross power cables at right angles
- 5.05.04 Power and control cables shall be secured fixed to trays/support with self locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.
- 5.05.05 Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.
- 5.05.06 Individual cables or small groups which run along structures/walls etc will be clamped by means of 16 SWG GI saddles on 25x6mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables. Alternatively small group of cables can be taken through 100mm slotted channel/ISMC 100. They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be drilled where the minimum weakening of the structure will result.
- 5.05.07 Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300mm for cables upto 25mm diameter and maximum 500mm for cables larger than 25mm dia and cables laid in vertical run of cable trays shall be clamped at an interval of 900mm.



- 5.05.08 Where cables cross roads/rail tracks, the cables shall be laid in Hume pipe/PVC pipe. At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.
- 5.05.09 Power and Control Cables, as far as possible, shall be laid in complete, uncut lengths from one termination to the other. Straight through joints in power cable shall be allowed only in nearest of rare situation only after approval of owner.
- 5.05.10 Joints for less than 250 Meters run of cable shall not be permitted.
- 5.05.11 In each cable run some extra length shall be kept at suitable point to enable one LV/two HV straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.
- 5.05.12 Wherever few cables are branching out from main trunk route troughs shall be used.
- 5.05.13 Cables shall be neatly arranged in the trenches/trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the contractor.
- 5.05.14 The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable laying, cable drum schedule shall be prepared by electrical contractor and get that approved by site engineer to minimize/avoid straight through joints. The actual number of straight through joints required shall be worked out by the contractor. During the erection period the contractor shall furnish a monthly report on cable position in an approved proforma so as to keep the owner appraised of the position.
- 5.05.15 The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.
- 5.05.16 Minimum number of spare cores required to be left for interconnection in control cables shall be as cl.3.07.00, chapter 16.



5.05.17 Electrical cable trays exposed to hazardous process fluid shall be covered with detachable G.I. covers. The covers shall be suitable to resist wind forces.

For cables laid above ground in cable racks, asbestos sheeting of 3mm thickness shall be provided below the bottom cable tray to protect the cables from fire.

5.05.18 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

5.05.19 Separation

Sufficient spacing not less than 300 mm shall be provided between different tiers of trays and the same shall be maintained to permit adequate access for installation and maintenance of cables.

At least 300mm clearance shall be provided between :

- HV power & LV power cables,
- LV power & LV control/instrumentation cables,

5.05.20 Segregation

Segregation means physical isolation to prevent fire jumping.

Cables from two different services viz. supply from Station Board and Unit Board shall be segregated.

Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

For Coal Handling Plant all the cables of one stream shall be segregated from the cables of the other stream and shall run on either side of the trestle.

5.06.00 Cable fire sealing

Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be sealed by a fire proof



sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.

Wherever the cables/cable trays pass through walls/floors, fire proof cable penetration seals rated for one hour shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS: 476 (Part-20) or equivalent standard.

In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar Seal and Fire Retardant Cable coating compound. Also the cable runs both before and after the fire scale shall be suitably sprayed with anti-fire propagation liquid.

5.07.00 Cable laying in trenches between switchyard and Transformer yard

- 5.07.01 RCC cable trenches with removable covers will be provided by the contractor. Cables shall be laid in 3 or 4 tiers in these trenches. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases. RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of cable laying and reinstating them in their proper positions after the cables are laid shall be done by the contractor at no extra cost.
- 5.07.02 For cable trays are laid in trench in more than two tiers a space of minimum 600 mm shall be available for maintenance. In case two or more tiers of cable trays are running parallel along both sides of trench walls there shall be space of minimum 600 mm between them.
- 5.07.03 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cable leaving trenches shall be coiled and provided with a protective pipe or cover till such times the final termination to the equipment is completed.
- 5.07.04 Prior to laying of cables inside trenches, the contractor shall properly clean inside of those trenches.



- 5.07.05 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer. Space between individual tiers shall be filled and compacted with soil and sand.
- 5.07.06 As each row of cables is laid in place and before covering with sand every cable shall be given on insulation test in the presence of Site Engineer. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.
- 5.07.07 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.
- 5.07.08 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection up to a minimum of 150mm above grade.
- 5.07.09 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following guide of the pipe fill shall be used for sizing the pipe size:

- a) 1 cable in pipe - 53% full
- b) 2 cables in pipe - 51% full
- c) 3 or more cables - 43% full
- d) Multiple cables - 40% full

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/'PUTTI' for sealing purpose. Alternatively, G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and no separate payment shall be allowed.



- 5.07.10 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures, the electrical contractor shall determine their location and obtain approval of the Site Engineer before cutting is done.

6.00.00 CABLE IDENTIFICATION

- 6.01.00 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry & exit, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags.

- 6.02.00 If laying of underground cable is specifically agreed by Owner as a special case then the underground cables shall be provided with identity tags of Stain less steel securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas cable trenches shall be identified by means of markers. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M for straight run and at cable joint locations with additional inscription 'Cable Joint'. For buried cables the marker shall project 150mm above ground.

- 6.03.00 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

7.00.00 CABLE TERMINATIONS & CONNECTIONS

- 7.01.00 The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer" instructions, drawings and/or as directed by Site Engineer. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.
- 7.02.00 Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated



- sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Engineer in charge of TANGEDCO.
- 7.03.00 Responsibility of proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by the contractor.
- 7.04.00 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.
- 7.04.00 Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the contractor at the discretion of the Engineer- in-Charge.
- 7.05.00 Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.
- 7.06.00 The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter 'S' alongwith cable numbers and coiled up after end sealing.
- 7.07.00 All cable terminations shall be appropriately tightened to ensure secure and reliable connections.
- 7.08.00 It is the responsibility of the Contractor to terminate the cables at motor terminals in correct phase sequence to ensure the proper direction of rotation.
- 7.09.00 All cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.
- 7.10.00 All cable entries shall be through bottom only and top entry terminations are made only after getting approval of Site Engineer.



- 7.11.00 Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.
- 7.12.00 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/wiring/ inter-connection diagram. Contractors shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.
- 7.13.00 Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided.
- 7.14.00 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.
- In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.
- 7.15.00 Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors.
- Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor.
- Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.



7.16.00 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

7.17.00 All cable entry points shall be properly sealed and made dust and vermin proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least three hours.

7.18.00 Cable accessories for H.V. Systems

7.19.00 The H.V. cables terminations/joints shall be done by skilled and experienced jointers duly approved by the Site Engineer.

7.20.00 The termination and straight through joint kits for use on high voltage system shall be suitable for the type of cables offered by the contractor or the type of cables issued by owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction shall be included in each kit.

7.21.00 The termination kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.

a. 'PUSH ON' type for LV cables.

b. Heat-shrinkable sleeve type for LV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

7.22.00 The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

a. 'TAPEX' of M-seal make or equivalent for LV cables



b. Heat-shrinkable sleeve type for LV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

8.00.00 QUALITY ASSURANCE PROGRAMME

Contractor shall furnish detailed Quality Assurance Programme and Quality Plans for all materials and accessories to be supplied and installed under the scope of the specification as per General Technical Conditions of technical specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.

9.00.00 LIST OF TESTS TO BE CONDUCTED

9.01.00 Type tests on Cable Trays support system

A) Test 1A:

On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 metre length of main support channel shall be fixed vertically at each end to a rigid structure as per appropriate fixing arrangement. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the following load intervals and other necessary points:

- i) Working load
- ii) Working load + point load
- iii) Off load



- iv) Proof load + point load
- v) Off load

The deflection measured at working loads shall not exceed 16 mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.

B) Test 1B: Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2

Test 2: On Main support channel type -C2 for cantilever arms fixed on both sides

a)Test 2A: A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per appropriate fixing arrangement. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at the following load intervals and other necessary points.

- i) Working load
- ii) Working load + Point load
- iii) Off load
- iv) Proof load + Point load
- v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of



proof load and point load applied

- b) **Test 2B:** The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.

Test 3: Tests on Channel Fixed on Beam/Floor

A length of main support channel section shall be fixed to steel structure/floor and have loads applied as detailed below and other important points not mentioned herein.

- a) **Test 3A :** A length of steel structure shall be rigidly supported. It should be fitted on a metre length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.
- b) **Test 3B:** With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.
- c) **Test 3C:** With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line.

The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.

Test 4 Channel nut slip characteristics (what ever applicable)

Tests 4A1, 4A2, 4A3:

A length of channel C1 section 200 mm long shall have fitted bracket with the two bolts fixing.



With loads applied at the appropriate position nut slip shall be determined with bolt torque of 30 NM, 50 NM and 65 NM No fewer than three measurements shall be made or each torque setting.

A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.

Tests 4B1, 4B2, 4B3:

The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing. With loads applied at the appropriate position, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting.

A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM

Test 5 Weld Integrity Test

After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.

Cable termination kit and straight through joints should have been tested as per IS: 13573 for 3.3kV and 11kV class.

Fire proof Cable Penetration system should have been tested for the following tests:

- a) Accelerated Ageing test
- b) Water absorption test
- c) Fire rating test
- d) Hose Stream test
- e) Vibration test followed by fire rating test

9.02.00 Routine/ Acceptance Tests

Following routine/acceptance tests shall be carried out on all the equipments, devices & materials supplied:

9.02.01 Galvanizing Tests



The quality of galvanizing shall be inspected visually and shall be smooth, continuous, and free from flux stains.

- i) Uniformity of coating – The coating of any article shall withstand four 1 minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.
- ii) The quality of cadmium/zinc plating on items with screw threads shall be inspected visually and shall be free from visible defects such as unplanted areas, blisters and modules.
- iii) In addition, the plating thickness shall be determined microscopically/chemically or electronically.

9.02.02 Welding

The quality of welding shall be visually inspected, particular attention being paid to the following points.

- 1) The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.
 - 2). The weld metal shall be properly fused with the parent metal without undercutting.
 - 3) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.
1. Physical and dimensional checks for all items.
 2. All conduits/pipes, etc. shall be routine/acceptance tested as per relevant standards.
 3. All acceptance and routine tests on cable glands as for BS: 6121. Additionally Proof torque test shall be carried out as acceptance on each body group of cable glands.
 4. Deflection test cable trays.
 5. All acceptance and routine tests on Junction boxes.



6. Following tests shall also be carried out on each type of equipments, devices and materials/items supplied:

- 1) Physical and Dimensional checks
- 2) Check/measurement of thickness for Nickel chrome plating for cable glands and tinning for cable lugs.
- 3) Check chemical composition of brass parts for cable glands.
- 4) Hardness check on gaskets.
- 5) Test for uniformity of galvanization.

9.02.03**Cable trays / supports and accessories**

- 1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.
- 2) Check for continuity of cable trays over the entire route.
- 3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
- 4) Check for earth continuity and earth connection of cable trays.



CHAPTER – 12

MOTORS

1.00.00 DESIGN CRITERIA

1.00.01 For the purpose of design of equipments /systems, an ambient temperature of 50 °C and relative humidity of 85% shall be considered. The equipment shall operate in a highly polluted environment.

1.00.02 Transient voltage dip on starting of the largest motor with DOL shall be limited to 20% of the nominal system voltage at the voltage terminals.

1.00.03 Rating

The motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency.

All motors shall be continuously rated (S1 duty). However, crane motors shall be rated for S4 duty, 40% cyclic duration factor.

Whenever the basis for motor ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10% above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations.

1.00.04 Starting Voltage requirement for all motors (except mill motors):

1. 85 % of rated voltage for motors up to 1000 kW
2. 80 % of rated voltage for above 1000 kW and up to 4000 kW
3. 75 % of rated voltage for above 4000 kW

For Mill Motors:

1. 85 % of rated voltage for motors above 1000 kW
2. 90 % of rated voltage for motors up to 1000 kW

1.00.05 Canopy shall be provided for outdoor motors.

1.01.00 Contractor shall provide fully compatible electrical system, equipments, accessories and services.



1.02.00 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.

1.03.00 Voltage and frequency variations:

Frequency: (+) 3% and (-) 5%

Voltage : **i. AC**

a. $\pm 6\%$ for 11 kV/3.3 kV

b. $\pm 10\%$ for 415 V

Combined 10 % (absolute sum)

ii. DC- +10% to -15% for 220 V DC

1.04.00 All LV motors above 10 kW with S1 duty shall be compulsorily of Energy efficient level IE 2 as per IS 12615: 2011.

1.05.00 The responsibility of coordination with electrical agencies and obtaining all necessary clearances shall be of the contractor.

1.06.00 Type

AC Motors:

(a.) Squirrel cage induction motor suitable for direct-on-line starting.

(b.) Crane duty motors shall be slip ring type induction motor

DC Motors

(a.) Shunt wound.

1.07.00 Temperature Rise

Air cooled motors

70°C by resistance method

Water cooled

80° C over inlet cooling water temperature mentioned elsewhere, by resistance method.

1.08.00 Degree of Protection

Degree of protection for various enclosures shall be as follows :

i) Indoor motors – IP 54



ii)	Outdoor motors	–	IP 55
iii)	CW motors (in case of screen prot. Drip proof)	–	IP 23
iv)	Cable box – indoor area	–	IP 54
v)	Cable box – outdoor area	–	IP 55

2.00.00 CODES AND STANDARDS

2.01.00 All motors shall confirm to the latest editions including all applicable amendment of relevant IS, IEC and CBIP standards/Publications. In case any other standard is followed that ensures equal or better quality, may be accepted. However the English version of the Standard adopted shall be submitted.

2.02.00 Major Standards, which shall be followed, are listed below. Any other applicable Indian standards for any component part even if not covered in the list shall also be followed

1.)	Three phase induction motors	:	IS:325, IEC:60034
2.)	Single phase AC motors	:	IS:996, IEC:60034
3.)	Crane duty motors	:	IS:3177, IEC:60034
4.)	DC motors/generators	:	IS:4722
5.)	Degree of protection by enclosures for rotating electrical machines	:	IS: 4691 IS: 4728 IS: 6362 IS: 2253
6.)	Noise levels for rotating electrical machines	:	IS: 12065
	Mechanical Vibrations for rotating electrical machines	:	IS: 12075

3.00.00 OPERATIONAL REQUIREMENTS

3.01.00 Starting Time

3.01.01 For motors with starting time up to 20 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs more than starting time .



- 3.01.02 For motors with starting time more than 20 secs and up to 45 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs more than starting time.
- 3.01.03 For motors with starting time more than 45 secs at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- 3.01.04 Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
- 3.01.05 Motors shall be capable of restarting under full load after a momentary loss of voltage with the possibility of 150 % nominal voltage during fast bus transfer.
- 3.02.00 Torque Requirements
- 3.02.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- 3.02.02 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.

4.00.00 DESIGN AND CONSTRUCTIONAL FEATURES

- 4.00.01 Suitable single phase space heaters shall be provided on motors rated 30 kW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided.
- 4.00.02 All motors shall be suitable for direct on line starting through any type of breaker.
- L All motors shall be either totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above can be Closed air circuit water cooled (CACW). CW motors can be screen protected drip proof (SPDP) type. Motors located in hazardous areas shall have flame proof enclosures conforming to IS: 2148 as detailed below

- (a) Fuel oil area : Group - IIB
- (b) Hydrogen generation plant Group - IIC
area :

4.00.03 Winding and Insulation

- (a) Type : Non-hygroscopic, oil resistant, flame resistant



- (b) Starting duty : Two hot starts in succession, with motor initially at normal running temperature
- (c) 11 kV / 3.3 kV AC motors : Class F: with winding temperature rise limited to class B. They shall withstand 1.2/50 micro sec switching surges of $4U+5$ KV (U =Line voltage in KV). The coil inter-turn insulation shall be suitable for 0.3/3 micro sec. surge of 32 KVp and 12 kVp for 11 kV and 3.3 kV system respectively followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.
- (d) 415V AC & 220V DC motors : Class 'F' with temperature rise limited to class 'B'
- 4.00.04 Motors rated above 1000 kW shall have insulated bearings to prevent flow of shaft currents.
- 4.00.05 Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.
- 4.00.06 Noise level and vibration shall be limited within the limits prescribed in IS: 12065 & IS: 12075 respectively. Motors shall withstand vibrations produced by driven equipment.
- 4.00.07 In MV/HV motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0°C, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum. Each bearing shall be provided with dial type thermometer with adjustable alarm contact and resistance type temperature detector. All HV motors shall be provided with shaft grounding rings for bearing protection and earthing shaft current.
- 4.00.08 MV/HV motors shall also be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage and shall be capable of either two starts in quick succession with third start after 5 minutes in cold condition or two starts at 15 minutes intervals in hot condition, both cases with voltage and frequency variation within specified limits.
- 4.00.09 Locked rotor current of the MV motors shall be limited to 600% (subject to IS tolerance) of the full load current of the motors and for HV motor shall be limited to 450% (inclusive of IS tolerance) of full load current of the motor.



Locked rotor current of the LV motor shall not exceed 600% of full load current inclusive of IS tolerance.

- 4.00.10 MV Motors shall be provided with differential protection. These motors shall be provided with star connected stator windings. The 3 nos. current transformers, one for each phase shall be mounted in a separate compartment in the neutral side terminal box. The three phases shall be connected to form the star point after they pass through the CTs. These differential protection CTs shall be supplied loose by 11/ 3.3 kV switchgear manufacturer.
- 4.00.11 Motor body shall be grounded at two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers.
- 4.00.12 HV motors can be offered with either elastimould termination or dust tight phase separated double walled (metallic as well as insulated barrier) cable boxes. In case elastimould terminations are offered, then protective cover and trifurcating sleeves shall also be provided. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided in case of cable boxes.
- 4.00.13 All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
- 4.00.14 The motors shall be suitable for bus transfer schemes provided on the 11 kV, 3.3 kV/415V systems without any injurious effect on its life.
- 4.00.15 All motors below 15 kW shall be provided with sealed ZZ bearings.
- 4.00.16 For motors rated 1000 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.
- 4.00.17 All motors shall be provided with an emergency stop push button near the motor as per the Indian Statutory regulations.
- 4.00.18 The motor terminal box shall be suitable for withstanding the maximum system fault current for a duration of at least 0.25 seconds.
- 4.00.19 Neutral in case of HV motors shall be kept accessible.



- 4.00.20 Motors shall be designed to easy access for drilling holes through motor feed of mounting flange for installation of dowel pins after assembly of the motor and driven equipment.
- 4.00.21 Well spacious working platforms shall be provided around the motor area for carrying out maintenance & testing works. Platform shall be minimum of 300 mm below the level of motor base plate.
- 4.00.22 Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.
- 4.00.23 For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box..
- 4.00.24 Lube oil pressure transmitters shall be provided to DCS for remote monitoring. Lube oil pressure very low trip to HV equipment shall be 2 out of 3 logic.
- 4.00.25 Capillary type temperature gauge cum switch shall be provided for DE / NDE of HV Motors
- 4.00.26 Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:
- Hot and cold air temperatures of the closed air circuit for CACA motors.
 - Hot and cold, air and water temperatures for CACW motors.
- The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.

4.00.27 Lifting Provisions

Motor weighing 25 kg or more shall be provided with eye bolt or other adequate provision for shifting. Electrical hoists shall be provided for motors above 1000 kgs for maintenance of the same.

4.00.28 DC MOTORS

DC motors shall be provided where specified/required. DC Motors shall be sized for operation with fixed resistance starting for reliability. DC motors shall be shunt wound type. Motors shall be capable of delivering the rated output at 220 V DC with (+) 10% and (-) 15% variations without exceeding its guaranteed temperature limits. 220 V DC



system shall be unearthed. Starting current of the DC motors shall be limited to 200% of the full load current of the motor, and is subject to IS tolerance. DC Motors shall be similar to AC Motors with respect to other features like enclosure type, cooling and class of insulation

4.00.30 Painting

Motor including fan shall be painted with corrosion proof paints of colour shade Siemens grey (RAL 7032).

4.00.31 Local Push Button Stations

The LPBS shall be installed near the motors to be controlled. Individual channel supports shall be used for each LPBS. These shall be installed as per approved erection detail drawing. LPBS for hazardous areas shall be CMRS certified and CCE approved.

All LPBS shall have necessary canopies. Wiring of LPBS shall be checked before giving control supply.

5.00.00 LIST OF TESTS TO BE CONDUCTED FOR HV, MV and LV MOTORS

5.01.00 TYPE TESTS

- (a) No load saturation and loss curves up to approximately 115% of rated voltage
- (b) Momentary overload test
- (c) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., core temp., coolant flow and its temperature shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.
- (d) Surge withstand test on the sample coil after placing it in stator core at $(4U + 5 \text{ KV})$ and with at least five impulse of 1.2/50 micro sec. wave, for HV motors only, where U is the line to line voltage in kV.
- (e) Surge-withstand test with 0.3/3 micro sec. wave on each type of 3.3/11 kV motor coils with at least five such impulses, followed by one minute power frequency high voltage test on turn to turn insulation, after cutting the coil and bringing out



the turns suitably. The power frequency test voltage shall be decided during detailed engineering.

- f) Dimensions (for motors covered by IS 1231:1974 and IS 2223:1983 only)
- g) Measurement of resistance of windings of stator and wound rotor.
- h) Reduced voltage running up test at no load (for squirrel cage motors up to 37kw only)
- i) Full load test to determine efficiency, power factor and slip.
- j) Insulation resistance test
- k) Test for vibration severity of motor
- l) Test for noise levels of motor
- m) Test for degree of protection by enclosure
- n) Temperature rise test at limiting values of voltage and frequency variations
- o) Over speed test

5.02.00 ROUTINE TESTS

The following shall constitute the routine tests.

- a) Insulation resistance test
- b) Measurement of resistance of windings of stator and wound rotor.
- c) No load test
- d) Locked rotor readings of voltage, current and power input at a suitable reduced voltage
- e) Reduced voltage running up test (for squirrel cage motor)
- f) Open circuit voltage ratio of stator and rotor windings (for slip ring motors); rotor;
- g) High voltage test

6.00.00 INSPECTION AND TESTING AT SITE

6.01.01 Insulation resistance of 415V motors shall be measured between the winding of the machine and its frame by means of a 500/1000V megger. A minimum value of 1 mega ohm for 415V motors shall be considered a safe value. In case of lower I.R. Value, the insulation value shall be brought up by any of the following methods as desired by the Site Engineer:

- (a.) Blowing hot air in case of big motors.
- (b.) Putting the motor in electric oven in case of smaller motors.
- (c.) Placing heaters or lamps around and inside in case of small motors after making suitable guarding and covering arrangements so as to conserve the heat.



6.01.02 Site Test

- (a.) Measurement of vibration.
- (b.) Measurement of insulation resistance and polarization index.
- (c.) Measurement of full load current.
- (d.) Test running of the motors, checking the temperature rise and identifying the hot spot etc.

6.01.03 3.3 kV motors shall be tested for insulation by 500/1000V megger and its value should not be less than the safe minimum insulation of $\geq 20 \text{ M}\Omega$ resistance at 60 deg. C. In case the insulation is low, the following method of drying has to be adopted:

- a. By locking the motor so that it cannot rotate and then applying such a low voltage to the stator terminals that full load current flows in the stator, keeping the stator winding temperature below 90 deg. C. In this a close watch shall be kept for any possible overheating and I.R. Values vs. temperature shall be plotted and heating continued till I.R. Value becomes steady.
- b. By blasting hot air from external source, Maximum temperature of winding while drying should be 70 deg. C to 80 deg. C. (Thermometer) or 90 deg. C. to 95 deg. C. by resistance method. Heating should be done slowly till steady temperature of winding is reached after 4 to 5 hours and for large machines after 10 hours. A record has to be kept for drying process, with half an hour readings and, after steady temperature is reached, at an interval of 2 hours. In case it is essential, the drying process can be supplemented by blower.



ANNEXURE – 1

ILLUMINATION LEVELS

Lighting System will provide the following illumination levels. The lighting fixture/clamp type and quantity will be selected to achieve the illumination level at different condition of the plant.

S.No.	Area/Structure	Average Illumination in Lux	Type of Luminaire	Type of lamp
1.0	Turbine Generator Building			
1.1	General Auxiliary Equipment Areas	200	Industrial Well Glass	70W/150W metal halide /125W metal halide Lamp
1.2	Cable Spreader Room	100	Industrial type fluorescent lamp with vitreous enamel reflectors	T5 fluorescent tube with electronic ballast or tri phosphorous tube.
1.3	All Switchgear Room Area	200	Industrial type fluorescent lamp with vitreous enamel reflectors	LED Lamp Fixtures
1.4	TG Building Operating Floor	200	Industrial integral high bay	250W/400W metal halide Lamp
1.5	Main Control Rooms, Computer Rooms	400	Decorative recessed mounted with mirror optic (Dark Lighter)	LED Lamp Fixtures
1.6	Battery Rooms	200	Industrial Corrosion proof luminaire	2 x 40W/36W FTL
1.7	Unloading and Maintenance bay	250	Industrial integral high bay	250 W/400 W HPMV Lamp
1.8	Service Building	300	Industrial type fluorescent lamp with vitreous enamel reflectors/ Industrial integral high bay	2 x 36W FTL/250W metal halide Lamp
2.0	Boiler Area			



2.1	Boiler area and platforms	100	Dust proof/dust tight integral well glass luminaire.	70W metal halide / 125 W metal halide lamp
2.2	Coal Bunker and Mill bay area, feeder floor, trippler floor	150	Dust proof/dust tight integral well glass luminaire	1 x80 W/125 W metal halide Lamp
2.3	ESP areas and Platforms	120	Dust proof/dust tight integral well glass luminaire	70 W metal halide /125 W metal halide Lamp
2.4	ESP Control room	400	Decorative recessed mounted with mirror optic for clean room areas	LED Lamp Fixtures
3.0	Transformer Yard			
3.1	General	50	General purpose flood light	250W/ 400 W metal halide Lamp or LEP
3.2	Near equipment	70	Dust proof/dust light integral well glass	1 x 70 W metal halide Lamp
4.0	Various Off-site building			
4.1	Equipment / Switchgear Room	200	Industrial type fluorescent lamp with vitreous enamel reflectors upto mounting height of 3.5M or industrial medium bay integral luminaire for mounting heights between 3.5 to 8.0 M	LED Lamp Fixtures.
4.2	Pump House	200	Industrial Well glass	70 W metal halide /125 W metal halide Lamp
5.0	Cooling Water Pump House area.			
5.1	Cooling tower area.	50	Industrial well glass.	70W metal halide /125W metal



SECTION C3

SPECIFIC TECHNICAL SPECIFICATION (CIVIL)

	2x660MW ENNORE SEZ SCTPS- SPECIFIC TECHNICAL REQUIREMENTS	SPECIFICATION NO.	
		VOLUME – II B	
		SECTION - C	SUB-SECTION -
		REV.	DATE 10.12.2014
		SHEET 1 OF 7	

3.00.00	GEO-TECHNICAL INVESTIGATION & FOUNDATION SYSTEM
3.01.01	BHEL is carrying out detailed geo-technical investigation in the proposed cooling tower site. The sub-strata details encountered at bore holes BH-114, 115, 116, & 117 are enclosed as Annexure-1. 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 & 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.
3.01.02	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 shallow foundation/ safe load carrying capacity of pile to be adopted for the design of foundations during detailed engineering shall be limited to the values mentioned elsewhere in the specification and any value of net SBC/ safe load carrying capacity of pile higher than the one indicated shall not be accepted. However, the bidder shall note that the net safe bearing capacity and foundation depth/ safe load carrying capacity of pile to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.
3.02.00	Foundation System
3.02.01	General Requirements a. All equipments/structures shall be supported on suitable open foundation or pile foundation as required along with ground improvement for sub-soil/ash. The method of ground improvement is as specified elsewhere in the specification. However based on the sub-strata, cooling tower shall be supported on pile foundation with ground improvement. b. All foundations shall be designed in accordance with the provisions of



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SPECIFIC TECHNICAL REQUIREMENTS**

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relevant part of latest revision of Indian Standards or as per the technical specification whichever is stringent.

- c. No major foundation shall rest on ash/filled up soil. However, minor foundations may be rested on ash/filled up soil along with necessary ground improvement.
- d. A combination of open and pile foundations shall not be permitted under the same structure.
- e. 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.
- f. Foundation shall be designed for worst combination of loads as described elsewhere in the specification.
- g. Ground water table shall be considered at finished ground level for design purposes unless specified elsewhere in the specification.
- h. Sulphate resistant cement with C3A content between 5 to 8% shall be used.
- i. Minimum grade of concrete shall be M35.
- j. Reinforcement shall conform to grade Fe 500/550 as per IS: 1786 unless noted otherwise. Fusion bonded epoxy coated reinforcement steel with coating conforming to IS: 13620 shall be used.
- k. As per IS 456, the environmental exposure condition of “very severe” shall be considered. Also, requirement of table 4 & 5 of IS 456 shall be satisfied depending on exposure condition.



**2x660MW ENNORE SEZ SCTPS-
SPECIFIC TECHNICAL REQUIREMENTS**

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3.02.02 Open foundations

In case open foundations are adopted for structures other than cooling tower (pile foundation is required for cooling tower) the following shall be adhered to in addition with necessary ground improvement.

- a. Minimum width of foundation shall be 1m.
- b. Minimum depth of foundation shall be 2m below ground level. Net SBC of open foundation resting on pond ash/soil deposit shall be restricted to 10T/sqm with necessary ground improvement. Any value of net SBC higher than the one indicated above will not be accepted even at deeper depths. However, the bidder shall note that the net SBC and foundation depth to be adopted for design during detailed engineering stage shall be got approved by BHEL/owner.
- c. It shall be ensured that all foundations of a particular structure/ building/ /equipment shall rest on one bearing stratum.
- d. The permissible settlement as mentioned under para “permissible settlement of foundations” or the permissible settlement from functional requirements whichever is more stringent shall be adopted for the design.
- e. Permissible settlement of 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 foundation resting on ash/soil shall be restricted to 25mm.
- f. 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.
- g. Expansive soil shall not be used for filling/back filling around foundations.

3.02.03 Pile foundations

In case pile foundations are adopted, then the following shall be strictly adhered to.

- a. Pile foundation shall be bored cast-in-situ RCC pile as per IS: 2911 part-1 section-2. Three stage flushing of the pile bore shall be ensured as per the methodology duly approved by BHEL/owner. The construction methodology to be adopted shall be suitable to ensure proper termination of pile in the desired strata and to ensure pile bore free from spoils.



**2x660MW ENNORE SEZ SCTPS-
SPECIFIC TECHNICAL REQUIREMENTS**

SPECIFICATION NO.

VOLUME – II B

SECTION - C

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REV.

DATE 10.12.2014

SHEET 4 OF 7

- b. Only RCC pile shall be provided.
- c. Minimum diameter of pile shall be 600 mm.
- d. Minimum length of pile shall be 25m below cut off level. Cut off level shall be at least 4m below ground level.
- e. The allowable load carrying capacity of the pile in vertical compression shall be limited to its structural capacity. However, the pile capacity to be adopted for design shall be the least of the estimated design value and that obtained from the pile load test. Maximum permissible lateral deflection at pile head shall be 5mm.
- f. Only straight shaft piles shall be used.
- g. Minimum cover to main reinforcement in the pile shall be 75mm.
- h. The piling work shall be carried out in accordance with the provisions of IS: 2911 (relevant part) and approved construction methodology. Minimum grade of concrete shall be M-35 with cement content not less 400 Kg/cu.m.
- i. The actual length of pile shall in no case be less than the design length. However, the safe load carrying capacity of pile shall be limited to the following after necessary ground improvement.

Safe Load Carrying Capacity of Bored Cast-in-situ RCC Piles

SL No	Pile dia (mm)	Pile capacity in vertical com- pression (MT)	Pile capacity in lateral (MT)	Pile capacity in Uplift (MT)
1	600	130	6.7	35
2	750	200	8.4	50
3	900	270	10	65

- j. Bidder shall furnish the design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile, reinforcement for job piles and test piles etc.), construction methodology/ specification for construction of piles and scheme of initial pile load tests in vertical, lateral and uplift load carrying capacities for BHEL/owner's approval.



**2x660MW ENNORE SEZ SCTPS-
SPECIFIC TECHNICAL REQUIREMENTS**

SPECIFICATION NO.

VOLUME – II B

SECTION - C

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REV.

DATE 10.12.2014

SHEET 5 OF 7

- k. Regular quality assurance checks for density of circulation mud, contamination mud and samples from pile bore bottom, slump of concrete, pile concrete integrity etc. shall be done by the bidder
- l. Dynamic cone penetration test (DCPT) shall be carried out for a depth of at least 2m below the pile termination depth. The frequency of DCPT shall be one test for each pile group (with four piles or more).



**2x660MW ENNORE SEZ SCTPS-
SPECIFIC TECHNICAL REQUIREMENTS**

SPECIFICATION NO.

VOLUME – II B

SECTION - C

SUB-SECTION -

REV.

DATE 10.12.2014

SHEET 6 OF 7

3.02.03 Pile Load Tests

Bidder shall install piles for initial load test. Minimum number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under.

1. Vertical (compression)	2
2. Lateral (horizontal)	2
3. Uplift (tension)	2

The initial pile load test shall be conducted up to a maximum test load of three times the estimated safe load carrying capacity of pile. In case of compression test, the method of loading shall be cyclic as per IS: 2911 (relevant part).

The routine load test on pile shall be conducted upto a maximum test load of one and half times the allowable pile capacity as per relevant Indian Standards. Number of routine pile load tests to be performed for each diameter/ allowable capacity of pile in vertical compression and lateral load shall be at least 1.5% of total number of job piles in each case. Piles for routine load test shall be approved by BHEL/owner.

Testing of piles and interpretation of pile load test results shall be carried out as per IS: 2911, Part-4. Bidder shall ensure that all equipments/ instruments are properly calibrated at a reputed laboratory/institution prior to their use and the calibration test certificates shall be submitted to BHEL/owner.

A report on the pile load tests shall be submitted for BHEL/owner's approval. In case, pile has not achieved the desired capacity after routine pile load test or piles have been rejected due to any other reason, then the bidder shall install additional pile(s) as required at his/her own cost and accordingly pile cap design shall also be reviewed and modified (if required) at no extra cost to BHEL/owner.

3.02.04 Pile Integrity Test:

Low strain pile integrity test shall be conducted on all job/test piles. The testing shall confirm to relevant ASTM.

3.02.05 Ground Improvement:

- a. Ground improvement shall be done by installing 550mm diameter and 15m deep driven cast-in-situ compaction piles.



**2x660MW ENNORE SEZ SCTPS-
SPECIFIC TECHNICAL REQUIREMENTS**

SPECIFICATION NO.

VOLUME – II B

SECTION - C

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DATE 10.12.2014

SHEET 7 OF 7

- b. Compaction pile shall be installed by driving of suitable MS casing pipe (removable) with a detachable M.S.shoe (flat/conical) at the bottom.
- c. Filling material shall be 1 sand: 2 stone aggregates. Sand shall confirm to IS 383 and the stone aggregates shall be 50mm & down and shall also confirm to IS 383. Fill material shall be placed in layers of 800mm and each layer be well compacted by dynamic compaction method.
- d. Before compaction, lift the casing for about 800mm from bottom and then the backfill shall be thoroughly compacted.
- e. This procedure shall be repeated for every layer till the ground level is reached for ground improvement.
- f. Center to center spacing between the compaction piles shall be limited to 3 times the diameter of compaction pile.

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE:- N = 3410'000
E = (-) 3182'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title: BORE LOG DATA SHEET

(Cooling Tower Area)

DOC No.: CET/ST/01/QC
Page: 01/02

Project: GTI Work for 2X660 MW Set at Ennor SE2 Coal Based STPP at Ash Dyke of NCTPS, Chennai

Job No. 3388 Bore Hole No. 114 (Cooling Tower Area) Date 26.11.14

Made by Shibaram Ghosh Checked by

No. of SP Tests	22	Samples	Nos.	Commencement Date	24.11.14
No. of Vane (V) Test	-	Undisturbed (UDS)	03	Completion Date	26.11.14
Length of Casing 8X	24'00"	Penetrometer (SPT)	22	Bore Hole Diameter	150 mm
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	8'935 M
Method of Boring Shell Wash		Water Sample (WS)	-	Water Struck At	
				Standing Water Level	

DESCRIPTION	SYMBOL	N-VALUE				SAMPLES	
		Each 15cm Penetration				Ref. No.	Depth (m)
Filled up soil consist of Light grey, fly ash		0	0	0	N=00	DS-01	0'50
2'45M						SPT-01	1'00 - 1'45
Very Soft to medium, steel grey to deep grey, Silty Clay with Sand mixture		0	0	0	N=00	UDS-01	2'00 - 2'45(S)
obs: micarist from SPT-04-(7'00-7'45M)						SPT-02	3'00 - 3'45
						UDS-02	4'00 - 4'45(S)
		0	0	1	N=01	SPT-03	5'00 - 5'45
						UDS-03	6'00 - 6'45(S)
		0	1	1	N=02	SPT-04	7'00 - 7'45
						UDS-04	8'00 - 8'45
9'00M		2	2	3	N=05	SPT-05	9'00 - 9'45
Medium, light grey, clayey silt with Sand mixture.						UDS-05	10'00 - 10'45(S)
obs: Steel grey patches		1	3	3	N=06	DS-02	11'00
						SPT-06	11'50 - 11'95
						DS-03	12'50
						UDS-06	13'00 - 13'45(S)
						DS-04	14'00
14'50M		6	6	9	N=15	SPT-07	14'50 - 14'45
medium dense, steel grey, Silty Sand with clay lamination						DS-05	15'50
						UDS-07	16'00 - 16'45
						DS-06	17'00
17'50M		8	7	12	N=19	SPT-08	17'50 - 17'95
Very stiff light grey, Silty Clay.						DS-07	18'50
obs: Steel grey patches.						UDS-08	19'00 - 19'45
						DS-08	20'00
20'50M		10	18	26	N=44	SPT-09	20'50 - 20'95
Dense, light brownish grey, Silty Sand with clay lamination						DS-09	21'50
		10	18	28	N=46	SPT-10	22'00 - 22'45
						DS-10	23'00
23'50M		10	21	26	N=47	SPT-11	23'50 - 23'95

S = Slip

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE :- N = 3410'000
E = 3182'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : BORE LOG DATA SHEET

DOC No. : CET/STP/01/0C
Page : 02/02

Project : GI Work for 2X660MN Shd at Ennore SEZ Coal Based STPP at ASH Dyke of NCTPS, Chennai

Job No. 3388 Bore Hole No. 114 (Cooling Tower) Date 26.11.14

Made by Shubram Ghosh Checked by

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 24.11.14
No. of Vane (V) Test	-	Undisturbed (UDS)	03	Completion Date	: 26.11.14
Length of Casing Sx:-	24'00m	Penetrometer (SPT)	22	Bore Hole Diameter	: 150mm
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 8'935m
Method of Boring Shell & Wash		Water Sample (WS)	-	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE			SAMPLES	
		Each 15cm Penetration			Ref. No.	Depth (m)
Hard, light brownish gray, Silty clay/ Clayey silt with sand mixture		12	24	26	DS-11	24'50
				N=50	SPT-12	25'00 - 25'45
		12	20	25	DS-12	26'00
28'00m Hard, Light obs yellowish brown, clayey Silty (Sand mixture)				N=45	SPT-13	26'50 - 26'95
		14	26	30	DS-13	27'50
				N=56	SPT-14	28'00 - 28'45
31'00m Very dense, yellowish brown, Clayey Silty Sand.		15	27	33	DS-14	29'00
				N=60	SPT-15	29'50 - 29'95
		14	23	38	DS-15	30'50
34'00m Very dense, yellowish brown, Silty Sand.				N=61	SPT-16	31'00 - 31'45
		23	39	45	DS-16	32'00
				N=88	SPT-17	32'50 - 32'95
38'50 Very dense, brownish gray, Silty Sand.		21	34	42	DS-17	33'50
				N=76	SPT-18	34'00 - 34'45
		20	40	54	DS-18	35'00
40'00m The bore hole is terminated at the depth of 40'00m below E.G.L.				N=94	SPT-19	35'50 - 35'95
		25	45	60	DS-19	36'50
				N=105	SPT-20	37'00 - 37'45
FOR C.E. TESTING CO. N.T. LTD. Rundu.		27	50	60	DS-20	38'00
				N=110	SPT-21	38'50 - 38'95
		30	60	54	DS-21	39'50
				N=100	SPT-22	40'00 - 40'35
		Penetration				

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
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Kolkata - 700 096

CO-ORDINATE: N = 3345'000
E = 3294'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title: BORE LOG DATA SHEET

DOC No.: CET/STP/01/0C
Page: 01/02

Project: G.T.I. WORK for 2X660MW Set at ~~Emmor~~ SEZ, Coimbatore, Tamil Nadu, India. NCTPS, Chennai

Job No. 3388

Bore Hole No. 115 (Cooling Tower)

Date 03/12/14

Made by Shilpram Ghosh

Checked by *[Signature]*

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 01.12.14
No. of Vane (V) Test	-	Undisturbed (UDS)	03	Completion Date	: 03.12.14
Length of Casing SX'-	20'00M	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 9.239 m.
Method of Boring	Shelly Wash	Water Sample (WS)	-	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE						SAMPLES	
		Each 15 Cm Penetration						Ref. No.	Depth (m)
Filled up Soil Consist of light grey, fly ash.								DS-01	0'50
← 2'45M →		0	0	0	-	-	N=00	SPT-01	1'00 - 1'45
								UDS-01	2'00 - 2'45(S)
		0	0	0	-	-	N=00	SPT-02	3'00 - 3'45
Very Soft, Steel grey to deep grey, silty clay with sand mixture.								UDS-02	4'00 - 4'45(S)
← 9'00M →		0	0	0	-	-	N=00	SPT-03	5'00 - 5'45
								UDS-03	6'00 - 6'45(S)
Very Soft, deep grey, clayey silt with sand mixture; obs! - micarist.								SPT-04	7'00 - 7'45
← 11'50M →		0	0	1	-	-	N=01	UDS-04	8'00 - 8'45(S)
								SPT-05	9'00 - 9'45
								UDS-05	10'00 - 10'45
Very Soft to medium, steel grey, clayey silt with sand mixture								DS-02	11'00
← 17'50M →		0	1	1	-	-	N=02	SPT-06	11'50 - 11'95
								DS-03	12'50
								UDS-06	13'00 - 13'45
Very stiff, brownish grey, clayey silt.								DS-04	14'00
obs! - steel grey patches								SPT-07	14'50 - 14'95
← 19'00M →								DS-05	18'50
								UDS-07	16'00 - 16'45
Brownish grey, silty fine sand.								DS-06	17'00
← 20'50M →								SPT-08	17'50 - 17'95
								DS-07	18'50
Some to very dense, brownish grey, silty coarse sand with clay laminae								UDS-08	19'00 - 19'45(S)
← 28'00M →		11	23	23	-	-	N=46	DS-08	20'00
								SPT-09	20'50 - 20'95
								DS-09	21'50
		12	22	24	-	-	N=47	SPT-10	22'00 - 22'45
								DS-10	23'00
		14	21	26	-	-	N=47	SPT-11	23'50 - 23'95
								DS-11	24'50
		24	33	40	-	-	N=73	SPT-12	25'00 - 25'45

S = Slip

C. E. Testing Company Pvt. Ltd.

ANNEXURE-I

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Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE: N = 3348'000
E = (-) 3294'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title: BORE LOG DATA SHEET

DOC No.: CET/STH/01/0C
Page: 02/02

Project: G.T.I. Works for 2X660MW Sets at Ennor SEZ, Coal Based STPP at Ash Dyke of NCTPS, Chennai

Job No. 3388

Bore Hole No. 115 (Cooling Tower)

Date 03/12/14

Made by Shibaram Ghosh

Checked by [Signature]

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 01.12.14
No. of Vane (V) Test	-	Undisturbed (UDS)	03	Completion Date	: 03.12.14
Length of Casing	8X1-2000	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 9.239 m.
Method of Boring	Shell & Wash	Water Sample (WS)	-	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE		SAMPLES	
		Each 15 cm Penetration	Ref. No.	Depth (m)	
Very dense, brownish grey, Silty coarse sand. obs: Kankars. 29'00m		26 39 45 - - N=8.4	DS-12	26'00	
			SPT-13	26'50 - 26'95	
Hard, yellowish brown, Silty clay. obs: Steel grey patches. 31'00m		22 40 48 - - N=8.8	DS-13	27'50	
			SPT-14	28'00 - 28'45	
		11 21 27 - - N=4.8	DS-14	29'00	
			SPT-15	29'50 - 29'95	
		10 26 20 - - N=4.6	DS-15	30'50	
			SPT-16	31'00 - 31'45	
		11 20 26 - - N=4.6	DS-16	32'00	
			SPT-17	32'50 - 32'95	
		13 22 27 - - N=4.9	DS-17	33'50	
			SPT-18	34'00 - 34'45	
		10 21 30 - - N=5.1	DS-18	35'00	
			SPT-19	35'50 - 35'95	
		11 20 32 - - N=5.2	DS-19	36'50	
			SPT-20	37'00 - 37'45	
		12 22 37 - - N=5.9	DS-20	38'00	
			SPT-21	38'50 - 38'95	
		17 30 51 - - N=8.1	DS-21	39'50	
			SPT-22	40'10 - 40'55	

FOR C.E. TESTING CO. PVT. LTD.
Shibaram Ghosh

[Signature]

The bore hole is terminated at the depth of 40'10m below E.G.L.

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Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE: N = 3390'000
E = (-)3340'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title: BORE LOG DATA SHEET

DOC No.: CET/STF/01/0C
Page: 01/02

Project: GTI Work for 2X660 MW Set at Ennore SE 2 Road Based STP at Ash Dike of NCTPS, Chennai
Job No. 3388 Bore Hole No. 116 (Cooling Tower) Date 29.11.14
Made by Shubaram Ghosh Checked by

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 27.11.14
No. of Vane (V) Test	-	Undisturbed (UDS)	04	Completion Date	: 29.11.14
Length of Casing SX:-	24'00m	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 10' L88 M
Method of Boring	Shell & Wash	Water Sample (WS)	00	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE					SAMPLES	
		Each 15 cm Penetration					Ref. No.	Depth (m)
Filled up Soil consist of light grey, fly ash.		0	0	0	-	N=0	DS-01	0'50
		0	0	0	-	N=0	SPT-01	1'00 - 1'45
		0	0	0	-	N=0	UDS-01	2'00 - 2'45(S)
3'00M		0	0	0	-	N=0	SPT-02	3'00 - 3'45
Very soft, brownish grey, clayey silt with sand mixture.		0	0	1	-	N=0	UDS-02	4'00 - 4'45(S)
		0	0	1	-	N=0	SPT-03	5'00 - 5'45
		0	1	1	-	N=0	UDS-03	6'00 - 6'45(S)
7'00M		0	1	1	-	N=0	SPT-04	7'00 - 7'45
Soft to medium, light grey clayey silt with sand mixed, obs. steel grey patches.		0	1	1	-	N=0	UDS-04	8'00 - 8'45
		0	1	1	-	N=0	SPT-05	9'00 - 9'45
		1	1	2	-	N=0	UDS-05	10'00 - 10'45
11'50M		1	1	2	-	N=0	DS-02	11'00
		1	1	2	-	N=0	SPT-06	11'50 - 11'95
		1	2	3	-	N=0	UDS-06	12'50
		1	2	3	-	N=0	DS-04	13'00 - 13'45(S)
Soft to medium, light grey, clayey silt with sand mixed.		1	2	3	-	N=0	DS-05	14'00
		1	2	3	-	N=0	SPT-07	14'50 - 14'95
		3	4	4	-	N=0	UDS-07	15'50
		3	4	4	-	N=0	DS-06	16'00 - 16'45
		3	4	4	-	N=0	SPT-08	17'00
		3	4	4	-	N=0	UDS-08	17'50 - 17'95
19'00M		3	4	4	-	N=0	DS-07	18'50
Brownish grey, silty clay.		11	20	29	-	N=4	SPT-09	19'00 - 19'45
20'50M		11	20	29	-	N=4	DS-08	20'00
		13	22	52	-	N=5	SPT-10	20'50 - 20'95
Dense to very dense, brownish grey, silty coarse sand.		13	22	52	-	N=5	DS-09	21'50
		12	21	29	-	N=5	SPT-11	22'00 - 22'45
obs. steel grey patches, clay laminae, kankars.		12	21	29	-	N=5	DS-10	23'00
		12	22	30	-	N=5	SPT-12	23'50 - 23'95
		12	22	30	-	N=5	DS-11	24'50
		12	22	30	-	N=5	SPT-12	25'00 - 25'45

S = Slip

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE: N = 3390'000
E = (-) 3340'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title: BORE LOG DATA SHEET

DOC No.: CET/STH/01/OC
Page: 02/02

Project: G.T.I. Work for 2X660 MW Sels at Ennore SEZ Coal Based STPP at Ashdyke of NCTPS, Chennai.

Job No. 3388 Bore Hole No. 116 (Cooling Tower) Date 22.11.14

Made by Shubaram Ghosh. Checked by

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 27.11.14
No. of Vane (V) Test	-	Undisturbed (UDS)	04	Completion Date	: 29.11.14
Length of Casing SX:-	24'00M	Penetrometer (SPT)	22	Bore Hole Diameter	: 150' MM
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 10'188 M.
Method of Boring	Shell & Wash	Water Sample (WS)	-	Water Struck At	: -
				Standing Water Level	: -

DESCRIPTION	SYMBOL	N-VALUE				SAMPLES	
		Each 15cm Penetration				Ref. No.	Depth (m)
Very dense, brownish grey, Silty Course Sand. obs:- Steel grey patches, clay laminae, Kankars. 29'00M		13	24	38	- - N= 6 2	DS-12	26'00
						SPT-13	26'50 - 26'95
		14	23	40	- - N= 6 3	DS-13	27'50
						SPT-14	28'00 - 28'45
Hard, yellowish brown, Silty clay. obs:- grey patches, Sand mixed. 34'00M		12	22	30	- - N= 5 2	DS-14	29'00
						SPT-15	29'50 - 29'95
		13	24	32	- - N= 5 6	DS-15	30'50
						SPT-16	31'00 - 31'45
Very dense, brownish grey, Silty Course Sand. obs:- Clay laminae, Kankars. 37'00M		14	27	40	- - N= 6 7	DS-16	32'00
						SPT-17	32'50 - 32'95
		14	27	41	- - N= 6 8	DS-17	33'50
						SPT-18	34'00 - 34'45
Very dense, yellowish, brownish grey, Silty Course Sand obs:- Kankars. 40'10M		26	60	45	- - N= 10 5	DS-18	35'00
						SPT-19	35'50 - 35'95
		22	41	51	- - N= 9 5	DS-19	36'50
						SPT-20	37'00 - 37'45
The bore hole is terminated at the depth of 40'10M below E.G.L.		24	39	48	- - N= 8 7	DS-20	38'00
						SPT-21	38'50 - 38'95
		29	38	42	- - N= 8 0	DS-21	39'50
						SPT-22	40'10 - 40'55

FOR C.E. TESTING CO. PVT. LTD.
Shubaram Ghosh

Shubaram Ghosh

C. E. Testing Company Pvt. Ltd.

ANNEXURE - I

Page - (7/8)

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE:

N = 3345'000
E = 3294'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : BORE LOG DATA SHEET

DOC No. : CET/STR/01/0C
Page : 01/02

Project : G.T.I. WORK for 2X660 MN AT EXIST. SEZ Canal raised STPP AT ASH DYKE OF N.C.T.S.

Job No. 3388 Bore Hole No. 117 (Cooling Tower) Date 01.12.14

Made by Shibaram Ghosh Checked by Randy

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 29.11.14
No. of Vane (V) Test	-	Undisturbed (UDS)	03	Completion Date	: 01.12.14
Length of Casing SX	20'00M	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	-	Disturbed (DS)	21	Level of Ground	: 10'775 M.
Method of Boring	Shell & Wash	Water Sample (WS)	-	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE					SAMPLES	
		Each 150mm Penetration					Ref. No.	Depth (m)
Filled up Soil consist of light grey, fly. Ash		0 0 0 - -	N=0 0				DS-01	0'50
2'00M		0 0 0 - -	N=0 0				SPT-01	1'00 - 1'45
Very Soft, steel grey to deep grey, Silty Clay with sand mixture		0 0 0 - -	N=0 0				SPT-02	2'00 - 2'45
5'00M		0 0 0 - -	N=0 0				SPT-03	3'00 - 3'45
Very Soft, brownish grey, Silty Clay.		0 0 0 - -	N=0 0				UDS-01	4'00 - 4'45(S)
9'00M		0 0 0 - -	N=0 0				SPT-04	5'00 - 5'45
		0 0 1 - -	N=0 1				UDS-02	6'00 - 6'45(S)
		0 0 1 - -	N=0 1				SPT-05	7'00 - 7'45
		0 0 1 - -	N=0 1				UDS-03	8'00 - 8'45
		0 0 1 - -	N=0 1				SPT-06	9'00 - 9'45
							UDS-04	10'00 - 10'45
Very Soft, deep grey, Silty Clay.		0 0 1 - -	N=0 1				DS-02	11'00
14'00M							SPT-07	11'50 - 11'95
							DS-03	12'50
							UDS-05	13'00 - 13'45
Loose, yellowish grey, Silty Sand.		3 4 5 - -	N=0 9				DS-04	14'00
							SPT-08	14'50 - 14'95
							DS-05	15'50
							UDS-06	16'00 - 16'45(S)
		12 20 24 - -	N=4 4				DS-06	17'00
Hard, light brownish grey, Silty Clay with high Percentage of Sand.							SPT-09	17'50 - 17'95
17'50M							DS-07	18'50
							UDS-07	19'00 - 19'45
		12 18 22 - -	N=4 0				DS-08	20'00
Hard, yellowish grey, Silty Clay with high Percentage of coarse Sand.							SPT-10	20'50 - 20'95
20'50M		14 24 30 - -	N=5 4				DS-09	21'50
							SPT-11	22'00 - 22'45
		16 27 36 - -	N=6 5				DS-10	23'00
Very dense, brownish grey, Silty coarse Sand.							SPT-12	23'50 - 23'95
23'00M		20 32 45 - -	N=7 7				DS-11	24'50
							SPT-13	25'00 - 25'45
							DS-12	26'00

S = Slip

[Signature]

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE:- N = 3345'000
E = (-) 3294'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : BORE LOG DATA SHEET

DOC No. : CET/STF/01/OC
Page : 02/02

Project : G.T.I. Work for 2X660 MW Sels at Ennore SEZ Coal Based STP at Ash Dyke of N.T.P.S. Chennai

Job No. 3388 Bore Hole No. 117 (Cooling Tower) Date 01.12.14

Made by Shibaram Ghosh Checked by

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 29.11.14
No. of Vane (V) Test	-	Undisturbed (UDS)	03	Completion Date	: 01.12.14
Length of Casing 3x1	20'00M	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 10'775 M.
Method of Boring Shell/Wash		Water Sample (WS)	-	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE						SAMPLES	
		Each 15 cm Penetration						Ref. No.	Depth (m)
Very dense, brownish grey, Silty Coarse Sand. 27'00M		21	30	42	-	-	N=72	SPT-14	26'50 - 26'95
								DS-13	27'50
Hard, yellowish brown, Silty clay. obs: steel grey patches 32'50M		11	19	27	-	-	N=46	SPT-15	28'00 - 28'45
								DS-14	29'00
		12	20	26	-	-	N=46	SPT-16	29'50 - 29'95
								DS-15	30'50
								UDS-08	31'00 - 31'15(R)
								DS-16	32'00
Hard, brownish grey, Silty clay. obs: yellowish patches. 34'00M		13	21	27	-	-	N=48	SPT-17	32'50 - 32'95
								DS-17	33'50
		22	30	35	-	-	N=65	SPT-18	34'00 - 34'45
								DS-18	35'00
Very dense, brownish grey, Silty Coarse Sand. obs: Kankars. 40'00M		27	43	57	-	-	N=100	SPT-19	35'50 - 35'95
								DS-19	36'50
		20	38	56	-	-	N=94	SPT-20	37'00 - 37'45
								DS-20	38'00
		22	40	59	-	-	N=99	SPT-21	38'50 - 38'95
								DS-21	39'50
The bore hole is terminated at the depth of 40'00M below FGL.		25	35	40	-	-	N=75	SPT-22	40'00 - 40'45

For C.E. TESTING CO. PVT. LTD.
Shibaram Ghosh

R = Refusal (Sample could not be recovered due to hard strata)

SECTION C4

SPECIFIC TECHNICAL SPECIFICATION (C&I)

	2X660 MW ENNORE SEZ STPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) NATURAL DRAUGHT COOLING TOWER	
CONTROL AND INSTRUMENTATION FOR NATURAL DRAUGHT COOLING TOWER		

	2X660 MW ENNORE SEZ STPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) NATURAL DRAUGHT COOLING TOWER	
Specific Technical Requirements (C&I): 1.1 Bidder to supply the following items as a minimum i) One no. Pressure Gauge and One no. Temp Gauge at Hot Water pipe header at T.P.. ii) One no. of Anemometer for measurement of wind velocity. iii) One no. of Psychrometer. iv) 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. v) Local Control Panel for Sump Pumps (Submersible Type). vi) Level switches for sump/tank level high/normal/low/very low interlocks. 1.2 The detailed specification of instruments is given in detail as below. 1.3 The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with. 1.4 Drawings/Documents and data to be furnished after award of the contract as per deliverables list. <u>MEASURING INSTRUMENTS</u> 1.1 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1, Division 1 area & flame proof) and an anti corrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag and double compression type Nickel-plated brass cable gland.		

	2X660 MW ENNORE SEZ STPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) NATURAL DRAUGHT COOLING TOWER	
	Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.	
1.2	All local gauges as well as transmitters, sensors and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance under the scope of specification shall be provided. The necessary root valves, impulse piping, drain cock, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting / erection of these local instruments shall be furnished even if not specifically asked for. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg / Cm².	
1.3	All primary instruments installed at “minus level or Floor” shall be with protection class of IP 68.	
1.4	All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.	
1.5	All limit switch shall be conform to IEC-60947-5-1.	
1.6	All Field Instruments used in acid or alkaline atmosphere shall be with standard Anti corrosion coating i.e. the combination of Polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).	
1.7	All wetted parts of instrument shall be suitable for sea water application (Duplex stainless steel or better).	
1.8	Painting of I & C equipment: Epoxy coating required for all I & C equipment.	
1.9	All valve actuator shall be provided with conventional actuators with integral starter for ON/OFF valves. The detailed specification of actuator is given in detail as below.	
2.0	These requirements are to be read in conjunction with detailed Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of Customer shall prevail without any commercial implication.	

	2X660 MW ENNORE SEZ STPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) NATURAL DRAUGHT COOLING TOWER	

C&I DELIVERABLES LIST

C&I DELIVERABLES LIST FOR NDCT		
SI.No	DRAWING NO.	DRAWING/DOCUMENT TITLE
INSTRUMENTATION		
1	PE-V9-412-165-I901	INSTRUMENT DATA SHEETS
3	PE-V9-412-165-I903	INSTRUMENT QP / CHECK LIST
RELAY BASED LCP		
1	PE-V9-412-165-I950	LOCAL CONTROL PANEL DATA SHEET
2	PE-V9-412-165-I951	WIRING DIAGRAM
3	PE-V9-412-165-I952	PANEL GA DRAWING
7	PE-V9-412-165-I956	BILL OF MATERIAL
8	PE-V9-412-165-I957	LOCAL CONTROL PANEL QUALITY PLAN
9	PE-V9-412-165-I958	RELAY BASED PANEL O & M MANUAL

	2X660 MW ENNORE SEZ STPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) NATURAL DRAUGHT COOLING TOWER	
FIELD & MEASURING INSTRUMENTS		

Accuracy	:	$\pm$ One (1) percent or better
Repeatability	:	$\pm$ 0.5(half) percent or better
Setting & Differential	:	Adjustable
Contact		
- Number	:	DPDT /2 SPDT
- Type	:	Auto reset with internal Adjustable snap action micro switch
- Rating	:	5 Amp, 240V AC / 0.2 Amp, 220V DC
Connection - instrument	:	Half (1/2) inch NPT Male Process
Electrical	:	Suitable for Plug in type connection. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.
- Over range protection	:	One Fifty (150) percent of full scale
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
Accessories		
- 3 / 5 valve manifold	:	As applicable for all switches
- Self cleaning type pulsation dampners/Snubber (Material SS316)	:	Pump and compressor discharge lines
- Syphon	:	For all steam lines
- Protective separating diaphragm	:	For fuel oil & corrosive liquid lines.
Mounting	:	Local (in LIE/LIR for BTG package).

3.03.03**PRESSURE & DIFFERENTIAL PRESSURE GAUGES (PG & DPG)**

Applicable standard	:	IS:3602-1966, IS/3624, ASME B 40.1
Type/Construction	:	
-760 mm to 1.0Kg/cm ²	:	Bellows/Diaphragm
-Above1.0Kg/cm ²	:	Bourdon Tube
- Suction side of pumps	:	Compound gauge

Materials

- Bourdon tube	:	316 SS
- Bellows	:	316 SS
- Movement	:	316 SS
- Case	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating



		shall be provided for corrosive atmosphere.
- Protective Diaphragm	:	Teflon
Dial size	:	150mm with shatter proof glass
Scale Details	:	Graduations in black lines on white dial, on white dial, 270 Deg. pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
Accuracy	:	$\pm$ One (1) percent or better
Connection - Instrument Process	:	1/2 inch NPT Male Bottom
Mounting	:	Local
	:	1/2 inch NPT Male (Back entry) mounted on local gauge board.
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 way needle valve/manifolds	:	For all gauges
- Self cleaning type	:	Pump and compressor discharge lines
Pulsation dampener/snubber (S316)	:	
- Syphon	:	For all steam lines
- Protective separating	:	For fuel oil and corrosive liquid lines

Other particulars

- External Zero adjustment	:	For all gauges
- Safety device	:	

Ranges 5 to 20 Kg/cm ²	:	Rubber blow out disc with open front construction.
Ranges above 20 Kg/cm ²	:	Neoprene safety diaphragm at the back with solid front construction.
- Over range protection	:	One Fifty (150) percent of full scale

Other Requirments

:	Movement mechanism shall be glycerin filled for oil services & vibration prone area.
:	For Fuel oil & corrosive liquid lines diaphragm type sensors required. Armored capillary of 10 M for Fuel oil & Corrosive liquid service.



- : Contact type pressure gauges are not acceptable for interlock & protection.
- : For condensate storage tank the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

3.03.04

TEMPERATURE TRANSMITTERS

Type	:	SMART type configurable from control room through HART protocol (HMS System).
Display type	:	Indicating type (5 digit LCD Display),
Accuracy	:	$\pm 0.10\%$,
Ambient temperature error	:	0.1% per 10°C change
Output	:	4-20 mA DC (2 wire system) HART compatible signals for analogue monitoring inputs to the distributed control system (DDCMIS), DCS & PLC.
Protection class	:	NEMA 4/IP66 or equivalent degree of protection for enclosure)/ (Explosion/Flame proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Material of accessories	:	SS316.
Stability	:	$\pm 0.1\%$ or ± 0.1 deg C of reading (whichever is great) for 2 years in case of RTD inputs and for 1 year in case of Thermocouples inputs.
Operating Voltage	:	16 – 48 V DC
Calibration	:	as per NIST monograph 125 for T/C & European Curve Alpha = 0.00385 for RTD .
Ref. Junction compensation	:	Provided
Span/zero adjustment	:	Locally adjustable, Non interacting
Auto calibration	:	Provided
Burn out protection upscale	:	Provided
Input - output isolation	:	Provided
Circuit ungrounded	:	Provided

Any RTD & Thermocouples shall be directly wired to DDCMIS/DCS/PLC for metal temperature application, bearing & winding temp application only.

The Temperature transmitter shall accept Universal dual inputs of all types of thermocouples & RTD, 0-5V input signals etc.



with two nipples of SS 316 having 1/2"NPT(M) threads at both ends

Thermowell : To suit Temp. switch with same design criteria as specified for RTDs.
Electrical : Suitable for Plug in type.

All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.

Other Particulars

- Capillary length : As per requirement (min 10 meters)
- Immersion Length : Within + ten (10) mm of center line of pipe with adjustable nuts.
- Extension neck length : Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
- Packing glands : Yes
IBR Certification : For high pressure service, Steam Temp, Fuel oil temp. measurement as per IBR rules and regulations
N.B : Switches designed for cross ambient operation shall be used in applications where the ambient temperature will approximate or exceed the switch set point.

3.03.09 TEMPERATURE GAUGES (TG)

Applicable standard : IS : 3602,BS:5235 ISA:RP:8.1
except as modified in this specification

Type/Construction

- Thermometer : Industrial type, Gas in Filled type with separable thermowell
- Thermowell : Bar stock

Material

- Bulb : 316 SS
- Capillary : Armoured SS (Applicable for capillary Type)
- Casing : SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating



shall be provided for corrosive atmosphere

Dial Size	:	150mm with shatter proof glass
Scale Details	:	270 degree dial rotation/deflection. Graduations in black lines on white dial provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges
Accuracy	:	$\pm$ One (1) percent or better
Response time	:	Maximum 15 seconds without thermowell and 30 seconds with thermowell
Connection		
- Pipe	:	M33 x 2
- Thermowell	:	To suit instrument with same design criteria specified for RTDs.
- Process Connection	:	(i) M 33 x 2 (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
- Extension	:	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
Other Particulars		
- Capillary length	:	5Meters/10 Meters as required
- Immersion Length	:	Within + ten (10) mm of center line of pipe with adjustable nuts.
- Extension neck length	:	Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
- Stop at Maximum value	:	For all gauges of scale
- Pointer	:	Externally adjustable
	:	In general, Contact type Temp. gauges are not acceptable for interlock & protection.
		Contact type Temp. gauges are acceptable for interlock & protection in case of bearing temp. only.
- Over range protection	:	150 percent (%) of full scale
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
IBR Certification	:	For high pressure service, Steam



Electrode assembly shall have blow out and leakage proof sealing arrangement. Field proven ceramic/zirconia probes with insulation suitable for design pressure and temperature are to be provided.

The system design shall be such that it shall ensure that failure of one probe circuit shall not affect another probe circuit and failure of any electrode will not hamper the system function and operation. Further the entire system shall be of proven fail-safe design.

The logic shall be such that the trip and alarm relay circuits shall be independent for each for Low, Low-Low, High and High-High levels of tank. Monitoring of set time for trip generation and provision of setting time delay shall be available in the system. Trip logic shall be independent and separate from faultfinding logic.

The system shall have fault diagnostic features such as process fault, system hardware fault, probe failure, circuit board failure, shorted wire etc. Further the system shall be able to distinguish between a cable fault and an electrode fault.

The necessary relays and relay modules for the Output Contacts shall be of proven design and each contact shall be rated for 5A, 240V AC/0.25A 220V DC rating. All these contacts shall be 2SPDT type. The **vessel** holding electrodes **shall be IBR certified**. The system shall be proven and approved by Factory mutual, USA of equivalent, IBR etc.

3.03.17

LEVEL SWITCHES (LS)

Type/Construction	:	a) External float cage type with magnetic switch actuator for tanks and vessels. b) Electrode/Capacitance (for oil tanks) c) Displacer -Top mounted for all clean water sumps. d) Conductivity type for high Pressure and high temperature enclosed vessel like drain pot, HP heaters etc.
Materials		
- Body	:	Cast Carbon Steel/Die cast Aluminum suitable for specified pressure and temperature ratings
	:	For corrosive liquids suitable anti-corrosive coat/lining shall be provided.
- Float/Displacer	:	316 SS
- Wire rope	:	316 SS
Differential	:	± 12 mm minimum (Adjustable)
Contacts		
- Number	:	DPDT/2 SPDT
- Type	:	Snap action micro switch Auto reset with internal Adjustable
- Rating	:	5 Amp 240V AC 0.2 Amp 220V DC
Connection - Process	:	One (1) inch SCRD NPT Female Or One (1) inch ANSI Flanged Four(4) inch ANSI Flange for sump services.
Electrical	:	Suitable for Plug in type connection



Temperature/pressure rating : As per service conditions
 Accessories : Counter flanges, still pipe of requisite length with anticorrosive coating for sump services.

Nuclear, capacitance, or ultrasonic type level switch for bulk material applications shall be provided.

3.03.17.01 Conductivity Type Level Switch

Type	:	Conductivity discrimination.
Mounting	:	Flanged – on standpipe.
Probe MOC	:	Stainless steel with high purity ceramic.
Probe rating	:	> Maximum design pressure of vessel.
Input	:	Four independent channel with selectable switching threshold for water conductivity.
Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
Contact type & rating	:	2SPDT or 1 DPDT @ 5A 30V DC.
Faults Detection	:	Power Fail/Electrode Connection Open circuit/short circuit to ground, Ground failure. In built Fail Safe Logic.
Indicator	:	One Red LED for steam/ one Green LED for water/ Two no. LED one each for Process & system fault.
Power supply	:	Dual 240V AC, 50 Hz, 1Ph. From UPS
Enclosure	:	IP-65, corrosion resistant & wall mounting type.
Accessories	:	i. PTFE cable from probe to electronics unit. Electronic unit shall be separate. Head mounted electronic unit is not preferred. ii. Mounting accessories iii. standpipe iv. Washer & gasket
Test pressure	:	Two times rated pressure

3.03.17.02 Capacitance Type Level Switch

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 3 meters.
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / ¾" NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.



Enclosure	:	Powder/Epoxy coated Die cast Aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
Ambient temperature	:	0-60 °C.
Mounting	:	On Top
Supply voltage	:	240V AC, 50Hz from UPS/ 24V DC
Relay output	:	2SPDT
Contact rating	:	5A min. at 240V AC on resistive load
Response time	:	100 m sec or better
Cable connection	:	¾" ET
Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

3.03.17.03 RF TYPE LEVEL SWITCH

A. Electronic Controller

1.	Input Supply	:	240 V AC from UPS
2.	Construction	:	Cast Aluminum Housing
3.	Relay Output	:	2 Nos. Relay Changeover Potential Free Contacts(2SPDT)
4.	Contact Rating :	:	5A at 240 V AC & 0.25 at 220 V DC
5.	Class of Protection	:	IP-66
6.	Ambient Temperature :	:	55 Deg. C(Max)
7.	Local Indication	:	Local LED Indications
	Green	:	Normal Level
	Red	:	Alarm Level
	Yellow	:	Probe Healthy
8.	Cable Connection	:	3/4" ET(2 Nos.) for Supply and Output 5/8" ET(1 No.) for Probe Connection
9.	Repeatability	:	100%

B. Sensing Probe

1.	Type of Probe	:	Rigid
2.	Material	:	Stainless steel SS 316
3.	Probe Head Housing	:	Cast Aluminum
4.	Insulation (B/W Active & Shield And Shield & Ground)	:	PTFE
5.	Probe Head Protection	:	IP-66
6.	Mounting	:	Side Mounted
7.	Cable Connection	:	5/8" ET(1No.)
8.	Process Connection	:	40 NB BSP THREADED
C.	Signal Cable	:	Coaxial cable for Connection Between Sensing probe and electronic Controller(@ 10 Mtrs. Per Level Probe)





STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks	
				M	C	B		
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V		
	DIAL SIZE							
	MODEL NO./TAG NO./TYPE							
	RANGE/SCALE							
	END CONNECTION							
2	CALIBRATION			P	W	V		
	ACCURACY							
	REPEATABILITY							
	HYSTERESIS							
3	OVER TEMP. TEST	P	W	V				
4	AMBIENT TEMP. COMPENSATION CHECK	1 OF TYPE	P	V	V			
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT	V	V	V			
	SENSOR							
	MOVEMENT							
	PROCESS CONNECTION							
	THERMOWELL							
	HOUSING							
	6		REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST	V		V	V
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V		
	MATERIAL TC & DIMN. CHECK							
	HYD.TEST							
	OVER RANGE TEST							

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- IBR certificate to be provided if called for in specn.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST		P	W	V		
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE	P	W	V		
5	REVIEW OF TC FOR	FOR LOT	V	V	V		
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST	V	V	V		
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW	V	V	V		

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material correlation is not available, MFR's compliance to be provided
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOAT OPERATED LEVEL SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	MODEL NO/TAG NO						
	TYPE						
	END CONNECTION						
2	ON/OFF DIFFL			P	W	V	
3	REPEATABILITY	SEE NOTE-5	---	P	W	V	
4	IR TEST			P	W	V	
5	HV TEST			P	V	V	
6	PR. TEST ON CHAMBER			P	V	V	
7	MATL. TC FOR CHAMBER & FLOAT	FOR LOT	---	V	V	V	
8	CONTACT CONFIG. & RATING FOR MICROSWITCH	FOR LOT	---	V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST	---	V	V	V	
10	MANUFACTURER TO ENSURE WELDING PROCEDURE, WELDERS & NDT AS PER ASME FOR PR >40 KG/CM ²		---	P	V	V	
11	CHECK FOR TEMP. SUITABILITY FOR MICROSWITCH AND LEAD WIRE	SEE NOTE-1 BELOW	---	V	V	V	
12	ACCESSORIES AS APPLICABLE		APPROVED SPEC./ DATA SHEETS	V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material correlation is not available, MFR's compliance to be provided
- IBR certificates shall be provided wherever required.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL

	2X660 MW ENNORE SEZ STPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) NATURAL DRAUGHT COOLING TOWER	
SUMP PUMP		

	CONTROL WRITE-UP FOR SUMP PUMPS SYSTEM PROJECT: 2x660 MW ENNORE SEZ	DRAWING NO:	
		REV. NO. 00	DATE:
		SHEET 1	OF 2

CONTROL & INSTRUMENTATION FOR SUMP PUMP SYSTEM

Introduction- Sump pumps are used to dewater various sump pits to nearest surface drain in the power house and other plant areas to ensure general housekeeping.

The system shall normally have 2 pumps. The measuring instruments recommended are level switches(float/displacer type) for level measurement and control of the system and pressure gauges at pump discharge for local pressure measurement. Any other instruments can be included dependent on the requirement or if demanded by the customer.

The sump pumps can be fixed submersible type where the pumps are fixed and submerged or can be portable submersible type where the pumps are trolley based and can be moved as per the need. In fixed type the level switches can be mounted at a suitable mounting place while in portable type the level switches are ported to the sump along with the pumps. The mounting of switches and location of LCP shall be chosen so as to have minimum cable length between the level switches and the LCP.

CONTROL WRITEUP

The operation of Sump pumps(fixed and portable type) shall be as follows:

Sump Pumps shall be controlled through a starter cum control panel. The local control panel shall be front opening, relay based. The starter cum control panel shall be suitable for indoor or outdoor as per the location of the sump pumps. Normally one pump will be running and the other shall be on auto standby. The following controls/interlocks shall be provided in the local control panel.

Controls philosophy

CONTROLS

- (a) Start/stop facility for each pump from LCP.
- (b) Selector switch for main/standby selection.
- (c) Auto/Manual selector switch for each pump.

AUTO START/STOP

- a) One number level switch (high level) provided in the sump shall start one number sump pump in the event of high water level in the sump.
- b) One number level switch (very high level) provided in the sump shall start second sump pump in the event of very high water level in the sump.
- c) One number level switch (low level) provided in the sump shall stop the running pumps in the event of low water level in the sump.
- d) If any of the working sump pumps trips the standby sump pump will come into operation automatically provided the very low level signal is not present.

Indications

- a) Sump pumps status (ON/Off/Trip).
- b) Level indications(Low,High,V.High)

	CONTROL WRITE-UP FOR SUMP PUMPS SYSTEM PROJECT: 2x660 MW ENNORE SEZ	DRAWING NO:	
		REV. NO. 00	DATE:
		SHEET 2	OF 2

General requirements for measuring instruments

Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experience manufacturers (from BHEL/customer approved vendor list) of specified type and range of equipment.. Further, all instruments shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, makes/ numbers as approved by BHEL during detailed engineering.

1. Every panel-mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a ground terminal and shall be suitably connected to panel grounding bus.
2. The necessary root valves, impulse pipings and all the other accessories required for mounting/erection of local instruments shall be furnished even if not specifically asked for.
3. Instruments shall be terminated up to LCP with control cable (1.5sqmm). The LCP shall be fully wired. All the necessary cables, flexible conduits, junction boxes and accessories for the above purpose shall be included.

	2X660 MW ENNORE SEZ STPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) NATURAL DRAUGHT COOLING TOWER	
LOCAL PANEL		



SPECIFICATION FOR LOCAL PANELS

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1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a)	IS-6005 : 1998	:	Code of practice for phosphating of iron and steel.
b)	IS-5 : 2007	:	Colors for ready mixed paints and enamels.
c)	IS-1248:2003	:	Direct Acting Indicating Analog Elec Measuring Instruments.
d)	IS/IEC 60947:Part 1:2004	:	Low Voltage switchgear & control gear: Part-I (General Rules)
e)	IS-8828:1996	:	Circuit breaker for household and similar installations.
f)	IS-13947 (Part-I):1993	:	Low Voltage switchgear & control gear : Part-I (General Rules)
g)	ISA-18.1:1979	:	Annunciator Sequences and Specification
h)	NFPA-496:2003	:	Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel

Frame thickness: Not less than 3.0mm

Enclosure thickness: Not less than 2.5 mm for load bearing sections (Mounted with instruments)
1.6 mm for doors and Not less than 2.0 mm for others

Gland plate thickness: 3.0mm

Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm. The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.



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- 3.1.7 The class of protection shall be in accordance with IP-55 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).
- 3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.
- 3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.
- 3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function. The devices shall be located in such a way so as to ensure easy access for operation / maintenance.
- 3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.
- 3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm² size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.
- 3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm² to 2.5mm² external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The panel shall have ten (20) percent spare terminal.
- 3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.
- 3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.
- 3.1.16 The panel shall be provided with a copper earth bus of 50 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm² size.
- 3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.



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3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type.



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Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test



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5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Shee No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Local Panels	:	Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels	:	Data sheet no. PES-145A-DS2-0



DATA SHEET FOR LOCAL PANELS

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TAG No. Qty.....

Data Sheet No.: PES-145A-DS1-0

Data Sheet A & B

DATA SHEET-A FOR LOCAL PANEL
(TO BE FILLED BY PURCHASER)

DATA SHEET-B
(TO BE FILLED-UP BY
BIDDER)

GENERAL

MANUFACTURER

CONSTRUCTION

☐ FOLDED ☐ WELDED

(As per requirement EDN)

ENCLOSURE SHEET THICKNESS

FRONT

■ 2.5 mm

OTHER

■ 2.5 mm

DOOR

■ 2.5 mm

OTHER

■ Load bearing sheet front shall have 2.5mm thickness

TECHNICAL

INPUT POWER SUPPLY *

(ANY OTHER POWER REQUIREMENT
TO BE DERIVED FROM THIS SUPPLY ONLY)
☐ 240V 50 Hz AC ☐ 220V DC

☐ 415V 3 PHASE 3W ☐ 415V 3 PHASE 4W

NO. OF FEEDERS

☐ ONE

■ TWO

STARTER WITH MCC

(CHECK WITH MAUX/ELEC)

■ REQUIRED

☐ NOT REQUIRED

IPR POSITION

☐ MCC

■ RELAY PANEL

CONTACT RATING OF RELAY

☐ 5 Amp, 230 V AC☐ 0.25 Amp, 220V DC

CONTROL SUPPLY

☐ 110V AC☐ 220V AC☐ 220V DC☐ Other.

(As per requirement)

ALARM ANNUNCIATOR WINDOW

(EXCLUDING SPARES)

____ NOS. (AS REQUIRED)

TEMP SCANNER

(IF REQUIRED –NO. OF CHANNELS TO BE
SPECIFIED UNDER SEC-C)☐ REQUIRED

■ NOT REQUIRED

PAINT TYPE

■ EPOXY

MIMIC (TYPE OF MIMIC- MATERAIL, THICKNESS
TO BE SPECIFIED DURING DETAILED ENGG.)☐ REQUIRED☐ NOT REQUIRED

PANEL COLOUR (EXTERNAL)

☐ LIGHT GREY (Shade 631 IS-5)☐ OPALINE GREEN (Shade 275)■ RAL 7032/RAL7035 (This shall be decided by
BHEL during detailed engg.)

FINISH (EXTERNAL)

☐ MATT☐ GLOSSY☐ SEMI GLOSSY

PANEL COLOUR (INTERNAL)

☐ WHITE☐ CREAM☐ OFF WHITE■ GLOSSY WHITE TWO COATS/ RAL 7035 WITH
FIRE RESISTANT PAINT (This shall be decided by
BHEL during detailed engg.)

FINISH (INTERNAL)

☐ MATT

■ GLOSSY

☐ SEMI GLOSSY



DATA SHEET FOR LOCAL PANELS

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TAG No. Qty.....

Data Sheet No.: PES-145A-DS1-0

Data Sheet A & B

DATA SHEET-A FOR LOCAL PANEL
(TO BE FILLED BY PURCHASER)

DATA SHEET-B
(TO BE FILLED-UP BY
BIDDER)

CLASS OF PROTECTION

☐ IP-42 (FOR INDOOR SERVICE)☒ IP-55 (FOR OUTDOOR SERVICE) ☐ ANY OTHER

CONTROL HARDWARE

☒ RELAY BASED

FOUNDATION ARRANGEMENT

☐ FOUNDATION BOLTS ☐ ANCHOR FASTENERS

WEIGHT OF PANEL (Kg.)

.....(Vendor to specify)

PANEL TYPE

☐ PRESSURISED ☐ UNPRESSURISED
As per Requirement

CABLE GLAND

☐ DOUBLE COMPRESSION

AMMETER (TYPE OF INPUT, IF REQUIRED)

☐ 1 Amp CT ☐ 4-20 mASCOPE OF SUPERVISION FOR
ERECTION & COMMISSIONING☐ APPLICABLE ☐ NA

PREPARED BY

CHECKED BY

APPROVED BY

NAME
DESIGNATION

SIGNATURE

DATE

COMPANY SEAL

NAME:

SIGNATURE:

DATE:



DATA SHEET FOR LOCAL PANELS

SPECIFICATION NO.:

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DATE:

SHEET 1 OF 2

TAG No. Qty.....

Data Sheet No.: PES-145A-DS1-0

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER		
	CONSTRUCTION		☐ FOLDED ☐ WELDED (As per requirement EDN)
	ENCLOSURE SHEET THICKNESS	FRONT	
		OTHER	
		DOOR	
		HEIGHT	
	OTHER		
TECHNICAL	INPUT POWER SUPPLY		
	NO. OF FEEDERS		
	CONTACT RATING OF RELAY		
	TEMP SCANNER		
	CONTROL SUPPLY		
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		
	PAINT TYPE		
	PANEL COLOUR (EXTERNAL)		
	FINISH (EXTERNAL)		
	TYPE OF MIMIC MATERIAL OF MIMC THICKNESS OF MIMIC		
	PANEL COLOUR (INTERNAL)		
	FINISH (INTERNAL)		
	CLASS OF PROTECTION		
	CONTROL HARDWARE		
	FOUNDATION ARRANGEMENT		
WEIGHT OF PANEL (Kg.)			

	DATA SHEET FOR LOCAL PANELS			SPECIFICATION NO.:		
				VOLUME		
				SECTION		
				REV. NO.	00	DATE:
				SHEET	2	OF 2
TAG No. Qty.....			Data Sheet No.: PES-145A-DS1-0			
Data Sheet C						
DATA SHEET-C FOR LOCAL PANEL (TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)						
	PANEL TYPE					
	CABLE GLAND					
	AMMETER (TYPE OF INPUT)					
	SCOPE OF SUPERVISION					
NAME SIGNATURE DATE	PREPARED BY		CHECKED BY		APPROVED BY	
					COMPANY SEAL NAME: SIGNATURE: DATE:	

- point microprocessor based Temperature Scanner and mounted on panel for every HT motor / pump / auxiliaries.
 - b. Illuminated PB shall be provided for Start / Stop, ON / OFF indication on the Desk / Panel.
 - c. Panel mounted Indicator/ Recorder shall be provided for flow, Temperature, Pressure, Level, vibration etc. for all analog points.
- xiii. Bidder shall provide Ammeters on control panel/desk for all HT motor current and LT motor current ≥ 15 KW & other important critical LT drives.

4.05.08**RELAY BASED LOCAL CONTROL PANEL/DESK**

Local control panel shall be of 2.5 mm steel construction, free standing type, totally enclosed dust and vermin proof with enclosure protection class of IP-55 as per IS: 13947 and colour shall be as per shade no. RAL 7032/7035. Panel shall be mounted on vibration dampers secured to steel frame on to the floor. Equipment and relays mounted on the panel shall be easily accessible. The panel shall be supplied completely wired upto terminal blocks for connecting external cables entering the panel from the bottom. Blank removable gland plate shall be provided with double compression type cable glands/conduits knockout along with the panel.

Terminal block shall be rated 600 volts minimum and shall have strap cage clamp type screw less terminals suitable for connection with 2x2.5 sq mm copper conductors on each side. Terminal block shall be provided with white marking strips. Fuses shall not be mounted on terminal blocks. At least 20 percent spare unused terminals shall be provided on terminal block.

Contactors, Relays, timers and other devices mounted on the panel shall have clearly visible identification marking. Separate contactors shall be provided for start & stop command. Common contactor for start & stop command are not acceptable. All fuses shall be HRC semiconductor type of AC supply. HRC link & fuse shall be of removable type having 45 kA rupturing capacity (min) for protection of various circuits.

The panel shall be provided with a 50x6 mm tinned copper earthing strip running throughout the length of the panel at the bottom. Panel shall be provided with space heaters with isolating DPN MCB, and thermostats. LED based illuminating lamps, complete with door switches; and 1 no. 6 pin 5/15amps sockets with DPN MCB.

Panel shall be provided with LED illuminating lamps with door switch and 6 point 5/15A, 240V AC socket with switch for maintenance purposes. Panel shall have removable lifting eye bolts for safe lifting from top during handling. Control power supply shall be provided from dual redundant feeders with auto change over scheme, surge protection devices and Power/Volt/AM meter.

The panel shall be provided with push buttons, indicating lamps, annunciators, indicating instruments, interlock/ deinterlock switches etc., required for the complete system. General details as specified in chapter 6 shall also be referred for engineering and design of relay panel/desk.

Coloured Mimic with 6mm thickness sheet for respective plant lay out shall be provided as specified in Annexure A, control system philosophy.



20% spare relays of each type and rating shall be mounted and wired in relays control panel/Desk. All contacts of relays shall be terminated in terminal blocks of relay control panel/Desk, Additionally in the relay control panel/Desk, 20% spare terminal blocks shall be 'provided so that additional relays can be mounted and wired.

The annunciation system shall consist of panel mounted audio-visual windows of 50x75 mm provided with plug-in-type solid-state logic 16 nos. high intensity LEDs in parallel. EACH relay based control panel shall be provided with 30 nos min. facia windows. Initiating contacts may be either NO or NC; a jumper or switch shall be provided in each card to make it suitable for either type of contact. A set of acknowledge, reset and test push buttons shall be provided on the panel. All printed circuit boards shall be of epoxy fibre glass construction.

The sequence of annunciation shall be as follows:

Condition	Visual	Audible
Normal	OFF	OFF
Alarm	Flashing	ON
Acknowledge	Steady	OFF

Return to Normal:

a.	Before acknowledge	Flashing	ON
b.	After acknowledge	Steady	OFF

Reset:

a.	Alarm condition	No change	No change
b.	Return to normal	OFF	OFF

4.06.00 **Online Computer Aided Microprocessor based Machinery Maintenance Management System (OCAMMMS)**

4.06.01 One no. Microprocessor based standalone online vibration/machinery monitoring and analysis system for each unit shall be used for condition monitoring, analysis & diagnostic of STG and HT drives/motors with fans / pumps, air compressor, and any other HT drives envisaged for subject plant. OCAMMMS shall take care of predictive maintenance of machine/equipment. And shall be compatible and of same family of turbine vibration monitoring system/HT drives vibrations system. For OCAMMMS a dedicated colour Operating station with 24" industrial type LED monitor & A4 color LJP and separate OCAMMMS redundant server (Server shall be capable to store bulk data for 5 years duration with facility for retrieval of same) shall also be provided to achieve the functions described under following items.

4.06.02 **General Description**

The bidder shall furnish a programmable On-line Machinery Management System that automatically acquires processes and displays vibration and process data for critical



desk shall be 30mm thick with the top 12mm of acrylic solid surface and the remaining 18mm of laminated medium density fibre board. Control desk shall consist of vertical, horizontal and base supports with their coverings for work surface, keyboard trays, Mouse pads, Monitor shelf and concealed cable and wire way management, perforated trays with covers in both horizontal & vertical directions.

- ii. To achieve durable & water resistant finish, a sheet of "plastic PVC membrane" on the surface of control desks shall be provided. Final paint finish with proper smoothening is to be ensured. Final finish of CD should be in line with relevant International standards. For more durability, the membrane sheet of the Control desk should extend 200 mm more into the underside of the desk. The cabling / wiring between OWS & CPU's, power supply cables etc. shall be aesthetically routed and concealed from view.
- iii. All the control desk shall be equipped with Anti vibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.
- iv. Doors shall be provided with neoprene/polyurethane gasket only.

6.05.00 SURFACE PREPARATION AND PAINTING

All panel exterior steel surfaces shall be ground smooth, and painted as specified below:

Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods. Alternatively 7 tank process shall be followed.

Two spray coats of inhibitive epoxy primer – surface shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalysed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil. The finish colours for exterior and interior surfaces shall conform to the following shades:

- a) Exterior - RAL 7032/RAL 7035.
- b) Interior - Glossy white two coats/RAL 7035 with fire resistant paint

One uniform colour shade as finalized shall be applicable for complete plant.

Paint films, which show sags, checks, blisters teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.

6.06.00 PANEL WIRING

Interconnecting wiring shall be provided between all electrical devices mounted in the panels, and between the devices and terminal blocks if the devices are to be connected



to equipment outside the panels by cabling and through pre-fabricated plug in cables. All alarm contacts located within a panel shall be wired to terminal blocks. Thermocouple and other special circuits shall be field wires direct to instrument terminal blocks without the use of panel wiring.

All control and instrument wiring used within the panels shall confirm to NEC and NEMA standards and shall be factory installed and tested at the works of a qualified manufacturer. All interior wiring shall be installed neatly and carefully, and shall be terminated at suitable terminal blocks. Sufficient clearance shall be provided for all control and instrumentation leads, and all incoming and outgoing leads shall be connected to terminal blocks suitably located for connecting external circuits.

All panel wiring shall have appropriate ferruling for clear identification. Interior wiring shall be so arranged that the external connections can be made with only one wire per terminal point. Any common connections shall be made internal side of the terminal blocks. Common connections shall be limited to two wires per terminal. Instrumentation cable shield wires shall be connected to separate terminal at the terminal block. Signal circuit shields shall be grounded separately.

All internal wiring (except low level instrument wiring) shall be National Electric Code Type SIS, Polymetric/Elastomeric insulated, tinned copper stranded conductor, switchboard wire, or owner approved equal.

Panel wiring shall have a flame resistant insulation with adequately sized 650/1100 V grade tinned copper stranded conductor based on current carrying capacities as etc forth by the National Electric Code.

Wire sizes shall be as specified herein and suitable for intended applications.

Wiring to door mounted devices shall be provided with (49 strand minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue braking of the conductor.

Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without unduly disturbing the wiring. No wire shall be routed cross the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices.

Panel wires shall be identified with wire number and each termination by means of Action craft products split sleeve or Borden Chemical Co. indelible tubing markers or owner approved equal. Corrections and modifications of all panel wiring shall be Bidder's sole responsibility. Any corrections/modifications required at site for successful commissioning shall be done by the Bidder without any additional costs. Terminal lugs furnished must be of the compression, insulated sleeve, half ring tongue type. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

Wires shall not be tapped or spliced between terminal points.

Panels, cabinets, consoles/desks will be provided with removable, gasketed cable gland plates and cable glands, for all floor slots used for cable entrance. Split type grommets shall be used for prefab cables.



Internal wiring in factory prewired electronic systems cabinets may be installed according to the Bidder's standard as to wire size, insulation, and method of termination on internal equipment except that insulation for all wiring power supply wiring, and interconnecting cables between devices shall pass the following tests.

- a) Flammability test IEEE 383/1974
- b) When tested under UITPP test method or ASTM 2893/77 light transmittance of 80%
- c) When tested under IEC 754-1 maximum acid gas generation shall be 2% by weight
- d) Oxygen index not less than 30 as per ASTM D 2863.

All terminations for intra panel wiring inter panel cabling and connecting the Bidders panels, PB stations, control stations etc. shall be with cage clamp Screwed less connections. Soldered connections are not acceptable. All field side or external input connections shall also preferably of Cage clamp/Spring Clamp/ Screwed less connection.

Conductor Clamping shall also confirm to Standard IEC – 60947-1 & IEC-60947-7-1.

Identification of conductors may be done by insulation colour coding identified on drawings or by printed wiring lists. Terminal blocks for connection of external circuits in to factory prewired electronic system cabinets shall meet all the requirements as described elsewhere in the specification. For all multicore cables, the outer sheath shall satisfy the properties identified above. However, for panel wiring, the wiring insulation shall also satisfy the properties identified above. The internal wiring shall be done in coloured wiring.

6.06.01

Following Wire size shall be utilized for internal wiring:

a.	Current (4-20 mA)	:	0.75 sq.mm
	Low voltage signals	:	
	(AI/AO & DI signals)		
b.	DO signals, Ammeter/	:	1.5 sq.mm
	voltmeter circuit, control		
	switches, indicator, recorder		
c.	Internal Illumination	:	2.5 sq.mm
d.	Size of Power supply cables shall be as below:-		
i.	1 to 16 Amp.	-	2.5 sq. mm
ii.	17 to 20 Amp.	-	4 sq. mm
iii.	21 to 32 Amp.	-	6 sq. mm
iv.	33 to 40 Amp.	-	10 sq. mm.
v.	41 to 60 Amp.	-	16 sq. mm
vi.	Power earth	-	4 sq. mm

6.07.00

INSTRUMENTS MOUNTING



2 x 660 MW ENNORE SEZ Supercritical Thermal Power
Project at Ash Dyke of NCTPS
Spec. No. CE/C/P&E/EE/E/OT.No.03/2013-14



6.07.01 Instruments and relays mounted on the panels shall be easily accessible for repair and replacement without disturbing other equipment their connected wiring. No special tools shall be needed for the purpose.

6.08.00 PANEL ILLUMINATION

Panels shall be provided with LED based illuminating lamps with door switch and six (6) point 6/16A, 240V AC universal type power sockets with switch for maintenance purposes. These switches shall be with quick make and break mechanism. 100 % spare LED lamps shall be provided with each panel, these are in additional to mandatory spares.

6.09.00 FUSE BLOCKS

Where fuse blocks rated 30 amp. 250 Volts are required by the specifications or the manufacturer's design, they shall be modular type with bakelite frame and reinforced retaining clips. Blocks shall be class H.2 pole, screw terminal fuse blocks. Blocks for other current and voltage ratings shall be similar in construction.

6.10.00 FUSES & MCB

All fuses shall be fast acting semiconductor types for AC supply and compatible to the UPS fuses. For all DC Powered devices, similarly the fuses shall be fast acting compatible to DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semi conductor fuses & 2 P thermomagnetic type MCB. Make of Fuses shall be GE or Siemens. For all the DC power supply circuits, electronic type DC MCB shall be used only. Make of DC MCB shall be Siemens, Phoenix contacts, Murr, Weidmuller, or Lutze.

50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.

6.11.00 MOULDED CASE CIRCUIT BREAKERS

Moulded case circuit breakers used in equipment covered under these specifications shall have not less than 5000 amp. Interrupting capacity at 220 Volts DC 10,000 Amp. Symmetrical interrupting capacity at 240 Volts AC. MCCB shall be provided at each main feeder line like ACDB & DCDB main feeders, PLC main feeder, control panels, UPS circuits etc.

6.12.00 GROUNDING

All panels and cabinets shall be provided with a continuous bare copper ground bus of minimum 6 mm x 25/50 mm cross section. The ground bus shall be bolted to the panel structure and effectively ground the entire structure. Each Ground bus shall have provision at each end for connection of ground leaks (6 mm x 50 mm GI Flats) by suitable bolting. All system cabinets shall be brought to a common system ground by the bidder. Electronic earthing resistance shall be < 0.5 ohms.

Each circuit requiring grounding shall be individually and directly connected to the panel ground bus by ring tongue type compression lugs. For electronic system cabinets the system ground bus shall be insulated from the cabinet enclosure and shall be separately



connected to the system ground. All system cabinets shall be brought to a common system ground by the bidder.

The Bidder shall furnish his recommendations regarding grounding requirements for all equipment/systems and shall specifically indicate the deviations if any from the above requirements as a part of his proposal.

6.13.00 TERMINAL BLOCKS

For all inputs to the system emanating from the field or other systems, the bidder shall furnish terminals suitable for correct size of field cables.

6.13.01 All outputs going to MCC/SWGR terminal blocks, shall be rated 600 volts minimum and shall have strap screw less terminals suitable for connection of wires with ring tongue type lugs. Standard terminal blocks shall be screw less cage clamps type. Terminal blocks shall be approximately sized for larger wire size of higher voltage insulated incoming conductors as necessary. All the TBs used shall be 6.6 polyimide to withstand corrosion and the metallic portion shall be coated against rust /corrosion. All metal parts should be non –ferrous in nature.

6.13.02 Terminal blocks shall be provided with white marking strips and re permitted by the safety codes and standards shall be without covers.

6.13.03 Fuses shall not be mounted on terminal blocks. Neither step type terminal blocks nor angle mounting of terminal blocks will be acceptable.

6.13.04 At least 20 per cent spare unused fully wired terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable with each panel, enclosure, cubicle, SOV Boxes etc.

6.14.00 NAME PLATES AND LABELS

Name plates of adequate size shall be provided for each panel on front and rear of the panel. Instruments/other accessories mounted inside the panels shall have identification marking clearly visible from inside.

Devices to be mounted on the panels shall also be labeled on the panels shall also be labeled on the outside of the panel. Name plates shall be of polyamide sheets with black letters on white background. Name plates shall be attached to the boards by means of stainless steel panhead screws. Fuses provided for protection of various boxes shall be accessible for replacement. Fuse boxes shall be provided with circuit label and fuse rated current and voltage.

Markings/Labels

All markers/labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1.



- iv. **Back up panel system** shall be designed for handling **the situation in clause 2.12.00 for failure of HMI.**
- v. **For electrical layout, complete backup panel with mosaic** shall have to be provided for complete on/off operations with necessary meters, DDU's, synchronoscope etc. as specified elsewhere in specification.
- iv. Control panel cum desk with HW annunciation windows, ILPBs, Ammeters, PBs, voltmeters, indicators, mimic, recorders etc. shall be provided as per Annexure A – Control System Philosophy for BOP packages. Profile/Overall GA of backup control panel cum desk for BOP packages shall be same as indicated in drawing no. 114-05-0105 attached with NIT.

2.06.00**PROTECTION, CLASS OF CABINETS / PANELS, ENCL.OSURES ETC.**

- a) All panels, desks cabinets, consoles & enclosures furnished at least comply with the requirements of protection classes as indicated below.
 - 1. In-door Air-conditioned (A.C.) areas - IP32/42 (min.)
 - 2. In-door Non A.C. areas:
 - (a) Ventilated enclosures - IP42
 - (b) Non Ventilated. IP 54
 - 3. Out-door IP55 / IP65
(As per the requirement)
- b) Distribution boxes, junction boxes, cold junction compensation boxes, terminal boxes and all other field mounted equipment to be furnished as per this specification shall have weather protection conforming to IP 65.
- c) The design of panels, cabinets, enclosures and packaging density of components mounted therein shall be such that the temperature rise does not exceed 10 deg. C above the ambient under the worst conditions.
- d) The panels housing electronic hardware shall be provided with flame and smoke detectors by bidder.
- e) Enclosures for peripheral equipments like printers, etc. shall take care of noise and shall ensure minimum possible noise disturb to the working personnel.

2.06.01

Guards, barriers and access doors, covers of plates shall be marked to indicate the hazard, which may occur upon removal of such devices. Danger or caution signs shall be used to warn of specific hazards such as voltage or current. The marking shall be permanently affixed to the equipment.

2.07.00**System Documentation**

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												VOLUME IIB				
												SECTION D				
												REV. NO. 01				
												SHEET 1				
		OF 7														
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
1.0	INCOMING Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	IS:1079 IS:513	IS:1079 IS:513	Test Certificate	3	---	2					
		2. Bend Test	CR	Mech. test	Sample	IS:1079 IS:513	IS:1079 IS:513	Log Book	2	---	---					
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---					
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---					
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---					
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1					
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	IS:2062	IS:2062	Log Book	2	---	---					
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---					
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---					
		4. Mill marking	MA	Visual	100%	IS:2062	IS:2062	Log Book	2	---	1					
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---					
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---					
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics																
\$ P W V - Agency Performing the Test. - Agency Witnessing the Test. - Agency Verifying the Test.																
1 - BHEL 2 - Vendor 3 - Sub-vendor																

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
		3. Conductor a) Resistance b) Size c) Sheet colour	MA MA MA	Electrical Measurement Visual	100% 100% 100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---					
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	3	---	2					
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	+ for relay & contactors only @ for all components except relays & contactors.				
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant IS	Relevant IS	Log Book	2	---	---					
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---					
		4. I.R.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---					
		5. H.V.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---					
		6. Calibration	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	1					
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---					
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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	P	W	V		
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make 2. Surface defects 3. IR / HV on Terminal Blocks	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---		
6.0	IN PROCESS Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---		
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---		
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---		
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---		
8.0	ASSEMBLY Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2		
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2		
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2		
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2		
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics \$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor													

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Sl. No.		Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
										P	W	V				
9.0		Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1				
			2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1				
			3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1				
			4. Surface quality after every dip	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1				
			5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1				
			6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1				
			7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1				
			8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1				
			9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1				
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												W	- Agency Witnessing the Test.	2	- Vendor	
												V	- Agency Verifying the Test.	3	- Sub-vendor	



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STANDARD QUALITY PLAN

FOR

LOCAL CONTROL PANEL

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$				Remarks
									P	W	V		
10.	Panel Wiring	1. Wiring Layout 2. Wiring Termination (Crimped Lugs) 3. Ferrule numbers 4. Colour of wiring 5. Size of Conductor	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	---	
			MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	---	
			MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	---	
			MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	1	
			MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	1	
11.	Component Mounting	1. Correct components 2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	---	
			MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	---	
12.	FINAL Final Inspection	1. Workmanship 2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components 3. Components identification Marking / Name plates	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
			MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	1	
			MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	1	

LEGEND: * CR - Critical characteristics

MA - Major characteristics

MI - Minor characteristics

\$ P - Agency Performing the Test.

W - Agency Witnessing the Test.

V - Agency Verifying the Test.

1 - BHEL

2 - Vendor

3 - Sub-vendor

 STD QUALITY PLAN NO.: PE-QP-999-145-1056		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										VOLUME IIB SECTION D REV. NO. 01 SHEET 6 OF 7 DATE: 22-02-2008			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.			
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1				
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1				
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1				
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1				
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1				
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1				
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1				

LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics		\$ P W V - Agency Performing the Test. - Agency Witnessing the Test. - Agency Verifying the Test.		1 - BHEL 2 - Vendor 3 - Sub-vendor	

 STD QUALITY PLAN NO.: PE-QP-999-145-1056		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										VOLUME IIB SECTION D REV. NO. 01 SHEET 7 OF 7 DATE: 22-02-2008			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	Type Test Certificate	3	---	1				
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant IS.	BHEL approved spec., drg., BOM & relevant IS.	Test Report	2	1	1				
15	FUNCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1				
		2. Instrument Calibration	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1				
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant IS.	BHEL approved spec/drg & relevant IS.	Inspection Report	2	1	1				

LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics		\$ P W V		- Agency Performing the Test. - Agency Witnessing the Test. - Agency Verifying the Test.		1 - BHEL 2 - Vendor 3 - Sub-vendor	

	2X660 MW ENNORE SEZ STPP	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) NATURAL DRAUGHT COOLING TOWER	
ACTUATORS		

CHAPTER – 13

ACTUATORS

1.00.00 ELECTRICAL ACTUATORS WITH INTEGRAL STARTERS

The Actuators shall be integral starters along with overload relays with built in SPP (Single Phase Preventer) with provision for operation from Control room, Local and by wireless set.

1.01.00 General

The actuator motors shall be suitable for use on 415 Volt 3 phase 50Hz power supply. The actuator comprising motor, integral reversing starter, local control facilities and terminals for remote control and indication shall be housed within a self contained, sealed enclosure. Actuator working platforms shall be provided for maintenance purpose.

Commissioning tools shall not form an integral part of the actuator and must be removable for secure storage/authorized release. In addition, provision shall be made for the protection of configured actuator settings by a means independent access to the commissioning tool.

For some specific applications, integral starter shall also be separately mountable casting type and plug-in. Such applications shall be decided during detail engineering.

1.02.00 Actuator Sizing

The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. The operating speed shall be such as to give valve closing and opening at approximately 4 to 5 mm per second unless otherwise stated in the job specification.

1.03.00 Environmental

Actuators shall be suitable for indoor and outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from 10°C to 50°C, upto 95% relative humidity.



Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

1.04.00 Enclosure

Actuators shall be 'O' ring sealed, watertight to IP68 degree of protection. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed at site for cabling.

1.05.00 Motor

The electric motor shall be Class F insulated, with a time rating of at least 15 minutes at 50°C or twice the valve stroking time, whichever is more, at an average load of at least 33% of maximum valve torque.

1.06.00 Motor Protection

Protection shall be provided for the motor as follows:

- The motor shall be de-energized in the event of a stall when attempting to unseat a jammed valve.
- Motor temperature shall be sensed by a thermostat de-energising the motor in case of overheating.
- Lost phase protection
- Overload protection
- Short circuit protection by suitably rated long acting fuse.

1.07.00 Gearing

The actuator gearing shall be totally enclosed in an oil-filled gear casing suitable for operation at any angle. All drive gearing and components must be of metal construction and incorporate a lost-motion hammer blow feature. For rising spindle valves the output shaft shall be hollow to accept a rising stem, and incorporate thrust bearings of the ball or roller type at the base of the actuator. The design should be such as to permit the opening of the gear casing for inspection or disassembling without releasing the stem thrust or taking the valve out of service.

1.08.00 Hand Operation

A hand wheel shall be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to power automatically by starting the motor. The hand wheel or selection lever shall not move on restoration of motor drive. Provision shall be made for the hand/auto selection



lever to be locked in both hand and auto positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in hand without damage to the drive train.

The hand wheel drive must be mechanically independent of the motor drive and any hand wheel gearing should be such as to permit emergency manual operation in a reasonable time. Clockwise operation of the hand wheel shall give closing movement of the valve unless otherwise stated in the job specification.

1.09.00 Drive Bushing

The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. Normally the drive bush shall be positioned in a detachable base of the actuator. Thrust bearings, when housed in a separate thrust base should be of the sealed for life type.

1.10.00 Torque and Turns Limitation

Torque and turns limitation to be adjustable as follows:

- Position setting range 2.5 to 100,000 turns, with resolution to 15 deg. of actuator output
- Torque setting 40% to 100% rated torque.

“Latching” to be provided for the torque sensing system to inhibit torque off during unseating or during starting in mid travel against high inertia loads.

The electrical circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit. Spare 1 NO + 1 NC Limit switch and Torque switch shall be provided in each Actuator.

1.11.00 Remote Valve Position/Actuator Status Indication

Four contacts shall be provided which can be selected to indicate any position of the valve. Provision shall be made for the selection of a normally closed or open contact form. Contacts shall maintain and update position indication during hand wheel operation when all external power to the actuator is isolated.

The contacts shall be rated at 5A, 250V AC, 30V DC.

As an alternative to providing valve position any of the four above contacts shall be selectable to signal one of the following:



- Valve opening, closing or moving
- Thermostat tripped, lost phase
- Motor tripped on torque in mid travel, motor stalled
- Remote selected
- Actuator being operated by hand wheel
- Position feedback has to be provided for all inching type applications. These shall be interfaced with plant DDCMIS

1.12.00 Local Position Indication

The actuator shall include a digital position indicator with a display from fully open to fully close in 1% increments. Red, green and yellow lights corresponding to open closed and intermediate position shall be included on the indicator. End of travel indication colours shall be reversible. The digital display shall be maintained and updated during handwheel operation when all external power to the actuator is isolated. The display shall incorporate valve, actuator and control status indication. Provision shall be made to orientate the display through increments of 90°. Provision shall be made in the design for the addition of a contactless transmitter to give a 4-20mA analogue signal corresponding to valve travel for remote indication when required.

1.13.00 Integral Starter and Transformer

The reversing starter, control transformer and local controls shall be integral with the valve actuator suitably housed to prevent breathing and condensation. The starter shall be suitable for 60 starts per hour and of rating appropriate to motor size. The starter logic shall be microprocessor- based. The controls supply transformer shall be fed from two of the incoming three phases and incorporate overload protection. It shall have the necessary tapings and be adequately rated to provide power for the following functions:

- Energization of the contactor coils
- DC output where required for remote controls
- Supply for all the internal electrical circuits

1.14.00 Integral Local Control and Control Mode Selector

The actuator shall incorporate local controls for Open, Close and Stop and a Local/Stop/Remote mode selector switch lockable in any one of the following three



positions: local control only, stop (no electrical operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control.

The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

Provision shall be made to orientate the local controls through increments of 90°.

1.15.00

Control Facilities

The necessary wiring and terminals shall be provided in the actuator for the following control functions:

- Open and close external interlocks to inhibit local and remote valve opening and/or closing control. Provision shall be made to configure the interlocks to be active in remote control only.
- Remote controls fed from an internal 24V DC supply and/or from an external supply rated 110V AC to be suitable for any one or more of the following methods of control:
 - Open, close and stop control
 - a) Open and close maintained or 'push to run' (inching) control
 - b) Overriding Emergency Shut-down to Close (or Open) valve from a normally closed or open contact

The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator in local mode
- Actuator in remote mode
- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.
- Limit switch OPEN trip
- Limit switch CLOSE trip
- Actuator in local mode.
- Actuator in inching mode.
- Actuator in self-retaining mode
- Actuator power switched off /single phasing.
- Torque switch trip, thermo switch trip and overload relay trip



(or close)

Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided

It shall be possible to reverse valve travel without the necessity of stopping the actuator. The starter contactors shall be protected from excessive current surges during travel reversal by an automatic time delay on energization of the contactor coils.

1.16.00 Monitoring Facilities

Facilities shall be provided for monitoring actuator operation and availability as follows:

Monitor (availability) relay, having one changeover contact, the relay being energised from the control transformer only when the Local/Off/Remote selector is in the Remote position to indicate that the actuator is available for remote (control room) operation.

Where required, it shall be possible to provide indication of Thermostat trip and Remote selected as discreet signals. The actuator shall include a diagnostic module, which will store and enable download of historical actuator operation and torque data to permit analysis of actuator and valve in-service performance. Data download shall be carried out without removing any covers and all shall be available locally to the actuator or remotely via telecom data transfer.

Diagnostic and configuration software shall be made available in a Lap Top PC for user.

1.17.00 Wiring and Terminals

Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end.

The terminals shall be embedded in a terminal block of high tracking resistance compound.

The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight sea land shall be provided with a minimum of 3 threaded cable entries with provision for a minimum of 4.



All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.

A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:

- Serial number
- External voltage values
- Wiring diagram number
- Terminal layout

This must be suitable for the contractor to inscribe cable core identification alongside terminal numbers.

1.18.00**Startup Kit**

Each actuator shall be supplied with a start-up kit comprising installation instruction manual, electrical wiring diagram and cover seals to make good any site losses during the commissioning period. In addition, sufficient actuator commissioning tools shall be supplied to enable actuator set up and adjustment during valve/actuator testing and site installation commissioning.

1.19.00**Performance Test Certificate**

Each actuator must be performance tested and individual test certificates shall be supplied free of charge. The test equipment should simulate a typical valve load, and the following parameters should be recorded:

- Current at maximum torque setting
- Torque at max. torque setting
- Flash test voltage
- Actuator output speed or operating time.

In addition, the test certificate should record details of specification such as gear ratios for both manual and automatic and second stage gearing if provided, drive closing direction, wiring diagram number.



1.20.00 The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

- Measurement of insulation resistance.
- Measurement of full load current.
- Test running of the motors



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	SPECIFIC TECHNICAL REQUIREMENTS (C&I) NATURAL DRAUGHT COOLING TOWER	
MANDATORY SPARES		

4.	Plugs	Two (2)
5.	Wall mounted handset stations	Five (5)
6.	Loudspeakers of each type	Two (2) of each type
7.	Transformers of each type and ratings	Six (6)
8.	Microphone capsules	Ten (10)
9.	Switch P.C.B.	Five (5)
10.	Diaphragm Assembly	Fifteen (15)
11.	Page mute & siren switch for Desk-top Unit	Two (2) each
12.	Driver unit for Wall mounted station	Ten (10) Nos.
13.	Amplifier PCB for Wall mounting station	Ten (10) Nos.
14.	Microphone assembly for wall mounted pilfer proof station	Five (5)
15.	Ear Piece Capsule	Ten (10) Nos.
16.	Electronic Cards	One (1)
17.	Junction Boxes	Two (2)

17.00.00 POWER AND CONTROL CABLES

- i) 11 KV Grade power cables for each type & size 10% of installed quantity
- ii) 3.3 KV Grade power cables for each type & size 10% of installed quantity
- iii) 1.1 KV Grade power cables for each type & size 10% of installed quantity
- iv) 1.1 < KV Grade control cables for each type & size 10% of installed quantity

III. CONTROL & INSTRUMENTATION PACKAGES

1.0.0	INSTRUMENTATION		For each unit
(I)	Each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system.	Nos.	20 % of Installed of each type.
1.00.01	Measuring Instruments		
1.00.01.01	Indicators, Recorders, Electrical Metering and Skid Mounted Instruments		



(i)	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	Nos.	10 % of Installed of each type/Model or a minimum of one number for each model and type, whichever is more
(ii)	For skid mounted instruments	Nos.	10% of total number of instruments for each Type and model or a minimum of one number for each model and type, whichever is more
1.00.01.02	Temperature Elements and Thermowells		
(i)	Thermocouple/RTD elements	Nos.	10% spare for each type and length of element furnished with thermocouple/RTD assemblies, or a minimum of one number of each type & length, whichever is more.
(ii)	Thermowells	Nos.	10% for each type of temperature sensors or a minimum of one for each type, whichever is more
1.00.01.03	Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, Level), Temperature, Pressure, Flow & Level Switch, safety switches, Gauges, meters, Transducer or any other instrument etc.	Nos.	10% of total number of instruments/transducers offered for each model and type for the project or a minimum of one number, whichever is more.
1.00.01.04	Flue Gas Analyzers & CEMS (Spare parts shall be furnished in accordance with manufacturer's recommendations for five years continuous operation or minimum quantities indicated as below (whichever is more)		
a)	Electronic Module/Mother Board /Signal Processing Unit for each type of Analyzer.	Nos.	10% of installed or at least one number of each type of module for each analyser type.



1.00.03	Steam and Water Analysis System (SWAS)		
1.00.03.01	High pressure reducing elements for sample flow.	Nos.	10% spare of qty installed.
1.00.03.02	Ion exchange columns with resin as utilized with cation conductivity analysers	Nos.	Four No
1.00.03.03	Conductivity cells as utilised with conductivity monitors	Nos.	Two nos of each type
1.00.03.04	pH flow-through type cells used with pH monitors	Nos.	Two nos. of each type
1.00.03.05	Chemical reagents for all analysers	Set	12 months continuous operation of all analysers from date of taking over.
1.00.03.06	Chemical reagents for colorimetric silica analyzers	Set	12 months continuous operation of all analysers from date of taking over.
1.00.03.07	Electronic Modules	Nos.	One (1) no. for each type of Analyser.
1.00.03.08	Pressure gauge, solenoid valves, temperature gauge, Back Pressure regulating valves, 3 way grab valves, needle valves, isolation valves, PRV, flow switch, flow indicator and temperature switch, erection hardware's, valves in SWAS.	Nos.	Two (2) no. of each type
1.00.03.09	Primary coolers/secondary coolers.	Nos.	Three (3) No of each type
1.00.04	Relay based Control Panels		
1.00.04.01	LEDs for indicating lights	Nos.	10% of qty installed.
1.00.04.02	Control circuit fuses/MCB/MCCB/Semiconductor Fuses	Nos.	300% of installed of each type, current rating.
1.00.04.03	Relays modules & contactors.	Nos.	20% spare of qty Installed of each type & rating.
1.00.05	Alarm Annunciation System		
1.00.05.01	logic modules, group card modules, power supply modules, Hooters and any other electronic module.	Nos.	20% spares of each type installed
1.00.05.02	un-engraved window boxes complete with LED etc.	Nos.	5% spares of each size installed
1.00.05.03	LEDs for annunciation facia windows and LEDs box assemblies offered for the project	Nos.	20% of qty installed



1.00.05.04	Annunciator hooter	Nos.	One (1) No. of each type
1.00.06	Un-interrupted Power Supply System and DC Control Power Supply System		
1.00.06.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)		
1.00.06.02	Fuses/Semiconductor Fuses	Nos.	300% of installed of each type, current rating with each panel /board
1.00.06.03	Miscellaneous parts for the power supplies such as SCRS, transistors, resistors, diodes, light bulbs, static switches , blocking diodes etc	Nos.	Minimum of 10% or atleast two (which ever is more) of each type
1.00.06.04	Battery cells complete with contactor,cover plates etc	Nos.	10% of qty installed
1.00.06.05	Electronic Modules like Rectifier control card, inverter control card, Driver card, IGBT Module, DC-DC converter card or any other card as listed in approved BOM for UPS, AC supply & 24 V DC supply etc.	Set	1 Set of each type & rating
1.00.06.06	Miniature Circuit breakers for AC and DC supply.	Nos.	20 % of installed or 10 Nos of each type (which ever is more) for ACDB and DCDB.
1.00.06.07	Digital/analog panel meters/indicators	Nos.	5% or 2 no. of each type (whichever is more)
1.00.06.08	CT's, CVT's VT's chokes, AC/DC isolators, contactors, timers, relays.	Nos.	10% or 2 nos. of each type and rating, (whichever is more)
1.00.06.09	Cooling Fans in UPS & 24 V DC charger panels	Nos.	10% or 2 nos. of each type and rating, (whichever is more)
1.00.06.10	following accessory equipment for the battery shall be furnished : a) Cell lifting facilities b) Assembly wrenches c) Vent plug hydrometer d) Vent plug thermometer e) Supply of corrosion-preventive grease. f) 10% spare cells.	Set	Two sets



1.00.06.11	Electronic modules of each type & rating for UPS and DC control power supply system.	Set	One set of with each set consisting of at least one number of each type of electronic module for inverters, chargers, static switch, stabiliser etc. as per approved BOM.
1.00.06.12	MCCB for UPS & 24 V DC charger panels, ACDB, DCDB.	Nos.	20 % of installed or 5 Nos of each type (which ever is more)
1.00.07	Erection hardware		
1.00.07.01	Instrument valves	Nos.	Ten (10) percent of each type & Size installed
1.00.07.02	Condensate pots of each type & Size installed	Nos.	Ten (10) percent of total number of Installed or four numbers whichever is higher .
1.00.07.03	Manifold	Nos.	Ten (10) percent of each type & Size installed
1.00.07.04	Fittings	Nos.	Ten (10) percent of each type & Size installed
1.00.08	LVS		
1.00.08.01	LEDs	Nos.	20% (Installed) spares of each type & size.
1.00.08.02	LVS Filters	Nos.	50% spare or min 6 nos.
1.00.08.03	Electronic cards of each type for LVS	Nos.	3 nos. or 20% whichever is more
1.00.08.04	Interfacing cables	Set	Two Set of each type & size.
1.00.08.05	Power supply modules of each type for LVS	Nos.	3 nos. or 20% whichever is more
1.00.08.06	Cooling modules of each type for LVS	Nos.	3 nos. or 20% whichever is more
1.00.08.07	LVS Controller of each type for LVS	Nos.	2 nos.
1.00.09	Master Slave Clock system		
(i)	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)	Set	
(ii)	Electronic cards	Nos.	One No. of each type & model
(iii)	Signal Conditioner cards	Nos.	One No. of each type & model



SECTION D1

STANDARD TECHNICAL SPECIFICATION (MECHANICAL)

STANDARD TECHNICAL SPECIFICATION FOR NDCT

DATASHEET A

DOCUMENT DISTRIBUTION SCHEDULE

STANDARD QUALITY PLANS



TITLE :
STANDARD TECHNICAL SPECIFICATION
FOR
NATURAL DRAFT COOLING TOWERS

SPECIFICATION NO. PE-TS-999-165-N004

VOLUME : II B

SECTION : D **Part-A**

REV. NO. 0 **DATE :** 22.03.2003

SHEET 1 of 9

1.0 GENERAL:

- 1.1 This standard specification covers the design, manufacture and assembly, inspection and testing at the Vendor's and/or his sub-vendor's works, suitable painting and packing requirements for transportation, erection, commissioning and testing at site of all materials and equipments inclusive of complete electrical and civil works for the Natural Draft Cooling Tower complete with all accessories as specified hereinafter.

2.0 CODES AND STANDARD:

- 2.1 The design, manufacture, inspection and testing and performance of the Cooling Tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American Standards and Codes of practice. The latest editions of the following standards and publications shall be followed in particular.

- a) Cooling Tower Institution of USA, Bulletin ATP-105: Acceptance Test Code for Industrial Water Cooling tower.
- b) PTC-23: ASME Performance Test Code for Atmospheric Water Cooling equipment.
- c) For Electrical, Civil Codes/ Standards refer respective Specification.
- d) BS-4485 – Specification for Water Cooling Tower.

- 2.2 In case of any conflict between the above codes/ standards and this specification, the later shall prevail and in case any further conflict in the matter, the interpretation of the specification by the Engineer shall be final and binding.

3.0 DESIGN REQUIREMENTS:

- 3.1 The Cooling Tower shall be designed for continuous operation to cool not less than the design flow of water from specified inlet temperature to outlet temperature at a design ambient wet bulb temperature as indicated under Data Sheet-A enclosed to this specification.

- 3.2 All the components shall be capable of safe, proper and continuous operation at all cooling water flows up to and including those specified under Data Sheet-A and shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

- 3.3 The cooling tower shall be Natural Draft cross flow/ counter flow type as per enclosed Data Sheet-A.

- 3.4 The vendor under this specification shall assume full responsibility in proper design and operation of each and every component of the cooling tower as well as the cooling tower as a whole unit.

	TITLE : STANDARD TECHNICAL SPECIFICATION FOR NATURAL DRAFT COOLING TOWERS	SPECIFICATION NO. PE-TS-999-165-N004	
		VOLUME : II B	
		SECTION : D Part-A	
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3.5	The Cooling tower shall be suitable for handling the fluid as per Data Sheet-A and also for achieving the specified parameters in Data Sheet-A.		
3.6	The Cooling tower shall be designed such that the drift losses and the evaporation losses are limited to the values as specified in Data Sheet-A.		
3.7	The Cooling Tower structure shall be of adequate strength to withstand the wind load and the effect of earthquake on the structure. Design wind pressure and horizontal/vertical seismic coefficient shall be taken as mentioned in the specification for civil works enclosed to this specification.		
4.0	CONSTRUCTIONAL FEATURES:		
4.1	Casing and Louver (If required):		
4.1.1	The Louvers shall be designed for air entry to the tower with low velocity for minimum pressure drop and less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards.		
4.1.2	The louvers and casing shall be made of material as specified in the Data Sheet-A.		
4.2	Partitions:		
4.2.1	Partitions shall be provided so that one section can be taken out of service without affecting the operation of capacity of other section.		
4.3	Fill:		
4.3.1	Cooling tower fills type and material shall be as specified in Data Sheet-A.		
4.3.2	Design and arrangement of the fills shall be so as to expose high air/ water surface with minimum air pressure drop.		
4.4	Fill Supports:		
4.4.1	Fills shall be supported at frequent intervals, which shall minimise sag. Possibility of dislodgement and damage to fill materials as a consequence of induced vibration in the fill.		
4.5	Drift Eliminations:		
4.5.1	Multipass drift eliminators with minimum two-pass zig zag path type shall be provided so as to limit the drift loss to that specified in Data Sheet-A.		
4.5.2	The eliminator frame shall be of rugged construction and shall be firmly secured to the structural		



TITLE :
STANDARD TECHNICAL SPECIFICATION
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NATURAL DRAFT COOLING TOWERS

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frame to arrest vibration. Suitable access to the eliminator frame work from the basin should be provided for any maintenance or physical replacement of eliminator blades etc., when the particular cell is taken out for maintenance.

4.6 Hot Water Distribution System:

4.6.1 Motorised/Manual valves (as indicated in Data sheet A) shall be provided in the hot water distribution piping such that each section can be isolated without affecting the operation of other section.

4.6.2 The pipes and valves in hot water distribution system shall be designed to take care of the possible thermal stresses due to temperature variation. This could be achieved by providing sliding supports for supporting all the pipes fabricated from carbon steel.

4.6.3 The hot water distribution piping and valves shall be designed for the design pressure as indicated in the Data Sheet-A.

4.7 Cold Water Basin:

4.7.1 The cooling tower basin shall be constructed in RCC (unless otherwise specified in Data Sheet-A). The capacity of the cooling tower basin shall be as indicated in Data Sheet-A.

4.7.2 The cold water basin shall be partitioned into two chambers or as specified in Data Sheet-A. The two sections of the Cooling Tower basin should be separate water tight compartments, which can be isolated one at a time for cleaning/maintenance purposes.

4.7.3 Sludge pits with isolating valves and spool pipe having flanged ends shall be provided for individual basin chamber for connection to drainage pipe.

4.7.4 For each basin chamber, there shall be a cold-water outlet channel. In the connection between basin chamber and cold water outlet channel there shall be a stationary coarse bar screen and gate in the absence of any specific preference under Data Sheet-A.

4.7.5 Each basin chamber shall have an overflow arrangement and scouring arrangement.

4.8 Submersible sludge Pumps:

4.8.1 The submersible type sludge pumps complete with electric motors, discharge side valves, piping, supports, hangers and clamps etc. shall be supplied at the option of the purchaser for each cooling tower for basin draining/ desludging. The quantity, design parameters and the materials of construction of the vertical sludge pumps shall be as per Data Sheet-A. Each pump shall be non-clog type, self water lubricated. The vertical sludge pumps shall be treated as an optional item and are to be offered if asked for in the Data Sheet-A enclosed to this specification.



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4.9.0 Screens & Gates in Cold Water outlet Chamber:

4.9.1 The screens shall be vertical stationary type; the opening size and the mesh aperture shall be as per Data Sheet-A. The guides for the screens to be embedded in the concrete shall be of material as per Data Sheet-A.

Lifting lugs or eye bolts shall be provided on top of the screen frame for ease of handling.

4.9.2 For handling screens, one set of monorail with supporting structure and chain pulley hoist complete with lifting chain and trolley for mounting the hoist shall be furnished. The chain pulley hoist shall be manually operated and shall conform to IS-3832 class-II.

4.9.3 The gates fixed in vertical sections in cold water outlet chamber shall be as per standard practice and quality, material and type shall be as given in Data Sheet-A.

4.9.4 The isolating valves on the scour lines within the sludge pits shall conform to class I of IS-780 and shall be of reputed make.

4.10 Hardware:

4.10.1 All nails and fastening bolts, nuts and washers etc used in the cooling tower which are coming in direct contact with water or humid air shall be made of stainless steel 304, all others nuts & bolts etc. shall be made of HDG steel.

4.11.0 Access:

4.11.1 Two R.C.C. staircases for approach to the hot water distribution level

4.11.2 Doors for entrance into Cooling Tower Distribution level shall be provided as specified in Data Sheet -A.

4.11.3 Two external ladders for approach to top of cooling tower from water distribution level.

4.11.4 Access/platforms for inspection and maintenance of hot water distribution system along with spray nozzles.

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

4.11.6 Whether specifically mentioned in the data sheet or not, steel components and fittings used in walkways, handrails and access doors shall be hot dip galvanised after fabrication.

5.0 INSPECTION AND TESTING:

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5.1

The inspection/ testing of cooling tower and its various components shall be as per the approved Quality Plans.

5.2

Hydrostatic test for the hot water distribution piping shall be conducted at site after complete erection. The test pressure and duration shall be as per Data Sheet-A.

6.0

TEST AT SITE:

6.1

The Cooling Tower as a whole shall be tested at site to check and ascertain that the performance meets the requirements of the specification. It is the responsibility of the vendor to conduct the performance test of the cooling tower and prove the specified parameters to the satisfaction of the purchaser. The test shall be witnessed by the purchaser/ customer's representative or both, for which 15 days clear notice will be given to purchaser by the vendor.

6.2

The performance test of the cooling tower shall be carried out in accordance with cooling tower Institute Bulletin No. ATP 105 Acceptance test for Industrial Cooling Tower.

The details of the proposed test procedure shall be submitted by the vendor sufficiently in advance of the commencement of test for the review and approval of the purchaser.

6.3

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

6.4

All testing and calibrating instruments required for the site performance test shall be arranged by the cooling tower supplier without any extra cost. All instruments used by the supplier shall be duly calibrated from a recognised Institution and the same is to be arranged by the supplier.

7.0

PERFORMACNE GUARANGTEE, TOLERANCE & PENALTIES:

7.1

Each equipment shall be guaranteed to meet the performance requirement as specified.

7.2

The tests shall be conducted at the manufacturer's works/ site in accordance with this specification and rectification of all defects shall be satisfactory done without charging any extra amount to purchaser.

7.3

The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within a time period decided by purchaser. No extra amount shall be charged to purchaser for such rectification. After rectification, retesting will be done by purchaser/ customer's representative without any extra cost to purchaser till satisfactory performance is achieved.

7.4

The vendor shall submit performance curves for the cooling tower showing variation in performance from the design duty point with change in approach to wet bulb temperature,

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cooling range, water loading of the tower.

7.5 The vendor shall guarantee the performance of the whole cooling tower plant to meet the specifications when tested in accordance with cooling tower institute acceptance test code ATP-105, performance curves as per ATP-105 shall be furnished by the vendor.

7.6 If any defects are observed, the bidder shall rectify the same without extra cost to the purchaser. Even after rectification if the guaranteed performance is not achieved, then for every increase of 0.5 degree C or part thereof in the cold water temperature over design conditions, a sum as specified in data Sheet-A shall be paid by vendor to the purchaser for shortfall of guarantee, for the cooling tower.

7.6.1 In case the cold water temperature exceeds the acceptable limits of purchaser, the whole plant will be rejected and the vendor shall refund the entire money paid to him together with any penalty levied otherwise.

8.0 SPECIAL CLEANING PROTECTION & PAINTING:

8.1 All equipment shall be neatly finished. All exposed metal/ concrete/ wooden surface shall be smooth and free from burrs/ projections.

The metal surfaces to be painted should be accessible, suitable for priming and affording maximum protection throughout the life of the plant. The surface preparation shall be done either mechanically or chemically by one or more of the methods as given in IS-1477 (Part-I) and shall include the following:

a) Removal of oil, grease, dirt and swarf etc., as per Section 6.1 of IS-1477 (Part-I).

b) Removal of rust and scale etc., as per Section 6.2 of IS-1477 (Part-I).

c) Sand blasting/ shot blasting as per Section 6.2.4 of IS-1477 (Part-I) or wire brushing and picking as specified in Data Sheet-A.

8.2 INSIDE SURFACE OF PIPING & VALVES IN HOT WATER RISERS:

8.2.1 The inside surfaces of the piping and the valves which are in contact with water and which are not made of stainless steel or other corrosion resistant materials shall be painted with coal tar based epoxy paint of approved make and quality over a coat of Zinc Chromate Primer. The thickness of cured coating shall be as specified in Data Sheet-A.

8.3 Outside Surface of Piping (Buried):

8.3.1 Surface treatment as specified in Data Sheet-A.



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8.3.2 Coating/ wrapping/ concrete lining as specified in Data Sheet-A.

8.4 **Outside Surface or Piping (Exposed):**

8.4.1 Surface treatment as specified in Data Sheet-A.

8.4.2 One coat of red oxide primer.

8.4.3 Synthetic enamel paint of approved shade, make and quality. The thickness of cured coating shall be as specified in Data Sheet-A.

8.5 All steel parts used for cooling tower construction shall be hot dip galvanised as per IS-4736 after shop fabrication. The external surfaces of the flow regulating valves access platform, access door and also the hoisting derrick subjected to hot water fumes shall also be thoroughly cleaned and treated and shall be coated with rust preventing paints.

8.6 All parts shall be properly boxed, crated or otherwise protected for transportation. Exposed metal finished surfaces shall be thoroughly greased before transportation.

8.7 The external and internal surfaces of the tower shall also be painted.

9.0 **DRAWING AND DATA AFTER AWARD OF CONTRACT:**

The vendor shall furnish drawings and other technical documents as given in Data Sheet-C, enclosed with the specification.

10.0 **SPECIAL TOOLS & TACKLES:**

Special tools & tackles, if any, shall be included in scope of supply by the vendor. A list giving description of such tools & tackles shall be furnished by vendor.



TITLE :

DATA SHEET – C
FOR
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DATA / DOCUMENTS TO BE FURNISHED BY VENDOR AFTER AWARD OF CONTRACT

1. General Arrangement drawing of complete cooling tower (showing plan, front elevation and side elevation) incorporating principal dimensions limits of scope of supply of piping, limits of civil works included, showing extent of platforms, walk ways, handrails, access doors staircase, end wall derrick etc. and the limits of scope of supply of electrical works.
2. General Arrangement drawing of Cooling Tower basin indicating overflow and desludging arrangement.
3. General Arrangement and Sectional Assembly drawings pertaining to the following components of the Cooling Tower.
 - a) Tower fill with supporting arrangement.
 - b) Drift eliminator installation and details.
 - c) Complete hot water distribution system including flow regulating valves, distribution basin/ pipes and nozzles etc.
4. Arrangement drawing of the cold water outlet chambers and sludge pits incorporating also the arrangement of screens, gates, valves and piping terminal details.
5. Cooling tower performance curves showing wet bulb temperature V/s. cold water temperature for design cooling range, 90% cooling range and 110% cooling range at 90% ,100% and 110% of design flow.
6. Detailed GA and sectional assembly drawing of BF valves in hot water risers indicating materials of construction of various components.
7. General Arrangement and cross-sectional assembly drawings of sludge pumps and motor drives along with their performance curves.
8. Electrical drawings and data.
 - i) Cable Schedule
 - ii) Cable tray and trench layout.
 - iii) Drawing on illumination system of cooling tower structure including wiring diagram showing conductor and conduct sizes and design calculation.
 - iv) Drawing on Aviation Obstruction Lighting System.
 - v) Drawing on grounding system inclusive of lighting protection system.



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DATA SHEET – C
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- vi) Drawing of lighting sub-distribution board & junction boxes.
- 10. Drawings, data and calculation on civil works :
 - i) Design calculations for strength and suitability showing justification for size of members chosen for all structural components of cooling towers inclusive of prestressed concrete fill where applicable. All civil and structural design calculations shall be furnished by the supplier for approval of the purchaser.
 - ii) Load drawings setting out clearly and concisely the various loads taken into consideration for design.
 - iii) Civil drawings for cold water basin, sludge sumps, connecting channels, partitions, louvers, end walls, longitudinal beams, hot water distribution basin, its covering, staircase, platforms, cable trenches, etc. all complete.
 - iv) Bar bending details for all reinforced concrete structures.
 - v) Insert details, anchor bolt details.
 - vi) Final painting schedule.
 - vii) Other drawings & data as necessary.
- 11. Test procedure along with details of tests to be conducted for the offered cooling tower.
- 12. Quality Plan along with complete details of the testing and inspection requirements of mechanical and electrical items of the cooling tower in BHEL format.
- 13. Operation and Maintenance Manuals
- 14. Field Quality Plan for site activities – viz. Civil works & Erection.
- 15. Cooling tower performance test procedure.



TITLE:

**TECHNICAL SPECIFICATION
COOLING TOWER
2X660 MW ENNORE SEZ STPP
DATASHEET - A**

SPEC. NO.: **PE-TS-412-165-N001**VOLUME: **II B**SECTION: **D1**REV. NO. **0** DATE **12.12.14**SHEET **1** OF **6****1.0 GENERAL INFORMATION**

No. of Cooling Towers required	:	Two (02) nos.
Location		Out door
Duty		Continuous
Type		Natural draft Counter flow with PVC Splash Bar type
Basin Sill level		EL (+) 0.5 M
Finished ground level		EL (+) 0.0 M

**2.0 DESIGN PERFORMANCE FOR EACH
COOLING TOWER**

2.1	Design Cooling water flow	:	90000 M ³ /hr.
2.2	Design ambient wet bulb temp.	:	28.0 °C
2.3	Design inlet air wet bulb temperature.	:	28.0 °C
2.4	Approach w.r.t. design inlet air wet bulb temperature (viz. 28.0°C)	:	5.0 °C
2.5	Cold water temperature	:	33 °C
2.6	Hot water inlet temperature	:	42 °C
2.7	Cooling Range	:	9 °C
2.8	Design ambient Relative Humidity	:	Based on meteorological data of Chennai for last 50 years
2.9	Liquid Handled	:	Sea water (refer details of cooling water analysis)
	a) Total CW Pumping head permissible viz. static head plus frictional losses as below:	:	Not to exceed 16 MWC
			• Static head w.r.t. FGL • Frictional losses within bidders T.P. with 10% margin • Velocity head
2.10	Maximum permissible drift loss	:	Max. 0.005 %
2.11	Design pressure for hot water distribution system	:	5 kg/cm ² (g)
2.12	Maximum Basin Diameter	:	130 M
2.13	Maximum Cooling tower flow capacity to be considered for design of hot water distribution	:	Min 120% of design CW flow.



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and cold water channel

3.0 SPECIAL FEATURES

3.1 Basin type : Sectionalized (two compartment) by partition wall. Each basin chamber shall have overflow arrangement and sludge pit end with necessary dewatering arrangement.

3.2 Whether fills are removable : Yes

3.3 Fills supporting by nailing acceptable : NO

4.0 Cold Water Basin Details

4.1 Finished ground level : EL (+) 0.0 M

4.2 Maximum water level : EL (+) 0.2 M

4.3 Min. Water level : EL (-) 0.95 M

4.4 Storage capacity between Normal and minimum water levels : 10 minutes (Between Max. & Min. Water Level) of Cooling tower design Flow.

4.5 Invert level of CT Basin : EL (-) 1.45 M (at basin centre)

4.6 Invert level of CW Channel near CT level : EL (-) 5.15 M

4.7 a) Depth of Sludge pit : Suitable for complete dewatering. To include sludge pump submergence & clearance depth below basin/ channel invert level

b) Submersible type sludge pumps : 1 working + 1 standby
(Min capacity of 200 cub M / hr
OR
Pumps sized to empty each basin partition in 10 hrs whichever is higher.)

4.8 Number of sludge pits : Common sludge pit with inter connection with both compartments of CW basin.

4.9 Number of cold water outlet channels : One for each compartment of CW basin. Cold water outlet shall be 10 M wide (clear width – excluding wall thickness) at CT basin outlet for each compartment. At T.P Bidder to match same as per T.P. Drawing.

4.10 Depth of CW channel : 5.15 M up to FGL (Ref Annexure-1)

4.11 Number of screens and gates in common outlet channel : One for each compartment of CW basin

4.12 Maximum allowable effective velocity through Cold water channel at Min. : 0.6 M/Sec.



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Water Level

- 4.13 Maximum allowable effective velocity through gates at Min. Water Level : 1.2 M/Sec.
- 4.14 Max. allowable effective velocity through screens at Min. Water Level : 0.6 M/Sec.
- 4.15 Length of outlet channel including expansion joint in bidder's scope : As per terminal point details in Section C1 and details as shown in the enclosed Annexure-2.

5.0 COOLING TOWER ACCESS DETAILS

- 5.1 Required number of stair cases from ground level up to hot water inlet trough cooling tower roof : Two (2) Nos.
- 5.2 Number of cage ladders from ground floor to cooling tower top. : Total Four (4) Nos.: Two from reinforced concrete stairs to platform at the top of the tower and other two shall be from ground level itself.
- 5.3 Internal walkway of platform with hand rails : Peripheral walkway above fill level inside of the cooling tower
- 5.4 External walkway platform : 1.2 M width around the circumference at top and at each aviation lamp levels
- 5.5 Platform for access of BFV : Provided by Bidder.

6.0 HOT WATER SUPPLY HEADER TERMINALS

- : As per terminal point Annex-2 enclosed. CW RCC Duct piping in BHEL scope 4000mmX3000mm shall be terminated with centre line of pipe elevation as shown in sketch. Further RCC Duct/Piping from T.P. with isolating Motorized B.F. Valves in each riser shall be in bidder's scope.

7.0 SCOPE OF SUPPLY :

- 7.1 Cooling tower basin outlet channels/ sump and sludge pits : Yes
- 7.2 Hot water piping to distribution Duct : Yes
- 7.3 Hot water header isolation valves(motorised) on risers : Yes
- 7.4 Flanges/counter flanges for all flanged connections with bolts, nuts & gaskets etc. : Yes
- 7.5 Screen & guide for each cold water outlet sump/ channel : Yes
- 7.6 Stop Log gate with guides and sealing device for each cold water outlet sump/ : Yes



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channel.

7.7	Isolation valves in sludge pit	:	Yes
7.8	Drain Piping from sludge pit to terminal point	:	Yes
7.9	Pulley block for lifting each screen and stop log gate in cold water outlet sump/ channel	:	Yes
7.10	All necessary supports, hangers	:	Yes
7.11	Base plates, foundation plates, anchor bolts, sleeves, inserts, bolts, nuts for all equipment supplied	:	Yes
7.12	Drift Eliminator	:	Yes
7.13	Electrical		
	As per electrical plant specification	:	Yes
7.14	All related Civil works included	:	Yes

8.0 MATERIAL OF CONSTRUCTION

8.1	Cold water basin, outlet channel/ sump & sludge pit.	:	R.C.C.
8.2	Shell	:	R.C.C
8.3	Basin partition wells	:	R.C.C
8.4	Internal walk way	:	R.C.C.
	External walkway platform		R.C.C
8.5	Staircase/Ladders	:	R.C.C./SS 316
	Hand rail		Hot dip galvanized steel
8.6	Supporting structures	:	R.C.C.
	Hot water distribution basin		R.C.C
8.7	Hot water distribution nozzles	:	Polypropylene
8.8	Fills	:	PVC Splash Bar
8.9	Fill support col, beams & trusses	:	R.C.C
8.10	Louvers	:	R.C.C.
8.11	Drift eliminators	:	PVC UV Stabilised
8.12	Fasteners/wetted parts	:	SS-316L
8.13	Piping		Above 150 Nb : Carbon steel plates to IS 2062 internally lined with CorroCoat or Poly Urea Coating of 1500 Microns DFT, rolled and welded as per IS 3589

Below and 150 Nb : IS 1239 (Heavy



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Grade) internally lined with CorroCoat or
Poly Urea Coating of 1500 Microns DFT

- 8.14 Water Distribution Pipes (Inside CT) : GRP/FRP
- 8.15 Hot water line valves
- a) BF Valves : Body: Duplex SS
Shaft: Duplex SS
Test pressure & duration shall comply
with AWWA C504
- b) Sludge pit isolation valves
- Body : Duplex SS
Spindle & Trim : Duplex SS
- 8.16 Sludge outlet pipe : As per the material specified above in
8.13
- 8.17 Submersible Pumps : Casing: Duplex SS
Impeller: Duplex SS
- 8.18 Stop log gates with rubber seals in cold water outlet channel : SS 316L
- 8.19 Guide for stop log gates : SS-316L
- 8.20 Screen : SS -316L
- 8.21 Guide for Screen : SS- 316L
- 8.22 Bolts, butts & other hardware : SS-316L

Note:

- (a) Carbon /Mild steel parts or structures used in Cooling Tower or its vicinity shall be Heavily Galvanised.
- (b) Material of construction for items not specified shall be subject to purchaser's approval during detailed engineering stage, in the event of order.

9.0 Pipe work Painting / Protection of Pipes:

- 9.1 Internal surface Surface preparation : Sand blast to SA 2.5
Internal Paint: Application of two(2) coats
of (DFT of each coat 40 to 50 microns)
Epoxy based Zinc rich primer followed by
2 to 3 coats of coal tar epoxy paint to
achieve total DFT of min. 150 microns.

- 9.2 External surface – over ground piping: Surface preparation : Sand blast to SA 2.5
Internal Paint: Application of two(2) coats
of (DFT of each coat 40 to 50 microns)
Epoxy based Zinc rich primer followed by
2 to 3 coats of coal tar epoxy paint to
achieve total DFT of min. 150 microns.

- 9.3 External surface – Burried piping: **Surface preparation:** Sand blast to SA
2.5



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External Paint:

Intermediate: Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.

Final Coat: Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982. The total thickness of the coating will not be less than 4.0 mm

Alternatively, Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003. Wrapping thickness shall be 4.0 mm.

INSPECTION AND TESTING

10.0	Quality Surveillance by	:	Manufacturer, purchaser and customer
10.1	Material testing and identification	:	Required
10.2	Stage inspection to be witnessed by Purchaser and customer	:	Yes
10.3	Hydrostatic test for piping & valves required	:	Yes
10.4	Hydrostatic test to be witnessed by Purchaser and customer	:	Yes
10.5	Field performance test of individual items and the cooling tower as a whole required	:	Yes
10.6	Field performance test to be done by	:	Approved CTI agency along with bidder for one Tower. For remaining towers by Bidder.
10.7	All testing instruments by supplier	:	Yes
10.8	Commissioning at site by	:	Bidder
10.9	Mandatory spares:	:	Refer Section C4 of Vol IIB

Attachments:

- Sketch showing details CT and CW Channel Levels. Annexure-1.
- Key Plan showing Terminal Points- Annexure-2.

SEA WATER ANALYSIS

S.No.	Parameter	Unit	Value (Range)
1	General		
a	pH		7.94-8
b	Conductivity	millisiemens/cm	43.8-44.1
c	Temperature	Deg C	25-32
d	Turbidity	NTU	20-40
e	Total Organic carbon (total/ dissolved)	PPM of C	2.4-2.84
f	CO ₂	Mg/l	<2
g	TDS	Mg/l	39600-39740
h	BOD	Mg/l	10-12
i	COD	Mg/l	88-96
j	Oil & Grease	Mg/l	<10
k	Phenols	Mg/l	0.08-0.09
l	Free Residual Chlorine	Mg/l	<0.2
2	Cations		
a	Calcium	Mg/l	459-478
b	Magnesium	Mg/l	1510-1516
c	Sodium	Mg/l	10100-12000
d	Potassium	Mg/l	358-450
e	Ammonia	Mg/l	4.43-5.42
f	Strontium	Mg/l	12.9-12.4
g	Barium	Mg/l	1.55-1.58
h	Aluminum Total	Mg/l	1-1.8
i	Aluminum Dissolved	Mg/l	0.8-1.0
j	Manganese Total	Micro g/l	0.2-0.6
k	Manganese Dissolved	Micro g/l	0.1-0.2
l	Iron total	Micro g/l	220-260
m	Iron Dissolved	Micro g/l	Below detectable limit (detectable Limit : 10)
3	Anions		
a	Chloride	Mg/l	18994-19194
b	Sulphate	Mg/l	3710-3949
c	Nitrate	Mg/l	136-152
d	Nitrite	Mg/l	0.46-0.62
e	Bicarbonate	Mg/l	144-148
f	Carbonate	Mg/l	Nil
g	Fluoride	Mg/l	2.64-2.8
h	Boron	Mg/l	0.14-0.17
i	Phosphate	Micro g/l	240-380
j	Sulphide	Micro g/l	Below detectable limit (detectable Limit : 100)
k	Silica Dissolved	Micro g/l as SiO ₂	200-250
4	Heavy Metals		
A	Arsenic	Micro g/l	Below detectable limit (detectable Limit : 2)
B	Mercury	Micro g/l	Below detectable limit (detectable Limit : 1)
C	Cadmium	Micro g/l	120-130
D	Copper	Micro g/l	200-220
E	Nickel	Micro g/l	470-490
F	Molybdenum	Micro g/l	Below detectable limit (detectable Limit : 100)

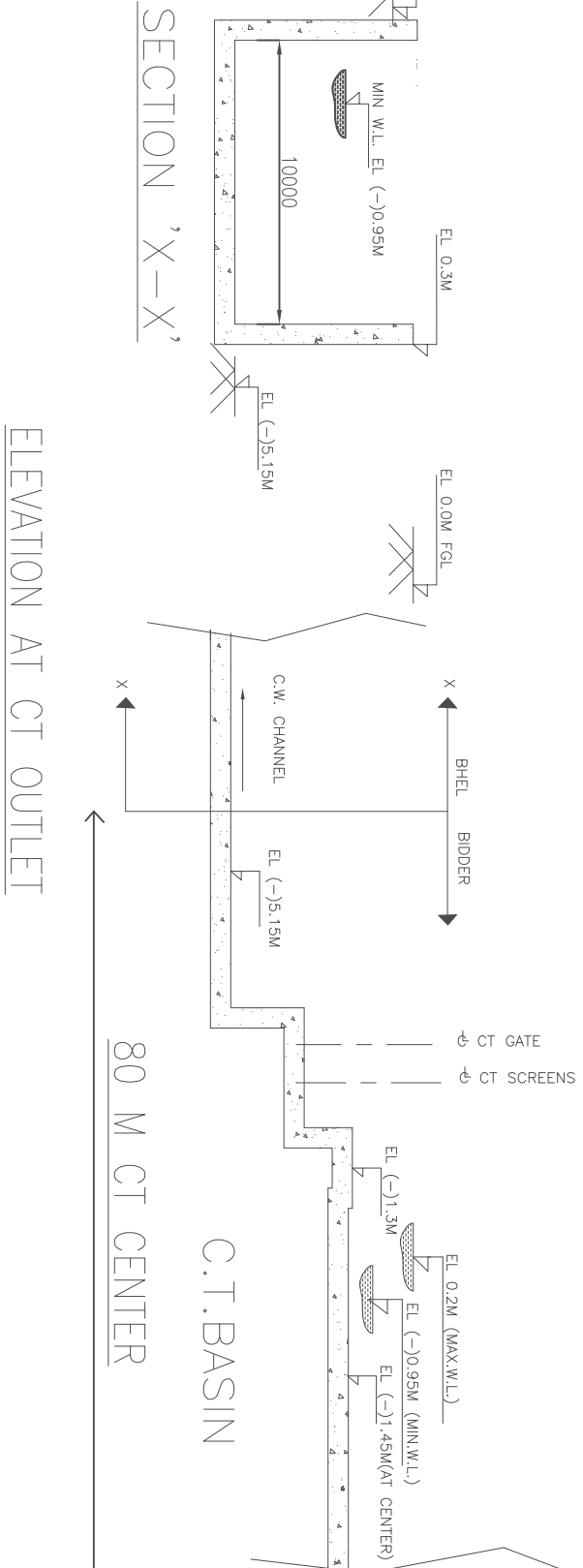


5	Suspended Particle Size Range		
A	10 micron & above	Mg/l	Below detectable limit (detectable Limit : 10)
B	5 micron to 10 micron	Mg/l	Below detectable limit (detectable Limit : 10)
C	1 micron to 5 micron	Mg/l	Below detectable limit (detectable Limit : 10)
D	0.1 micron to 1 micron	Mg/l	20-26
6	Colloidal Particle Size Range		
A	SDI (10 Minutes)	-	10-20
B	SDI (5 Minutes)	-	20-40
7	Density of sea water	Kg/ cum	1030

Note : Unless otherwise indicated all elements shall be expressed in respective ionic form only.



ANNEXURE-1



DRAWING/ DOCUMENTS DISTRIBUTION SCHEDULE

Sl. No.	Type of Document	Number of Copies	
		For Approval	Final
1	Drawings/Documents/Quality Plans etc.	3 Nos	13 Prints
2	Datasheets	3 Nos	13 Prints
3	Test Certificates & Reports	3 Nos	13 Prints
4	Erection/ Installation/ O&M Manuals	3 Nos	13 Prints
5	As Built Drawings/ Documents	3 Nos	13 Prints

1. VENDOR

STANDARD QUALITY PLAN

ITEM: COOLING COVER

COMPANY INFORMATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE WORKS	FORMAT OF RECORD	ASPECT	REMARKS
	(1)	(1)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1. PHYS. CHECK. PROPS.		MA	PHYS., CHEM. ANALYSIS	15:2814	APPD. DATA SHEET	APPD. DATA SHEET	ILAB. REPORT	3/2	12.1
2. DIMENSIONS, VISUAL DEFECTS:		MI	PHYS., VISUAL	15:2814	INF. DRG.	INF. DRG.	ILDS BOOK	3/2	12.1
3. UNIFORMITY, VT., ADHESION, SURFACE DEFECTS OF LINING COATING		CR	DIP. TEST, STRIP TEST, ADHESION TEST, VISUAL TEST	15:5358	15:5358, APPD. DATA SHEET	15:5358, APPD. DATA SHEET	ITG	3/2	12.1
1. DEFECTS		MA	VISUAL EXAM.	1001	TECH. SPECK.	TECH. SPECK.	IR	3/2	12.1
2. DIMENSIONS		MA	EXES.	IRAKOON	15:2372	15:2372	IR	3/2	12.1
1. PRESERVATIVE RETENTION & PENETRATION		CR	ANALYSIS	11/BATCH	15:2372, 15:101	15:2372	IR	3/2	12.1
1. PHYS. CHECK. PROPS.		MA	PHYS., CHEM. ANALYSIS, REAS.	RANDOM	APPD. DATA SHEET	APPD. DATA SHEET	ITC	3/2	12.1
2. UNIFORMITY, VT., ADHESION, SURFACE DEFECTS OF LINING COATING		CR	DIP. TEST, STRIP TEST, ADHESION TEST, VISUAL EXAM.	15:1026	APPD. DATA SHEET	APPD. DATA SHEET	ITC	3/2	12.1

DATE: 12/25/92

DATE: 10/1-12/95 10/1/95

NAME: _____

PARTY: _____

SIGNATURE: _____

DATE: _____

CUSTOMER/CONSULTANT: _____

VENDOR: _____



PROJECT
VEHICLE

COMPONENT / LOCATION
(2)

STANDARD QUALITY PLAN

SYSTEM
HEAVY COOLING TOWER

QUALITY ASSURANCE



CHARACTERISTICS CHECKED	DATE	TYPE/METHOD OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE WORKS	FORMAT OF RECORD	AGENCY	REMARKS
1. COATING RESISTANCE	1/14	151	1001	181	191	1101	111
2. CONTACT RATING	1/14	151	1001	181	191	1101	111
3. INSULATION RES.	1/14	151	1001	181	191	1101	111
4. DI-ELECTRIC STRENGTH	1/14	151	1001	181	191	1101	111
5. DETECTION	1/14	151	1001	181	191	1101	111
6. DEGREE OF PROTECTION & VIBRATION TEST	1/14	151	1001	181	191	1101	111
7. FINISH	1/14	151	1001	181	191	1101	111
8. SURFACE DEFECTS	1/14	151	1001	181	191	1101	111
9. MEAS. STRENGTH	1/14	151	1001	181	191	1101	111
10. VISUAL ELEM.	1/14	151	1001	181	191	1101	111
11. SPARE TEST	1/14	151	1001	181	191	1101	111
12. RANDOM	1/14	151	1001	181	191	1101	111
13. INFO. DRG.	1/14	151	1001	181	191	1101	111
14. INFO. DRG. / APPD.	1/14	151	1001	181	191	1101	111
15. INFO. DRG. / DATA SHEET	1/14	151	1001	181	191	1101	111
16. INFO. DRG. / DATA SHEET / APPD.	1/14	151	1001	181	191	1101	111
17. INFO. DRG. / DATA SHEET / APPD. / INFO.	1/14	151	1001	181	191	1101	111
18. INFO. DRG. / DATA SHEET / APPD. / INFO. / DRG.	1/14	151	1001	181	191	1101	111
19. INFO. DRG. / DATA SHEET / APPD. / INFO. / DRG. / INFO.	1/14	151	1001	181	191	1101	111
20. INFO. DRG. / DATA SHEET / APPD. / INFO. / DRG. / INFO. / INFO.	1/14	151	1001	181	191	1101	111

2.1. NO.	151/507/12	SIGNATURE	DATE
2.2. NO.	151/507/12	SIGNATURE	DATE
2.3. NO.	151/507/12	SIGNATURE	DATE
2.4. NO.	151/507/12	SIGNATURE	DATE
2.5. NO.	151/507/12	SIGNATURE	DATE
2.6. NO.	151/507/12	SIGNATURE	DATE
2.7. NO.	151/507/12	SIGNATURE	DATE
2.8. NO.	151/507/12	SIGNATURE	DATE
2.9. NO.	151/507/12	SIGNATURE	DATE
2.10. NO.	151/507/12	SIGNATURE	DATE
2.11. NO.	151/507/12	SIGNATURE	DATE
2.12. NO.	151/507/12	SIGNATURE	DATE
2.13. NO.	151/507/12	SIGNATURE	DATE
2.14. NO.	151/507/12	SIGNATURE	DATE
2.15. NO.	151/507/12	SIGNATURE	DATE
2.16. NO.	151/507/12	SIGNATURE	DATE
2.17. NO.	151/507/12	SIGNATURE	DATE
2.18. NO.	151/507/12	SIGNATURE	DATE
2.19. NO.	151/507/12	SIGNATURE	DATE
2.20. NO.	151/507/12	SIGNATURE	DATE

1.1. PIPES, FITTINGS & PIPE WORKS
1.2. VALVES (ALL TYPES)
1.3. PUMPS
1.4. LIGHTING PLAN
1.5. REFER STANDARD QUALITY PLAN FOR PIPES, FITTINGS & PIPE WORKS
1.6. REFER RESPECTIVE STANDARD QUALITY PLANS
1.7. REFER STANDARD QUALITY PLAN FOR CENTRIFUGAL PUMPS
1.8. REFER STANDARD QUALITY PLAN FOR CONTROL PANELS

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[illegible]

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BIKUNI, (EAT) TUCUMEN-S-LIALLO
COPORTE-SUMIT-ASSURANCE

STANFORD CULIVIT FLOW

SYSTEM
ITEM: COOLING-EXPL

[illegible]

31-A0-

DAVE

STORYLINE

NAME _____

כְּרוֹמָאנֵט: טֶגֶל טַבְּלֵטָה

7518-

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[illegible]

SYSTEM	ITEM	BUTTERFLY VALVES
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19	20	21
22	23	24
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322	323	324
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337	338	339
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352	353	354
355	356	357
358	359	360
361	362	363
364	365	366
36		

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STANDARD QUALITY PLAN

PROJECT:
VENDOR:

SYSTEM: BUTTERFLY VALVES
ITEM

S NO	COMPONENT/OPERATION	CHARACTERISTICS CHECKED	Q.A. ECO- AN	TYPE METHOD OF CHECK	EXTEN. OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P W V	REMARKS	
1	2	3	4	5	6	7	8	9	10	11	
		2 DIMENSION	MA	MEASURE- MENT UT	100%	DO- ASTM A435	DO- ASTM A435	INSPN. REPORT 3/2 INSPN. REPORT 3/2	3/1 3/1		
		3. INTERNAL DEFECTS FOR THICKNESS 50MM AND ABOVE	CR		100%						
		4 WEAT TREATMENT	SRM-1 CHART	100%	STANDARD PRACTICE	STANDARD PRACTICE	CORRELATED SRM-1 CHART	3/2			
4	PAINTING IS SUPPLY MAKE	1 VERIFICATION OF MAKE GRADE	MA	VISUAL	100%	TECH. SPEC. DATA SHEET	TECH. SPEC. DATA SHEET	INSPN. REPORT 3/2	3/2	1	
5	OPENING AS GEAR BOX GE	COMPOSITION	MA	CHEM ANALYSIS	ONEBA-14	AS PER MATERIAL SPEC	AS PER MATERIAL SPEC	TC-C	3	3/1	
5	GEAR SHAFT	HARDNESS	MA	MEAS	SAMPLE-3	AS PER APPD DRG. MATL. SPEC	AS PER APPD DRG. MATL. SPEC	TC-C REPORT	3	3/1	
		DIMENSION	MA	DO-	DO-	DO-	DO-	TC-C	3	3/1	
		NOT	MA	UTIMEP	100%	DO-	DO-	TC-C	3	3/1	
5	TEST OF GEAR BOX 3.5 TON TORQUE	TORQUE TRANSMITTING	MA	TESTING	ONECTV =	AS PER APPD DRG. MATL. SPEC	AS PER APPD DRG. MATL. SPEC	TC-C CMP	3	3/1	
5	ELITE ACTUATORS	TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	MECH. ELEC TESTS	100%	TECH. SPEC. APPD DRG. DATA SHEET IS 9234	APPD DRG. DATA SHEETS 9234	INSPN. REPORT 3	3/1		
O.P. NO	PERMISE: SOP/03			PREPARED BY:		REVIEWED BY:		APPROVED BY:		ACCEPTED-BY	
				PER		COS & PER		PER			VENDOR
REV NO/DATE	00/0-10-97	NAME									
		SIGNATURE									
PAGE NO.	2 OF 7	DATE									

BIHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD 2 QUALITY PLAN

PROJECT
VENDOR

SYSTEM:
ITEM: BUTTERFLY VALVES

S. NO.	CHARACTERISTICS CHECKED	CAT. EGO. RY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE CRITERIA	FORMAT OF RECORD		AGENCY		REMARKS
							P	W	P	W	
1	2. TRAVEL / STROKE 3. TRAVEL TIME 4. OPERATION OF LIMIT SWITCH 5. MANUAL OPERATION THROUGH HAND WHEEL 6. OPERATION TEST WITH POWER SUPPLY VARIATION: ENGISE TO OPEN/CLOSE, CURRENT DRAWN 1 IR, MV, IR 8. DEGREE OF PROTECTION	MA MA MA MA MA MA MA MA	5	6	3	8	9	10			
2	1. CHEM. & PHYS. PROPS 2. HARDNESS 3. DIMENSIONS 4. LEAK TIGHTNESS 1. CHEM. PHYS. PROPS 2. DIMENSION	MA MA MA MA MA MA	CHEM. PHYS. TESTS MEAS MEAS HYDRO TEST CHEM. PHYS. TESTS MEASUREMENT	100% 100% 100% 100%	APPD. DRG. DATA SHEET DO MFG. DRG APPD. DATA SHEET APPD. DATA SHEET MFG. DRG.	DO DO MFG. DRG. NO LEAKAGE APPD. DATA SHEET MFG. DRG.	TEST CERT DO DO INSPECTION REPORT TEST CERT LOG SHEET	3/2 3/2 3/2 3/2 3/2 3/2	2.1 2.1 2.1 2.1 2.1 2.1		
Q.P. NO	PEMMSE/SQP/03		PREPARED BY: PEM	REVIEWED BY: QQS & PEM	APPROVED BY: PEM			ACCEPTED BY VENDOR			
REV. NO. DATE	0078-10-97		NAME					NAME			
PAGE NO	3 OF 7		SIGNATURE					SIGN			
			DATE					DATE			



BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM :
ITEM : BUTTERFLY VALVES

S. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECKED	CAT. TYPE / EQUIP. METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORM OF RECORD	AGENCY P W V	REMARKS
1									
20	COMPRESSOR	1. DIM. PHYS. PROPS. 2. C. TENSIONS 3. T. TENSNESS	MA MA MA	TESTS MEAS MEAS	MATL. SPEC. APPD. DRG. MFG. DRG. -OO-	MATL. SPEC. APPD. DRG. MFG. DRG. -OO-	LOG. BT. CK. -OO- TEST. RPT.	3/2 3/2 3/2	1 2 2
21	IMPROCESS CONTROL	1. S. TFACE DEFECTS 2. O. TENSIONS 3. UT. TIGHTNESS OF DRG.	MA MA MA	PT MEAS HYDRO TEST	ASTME-165 MFG. DRG. TECH. SPEC. APPD. DRG./DATA SHEET	NO DEFECTS -APPD. DRG. -NO LEAKAGE	INSPN. REPORT LOG. BT. CK. INSPN. REPORT	3/2 3/2 3/2	2 2.1
22	SHAFT	1. O. TENSIONS 2. S. TFACE DEFECTS 3. UT. TIGHTNESS OF DRG.	MA MA MA	MEAS PT MEAS	MFG. DRG. ASTME-165	APPD. DRG. NO SURFACE DEFECTS	LOG. BT. CK. INSPN. EPCONT	3/2 3/2	2 2.1
23	SEATING	1. O. TENSIONS 2. UT. TIGHTNESS OF DRG.	MA MA	MEAS PEEL. STRE. ON/DRG.	MFG. DRG. ASTMD-429	APPD. DRG. ASTMD-429	LOG. BT. CK. TEST. RPT.	3/2 3/2	2 2.1
24	THICKNESS	3. T. TENSNESS	MA	MEAS	MFG. DRG.	MFG. DRG.	-OO-	3/2	2
ACCEPTED BY									
VENDOR									

D.P. NO.	PEM/MS/ISO/101	PREPARED BY	REVIEWED BY	APPROVED BY	NAME
		PEM	COS & PEM	PEM	
REV NO/DATE	00/8-10-97	SIGNATURE			SIGN.
PAGE NO.	4 OF 7	DATE			DATE

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BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD 2 QUALITY PLAN

PROJECT VENDOR: BUTTERFLY VALVES

S. NO.	COMPONENT OPERATION	CHARACTERISTICS CHECKED	CAT. EQ. RT	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
2.1	WELDED FLANGES IN WATER FLANGES	4 SURFACE DEFECTS	MA	PT	100%	ASTME 165	NO SURFACE DEFECTS	DO	3/2	2	1	
2.2		1 FIT UP	MA	PHYS TESTS	100%	ASME IX	ASME IX	FORMATS OF ASME IX	3/2	2.1	1	
2.3		2 INTERNAL DEFECTS OF WELDMENTS	CR	RT/AUT	100%	WFG DRG	WFG DRG	LOG BOOK	3/2	2.1	2.1	FOR FABRICATED FLANGES ONLY FILMS TO BE SOWN TO SHEL
2.4		CORRECTNESS	MA	EXAM	100%	ASME SEC IX	ASME SEC IX	RADIO GRAPH REPORT FILMS	3	2.1	2.1	
2.5	WELDING PROCEDURE SPECIFICATION	WELD SOUNDNESS	MA	VISUAL PHYS. TESTS RT (AS APPLICABLE)	100%	ASME SEC IX	ASME SEC IX	OW 482 OF ASME SEC IX	3/2	2.1	2.1	WELDING PROCEDURE APPROVED BY THE AS WELL AS JOINT PARTY (LY JOINTS, SJOI OR EQ)
2.6	WELDER PERFORMANCE QUALIFICATION	WELD SOUNDNESS	MA	DO	100%	ASME SEC IX	ASME SEC IX	OW 484 OF ASME	3/2	2.1	2.1	

Q.P. NO.	PEM/MSE/SQP/03	APPROVED BY	REVIEWED BY	PREPARED BY
REV. NO/DATE	00/8-10-97	PEM	QOS & PEM	PEM
PAGE NO.	5 OF 7	NAME	SIGNATURE	DATE



BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM : BUTTERFLY VALVES
ITEM :

NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CALC. BY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
									1. W 2. V	
2.1.1	WELD FIT-UPS	1. DIMENSIONAL ALIGNMENT	MA	MEAS. VISUAL EXAM	100%	WPS, MFG. DRAWING	WPS, MFG. DRAWING	IN LOG BOOK	2.1	
2.1.2	ROD RUNS	1. SURFACE DEFECTS	MA	PENETRANT TEST	100%	ASTM 165	NO SURFACE DEFECT	INSPECTION REPORT	2.1	
2.1.3	WELD VENTS	1. SURFACE DEFECTS	MA	DOO	100%	ASTM 165	ASME VIII DIV 1	INSPECTION REPORT	2.1	
2.1.4	BUYER VENTS	1. SURFACE DEFECTS	MA	UT/RT	100%	ASME SEC. V	ASME SEC. VIII DIV 1	INSPECTION REPORT	2.1	
2.1.5	BUYER VENTS	1. SURFACE DEFECTS	MA	SR	100%	ASME SEC. V	ASME SEC. VIII DIV 1	INSPECTION REPORT	2.1	
2.1.6	FINAL ASSEMBLY	1. VERIFICATION OF ALL PREVIOUS TEST AND DOCUMENTS	MA	DOO	100%	TECH. SPEC.	TECH. SPEC.	TEST CERT.	2.1	
2.1.7	TEST (HYDRAULIC)	1. BODY TEST 2. DISC STRENGTH 3. SEAT LEAKAGE 4. PERFORMANCE TEST	MA MA MA MA	HYDRO TEST HYDRO TEST (TYPE DOO PERFORM. ANCE	100% 100% 3 TIMES UNDER NO LOAD/FLOW COND. BOTH MANUAL & THROUGH OPERATORS	TECH. SPEC. / REL. STD.	TECH. SPEC. / REL. STD.	TEST CERT.	2.1 2.1 2.1 2.1	

O.P. NO.	PERMISE/ISO/103	NAME	PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY
REV. NO. DATE	00/8-10-97	SIGNATURE	PEM	COS. & PEM	PEM	VENDOR
PAGE NO.	6 OF 7	DATE				

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BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT VENDOR

SYSTEM ITEM

BUTTERFLY VALVES

COMPONENT	CHARACTERISTICS CHECKED	CAT. EGO. RY	TYPE / METHOD OF CHECK	EXTN. OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY		REMARKS
								P	V	
5 TESTING OF ACCESSORIES	6 PROOF OF DESIGN TEST	MA	TESTING	100%	TECH SPEC REL STD	TECH SPEC REL STD	TC	32	32	NOTE: IF CYCLE LIFE TEST ALREADY CONDUCTED, SIMILAR SIZE RANGE & VALVE REPORT SHALL BE LIMITED
		MA	TESTING	1 TYPE	DO.	DO.	TC	32	32	
SHIPPING RELEASE FINAL INSPECTION	1 OVERALL DIMENSIONS	MA	MEASURE	100%	APPD DRG	APPD DRG	APPD DRG	32	32	
	2 DOCUMENTATION VIEW	MA	REVIEW	100%	TECH SPEC APPD DRG	TECH SPEC APPD DRG	TECH SPEC APPD DRG	32	32	
	3 CLEANLINESS	MA	VISUAL	100%	DO.	DO.	DO.	32	32	
	4 NAME PLATE DETAILS	MA	VISUAL	100%	DC	DC	DC	32	32	
	5 STAMPING	MA	STAMPING	100%	DO.	DO.	DO.	32	32	
PAINTING	1 SURFACE PREP	MA	VISUAL MEAS	100%	TECH SPEC	TECH SPEC	INSPECTION REPORT	32	32	
	2 UNIFORMITY & THICKNESS	MA	DO.	100%	DO.	DO.	DO.	32	32	

O.P. NO. _____

REV NO/DATE _____

PAGE NO. _____

PREPARED BY: _____

NAME _____

SIGNATURE _____

DATE _____

REVIEWED BY: _____

NAME _____

SIGNATURE _____

DATE _____

APPROVED BY: _____

NAME _____

SIGNATURE _____

DATE _____

ACCEPTED BY: _____

VENDOR: _____

		QUALITY PLAN			CUSTOMER:		PROJECT:		SPEC. NO. :						
		SHEET 1 OF 3		BIDDER/VENDOR		QP NO. PE-QP-999-100-M004		REV. 00 DT. 31.03.99		SPEC. TITLE					
S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	SYSTEM	POWER CYCLE/ LP VALVES	EXTENT OF CHECK	CATE- GORY	TYPE/METHOD OF CHECK	REFERENCE DOCUMENT	GATE/ GLOBE VALVE	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	SECTION	VOLUME	REMARKS

1.0	MATERIALS	1. PHYS. CHEM. PROPS	MA	PHYS. CHEM. TESTS	ONE/HEAT	APPD. DRG./ TECH. SPEC.	APPD. DRG./ TECH. SPEC.	TEST CERT.	3/2	2	1	CORRELATION REQD. FOR BODY BONNET, SPINDLE - FOR GREY C.I. ONLY PHYS. TEST.
1.1	BODY, BONNET, YOKE, WEDGE/DISC, SPINDLE, BODY SEAT, BACK SEAT, THRUST PLATE	2. HEAT TREATMENT 3. SURFACE DEFECTS	MA MA	REVIEW OF H.T. CHART VISUAL	100% 100%	-DO- MSS-SP-55	-DO- MSS-SP-55	H.T. CHART INSPN. REPORT -DO-	3/2 3/2	2 2	1 1	
1.2	BODY & BONNET FOR RATING 900 & ABOVE (ALSO FOR LOWER RATING IF REQUIRED IN SPEC.)	1. SURFACE DEFECTS 2. SUB-SURFACE DEFECTS	CR CR	PT/MT RT/UT	100% 100%	ANSI B16.34 AND TECH. SPEC. ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC. ANSI B16.34 AND TECH. SPEC.	-DO- -DO-	3/2 3/2	2,1 -	-	FILM REVIEW BY BHEL
1.3	ACTUATORS 1. ELECTRIC ACTUATORS	1. TORQUE TESTING & SETTING OF TORQUE SWITCH 2. TRAVEL/STROKE 3. TRAVEL TIME 4. OPERATION OF LIMIT SWITCH 5. MANUAL OPERATION THROUGH HAND WHEEL 6. OPERATION TEST WITH POWER SUPPLY VARIATION ENERGISES TO OPEN/CLOSE 7. IR, HV, IR 8. DEGREE OF PROTECTION	MA MA MA MA MA MA MA MA	{ MECH., ELEC. TESTS { { { { { { { WATER, DUST TEST	100% 1/TYPE	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334 TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	APPD. DRG./ DATA SHEET/ IS:9334 APPD. DRG./ DATA SHEET/ IS:9334	INSPN. REPORT 3RD PARTY TEST CERT.	3 3	2,1 -	1* 2,1	*BHEL TO WITNESS IF QTY. MORE THAN 10/ TYPE

BHEL	PARTICULARS	BIDDER/VENDOR
	NAME	
	SIGNATURE	
	DATE	
		BIDDER'S/ VENDOR'S COMPANY SEAL

		QUALITY PLAN				CUSTOMER:		PROJECT:		SPEC. NO. :				
		SHEET 3 OF 3		CHARACTERISTICS CHECKED		SYSTEM		POWER CYCLE/ LP VALVES		REV. 00 DT.31.03.99				
COMPONENT/ OPERATION		CATE- GORY		TYPE/METHOD OF CHECK		EXTENT OF CHECK		ITEM: GATE/ GLOBE VALVE		SPEC. TITLE				
S.NO.								REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	SECTION	VOLUME	REMARKS
											P	W	V	

5.2	SEAT & BACK SEAT FOR MOTORISED/ PNEU. VALVES WITH ACTUATOR OPERATION AL TESTING	1. LEAK TIGHTNESS OF SEAT	CR	HYDRUALIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2,1	-		
5.3	1. MANUALLY OPERATED VALVES	1. SMOOTH & FULL OPENING AND CLOSING	CR	MANUAL	100%	TECH. SPEC.	SMOOTH OPERATION OF VALVES & CLEAR BORE	INSPN. REPORT	3/2	2,1	-		
	2. MOTOR /PNEU OPERATED VALVES	1. ASCENDING& DESCENDING LIFT CHARACTERISTIC	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	APP. DRG./ TECH. SPEC./ IS:9334	INSPN. REPORT	3/2	2,1	-		
		2. LIMIT/TORQUE SWITCH SETTING FOR OPENING AND CLOSING TIME	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	TECH. SPEC./ APPD.DRG	INSP. REPORT	3/2	2,1	-		
6.0	COMPLETE VALVES END CONNECTION DETAILS	1. OVERALL DIMENSION 1. DIMENSIONS	MA	MEAS	SAMPLE 100%	APPD.DRG	APP.DRG.	-DO-	3/2	2,1	-		
7.0		2. SURFACE DEFECTS FOR B.W. ENDS	CR	PT	100%	ASTME:165	RELV STD NO DEFECTS	TEST CERT.	3/2	2	1		
8.0	FINAL INSPECTION	1. CLEANLINESS & COMPLETENESS	MA	VISUAL	100%	APPD. DRG./ TECH. SPEC.	APPD. DRG./ TECH. SPEC	INSPN. REPORT	3/2	-	2,1		
9.0	PAINTING	1. SURFACE PREPARATION 2. UNIFORMITY & THICKNESS	MI	VISUAL	100%	TECH. SPEC.	TECH. SPEC.	INSPN. REPORT	3/2	-	2,1		
		AS PER BHEL TECH. SPEC	MI	MEASUREMENT	100%	-DO-	-DO-	INSPN. REPORT	3/2	2	1		
10.0	PACKING		MA	VISUAL	100%	AS PER BHEL TECH. SPEC.	AS PER BHEL TECH. SPEC	-DO-	3/2	-	2,1		

ABBREVIATIONS

CR = CRITICAL CHARACTERISTIC

MA = MAJOR CHARACTERISTIC

MI = MINOR CHARACTERISTIC

P

= PERFORMED BY

= PURCHASER (BHEL)2

W

= WITNESSED BY

= VENDOR

V = VERIFIED BY

3 = SUB VENDOR OF THE VENDOR

BHEL	PARTICULARS	BIDDER/VENDOR
	NAME	
	SIGNATURE	
	DATE	
		BIDDER'S/ VENDOR'S COMPANY SEAL



QUALITY PLAN				CUSTOMER :		PROJECT :		SPEC. NO				
SHEET 1 OF 3				BIDDER/VENDOR		QP NO. PE-QP-999-100-MO41		REV.00 DT. 31.03.99		VOLUME: II-B		
SYSTEM:				ITEM: PIPES & FITTINGS		REFERENCE DOCUMENT		ACCEPTANCE NORMS		SECTION D		
S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	APPD. DATA SHEET/ TECH. SPEC.	APPD. DATA SHEET/ TECH. SPEC.	MANUFAC- TURING DRG.	FORMAT OF RECORD	AGENCY	REMARKS	
										P	W	V
1.0.0	MATERIAL CONTROL											
1.1.0	PIPES (MILL MADE)	1. PHY., CHEM. PROPS, DIMENSIONS, SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE), LEAK TIGHTNESS	MA	PHY. CHEM. TESTS MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART HYDRO TEST	TECH. SPEC., IS:4711	APPD. DATA SHEET/ TECH. SPEC.	APPD. DATA SHEET/ TECH. SPEC.	MANUFAC- TURING DRG.	MFR.TC/ LAB REPORT	3	2,1	SAMPLE IDENTIFICATION BY BHEL
1.2.0	FITTINGS	1. PHY. CHEM. PROP., 2. DIMNS., SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE)	MA	PHY., CHEM. TESTS MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART	1/HEAT 100%	-DO- -DO-	-DO- -DO-		-DO- -DO-	3/2 3/2	2,1 2,1	-DO-
1.3.0	PLATE FOR FLANGES, FABRICATED PIPING AND FORGINGS FOR FLANGES	1. PHY. CHEM. PROP., 2. DIMNS., SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE)	MA	PHY., CHEM. TESTS MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART	1/CAST 100%	-DO- -DO-	-DO- -DO-		-DO- -DO-	3 3	2,1 2,1	-DO-
2.0.0	IN PROCESS CONTROL											
2.1.0	PIPES, FITTINGS, FLANGES - MACHINING, BENDING	1. DIMNS. INCLUDING THINNING, OVALITY, FINISH, WRINKLES ETC.	MA	MEASUREMENTS, VISUAL EXAM.	100%	MANUFAC- TURING DRG.	MANUFAC- TURING DRG.		I. R	3/2	2,1	
2.2.0	WELDING PROCEDURE SPECIFICATION	1. CORRECTNESS	MA	EXAM	100%	IS:7307/ ASME - IX	IS:7307/ ASME - IX		FORMAT OF IS:7307/ ASME - IX	3/2	2,1	
2.3.0	PROCEDURE QUALIFICATION AND WELDER'S QUALIFICATION	1. WELD SOUNDNESS	MA	PHY. TESTS	ASME IX IS:7310 IS:7307	IS:7310/ ASME - IX	IS:7310/ ASME - IX		FORMAT OF IS:7310/ ASME - IX	3/2	2,1	
2.4.0	WELD FIT-UPS	1. DIMNS.,	MA	MEASUREMENT.	100 %	W.P.S.	W.P.S.		I.R	3/2	2	1

BHEL		BIDDER/VENDOR	
PARTICULARS	NAME	SIGNATURE	DATE
BIDDER'S/VENDOR'S COMPANY SEAL			

QUALITY PLAN										CUSTOMER :		PROJECT :		SPEC. NO			
SHEET 2 OF 3										BIDDER/VENDOR		OP NO./P.E-QP-999-100-MO41		REV/00 DT. 31.03.99		VOLUME: II-B	
SYSTEM:										ITEM: PIPES & FITTINGS		SECTION D					
S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P W V	REMARKS							
2.5.0	WELDS	ALIGNMENT, ORIENTATION		VISUAL		APPD. DRGS.	APPD. DRGS.										
	A) BUTT WELDS WITH JOINT EFFICIENCY OF 1.0 & 0.9																
	i) ROOT RUN	i) WELD DEFECTS	MA	PENETRANT TEST	100%	IS-3658/ ASTM E 165	ASME VIII DIV.I ASME B 31.1	INSPN, REPORT	3/2	2	1						
	ii) FINAL RUN	i) WELD DEFECTS	MA	-DO- RADIOGRAPHY TEST	100%	-DO- ASME B 31.1	-DO- ASME B 31.1	-DO- -DO-	3/2	2/1	-	2/1	FILMS TO BE SHOWN TO BHEL FOR APPROVAL				
3.0.0	B) OTHER BUTT WELDS WITH JOINT EFF. LESS THAN 0.9	1. WELD DEFECTS (FOR ROOT RUN & FINAL RUN)	MA	PENETRANT TEST	100%	IS-3658/ ASTM E 165	ASME B 31.1	INSPN, REPORT	3/2	2.1	-						
	COMPLETE PIPE WORK & PIPES INCLUDING GALVANIZED/ RUBBER LINED PIPING (BEFORE GALVANIZING/ RUBBER LINING)	1. WORKMANSHIP AND FINISH, DIMNS., ORIENTATION, LEAK TIGHTNESS	CR	MEAS. VISUAL, HYDRO TEST AT 1.5 X DESIGN PRESS.	100%	APPD. DRGS.	APPD. DRGS., NO LEAKAGE	I.R.	3/2	2.1	-						
3.1.0	COMPLETE PIPE WORK (DULY GALVANIZED AS APPLICABLE)	1. FREEDOM FROM SURFACE DEFECTS	MA	VISUAL	100%	IS-4736/ IS 2629 & TECH. SPECN.	IS-4736/ IS 2629 & TECH. SPECN.	INSPN, REPORT	3/2	2.1	-						
	2. UNIFORMITY OF COATING		MA	DIP TEST		SAMPLING AS PER IS	IS 2633 & TECH.	-DO-	3/2	2.1	-						
BHEL.										PARTICULARS		BIDDER/VENDOR					
										NAME							
										SIGNATURE							
										DATE							
										BIDDER'S/VENDOR'S COMPANY SEAL							



QUALITY PLAN				CUSTOMER :		PROJECT :		SPEC. NO			
SHEET 3 OF 3				BIDDER/VENDOR		QP NO. PE-QP-999-100-MO41		REV.00 DT. 31.03.99		VOLUME: II-B	
CHARACTERISTICS CHECKED				SYSTEM:		ITEM: PIPES & FITTINGS		SECTION D		REMARKS	
S.NO.	COMPONENT/ OPERATION	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	P	W	V
3.2.0	COMPLETE PIPE WORK (RUBBER LINING AS APPLICABLE)										
	3. MASS OF ZINC COATING	MA	STRIP TEST	-DO-	IS 4736/ IS 6745 & TECH. SPECN.	IS 4736 & TECH. SPECN.	-DO-	3/2	2.1	-	
	5. ADHESION	MA	ADHESION TEST	-DO-	IS-2629/ IS 4736 & TECH. SPECN.	IS-2629/ IS 4736 & TECH. SPECN.	-DO-	3/2	2.1	-	
----- AS PER QUALITY PLAN FOR RUBBER LINING -----											
4.0.0	PAINTING AND PACKING										
	1. SURFACE PREPARATION, DFT, NO. OF COATS, SOUNDNESS OF PACKING, MARKING ETC.	MA	VISUAL EXAM, MEASUREMENT	100%	APPD. PROCEDURE	APPD. PROCEDURE	I.R. MFRS CHECK LIST	3/2	-	2.1	

BHEL		PARTICULARS		BIDDER/VENDOR	
		NAME			
		SIGNATURE			
		DATE			
				BIDDER'S/ VENDOR'S COMPANY SEAL	

		MANUFACTURERS NAME & ADDRESS (AS PER BHEL APPROVED VENDOR LIST)		STANDARD QUALITY PLAN				PROJECT PACKAGE		REMARKS	
		ITEM: Chain Pulley Block With Trolley		QP NO REV DATE PAGE	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	PROJECT No CONTRACTOR			
Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	7	8	9	AGENCY		
1	2	3	4	5	6	7	8	9	M	C	N
RAW MATERIAL & B/OUT ITEMS:											
1	HOOKS	DIMENSIONS CHEMICAL COMPOSITION IDENTIFICATION & CORRELATION WITH TC	MA MI MA	MEASUREMENT LAB ANALYSER VERIFICATION		IS 8610 GR M/ P DRAWING	DRAWING & SPECIFICATION	T.C.	P	-	-
1	LOAD CHAIN	DIMENSIONS BREAKING STRENGTH		MEASUREMENT TENSILE TEST	100%	IS 6216	IS 6216	MFR'S TC	P	-	-
1	RAW MATL FOR GEAR/RATCHET PAWL/RATCHET WHEEL	CHEMICAL COMPOSITION	MA	LAB ANALYSIS	ONE SAMPLE PER LOT	SPECS AS PER APPD. DRG.	RELEVANT STANDARD	TC	P	-	-
1	LOAD CHAIN WHEELS	TENSILE STRENGTH	MA	TENSILE TEST	ONE SAMPLE PER LOT	SPECS AS PER APPD. DRG.	RELEVANT STANDARD	TC	P	-	-
		LEGENDS		* RECORDS IDENTIFIED WITH 'TICK' () SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION ** M: MANUFACTURER/SUBCONTRACTOR C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N: CUSTOMER INDICATE 'P' PERFORM "W" WITNESS AND "V" VERIFICATION AS APPROPRIATE "CHP" CUSTOMER SHALL IDENTIFY IN COLUMN "N"							
MANUFACTURER/ SUB CONTRACTOR		CONTRACTOR	REVIEWED BY								
SIGNATURE			NAME & SIGN OF APPROVING AUTHORITY & SEAL								

MANUFACTURERS NAME & ADDRESS (AS PER BHEL APPROVED VENDOR LIST)			STANDARD QUALITY PLAN					PROJECT PACKAGE PROJECT No CONTRACTOR			
ITEM: Chain Pulley Block With Trolley			QP NO REV DATE	0 20.02.2001	PAGE 2 of 3		ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS	
Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	8	9	D+ M C N	10	11
1	2	3	4	5	6	7	8	9	D+ M C N	10	11
2	PROCESS 2 HOOKS	PROOF LOAD DPT AFTER PROOF LOAD	MA MA	LOAD TEST	100% 100%	IS 8610 ASTM 709	IS 8610 ASTM 709	IR IR	P P	W W	
2	RACHET PAWL/RACHET WHEEL	HARDNESS SURFACE CRACKES	MA MA	HARDNESS TESTER DPT	100% 100%	IS : 1832 ASTME	IS : 3832	IR	P P	W W	
2	LOAD CHAINS	PROOF - LOAD	MA	LOAD TEST	100%	IS : 6216	IS:6216	MFRS	P		
3	FINAL INSPECTION 3 COMPLETE ASSEMBLY	PROOF LOAD TEST OPERATIONAL EFFORT HEIGHT OF LIFT SWIVELLING OF HOOK	CR MA MA MA	LOAD TEST LOAD TEST MEASUREMENT VISUAL	100% RANDOM 100% 100%	IS: 3832 IS: 3832 IS: 3832 IS: 3832	IS: 3832 IS: 3832 IS: 3832 IS: 3832	IR IR IR IR	P P P P	W W W W	
			LEGENDS								
			* RECORDS IDENTIFIED WITH 'TICK' () SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION								
			** M: MANUFACTURER/SUBCONTRACTOR								
MANUFACTURER/ SUB CONTRACTOR			CONTRACTOR								
SIGNATURE							REVIEWED BY				
							NAME & SIGN OF APPROVING AUTHORITY & SEAL				

		MANUFACTURERS NAME & ADDRESS (AS PER BHEL APPROVED VENDOR LIST)		STANDARD QUALITY PLAN				PROJECT PACKAGE			
		ITEM: Chain Pulley Block With Trolley		QUANTUM OF CHECK	TYPE OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS	
Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	3	5	6	7	8	9	10	11
1			4								
3	PAINTING	CLEANED SHADE OF PAINT GOLDEN YELLOW	MA								
3	NAME PLATE	VERIFICATION	MI			100%	PR				
3	PACKING	VERIFICATION	MI			100%	PR				
LEGENDS * RECORDS IDENTIFIED WITH 'TICK' () SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION ** M: MANUFACTURER/SUBCONTRACTOR C: CONTRACTOR NOMINATED INSPECTION AGENCY (BHEL) INDICATE 'P' PERFORM 'W' WITNESS AND 'V' VERIFICATION AS APPROPRIATE "CHIP" NTPC SHALL IDENTIFY IN COLUMN "N"											
MANUFACTURER/ SUB CONTRACTOR		CONTRACTOR						REVIEWED BY			
SIGNATURE								NAME & SIGN OF APPROVING AUTHORITY & SEAL			

PROJECT VENDOR										SYSTEM ITEM SUBMERSIBLE PUMP SET									
BH RAT. HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT										STANDARD QUALITY PLAN									
S. NO.	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CAUSE BY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS									
1	RAW MATERIAL AND BOUGHT OUT CONTROL																		
2	PUMP BALLS, DISCHARGE CASTING, SUCTION CASTING MOTOR START BRG MOUNTING	1. PHYSICAL CHEM PROPS	CO	PHYS CHEM ANAL	1 MEAT BATCH	APPD. DRUGAPPO DATA SHEET	APPD. DRUGAPPO DATA SHEET	LAB REPORT	32	2.1 COMPLIANCE TC FOR C.I.E.M.S. AND TC FOR OTHERS									
3	IMPELLER	1. PHYSICAL CHEM PROPS	CO	DC	DO	50	50	DO	32	2.1 COMPLIANCE TC									
4	BEARING SLEEVE, BEARING RINGS, COUPLING BEARING BUSHES	1. PHYSICAL CHEM PROPS	MA	DC	DO	50	50	DO	32	2.1 COMPLIANCE TC									
5	HEAT TREATMENT OF CASTINGS, APPLICATION OF CASTINGS TO BE ANALYZED	1. HEAT CYCLE	MA	VER OF 1 CHARTS	1. MEAT BATCH	DO	DO	CORRELATED SMART CHARTS	32	2.1 COMPLIANCE TC									
6	BACKGROUNDS FOR PUMP AND MOTOR SHAFTS	1. PHYSICAL CHEM PROPS	CO	PHYS CHEM ANAL	1. CAST OF 180°	DO	DO	LAB REPORT	32	2.1 IDENTIFICATION BY BH&L FOR C.I.E.M.S.									
7	SHAFTS	2. DIMENSIONS	MA	VE-3	100%	VER DPO	VER DPO	VER TC	32	2.1 CASES TO BE OF APPROVED, WORKS ONLY									
8	CABLE	3. INTERNAL DEFECTS, PERMANENT ABOVE DIA. SHAFT	CO	1	100%	VER DPO	VER DPO	VER TC	32	2.1 CASES TO BE OF APPROVED, WORKS ONLY									
9		1. DIMENSIONS	MA	DC	100%	VER DPO	VER DPO	VER TC	32	2.1 CASES TO BE OF APPROVED, WORKS ONLY									
D P NO		REM/ISE/SOP/05		REVIEWED BY		APPROVED BY		ACCEPTED BY											
REV NO/DATE		00/8-10-97		PEM		PEM		VENDOR											
PAGE NO		1 OF 4		NAME		SIGNATURE		NAME											
								SIGN											
								DATE											

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STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM: SUBMERSIBLE PUMP SET

VENDOR	CHARACTERISTICS CHECKED	CAT. EGY. REV.	TYPE / METHOD / WORK	T. T. CHECK	REFERENCE DOCUMENTS	ACCEPTANCE CRITERIA	FORMAT OF RECORD	REMARKS	ACCEPTED BY	
									NAME	DATE
10.11	MAKE BEARING SURFACE FINISH	MA	SUAL C. N.	100%	MFR. DPG	MFR. DPG	MFR. TC		APPROX. 1.141E	
PROCESS CONTROL	SUAL DEFECTS	MA	SUAL	100%	100%	N. M. M. J. 1.141E	LOG BOOK			
	DIMENSIONS	MA	MENS	100%	100%	1.141E	100			
	LEAK - GATE	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	SURFACE DEFECT	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
SUB-ASSEMBLY: ASSEMBLY CONTROL	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	MA	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
10.11	MAKE BEARING SURFACE FINISH	MA	SUAL C. N.	100%	MFR. DPG	MFR. DPG	MFR. TC		APPROX. 1.141E	
PROCESS CONTROL	SUAL DEFECTS	MA	SUAL	100%	100%	N. M. M. J. 1.141E	LOG BOOK			
	DIMENSIONS	MA	MENS	100%	100%	1.141E	100			
	LEAK - GATE	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	SURFACE DEFECT	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
SUB-ASSEMBLY: ASSEMBLY CONTROL	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	MA	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
10.11	MAKE BEARING SURFACE FINISH	MA	SUAL C. N.	100%	MFR. DPG	MFR. DPG	MFR. TC		APPROX. 1.141E	
PROCESS CONTROL	SUAL DEFECTS	MA	SUAL	100%	100%	N. M. M. J. 1.141E	LOG BOOK			
	DIMENSIONS	MA	MENS	100%	100%	1.141E	100			
	LEAK - GATE	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	SURFACE DEFECT	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
SUB-ASSEMBLY: ASSEMBLY CONTROL	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	MA	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
10.11	MAKE BEARING SURFACE FINISH	MA	SUAL C. N.	100%	MFR. DPG	MFR. DPG	MFR. TC		APPROX. 1.141E	
PROCESS CONTROL	SUAL DEFECTS	MA	SUAL	100%	100%	N. M. M. J. 1.141E	LOG BOOK			
	DIMENSIONS	MA	MENS	100%	100%	1.141E	100			
	LEAK - GATE	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	SURFACE DEFECT	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
SUB-ASSEMBLY: ASSEMBLY CONTROL	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	MA	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
10.11	MAKE BEARING SURFACE FINISH	MA	SUAL C. N.	100%	MFR. DPG	MFR. DPG	MFR. TC		APPROX. 1.141E	
PROCESS CONTROL	SUAL DEFECTS	MA	SUAL	100%	100%	N. M. M. J. 1.141E	LOG BOOK			
	DIMENSIONS	MA	MENS	100%	100%	1.141E	100			
	LEAK - GATE	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	SURFACE DEFECT	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
SUB-ASSEMBLY: ASSEMBLY CONTROL	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	CP	1.141E	100%	1.141E	1.141E	1.141E		1.141E	
	1.141E	MA	1.141E	100%	1.141E	1.141E	1.141E		1.141E	

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT
VENDOR

SYSTEM
ITEM

SUBMERSIBLE PUMPS SET

S. NO	COMPONENT OPERATION	CHARACTERISTICS CHECKED	QA. TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE CRITERIA	DATE OF RECORD	AGE IN P. VI	REMARKS
4.3	STRIPDOWN AFTER PERFORMANCE TEST	1. UNIFORM WEAR, TEAR & BREAKAGE	VISUAL EXAM. AFTER STRIPPING	100%	TECH. SPEC	NO UNIFORM WEAR, TEAR & BREAKAGE	30		
4.4	COMPLETE PUMP SET UNIT	1. COMPLETENESS CORRECTNESS WORKMANSHIP AND FINISH OVERALL DIMENSIONS	MA VISUAL EXAM. MEAS	100%	APPD. GA. DRG	APPD. GA. DRG	40		
4.5	COMPLETION OF ALL STAGES	1. COMPLETION	MA VERIF. OF IRS TCS	100%	TECH. SPEC. APPD. DRG. APPD. SHEETS	TECH. SPEC. APPD. DRG. APPD. SHEETS	50		
4.6	PARTING	1. SURFACE PREP	VISUAL MEAS	100%	DOO	DOO	30		
4.7	PACKING	2. UNIFORMITY & FINISH SOUNDNESS AESTHETIC	DC VISUAL	100%	WPR STAND	WPR STD	40		

O.P. NO.	REV. NO/DATE	PAGE NO.	APPROVED BY		ACCEPTED BY	
			NAME	SIGNATURE	NAME	SIGNATURE
			DATE	DATE	DATE	DATE

BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT									
SYSTEM REM SUBMERSIBLE PUMP SET									
STANDARD QUALITY PLAN									
COMPONENT	CHARACTERISTICS REQUIRED	QTY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	FORMAT OF RECORD	AGENCY	REMARKS	
1. MOTOR & MOTOR CONTROL	1.1. STATIC DYNAMIC BALANCING	CP	100%	ISO 1846	IS 4426:3	IR	3/2	WITNESSING C.N. FOR RATING 5 KW & ABOVE	
2. PUMP ASSEMBLY	2.1. COMPLETION TEST CORRECTION	ML	100%	MEG DRG	MEG DRG	DO	3/2	DO	
3. ELECTRICAL WIRING	3.1. WIRING DIAGRAM	ML	100%	MEG DRG	MEG DRG	DO	3/2	DO	
4. FINAL INSPECTION, TESTS PACKAGING, DISPATCH CONTROL	4.1. FINAL INSPECTION	CP	100%	TECH. SPEC. 3680	IS 4426:3	PERFORMANCE TEST RECORD	3/2	MINIMUM 12 HRS. RUNNING ON HEAD TO MINIMUM 10% ON COVER & PUMP OPERATING RANGE AS PER 1.2.5-EE7 SHALL BE 12 HRS.	
5. MOTOR & MOTOR CONTROL	5.1. MOTOR & MOTOR CONTROL	CP	100%	MEG DRG	MEG DRG	DO	3/2	DO	
6. PUMP ASSEMBLY	6.1. PUMP ASSEMBLY	ML	100%	MEG DRG	MEG DRG	DO	3/2	DO	
7. ELECTRICAL WIRING	7.1. ELECTRICAL WIRING	ML	100%	MEG DRG	MEG DRG	DO	3/2	DO	
8. FINAL INSPECTION, TESTS PACKAGING, DISPATCH CONTROL	8.1. FINAL INSPECTION	CP	100%	TECH. SPEC. 3680	IS 4426:3	PERFORMANCE TEST RECORD	3/2	MINIMUM 12 HRS. RUNNING ON HEAD TO MINIMUM 10% ON COVER & PUMP OPERATING RANGE AS PER 1.2.5-EE7 SHALL BE 12 HRS.	
O/N/C		PENDING SUPPLIES		REVIEWED BY		APPROVED BY		ACCEPTED BY	
RF / NO DATE		NAME		CQS & PEM		PEM		VENDOR	
PAGE NO.		SIGNATURE		NAME		SIGN		DATE	
1 OF 4		DATE		NAME		SIGN		DATE	

		QUALITY PLAN			CUSTOMER:		PROJECT:		SPEC. NO. :		
					BIDDER/VENDOR		QP NO. PE-QP-999-100-M004		REV. 00 DT. 31.03.99		SPEC. TITLE
S.NO.	COMPONENT/ OPERATION	SHEET 1 OF 3	CHARACTERISTICS CHECKED	SYSTEM	POWER CYCLE/ LP VALVES	CATE- GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	GATE/ GLOBE VALVE		REMARKS
									REFERENCE DOCUMENT	ACCEPTANCE NORMS	
									P	W	V

1.0	MATERIALS	1. PHYS. CHEM. PROPS	MA	PHYS. CHEM. TESTS	ONE/HEAT	APPD. DRG./ TECH. SPEC.	APPD. DRG./ TECH. SPEC.	TEST CERT.	3/2	2	1	CORRELATION REQD. FOR BODY BONNET, SPINDLE - FOR GREY C.I. ONLY PHYS. TEST.
1.1	BODY, BONNET, YOKE, WEDGE/DISC, SPINDLE, BODY SEAT, BACK SEAT, THRUST PLATE	1. HEAT TREATMENT	MA	REVIEW OF H.T. CHART VISUAL	100%	-DO-	-DO-	H.T. CHART	3/2	2	1	
		3. SURFACE DEFECTS	MA		100%	MSS-SP-55	MSS-SP-55	INSPN. REPORT -DO-	3/2	2	1	
1.2	BODY & BONNET FOR RATING 900 & ABOVE (ALSO FOR LOWER RATING IF REQUIRED IN SPEC.)	1. SURFACE DEFECTS	CR	PT/MT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.		3/2	2,1	-	
		2. SUB-SURFACE DEFECTS	CR	RT/UT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	FILM REVIEW BY BHEL
1.3	ACTUATORS	1. TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	MECH., ELEC. TESTS	100%	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	INSPN. REPORT	3	2,1	1*	*BHEL TO WITNESS IF QTY. MORE THAN 10/TYPER
		2. TRAVEL/STROKE	MA									
		3. TRAVEL TIME	MA									
		4. OPERATION OF LIMIT SWITCH	MA									
		5. MANUAL OPERATION THROUGH HAND WHEEL	MA									
		6. OPERATION TEST WITH POWER SUPPLY VARIATION ENERGISES TO OPEN/CLOSE	MA									
		7. IR, HV, IR	MA	WATER, DUST TEST	1/TYPER	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	3RD PARTY TEST CERT.	3	-	2,1	
		8. DEGREE OF PROTECTION	MA									

BHEL	PARTICULARS		BIDDER/VENDOR
	NAME		
	SIGNATURE		
	DATE		
			BIDDER'S/ VENDOR'S COMPANY SEAL

		QUALITY PLAN				CUSTOMER:		PROJECT:		SPEC. NO.:	
BIDDER/VENDOR		SYSTEM		POWER CYCLE/ LP VALVES		ITEM:		GATE/ GLOBE VALVE		SPEC. TITLE	
SHEET 2 OF 3		CHARACTERISTICS CHECKED		GATE TYPE/METHOD OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE CRITERIA		SECTION	
S.NO. COMPONENT/ OPERATION		GATE GORY		OF CHECK		OF CHECK		FORMAT OF RECORD		AGENCY V	
REMARKS		REMARKS		REMARKS		REMARKS		REMARKS		REMARKS	

2.0	2. PNEUMATIC ACTUATORS	1. LEAK TIGHTNESS	CR	PNEUMATIC TEST AT 1.2 X DESIGN	100%	APPD. DATA SHEET/MFG. STD.	NO LEAKAGE	INSPN. REPORT	3	2.1	1*	*BHEL TO WITNESS IF QTY. MORE THAN 10/ TYPE
3.0	3.0 IN-PROCESS INSPECTION OF ALL COMPONENTS	2. ACCURACY	CR	CALIBRATION	100%	-DO-	APPD. DATA SHEET/MFG. STD.	CALIBRATION REPORT	3	2.1	1*	
3.1	3.1 WEDGE/DISC, BODY SEAT RING, BACK SEAT, SPINDLE, THRUST PLATE	3. SIMULATION (OPERATION, AIR TO OPEN/CLOSE)	CR	OPERATION AT RATED PRESSURE P.T	100%	-DO-	-DO-	INSPN. REPORT	3	2.1	1*	
3.2	3.2 WEDGE/DISC, BODY SEAT RING, BACK SEAT, SPINDLE, THRUST PLATE	1. SURFACE DEFECTS	CR	P.T.	100%	ASTME.165 & TECH.SPEC.	ANSI B16.34 & TECH.SPEC.	-DO-	3/2	2.1	2.1	FOR 900 CLASS & ABOVE TO BE WITNESSED BY BHEL
3.3	3.3 WEDGE/DISC, BODY SEAT RING, BACK SEAT, SPINDLE AND BACK SEAT	1. DIMENSIONS, WORKMANSHIP AND FINISH	MA	MEAS., VISUAL TESTING	100%	MFG.DRG.	MFG.DRG.	LOG BOOK	3/2	-	-	
3.4	3.4 WEDGE/DISC, BODY SEAT RING, BACK SEAT, SPINDLE AND BACK SEAT	1. HARDNESS	MA	TESTING	100%	APP.DRG.	APP.DRG./ ANSI B16.34	TEST CERT.	3/2	-	2.1	
4.0	4.0 ASSEMBLY	1. LAPPING	CR	BLUE MATCHING	100%	ANSI B16.34 AND TECH. SPEC./	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2.1	
5.0	5.0 TESTING BODY, SEAT, BACK SEAT	1. LEAK TIGHTNESS OF BODY	CR	HYDRAULIC TEST	100%	UNIFORM METAL TO METAL CONTACT	INSPN. REPORT	3/2	-	2.1	2.1	
5.1	5.1 TESTING BODY, SEAT, BACK SEAT	2. LEAK TIGHTNESS OF BACK SEAT AND SEAT	CR	-DO-	100%	APPD. DRG.	APPD. DRG.	-DO-	3/2	2.1	2.1	
		3. VALVE LIFT	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2.1	2.1	
		1. DIMENSIONS	MA	MEAS.	100%	APPD. DRG.	APPD. DRG.	-DO-	3/2	2.1	2.1	
		2. WEAR TRAVEL	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2.1	2.1	
		3. LEAK TIGHTNESS OF SEAT	CR	PNEUMATIC TEST	100%	-DO-	-DO-	-DO-	3/2	2.1	2.1	

BHEL		PARTICULARS		BIDDER/VENDOR	
NAME		SIGNATURE		DATE	
BIDDER'S/ VENDOR'S COMPANY SEAL		BIDDER'S/ VENDOR'S COMPANY SEAL		BIDDER'S/ VENDOR'S COMPANY SEAL	

		QUALITY PLAN		CUSTOMER:		PROJECT:		SPEC. NO. :					
				BIDDER/VENDOR		QP NO. PE-QP-999-100-M004		REV. 00 DT. 31.03.99		SPEC. TITLE			
S.NO.	COMPONENT/ OPERATION	SHEET 3 OF 3	CHARACTERISTICS CHECKED	SYSTEM	POWER CYCLE/ LP VALVES	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	SECTION	VOLUME	REMARKS

5.2	SEAT & BACK SEAT FOR MOTORISED/ PNEU. VALVES WITH ACTUATOR OPERATIONAL TESTING	1. LEAK TIGHTNESS OF SEAT	CR	HYDRUALIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2.1	-	
5.3	1. MANUALLY OPERATED VALVES	1. SMOOTH & FULL OPENING AND CLOSING	CR	MANUAL	100%	TECH. SPEC.	SMOOTH OPERATION OF VALVES & CLEAR BORE	INSPN. REPORT	3/2	2.1	-	
	2. MOTOR /PNEU OPERATED VALVES	1. ASCENDING& DESCENDING LIFT CHARACTERISTIC 2. LIMIT/TORQUE	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	APP. DRG./ TECH. SPEC./ IS:9334	INSPN. REPORT	3/2	2.1	-	
6.0	COMPLETE VALVES END CONNECTION DETAILS	SWITCH SETTING FOR OPENING AND CLOSING TIME	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	APPD. DRG.	INSP. REPORT	3/2	2.1	-	
7.0		1. OVERALL DIMENSION 1. DIMENSIONS	MA	MEAS	SAMPLE 100%	APPD. DRG. / RELV. STD	APPD. DRG. / RELV. STD	-DO-	3/2	2.1	-	
8.0	FINAL INSPECTION	2. SURFACE DEFECTS FOR B.W. ENDS 1. CLEANLINESS & COMPLETENESS	CR	PT	100%	ASTME:165	NO DEFECTS	TEST CERT.	3/2	2	1	
9.0	PAINTING	1. SURFACE PREPARATION 2. UNIFORMITY & THICKNESS	MA	VISUAL	100%	APPD. DRG./ TECH. SPEC.	APPD. DRG./ TECH. SPEC.	INSPN. REPORT	3/2	-	2.1	
10.0	PACKING	AS PER BHEL TECH. SPEC	MI	MEASUREMENT	100%	TECH. SPEC.	TECH. SPEC.	INSPN. REPORT	3/2	-	2.1	
			MA	VISUAL	100%	-DO-	-DO-	-DO-	3/2	2	1	
			MA	VISUAL	100%	AS PER BHEL TECH. SPEC.	AS PER BHEL TECH. SPEC.	-DO-	3/2	-	2.1	

ABBREVIATIONS
 CR = CRITICAL CHARACTERISTIC P = PERFORMED BY W = WITNESSED BY V = VERIFIED BY
 MA = MAJOR CHARACTERISTIC 1 = PURCHASER (BHEL)2 = VENDOR 3 = SUB VENDOR OF THE VENDOR
 MI = MINOR CHARACTERISTIC

BHEL	PARTICULARS	BIDDER/VENDOR
	NAME	
	SIGNATURE	
	DATE	
		BIDDER'S/ VENDOR'S COMPANY SEAL

SECTION D2

STANDARD TECHNICAL SPECIFICATION (ELECTRICAL)

STANDARD QUALITY PLANS

QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :							
BIDDER/ VENDOR		STANDARD QP NO. : PE-QP-999-558-E001, REV.0		SPECIFICATION TITLE :									
SHEET 2 OF 5		SYSTEM		ITEM:ILLUMINATION		DOC. NO. :							
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS			
									P	W	V		
1	2	3	4	5	6	7	8	9	10	11			
3.0	LIGHTING TRANSFORMER	6. TYPE TEST	MA	ELECT	1/RATING	IS- 8623 (PART-1)/ IEC-439-1/ IS:60947/ APPD DATA SHEET	IS- 8623 (PART-1)/ IEC-439-1/ IS:60947/ APPD DATA SHEET	TEST REPORT	3/2	-	1**	** Refer note 3 & 4	
		1. ROUTINE TEST											
		a) TYPE/ RATING	CR	VISUAL	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		b) WIND. RESISTANC	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		c) V. RATIO / VECTOR	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		d) Z VOLT/ Z SCKT	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		e) LOAD LOSS/ CURRENT	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		f) NO LOAD LOSS	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		g) SOURCE WITHSTAND	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
		h) INDUCED O/V	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2.1	-		
4.0	CONDUITS	2. TYPE TEST	MA	TEST	1/RATING	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	TEST REPORT	3/2	-	1**	** Refer note 3 & 4	
		1.MATERIAL	MA	VISUAL,MECH, & CHEMICAL	APPD DATASHEET/ IS 9537	IS-9537	IS-9537	INSPT. REPORT	3	2	1		
		2.DIMENSIONS	MA	MEASUREMENT	APPD DATASHEET/ IS 9537	IS-9537	IS-9537	INSPT. REPORT	3	2	1		
		3. MECH. PROPERTIES											
		a) BENDING TEST	CR	TEST	IS 9537-II	IS-9537	IS-9537	INSPT. REPORT	3	2.1	-		
		b) COMPRESSION	CR	TEST	IS 9537-II	IS-9537	IS-9537	INSPT. REPORT	3	2.1	-		
		c) BEND	CR	TEST	BHEL APPPD DATASHEET/ IS 9537	APPD DATASHEET/ IS 9537	APPD DATASHEET/ IS 9537	INSPT. REPORT	3	2.1	-		
		4. GALVANISATION TEST											
		a) ZINC COATING	CR	TEST	IS 9537-II	IS-2633	IS-2633	INSPT. REPORT	3	2.1	-		
		BHEL											
LEGEND :		1 - BHEL/ CUSTOMER		2 - VENDOR		3 - SUB- VENDOR		P - PERFORM		W - WITNESS		V - VERIFICATION	
												BIDDER'S/VENDORS COMPANY SEAL	



CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :		SPECIFICATION TITLE :						
BIDDER/ VENDOR		STANDARD QP NO. : PE-QP-999-558-E001, REV.0		SPECIFICATION TITLE :		SPECIFICATION NO. :						
SYSTEM		ITEM:ILLUMINATION		DOC. NO. :								
SHEET 3 OF 5												
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS		
1	2	3	4	5	6	7	8	9	P W V	11		
5.0 ELECTRIC POLES	5.1 MATERIAL	b) MASS OF ZINC COAT.	CR	TEST	IS 9537-II	IS-6745/4759/ APPD DATASHEET	IS-6745/4759/ APPD DATASHEET	INSPT. REPORT	3	2,1 -	BY ELCOMETER	
		c) COATING THICKNESS	CR	TEST	IS 9537-II	IS-9537/ APPD DATASHEET	IS-9537/ APPD DATASHEET	INSPT. REPORT	3	2,1 -		
		d) EPOXY THICKNESS	MA	VISUAL	PHYSICAL	IS 9537-II	50 MICRONS	50 MICRONS	INSPT. REPORT	3		2,1 -
		1.CHEMICAL COMP.	MA	CHEM. ANALYSIS	IS 2713 IS 228 & IS 1608	IS-2713 IS-228 & IS-1608	IS-2713 IS-228 & IS-1608	-DO-	3/2	-		2,1
5.2 FINAL INSPECTION		2.PHYSICAL PROP.	MA	PHY.TESTS	-DO-	-DO-	-DO-	-DO-	3/2	-	2,1	
		1.WORKMANSHIP AND FINISH	MA	VISUAL & MEAS	IS 2713	APPD DRG./ IS:2713	APPD DRG./ IS:2713	-DO-	3/2	2,1 -	FOR DEFLECTION & DROP TEST, TC VERIFICATION BY BHEL	
		2.DIMENSIONS	MA	-DO-	-DO-	-DO-	-DO-	-DO-	3/2	2,1 -		
		3.WEIGHT	MA	-DO-	-DO-	-DO-	-DO-	-DO-	3/2	2,1 -		
		4.TESTS AS PER IS-2713	MA	-DO-	-DO-	IS-2713	IS-2713	-DO-	3/2	2,1 -		
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										
		DATE										
LEGEND :		1 - BHEL/ CUSTOMER	2 - VENDOR	3 - SUB-VENDOR	P - PERFORM	W - WITNESS V - VERIFICATION						

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :	
SHEET 4 OF 5		BIDDER / VENDOR		SYSTEM		STANDARD QP NO. : PE-QP-989-558-E001, REV.0		SPECIFICATION TITLE :	
CHARACTERISTIC CHECK		CAT.		TYPE/ METHOD OF CHECK		EXTENT OF CHECK		REFERENCE DOCUMENT	
COMPOONENT/OPERATION		3		4		5		6	
1	2	3		4		5		6	
6.0	HIGH MAST								
6.1	High Mast Shaft	a) Dimensional conformity b) Galvanising		MA MA		MEASURE MEASURE		10% or Min. 2 Nos -do-	
6.2	Head Frame	a) Dimensional conformity		MA		MEASURE		-do-	
6.3	Lantern Carriage	a) Dimensional conformity b) Galvanising		MA MA		MEASURE MEASURE		-do- -do-	
6.4	Double drum Winch	a) Load Capacity		MA		MEASURE		-do-	
6.5	Stainless Steel Wire Ropes	a) Breaking Capacity		M		MEASURE		100%	
6.6	FEEDER PILLAR								
7.0	JUNCTION BOXES & RECEPTACLES	1.DIMENSIONS		MA		MEASUREMENT		100%	
		2.PAINT SHADE/ THICKNESS		MA		VISUAL/MEAS.		10%	
		3.HV/IR/HV		MA		ELECT.TESTS		100%	
		4.DEGREE OF PROTECTION		MA		TEST		1/SIZE	
		5.SPECIAL TESTS IF ANY.EXPLOSION PROOF ~~FLAME PROOF~~		MA		TEST		1/SIZE	
		6. OPERATION CHECK		MA		TEST		10%	
		7. MECHANICAL INTERLOCK		MA		TEST		10%	
BHEL		PARTICULARS		BIDDER/VENDOR					
		NAME							
		SIGNATURE							
		DATE							
LEGEND :		1 - BHEL/ CUSTOMER		2 - VENDOR		3 - SUB-VENDOR		P - PERFORM	
								W - WITNESS	
								BIDDER'S/VENDORS COMPANY SEAL	
								V - VERIFICATION	

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :			
		SHEET 5 OF 5		BIDDER / VENDOR :		STANDARD QP NO. : PE-QP-989-558-E001, REV.0		SPECIFICATION TITLE :			
		SYSTEM		ITEM:ILLUMINATION		DOC.NO. :					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS	
1	2	3	4	5	6	7	8	9	P W V	11	
8.0	PVC WIRES	1.SURFACE DEFECTS	MA	VISUAL	10%	IS:694 IS:1554	IS:694 IS:1554	INSPN. REPORT & TEST REPORT FROM MANUFACTURER	3 -	2,1 TO BE PROCURED FROM BIS APPROVED SOURCE	
		2.DIMENSIONS	MA	MEASUREMENT	10%	-DO-	-DO-	-DO-	3 -	2,1	
		3.ACCEPTANCE TESTS	MA	-DO-	IS: 694	-DO-	-DO-	-DO-	3 -	2,1	
		4.ROUTINE TESTS	MA	-DO-	100%	-DO-	-DO-	-DO-	3 -	2,1	
		5.TYPE TESTS	CR	ELEC. TESTS	ONE/TYPE & SIZE	IS:694 IS:1554	IS:694 IS:1554	TEST CERT.	3 -	1** ** Refer note 3 & 4	
NOTES: 1. IN CASE TYPE TEST CERTIFICATE FOR DEGREE OF PROTECTION/EXPLOSION PROOFNESS FROM INDEPENDENT LAB. IS NOT AVAILABLE, THE ITEM SHALL BE TESTED AT AN INDEPENDENT LAB. 2. ITEMS LIKE CEILING FANS, EMERGENCY LIGHTING UNIT, FLEXIBLE CONDUIT, EARTHING WIRE & FLATS, 24V SUPPLY MODULE, LADDERS, HUMPE PIPE, SWITCHBOXES, EXIT SIGNS, STRUCTURAL STEEL ETC. WILL BE CLEARED BASED ON COC (CERTIFICATE OF COMPLIANCE). 3. TYPE TEST CERTIFICATES TO BE FURNISHED FOR VERIFICATION BY BHEL ENGINEERING/CUSTOMER. 4. CONDUCTION OF TYPE TESTS TO BE DONE IF REQUIRED BY BHEL TECHNICAL SPECIFICATION & TEST CERTIFICATES FOR THE SAME TO BE FURNISHED FOR VERIFICATION BY BHEL ENGINEERING/CUSTOMER. 5. TYPE TEST REPORT DULY VERIFIED BY BHEL ENGINEERING/CUSTOMER SHALL BE SUBMITTED FOR VERIFICATION DURING INSPECTION.											
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
LEGEND :		1 - BHEL/ CUSTOMER		2 - VENDOR		3 - SUB- VENDOR		P - PERFORM		W - WITNESS V - VERIFICATION	

		QUALITY PLAN		CUSTOMER :				PROJECT TITLE :				SPECIFICATION NO. :			
		SHEET 1 OF 2		BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-509-E001, REV. 0				SPECIFICATION TITLE:					
		SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	SYSTEM CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	DOC. NO. :	AGENCY	REMARKS		
1	2	3	4	5	6	7	8	9	10	11					
1.0	RAW MATERIAL														
1.1	MILD STEEL (FLATS & RODS) AS PER SPECIFICATION	1.CHEMICAL & PHYSICAL PROPERTIES	MA	VERIFICATION, OF TC'S	100%	IS:2062	IS:2062	MILL TC	3	1/2	Refer note in Remark at Si. No.3				
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS - 1730	IS - 1730	QC RECORD	3/2	-					
		3.SURFACE FINISH	MA	VISUAL	100%	IS : 1079	IS : 1079	QC RECORD	3/2	-					
1.2	ZINC	1.CHEM.COMP.	MA	CHEM.TEST	SAMPLE	IS - 209	IS - 209	QC RECORD	3/2	-	1/2				
2.0	IN-PROCESS														
2.1	CUTTING, DRILLING	1.DIMENSIONS	MA	MEASUREMENT	100%	APP. DATA SHEET/ APP. DRAWING	APP. DATA SHEET/ APP. DRAWING	QC RECORD	2	-	1				
		2.SURFACE FINISH	MA	VISUAL	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1				
2.2	SURFACE PREPARATION	1.CLEANING PICKLING, RINSING, & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-				
		2.SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-				
BHEL															
PARTICULARS			BIDDER/VENDOR												
NAME															
SIGNATURE															
DATE															
LEGEND :															
1 - BHEL/ CUSTOMER			2 - VENDOR		3 - SUB- VENDOR		P - PERFORM		W - WITNESS		V - VERIFICATION				
BIDDER'S/VENDORS COMPANY SEAL															

		CUSTOMER :		PROJECT TITLE :			SPECIFICATION NO. :								
		BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-509-E001 REV. 0			SPECIFICATION TITLE :								
SHEET 2 OF 2		EARTHING		ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS			DOC. NO. :								
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	P	W	V	REMARKS		
1	2	3	4	5	6	7	8	9	10				11		
2.3	GALVANISING	1. TEMPERATURE OF BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	-	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.		
		2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	-			
		3. RATE OF IMMERSION	MA	VISUAL/ MEASUREMENT	100%	IS - 2629/ MFRS PRACTICE	IS - 2629/ MFRS PRACTICE	QC RECORD	3/2	-	2	-			
		4. SURFACE QUALITY	MA	VISUAL	100%	IS - 2629	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN ETC.	QC RECORD	3/2	-	-	-			
		3.0	FINISHED ITEMS	1. CHEMICAL	MA	CHEMICAL	1 No./LOT/SIZE	IS-2062	IS-2062	LAB TC	2	-		1	Note : Sample shall be selected by BHEL & testing shall be done at NABL/ govt. approved lab
				2. DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1) LEVEL S-4	APP. DATA SHEET/ APP. DRAWING	APP. DATA SHEET/ APP. DRAWING	INSP. REPORT	2	1		-	
		3. SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1) LEVEL S-4	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP. REPORT	2	1	-	-			
		4. MASS OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-6745 / APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	-			
		5. UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-2633	IS-2633	INSP. REPORT	2	1	-	-			
		6. THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	-			
		6. ADHESION	MA	MECH. TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-	-			
BHEL															
PARTICULARS				BIDDER/VENDOR											
NAME															
SIGNATURE															
DATE															
LEGEND :				1 - BHEL/ CUSTOMER	2 - VENDOR	3 - SUB- VENDOR	P - PERFORM	W - WITNESS	BIDDER'S/VENDORS COMPANY SEAL						
									V - VERIFICATION						

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :			
		SHEET 1 OF 2		BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-989-507-E006, REV. 0		SPECIFICATION TITLE :			
SL. NO.		COMPONENT/OPERATION	CHARACTERISTIC CHECK	SYSTEM CABLEING		ITEM : CABLE TRAY SUPPORT MATERIAL (WELDED TYPE)		DOC. NO. :			
				CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS
1		2	3	4	5	6	7	8	9	10	11
1.0 RAW MATERIAL											
1.1 MILD STEEL SECTIONS (CHANNEL & ANGLES) AS PER SPECIFICATION		1.CHEMICAL & PHY. PROPERTIES									
		2.DIMENSIONS									
		3.SURFACE FINISH									
1.2 ZINC		CHEM. COMP.									
2.0 IN-PROCESS											
2.1 CUTTING		1.DIMENSIONS									
		2. WELDING QUALITY (IF APPLICABLE)									
		3.SURFACE FINISH									
2.2 SURFACE PREPARATION		1.CLEANING, PICKLING, RINSING & FLUXING									
		2. SURFACE QUALITY									
2.3 GALVANISING		1.TEMPERATURE OF BATH									
		If vendor doesn't have his own galvanizing plant duly approved by BHEL-PEM, then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.									
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
LEGEND :				1 - BHEL/ CUSTOMER	2 - VENDOR	3 - SUB-VENDOR	P - PERFORM	W - WITNESS	V - VERIFICATION		
				BIDDER'S/VENDORS COMPANY SEAL							

		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :					
		QUALITY PLAN		BIDDER/ VENDOR :		SPECIFICATION TITLE:					
		SHEET 2 OF 2		SYSTEM CABLING		ITEM : CABLE TRAY SUPPORT MATERIAL (WELDED TYPE)					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS	
1	2	3	4	5	6	7	8	9	10	11	
3.0	FINISHED ITEMS	2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-
		3. RATE OF IMMERSION	MA	VISUAL MEASUREMENT	100%	IS - 2629 / MFR'S PRACTICE	IS - 2629 / MFR'S PRACTICE	QC RECORD	3/2	-	2
		4. SURFACE QUALITY	MA	VISUAL	100%	IS - 2629	FREE FROM BURRS ROUGHNESS, SLAG, FLUX, STAIN, ETC.	QC RECORD	3/2	-	-
		1.DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1) LEVEL S-4	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-
		2. SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1) LEVEL S-4	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP. REPORT	2	1	-	
		3.MASS OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-6745 / APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-
		4.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-2633	IS-2633	INSP. REPORT	2	1	-
		5.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
LEGEND : 1 - BHEL/CUSTOMER 2 - VENDOR 3 - SUB-VENDOR P - PERFORM W - WITNESS V - VERIFICATION											
BIDDER'S/VENDORS COMPANY SEAL											

		CUSTOMER :		PROJECT TITLE :				SPECIFICATION NO. :				
		QUALITY PLAN		STANDARD QP NO. : PE-QP-999-507-E005, REV. 0				SPECIFICATION TITLE:				
		SHEET 1 OF 2		ITEM : CABLE TRAYS & ACCESSORIES				DOC. NO. :				
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL											
1.1	ROLLED SHEET	1.CHEM.& PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	IS:1079	IS:1079	MILL TC	3/2	-	1/2	Steel shall be procured from SAUTISCO/RINJIBHUSAN/JINDAL ISPAT/ESSAR/LLOYD/ IISCO/ authorised SAIL Re Rollers.
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS-1730/ APPD. DATA SHEET	IS-1730/ APPD. DATA SHEET	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS-1079	IS-1079	QC RECORD	3/2	-	-	
1.2	ZINC	CHEM.COMP.	MA	CHEM TEST	EACH HEAT	IS-209	IS-209	QC RECORD	3/2	-	1/2	
2.0	IN-PROCESS											
2.1	FABRICATION	1.DIMENSIONS	MA	MEASUREMENT	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1	
		2.WELDING QUALITY	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	Welding is to be done by qualified welders in accordance with ASME SEC. IX article III. WPS , PQR & WPD to be reviewed during inspection.
		3.SURFACE FINISH	MA	VISUAL	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING PICKLING & RINSING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2. SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-	
BHEL												
PARTICULARS												
NAME												
SIGNATURE												
DATE												
LEGEND : 1 - BHEL/CUSTOMER 2 - VENDOR 3 - SUB-VENDOR P - PERFORM W - WITNESS V - VERIFICATION												
BIDDER'S/VENDORS COMPANY SEAL												

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE :		SPECIFICATION NO. :			
		SHEET 2 OF 2		BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-989-507-E005, REV. 0		SPECIFICATION TITLE:			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS	
			4	5	6	7	8	9	10	11	
2.3	GALVANISING	1.TEMPERATURE OF ZINC BATH 2.DROSS 3.RATE OF IMMERSION 4.SURFACE QUALITY	MA MA MA MA	TEMPERATURE INDICATOR VISUAL VISUAL VISUAL	CONTINUOUS PERIODIC 100% 100%	IS-2629 IS 2629 IS 2629/ MFR'S PRACTICE IS 2629	IS-2629 IS 2629 IS 2629/ MFR'S PRACTICE FREE FROM BURRS, ROUGHNESS, SLAG FLUX, STAIN, ETC.	QC RECORD QC RECORD QC RECORD QC RECORD	2/3 2/3 2/3 2/3	- - 2 -	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.
3.0	FINISHED ITEMS										
3.1	(CABLE TRAY, ACCESSORIES & HARDWARES)	1.DIMENSIONS 2.SURFACE FINISH 3.RIGIDITY (FOR TRAYS) 4.MASS OF ZINC COATING 5.UNIFORMITY OF ZINC COATING 6.THICKNESS OF ZINC COATING 7.ADHESION	MA MA MA MA MA MA MA	MEASUREMENT VISUAL DEFLECTION TEST CHEM. TEST CHEM. TEST ELCOMETER MECH.TEST	IS-2500 (PART 1) LEVEL S-4 IS-2500 (PART 1) LEVEL S-4 2 No./ LOT/TYPE IS-4759 IS-4759 IS-4759	APPD. DRG APPD. DRG APPD. DRG IS-6745/ APPD. DATASHEET IS-2633 APPD. DATASHEET IS-2629	APPD. DRG FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC. APPD. DRG APPD. DATASHEET IS-2633 APPD. DATASHEET	INSP.REPORT INSP.REPORT INSP.REPORT INSP.REPORT INSP.REPORT INSP.REPORT	2 2 2 2 2 2	1 1 1 1 1 1	Fasteners shall be of reputed make. Overall thickness of finished product shall not be less than the thickness of cable tray & accessories defined in technical datasheet. Following shall be engraved/ punched on each standard length of cable tray at the center of both sides of runner: 'PEW' (length of letter 90mm & height 30mm). 600MM wide cable tray to be tested. Maximum deflection shall not exceed 7MM on mid span on uniform loading of 100KG/M.
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
LEGEND :				1 - BHEL/CUSTOMER	2 - VENDOR	3 - SUB-VENDOR	P - PERFORM	W - WITNESS	BIDDERS/VENDORS COMPANY SEAL		
									V - VERIFICATION		

CUSTOMER :			PROJECT		SPECIFICATION :		
BIDDER/ VENDOR :			TITLE		NUMBER :		
QUALITY PLAN			QUALITY PLAN		SPECIFICATION		
SHEET 1 OF 2			NUMBER PED-506-00-Q-006, REV-01		TITLE		
COMPONENT/OPERATION			ITEM AC ELECT. MOTORS BELOW 55KW (LV)		SECTION		
SL. NO.			REFERENCE DOCUMENT		VOLUME III		
CHARACTERISTICS CHECK			ACCEPTANCE NORM		REMARKS		
CAT.			FORMAT OF RECORD		AGENCY		
TYPE/ METHOD OF CHECK			P		W V		
EXTENT OF CHECK			9		10		
4			7		11		
5			8				
6			9				
10			11				
1			2				
2			3				
3			4				
4			5				
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	QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :					
			BIDDER/ : VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01		SPECIFICATION : TITLE :					
	SHEET 2 OF 2		SYSTEM CAT.		ITEM AC ELECT. MOTORS BELOW 55KW (LV)		VOLUME III					
	COMPONENT/OPERATION CHARACTERISTICS CHECK	TYPE/ METHOD OF CHECK		EXTENT OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		REMARKS
1	2	3	4	5	6	7	8	9	10	11		
NOTES:												
1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 2 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY. 3												
Legends for Inspection agency 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										
		DATE										
BIDDER'S/VENDORS COMPANY SEAL												

		CUSTOMER :		PROJECT		SPECIFICATION :																			
		QUALITY PLAN		TITLE		NUMBER :																			
				QUALITY PLAN		SPECIFICATION :																			
				NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION :																			
SHEET 2 OF 9		BIDDER/ VENDOR		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III																	
COMPONENT/OPERATION		CHARACTERISTIC CHECK		EXTENT OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		AGENCY		REMARKS											
SL. NO.		CAT.		TYPE/ METHOD OF CHECK		CAT.		EXTENT OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		AGENCY		REMARKS							
1		2		3		4		5		6		7		8		9		10		11					
1.5		SHAFT (FORGED OR ROLLED)		1. SURFACE COND.		MA		VISUAL		100%		-		FREE FROM VISUAL DEFECTS		-DO-		3		-		-		VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED	
				2. CHEM. & PHYSICAL PROPERTIES		MA		CHEM. & PHYSICAL TESTS		1/HEAT NO. OR HEAT TREATMENT BATCH NO		MFG. DRG. SPEC.		RELEVANT IS		SUPPLIER'S TC		3		-		2			
				3. DIMENSIONS		MA		MEASUREMENT		100%		-DO-		MANUF'R'S DRG.		LOG BOOK		3		-		2			
				4. INTERNAL FLAWS		CR		UT		-DO-		ASTM-A388		MANUF'R'S SPEC. BHEL SPEC.		-DO-		3		2		1		FOR DIA OF 55 MM & ABOVE	
1.6		SPACE HEATERS, CONNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S		1. MAKE & RATING		MA		VISUAL		-DO-		MANUF'R'S DRG. SPEC.		MANUF'R'S DRG. SPEC.		-DO-		3		-		2			
				2. PHYSICAL COND.		MA		-DO-		-DO-		-		NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY		-DO-		3		-		2			
				3. DIMENSIONS (WHEREVER APPLICABLE)		MA		MEASUREMENT		SAMPLE		MANUF'R'S DRG./ SPEC.		MANUF'R'S DRG. / SPEC.		-DO-		3		-		2			
				4. PERFORMANCE/ CALIBRATION		MA		TEST		100%		-DO-		-DO-		INSP. REPORT		3		-		2			
BHEL		PARTICULARS		BIDDER/VENDOR																					
		NAME																							
		SIGNATURE																							
		DATE																						BIDDER'S/VENDORS COMPANY SEAL	

भारतीय विद्युत नियंत्रण बोर्ड 		CUSTOMER :		PROJECT		SPECIFICATION :							
		QUALITY PLAN		TITLE		NUMBER :							
						SPECIFICATION :							
						TITLE							
SHEET 3 OF 9		BIDDER/ VENDOR		NUMBER PED-506-00-Q-007, REV-03		VOLUME III							
COMPONENT/OPERATION		SYSTEM		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		SECTION		REMARKS	
SL. NO.	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	7	8	9	10	11				
1	2	3	4	5	6	7	8	9	10	11			
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	MA	VISUAL	100%	-	INSPT. REPORT	NO VISUAL DEFECTS	LOG BOOK AND OR SUPPLIER'S TC	3	-	2		
1.8	SHEET STAMPING (PUNCHEDED)	MA	TEST	SAMPLE	MANUF'S SPEC.	LOG BOOK	MANUF'S SPEC.	LOG BOOK	3	-	2		
1.9	CONDUCTORS	MA	VISUAL	100%	-	LOG BOOK	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-		
		MA	MEASUREMENT	SAMPLE	MANUF'S DRG. .	-DO-	MANUF'S DRG.	SUPPLIER'S TC	3	-	2	FOR MV MOTOR INSULATION/ARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT	
		MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	RELEVANT IS	LOG BOOK	3*	-	2*	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.	
		MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2		
BHEL		PARTICULARS		BIDDER/VENDOR									
		NAME											
		SIGNATURE											
		DATE											
		BIDDER'S/VENDORS COMPANY SEAL											

 भारत भारती		CUSTOMER :		PROJECT		SPECIFICATION :						
QUALITY PLAN		BIDDER/ VENDOR :		TITLE		NUMBER :						
SHEET 5 OF 9		SYSTEM		QUALITY PLAN		TITLE						
SL. NO.		CAT.		REFERENCE DOCUMENT		SECTION						
COMPONENT/OPERATION		TYPE/ METHOD OF CHECK		EXTENT OF CHECK		AGENCY						
CHARACTERISTIC CHECK		CAT.		METHOD OF CHECK		P W V						
1		3		4		5						
2		6		7		8						
9		10		11		12						
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVANT SPEC./ ASTM-E165	MANUF'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC./BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										
		DATE										
												BIDDER'S/VENDORS COMPANY SEAL

新和安研 		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :					
				BIDDER/ VENDOR :		TITLE		NUMBER :					
						QUALITY PLAN		SPECIFICATION :					
						NUMBER PED-506-00-Q-007, REV-03		TITLE					
SHEET 8 OF 9		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III		REMARKS					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	P	W	V	
1	2	3	4	5	6	7	8	9	10	11			
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC. 2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC. 3.VIBRATION & NOISE LEVEL 4.OVERALL DIMENSIONS AND ORIENTATION 5.DEGREE OF PROTECTION 6. MEASUREMENT OF RESISTANCE OF RTD & BTD 7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER 8. NAMEPLATE DETAILS 9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED) 10. PAINT SHADE, THICKNESS & FINISH	MA	ELECT. TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1	
			MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^{\$}	1	\$ NOTE - 2	
			MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1 ^{\$}	1	\$ NOTE - 2	
			MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-		
			MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3	
			MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^{\$}	1	\$ NOTE - 2	
			MA	-DO-	100%	-DO-	-DO-	-DO-	2	1 ^{\$}	1	\$ NOTE - 2	
			MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1 ^{\$}	1	\$ NOTE - 2	
			MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3	
			MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1 ^{\$}	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY \$ NOTE - 2	
BHEL				PARTICULARS		BIDDER/VENDOR							
				NAME									
				SIGNATURE									
				DATE				BIDDER'S/VENDORS COMPANY SEAL					

		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :											
QUALITY PLAN		BIDDER/ VENDOR		QUALITY PLAN		SPECIFICATION :											
		SYSTEM		NUMBER PED-506-00-Q-007, REV-03		TITLE											
SHEET 9 OF 9		CAT.		TYPE/ METHOD OF CHECK		EXTENT OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		SECTION AGENCY		VOLUME III REMARKS	
COMPONENT/OPERATION		CHARACTERISTIC CHECK															
SL. NO.	2	3	4	5	6	7	8	9	10	11							
1																	
NOTES: 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED. 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON. 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY																	
BHEL																	
PARTICULARS																	
NAME																	
SIGNATURE																	
DATE																	
BIDDER/SVENDORS COMPANY SEAL																	

TANGEDCO

**2X660 MW ENNORE SEZ STPP
AT ASH DYKE OF NCTPS, CHENNAI**

VOLUME -III

**TECHNICAL SPECIFICATION
FOR
COOLING TOWER**

Specification No. : PE-TS-412-165-N001 (REV. 0)



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



**TITLE : TECHNICAL SPECIFICATION
FOR
COOLING TOWERS
PREAMBLE**

SPEC. NO. PE-TS- 165-N101

VOLUME : III

SECTION :

REV. NO. 00

DATE : 09.05.11

SHEET 1 OF 2

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).



**TITLE : TECHNICAL SPECIFICATION
FOR
COOLING TOWERS
PREAMBLE**

SPEC. NO. PE-TS- 165-N101

VOLUME : III

SECTION :

REV. NO. 00

DATE : 09.05.11

SHEET 2 OF 2

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
FOR**

COOLING TOWERS

SPEC. NO. PE-TS -165-N101

VOLUME: III

SECTION :

REV. NO. 00

DATE : 09.05.11

SHEET 1 OF 1

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SECTION

TITLE

A DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER

A.1 COMPLIANCE CERTIFICATE

A.2 SCHEDULE OF DEVIATIONS

A.3 SCHEDULE OF PERFORMANCE GUARANTEE

A.4 SCHEDULE OF PRICES

A.5 SCHEDULE OF UNIT PRICES

A.6 General arrangement drawing for cooling tower, incorporating all relevant dimensions, cold water channels / sludge chamber/ screens/ gates in the cold water channel, staircase etc.

A.7 Pumping head calculations.

A.8 Thermal design calculations.

A.9 Tower performance curves.

B DOCUMENTS TO BE SUBMITTED ON PLACEMENT OF LOI

B.1 COOLING TOWER DATA SHEET-B

B.2 SCHEDULES AS PER LIST



**TITLE : TECHNICAL SPECIFICATION
FOR**

COOLING TOWERS

SPEC. NO. PE-TS-165-N101

VOLUME : III

SECTION : A

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SHEET 1 OF 1

DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER

- COMPLIANCE CERTIFICATE
- SCHEDULE OF DEVIATIONS
- SCHEDULE OF PERFORMANCE GUARANTEE
- SCHEDULE OF PRICES
- SCHEDULE OF UNIT PRICES
- ELECTRICAL LOAD DATA
- General arrangement drawing for cooling tower, incorporating all relevant dimensions, cold water channels / sludge chamber/ screens/ gates in the cold water channel, staircase etc.
- Pumping head calculations.
- Thermal design calculations.
- Tower performance curves



TITLE:

TECHNICAL SPECIFICATION
COOLING TOWERS

COMPLIANCE CERTIFICATE

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

VOLUME: III

SECTION:

REV. NO. 0 DATE 09.05.11

SHEET 1 OF 1

COMPLIANCE CERTIFICATE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnish same with the offer.

- a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions with regard to same.
- b) There are no other deviations w.r.t. specification other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'
- c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL/ CUSTOMER approval & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc.
- d) All drawings/ data-sheets/ calculations etc. submitted along with the offer shall be considered for reference only, same shall be subject to BHEL/ CUSTOMER approval in the event of order.
- e) The offered materials shall be either equivalent or superior to those specified in the specification.

For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.
- f) The commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself. Prices for special tools & tackles, if any, shall also be included in the base price.
- g) All sub vendors shall be subject to BHEL/ CUSTOMER approval in the event of order.
- h) The Performance guarantees shall stand valid till at least eighteen (18) months after full load commissioning of CT or as per commercial terms and conditions, whichever is later.
- i) Specifically confirm compliance with Cl. Nos. 6.0 and 11.0 and their sub clauses of Sec. C1 of Technical Specification specification.
- j) The hydrostatic testing of piping shall be carried out as specified i.e. at 1.5 times the design pressure.

FORM No. PEM - 0036-0

☒ Tick the applicable

* Deviations of deviations shall be listed in a separate sheet



TITLE

*** SCHEDULE OF DEVIATIONS**

- () From Conditions of Contract (Volume - I)
- () From General Technical Conditions (Volume - II A)
- () From Technical Specifications (Volume - II B)

SPECIFICATION NUMBER PE-ES-256-165-N001

VOLUME III PART - A

SHEET OF

We the undersigned hereby certify that the above mentioned are the only deviations.

PARTICULARS OF BIDDER / AUTHORIZED REPRESENTATIVE

NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL



TITLE:

**TECHNICAL SPECIFICATION
COOLING TOWERS****GUARANTEE SCHEDULE**

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

VOLUME: III

SECTION:

REV. NO. 0 DATE 09.05.11

SHEET 1 OF 1

1. Guaranteed Pumping head at design capacity (viz. static lift w.r.t. FGL up to top of topmost pipe without any siphon recovery & frictional losses from bidders terminal point onwards including 10% margin, etc)
2. Guaranteed Cold water temperature at design capacity & parameters with the working cells Deg. C

PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE

NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL



TITLE : SCHEDULE OF PRICES

2X660 MW ENNORE SEZ STPP

SPEC NO: PE-TS-412-165-N001

SL. NO.	** Description of Works Or Equipment/ System	Prices (in Lakhs of Rs.)
1.	Prices for two (2) nos. Natural Draft Cooling Towers to be covered under the following two heads only) a). Total Price For Design, Manufacture, Inspection/ Testing, Supplies, Packing for transportation & delivery complete with commissioning spares/ special tools and tackles/ including all accessories & equipments as specified and as necessary including Mandatory Spares for completion for two (2) numbers Cooling Towers. b). Total price for site civil works including receipt at site, handling, storage, civil & structural work (excluding supply of cement, structural and reinforced steel), erection, testing, Commissioning, trial run, PG test, handing over etc. complete with all accessories as per the specification. c). Total price for Cement, Reinforcement steel and structural steel Total a) + b) + c) <u>Notes :</u> i) Indicate all duties, taxes, etc. stating whether included/ excluded in above prices.	Rs Rs Rs Rs

Bidder shall furnish this price Schedule in his price offer only

PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE

NAME _____

DESIGNATION

SIGNATURE

DATE _____

COMPANY SEAL



**TITLE : SCHEDULE OF
UNIT PRICES**

2X660 MW ENNORE SEZ STPP

SPEC NO: PE-TS-412-165-N001

SL. NO.

** Description of Works Or Equipment/ System

Prices (in Lakhs of Rs.)

**1.0 Break up of Cl. 1.0 of "Schedule of Prices" for
design, manufacture supplies and site works:**

a) Design and engineering of one(1) no. CT **Rs.**

b) Manufacture and supply of following for one(1) no.
CT: **Rs.**

- Complete mechanical equipments
- Complete electrical and C&I equipments

c) Complete Civil works including steel and cement of
one no CT. **Rs.**

d) Erection & Commissioning of following for One (1)
no. CT: **Rs.**

- Complete mechanical equipments
- Complete electrical and C&I equipments

e) Performance Guarantee testing of One (1) no. CT. **Rs.**

f) Mandatory Spares as per Section C4 of Vol IIB **Rs.**

Note:

1.0 Sum total of Cl. 1.0 should match Cl. 1.0
(Schedule of prices). In the event of discrepancy
the least of two figures shall be considered for
award of contract.

2.0 Prices of commissioning & erection spares shall
be included in the price of cooling tower.

Bidder shall furnish this price Schedule in his price offer only

PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE

NAME

DESIGNATION

SIGNATURE

DATE

COMPANY SEAL



TITLE
DATA SHEET-B
NATURAL DRAFT COOLING TOWER

SPECIFICATION NO.: PE-TS-999-165-N004

VOLUME : III

SECTION : A

REV. NO. 0 **DATE** 22.03.2003

SHEET 1 **OF** 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
1.0	Type Model No.		
2.0	Quantity	Nos//Unit	
3.0	Rated Capacity	M ³ /Hr	
4.0	Design Wet Bulb Temperature	°C	
5.0	Cold Water Temperature	°C	
6.0	Cooling Tower Approach	°C	
7.0	Cooling Tower Range	°C	
8.0	Cooling Tower Loss		
	a. Evaporation Loss		
	b. Drift Loss		
	c. Blow Down Loss (Concentration Factor to be indicated)		
9.0	Total Differential Pressure Drop (Considering recovery)		
	a. Drop through Louvers	mm of H ₂ O	
	b. Drop through Fills	mm of H ₂ O	
	c. Drop through Eliminators	mm of H ₂ O	
	d. Velocity Pressure	mm of H ₂ O	
	e. Drop through plenum	mm of H ₂ O	



TITLE
DATA SHEET-B
NATURAL DRAFT COOLING TOWER

SPECIFICATION NO.: PE-TS-999-165-N004
VOLUME : III
SECTION : A
REV. NO. 0 **DATE** 22.03.2003
SHEET 2 **OF** 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
10.0	Basin Storage Capacity	M ³	
11.0	Plan Dimensions (Diameter)	M	
12.0	Overall Size of Cooling Tower (Plan Dimensions X Height)	MXM	
13.0	Required Pumping Head including all losses measured from Terminal Point	M	
14.0	Cooling Tower Levels		
	a. Graded Level	M	
	b. Maximum Water Level	M	
	c. Basin Curb Level	M	
	d. Minimum Water Level	M	
	e. Basin Bottom Level	M	
15.0	Overall Tower Height from Basin Floor	M	
16.0	Basin Dimensions		
	a. Diameter	M	
	b. Depth (from Basin Curb)	M	
17.0	Free Board (Above Max. Water Level)	mm	
18.0	Heat Transfer Data	mm	
	a. Heat Transfer Coefficient (K)		
	b. Tower Coefficient © Ka V/L	M	
	c. Average Fill Height	M	
	d. Total Fill Volume	M ³	



TITLE
DATA SHEET-B
NATURAL DRAFT COOLING TOWER

SPECIFICATION NO.: PE-TS-999-165-N004
VOLUME : III
SECTION : A
REV. NO. 0 **DATE** 22.03.2003
SHEET 3 **OF** 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	e. Total Tower Wetted Surface	M ²	
19.0	Hot Water Distribution Piping		
	a. Size (OD X Thk)	Mm X mm	
	b. Elevation of Center Line of Hot Water distribution Header	M	
	c. Design pressure for Hot Water Distribution System	Kg/cm ² (g)	
20.0	Isolation Valves in Hot Water Risers		
	a. Size	mm	
	b. Quantity		
	c. Type/Code & Standard		
	d. Make		
	e. Pressure drop across the valve in fully open position		
	f. Materials of Construction		
	i) Body		
	ii) Disc		
	iii) Drive Shaft/Stub Shaft		
	iv) Bearings		
21.0	Flow Control Valves (If Applicable)		
	a. Size	mm	
	b. Quantity		
	c. Type		
	d. Make		



TITLE
DATA SHEET-B
NATURAL DRAFT COOLING TOWER

SPECIFICATION NO.: PE-TS-999-165-N004
VOLUME : III
SECTION : A
REV. NO. 0 **DATE** 22.03.2003
SHEET 4 **OF** 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	f. Materials of Construction		
	i) Body		
	ii) Spindle		
	iii) Trim		
22.0	Isolating Valve in Sludge Pit		
	a. Size	mm	
	b. Quantity		
	c. Type		
	d. Make		
	e. Conform to which code in respect of design/testing		
	f. Materials of Construction		
	i) Body		
	ii) Stem		
	iii) Trim		
23.0	Stationary Screen		
	a. Quantity		
	b. Size & Material of Bar		
	c. Clear Space between the bar		
	d. Lifting Arrangement		
24.0	Fill & Fill Supports		
	a. Type of fill		
	b. Material		
	c. Expected Life	Years	



TITLE
DATA SHEET-B
NATURAL DRAFT COOLING TOWER

SPECIFICATION NO.: PE-TS-999-165-N004
VOLUME : III
SECTION : A
REV. NO. 0 **DATE** 22.03.2003
SHEET 5 **OF** 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER

d. Arrangement of Fill

e. Method to prevent dislocation of Fills Years

f. Type/Material/Size of fixing arrangement to supporting grid

g. Fill Support Grids

- i) Type
- ii) Material (give full specification)
- iii) Size

h. Grid Supporting Frames

- i) Type
- ii) Material (give full specification)
- iii) Size

i. Fasteners

- i) Type
- ii) Fill/Splash Bars
- iii) Fill Support Grids
- iv) Frames for Supporting the Grids

25.0 Drift Eliminators

a. Number of Passes

b. Gross Face Area per pass M²

c. Type

d. Eliminator Blades mm

- i) Material
- ii) Maximum Length of blade
- iii) Size and shape of blades
- iv) Type and material of drain boards



TITLE
DATA SHEET-B
NATURAL DRAFT COOLING TOWER

SPECIFICATION NO.: PE-TS-999-165-N004

VOLUME : III

SECTION : A

REV. NO. 0 **DATE** 22.03.2003

SHEET 6 **OF** 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER

e. Blade Support Spacers

i) Type

ii) Material

f. Support for Spacers

i) Type

ii) Material

g. Fasteners

i) Type

ii) Material

26.0 Gate in Cold Water Outlet Channel

a. Number per cold water outlet channel

b. Gate Type

c. Name of Manufacturer

d. Gate Size

e. Weight of each gate

f. Are elements of gate dismantling type?

g. Weight of each Element

h. Frame Type

i. Fixing arrangement of frame with RCC channel

j. Lifting Arrangement of Gate

**TITLE****DATA SHEET-B**
NATURAL DRAFT COOLING TOWER

SPECIFICATION NO.: PE-TS-999-165-N004

VOLUME : III

SECTION : A

REV. NO. 0 DATE 22.03.2003

SHEET 7 OF 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	k. Expected Life	Years	
27.0	Sludge Pump & Motor		
	a. Pump Type		
	b. Make & Model No.		
	c. Capacity	M ³ /Hr	
	d. TDH	MWC	
	e. Pump Speed	RPM	
	f. Pump Efficiency at Rated Flow		
	g. Power Consumption at Rated Flow	KW	
	h. Material of Construction		
	i) Impeller		
	ii) Casing		
	iii) Pump & Line Shaft		
	iv) Bearings		
	v) Impeller/Casing Wearing Rings		
28.0	Cooling Tower Materials of Construction		
	a. Casing		
	b. Louvers		
	c. Partition Walls		
	d. Basin Partition Walls		
	e. Stack		
	f. Stair Case		
	g. Hot Water piping		



TITLE
DATA SHEET-B
NATURAL DRAFT COOLING TOWER

SPECIFICATION NO.: PE-TS-999-165-N004

VOLUME : III

SECTION : A

REV. NO. 0 **DATE** 22.03.2003

SHEET 8 **OF** 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER

h. Hot Water distribution basin

i. Internal Walkways

j. Supporting Structure

k. Hand Rails

l. Structure Connector

m Bolts, nuts, washers and other hardware

n. Nails

o. Anchor Bolts

p. Hot Water Distribution Nozzle

q. Hot Water distribution Plates

r. Spacers

s. Mechanical Equipment Support

29.0 Weight of Equipments

a. Weight of Heaviest part to be handled Kgs.

b. Size of largest part to be handled Kgs

30.0 Inspection & Testing

a. Hydro Test Pressure for Hot water piping

i) Test Pressure

ii) Duration

Kg/cm² (g)

Minutes



TITLE
DATA SHEET-B
NATURAL DRAFT COOLING TOWER

SPECIFICATION NO.: PE-TS-999-165-N004
VOLUME : III
SECTION : A
REV. NO. 0 **DATE** 22.03.2003
SHEET 9 **OF** 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER

31.0 Painting Details

a. Externally painted Surfaces

	External Surface	Surface Preparation	Primer	Final Paint
i.	Piping (Under Ground)			
ii.	Piping (Over Ground)			
iii.	Stationary Screens			
iv.	Hoist Derric			
v.	Other Items			

a. Internally painted Surfaces

	Internal Surface	Surface Preparation	Primer	Final Paint
i.	Piping and Valves			
ii.	Other Items			

32.0	Maximum Water Handling capacity	M ³ /Hr		
33.0	Cooling Water Flow Rate (L)	Kg/m ² /Hr		
34.0	Dry Air Flow Rate (G)	Kg/m ² /Hr		
35.0	Ratio of Water to Air (L/G)			
36.0	Dry Air Flow	Kg/Hr		
37.0	Temperature of air leaving the Stack	°C		
38.0	Inlet air Enthalpy	KCal/Kg		
39.0	Exit air Enthalpy	KCal/Kg		
40.0	Total Heat Exchange/Kg of Inlet Dry air	KCal/Kg		
41.0	Losses in hot water piping in MWC	MWC		
42.0	Type of air inlet	MWC		

CHECKLIST — LIST OF SCHEDULES

Sl. No.	Form No.	Description	Tick Applicable Forms
1.	PEM-6024	Schedule of Drawings / Catalogues submitted with Bid	✓
2.	PEM-6025@	Schedule of Occurance of Key Events of Delivery, Erection & Commissioning	
3.	PEM-6026	Schedule of Equipment Manufacture, Despatch and Shipment to Site.	✓
4.	PEM-6027	Schedule of Weights & Dimensions	
5.	PEM-6028@	Schedule of Performance Guarantee	
6.	PEM-6030	Inspection Schedule	✓
7.	PEM-6031	Schedule of Cement and Steel and Quarterly Cement Requirement	
8.	PEM-6032	Schedule of Quarterly Requirement of Reinforcing Bars and Structural Steel	
9.	PEM-6033@	Bill of Quantities (Civil Works)	
10.	PEM-6035	Schedule of Bidder's Proposed Construction / Site Fabrication Facilities.	
11.	PEM-6036	Schedule of Deviations	✓
12.	PEM-6040	Schedule of Declaration	✓
13.	PEM-6041	Quality Plan	✓
14.	PEM-6042	Vendor's Drawings / Documents Schedule	✓
15.	PEM-6043@	Schedule of Occurance of Key Events for Civil / Structural Works	
16.	PEM-6046	Inspection Request	✓
17.	PEM-6051	Schedule of Prices	✓
18.	PEM-6052@	Schedule of Unit Prices	✓
19.	PEM-6053	Schedule of Prices for Commissioning & Mandatory Spares	✓
20.	PEM-6054	Schedule of Prices for Recommended Spares	✓
21.	PEM-6055	Schedule Prices for Erection and Maintenance Tools & Tackles	✓
22.	PEM-6056	Schedule of Bidder's Man-power for Supervision of E & C and their Charges.	✓
23.	PEM-6057	Schedule of Daily & Overtime Rates	
24.	PEM-6058	Schedule of Hire-charges for Construction / Site Fabrication Facilities	
For Forms marked with @ certain information to be filled by DEs - before issuing to bidder.			

FORM No. PEM - 6024-9



TITLE

**SCHEDULE OF DRAWINGS /
CATALOGUES SUBMITTED WITH BID**

SPECIFICATION NUMBER

VOLUME III PART - A

SHEET 12

Section C/D enclosed with the specification indicate the drawings / catalogues to be furnished with the bid. The bidder in addition to furnishing the same, can also include any other drawings / catalogues which he may desire to submit with the bid. This schedule duly lists out such drawings as enclosed by the bidder with the bid.

DRAWING / CATALOGUE NUMBER	DESCRIPTION	NUMBER OF SHEETS

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE

NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL



TITLE :
**SCHEDULE OF OCCURRENCE OF KEY EVENTS
OF DELIVERY ERECTION AND
COMMISSIONING**

SPECIFICATION NUMBER:

VOLUME III

PART-A

Sheet of

EQUIPMENT/SYSTEM.	DESCRIPTION OF KEY EVENTS	MONTHS FROM (DATE OF LOI)
We the undersigned hereby undertake to meet the schedule of occurrence of the key event as listed above regarding the delivery, Erection & Commissioning of Equipment/System		
PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE		

FORM No. PEN - 6026-0

		TITLE SCHEDULE OF EQUIPMENT, MANUFACTURE, DESPATCH AND SHIPMENT TO SITE		SPECIFICATION NUMBER VOLUME III PART - A SHEET OF	
Equipment / Major Bought-out Items	Time for Manufacture/ Procurement from Date of Issue of Letter of Intent (Weeks)	Time for Test, Dismantling Packing & Ready for Despatch (Weeks)	Time required for Shipment to Site (Weeks)	Total Time from Date of Issue of Letter of Intent to Shipment to Site (Weeks)	

We, the undersigned hereby undertake to meet the above time schedule in weeks for manufacture, despatch and shipment of each equipment and procurement of major boughtout items as listed above.

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE			



TITLE

SCHEDULE OF WEIGHTS & DIMENSIONS

SPECIFICATION NUMBER

VOLUME III PART - A

SHEET OF

The bidder shall state below the weights and dimensions of various packages for shipment covering the complete scope.

Description of Package(s)	Dimensions (in meters)	Weight (in tonnes)

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE

NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL

SPECIFICATION	NUMBER

P.O.

~~NUMBER~~

VOLUME - III PART-A

SHUTT 847

This schedule shall be in line with specification and quality plan requirements. The information in this form shall be furnished after receipt of LOI / PO.

PARTICULARS OF VENDOR'S / AUTHORISED REPRESENTATIVE

NAME _____

SIGNATURE _____

DATE _____

COMPANY SEAL

FORM No. PTM - 6040-9



TITLE

*** SCHEDULE OF DECLARATION**

SPECIFICATION NUMBER

VOLUME III PART - A

SHEET OF

DECLARATION

I.....certify that all the technical data and information pertaining to this specification are correct and are true representation of the equipment/system covered by our formal proposal number Dated..... and there is no deviation to the specification.

I hereby certify that I am duly authorised representative of the Bidder's company whose name appears above my signature.

Bidders Company Name

Authorised representative's
Signature

Name

Bidder's Intent

The bidder hereby agrees to fully comply with the requirements and intent of this specifications for the price indicated.

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE

[illegible]

(Form No. PEM-6042-0)

Column 1-	Serial Number
Column 2-	Component/Operation- The component and/or operation being checked shall be given here.
Column 3-	Characteristics check- The characteristics being checked shall be given here. e.g., chemical composition, mechanical properties, leak tightness, surface defects etc..
Column 4-	Category - 'CR' stands for critical characteristic - affecting safety of equipment and personnel 'MA' stands for major Characteristic - affecting safety of equipment and personnel 'MI' stands for minor characteristic - affecting appearance etc.
Column 5-	Type/Method of check e.g. chemical analysis tensile testing, hydraulic test, visual examination radiography etc.
Column 6-	Extent of check, such as, 100, 10, 1 per heat etc.
Column 7-	Reference Documents - Documents, such as technical specification, drawings, standard specifications (IS, BS ETC.) procedure, etc. according to which check is done.
Column 8-	Acceptance Norms - Standards etc. according to which acceptability or otherwise of the characteristics being checked is decided.
Column 9-	Format of Record - Formats, log sheets, reports, etc. in which the observations are recorded. Standard log sheets, reports, formats etc. of the Vendors shall be numbered and such reference numbers shall be included here.
Column 10-	Agency - The agency which performs the test/instruction shall be written in sub-column 'W' The agency which verifies test certificates/inspection records and carries out audit check of the components/operation shall be written in sub-column 'V'
	The agencies are codified '1' stands for (BHEL)
	as 1.2 & 3 '1'* means the operation shall be cleared by BHEL before the start of the next operation.
	'2' Stands for Vendor
	'3' stands for sub-Vendor of the Vendor and so on.

Entry	'3' in column 'P' means test/inspection to be performed by sub-Vendor's QC
Entry	'2' in column 'W' means test/inspection to be witnessed by Vendor's QC
Entry	'1' in column 'V' means verification shall be done by BHEL and next stage to be started only after the hold point is cleared by BHEL.
Column II-	Remarks - Any special remarks shall be given here.

1. In absence of correlation with the test certificate(s) (e.g. material identification) samples shall be drawn by BHEL and all tests as per relevant specifications shall be carried out in their presence or in recognized Government Laboratory.
2. When materials and components are initially identified and stamped by BHEL QS engineer, the identification marks shall be preserved till despatch. Wherever this is not possible, the identification mark shall be transferred to the components in the presence of BHEL QS Engineer unless other wise agreed.
3. For castings and forgings integral test specimens shall be provided. When this is not possible for casting, they shall be poured in the presence of BHEL QS Engineer unless otherwise, if witnessing of test by BHEL is called for.
4. When welders qualified by reputed inspection agencies or statutory bodies are not available, qualification tests shall be conducted in the presence of BHEL QS Engineer.
5. This Quality Plan is liable to be modified as per the requirements of approved drawings and changes in technical specifications/drawings. If there are contradictions in respect of column 7 & 8 between this Quality Plan and the approved drawings specifications, the latter shall prevail.
6. Wherever inspection by BHEL's Purchaser/Third Party/Statutory authorities are mandatory, this shall be complied with.
7. Inspection reports, log sheets, test reports/certificate, etc. shall be furnished to BHEL at the appropriate stage or at the time of final inspection, as required.
8. This Quality Plan is also applicable to spares, if any, under scope of supply of Vendor.
9. The quality plan shall be submitted in septuplicate (7 Copies).



**VENDOR's
DRAWINGS/DOCUMENTS SCHEDULE**
(Information in this form is to be furnished
only after receipt of LOI/IPO)

SPECIFICATION NO

VOLUME **III**

SECTION **PART-A**

REV NO. **0**

SHEET **1 OF 1**

TITLE OF SPECIFICATION

S. NO.	Vendor's Drawing/Document No. (VDN)	PEM's Drawing/Document No. (PDN)	First Submission Date
	TITLE		Final Approval Date
	VDN	PDN	
	TITLE		
	VDN	PDN	
	TITLE		
	VDN	PDN	
	TITLE		
	VDN	PDN	
	TITLE		
	VDN	PDN	
	TITLE		
	VDN	PDN	
	TITLE		
	VDN	PDN	
	TITLE		

PARTICULARS OF VENDOR's/AUTHORISED REPRESENTATIVE

NAME	SIGNATURE	DATE	COMPANY SEAL



**VENDOR'S
DRAWINGS/DOCUMENTS SCHEDULE**
(Information in this form is to be furnished
only after receipt of LOI/IPO)

SPECIFICATION NO

VOLUME **III**

SECTION **PART-A**

REV NO. **0**

SHEET **1 OF 1**

INSPECTION REQUEST
(From Vendor to BHEL Inspection Agency)

1. PROJECT TITLE

2. NAME OF VENDOR

3. BHEL'S LOI/PO NO

DATE

4. SYSTEM/ITEM DESCRIPTION

5. ITEM BEING OFFERED FOR INSPECTION WITH SL. NO. AS PER LOI/PO/BILLING SCHEDULE

6. DESCRIPTION AND SL. NO. OF INSPECTION AS PER QUALITY PLAN

7. QUANTITY OFFERED FOR INSPECTION

8. PLACE OF INSPECTION (FULL ADDRESS AND NAME OF SUB-VENDOR, IF ANY)

PLACE
ADDRESS.....
.....

9. CONTACT PERSON (FOR SL. NO. 8 ABOVE)-

NAME DESIGNATION.....
TELEPHONE..... FAX..... TELEGRAM..... TELEX.....

10. THE FOLLOWING DOCUMENTS ARE APPROVED BY BHEL AND AVAILABLE AT PLACE OF INSPECTION :

(A). QUALITY PLAN (B) DRAWINGS (C) DATA SHEETS, CHARACTERISTIC CURVES ETC.
(D). PLANT STANDARDS

11. REQUIRED DATE OF INSPECTION : LIKELY DURATION(No.of working days).....
WEEKLY OFF DAY WORKING HOURS

(At least 15 days prior notice shall be given by the Vendor to Inspection Agency)

We hereby certify that the above items are complete in all respects and have been fully inspected/tested by us and are found to be as per technical specification/approved drawings/data sheets/characteristic curves and are acceptable to our QC department. The detailed inspection and test reports of our QC department are enclosed.

VENDOR'S PARTICULARS

Name	Designation	Signature	Place	Date	Seal

FORM No. PEM-6053-0

* Unpriced schedule shall also be furnished along with Part-A Schedule in Technical Bid.

		TITLE				SPECIFICATION NUMBER			
		* SCHEDULE OF PRICES FOR COMMISSIONING AND MANDATORY SPARES				VOLUME III			
						SHEET ... OF ...			
The bidder shall indicate here the quantity required for erection / commissioning and mandatory spares for equipment as listed in Section-C / Section - D. If the listed spares are not adequate, then the bidder shall indicate those and additional spares considered necessary by him.									
Type	Manufacturer's Drawing No. / Part of spare	Description	Material	Quantity per Unit / Equipment	Quantity Required	If set, Nos Per set	Delivery period (Weeks)	Unit Price (Rs.)	Total Price (Rs.)
Erection and Commissioning									
Mandatory Spares									
Additional Spares Mandatory Erection / Commissioning									
PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE									

TITLE		SPECIFICATION NUMBER							
* SCHEDULE OF PRICES FOR RECOMMENDED SPARES		VOLUME III							
SHEET		OF							
The bidder shall give below a list of spares recommended for three years (or as otherwise specified in section - C) for trouble free performance of the equipment / system offered.									
S No	Manufacturer's Drawing No / Part of spare	Description	Material	Quantity per Unit / Equipment	Quantity recommended	If set, Nos. Per set	Delivery period (Weeks)	Unit Price (Rs)	Total Price (Rs)
PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE									
NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL					

	TITLE	SPECIFICATION NUMBER
	SCHEDULE OF PRICE FOR ERECTION AND MAINTENANCE TOOLS & TACKLES	VOLUME III
		SHEET ... OF ...

The bidder shall be give below the list of erection and maintenance tools and tackles as offered by him. This shall also include the customer's list of maintenance tools, if specified in Section - C / Section - D.

S. No	Description of Tools & Tackles	Quantity offered	Unit Price (Rs.)	Total Price (Rs.)

NOTE : The hire charges for vendor's equipment called for in this schedule shall include the cost of consumables, operation services, depreciation, wear and tear as well as vendor's over head and profit. (These rates will be payable by customer to the vendor, only if the customer's requires the use of this equipment for carrying out his own work out side the scope of this contract.)

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE				COMPANY SEAL
NAME	DESIGNATION	SIGNATURE	DATE	

FORM No. PEM - 6056-0



TITLE

**SCHEDULE OF BIDDER'S MAN POWER
FOR SUPERVISION OF E & C
AND THEIR CHARGES**

SPECIFICATION NUMBER

VOLUME III

SHEET _____ OF _____

The bidder shall indicate below, designation-wise, the personnel required for supervision of erection and commissioning and their charges.

SUPERVISION OF ERECTION

Sl. No.	Designation	Normal rate per day of 8 hours	Overtime rate per hour

SUPERVISION OF COMMISSIONING

Sl. No.	Designation	Normal rate per day of 8 hours	Overtime rate per hour

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (BEYOND USEFUL LIFE)
I.	CRANES :-			
1	Portal Gantry Crane 500T	15	24500.00	24500.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	11370.00	10940.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	56290.00	53560.00
4	PORTAL CRANE, 360T	15	14070.00	13390.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	55460.00	52770.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded)	15	68610.00	65280.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	33510.00	31880.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	20940.00	19920.00
9	MANITOWOC M-250T TRUCK CRANE	15	30160.00	28690.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	31660.00	30130.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	26390.00	25110.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	36110.00	34580.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	15130.00	14390.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	18850.00	18050.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	16750.00	15940.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	21780.00	20720.00
15	CRAWLER CRANE SUMITOMO, 150T	15	10890.00	10360.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	13400.00	12750.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	10830.00	10420.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	10720.00	10200.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	8880.00	8440.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	10050.00	9560.00
20	CRAWLER CRANE 100 T (KH 500)	15	10050.00	9560.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	5410.00	5210.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6140.00	5880.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5370.00	5150.00
24	Mobile Crane, 55MT (TIL)	12	4410.00	4230.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3030.00	2910.00
26	MOBILE CRANE, 20MT (TIL)	10	2270.00	2180.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2270.00	2180.00
28	MOBILE CRANE ESCORTS- 14MT	10	710.00	680.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	390.00	370.00

Annexure**C1**

DATE:31/08/2021

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (BEYOND USEFUL LIFE)
30	FORK LIFT 5T	5	650.00	640.00
31	FORK LIFT 3T	5	540.00	530.00

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2019 to 31/8/2021 (BEYOND USEFUL LIFE)
I.	CRANES :-			
1	Portal Gantry Crane 500T	15	27230.00	27230.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	12630.00	12160.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	62550.00	59520.00
4	PORTAL CRANE, 360T	15	15630.00	14880.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	61620.00	58630.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	76230.00	72540.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	37230.00	35420.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	23270.00	22140.00
9	MANITOWOC M-250T TRUCK CRANE	15	33510.00	31880.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	35180.00	33480.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	29320.00	27900.00
11 A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	40120.00	38420.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	16810.00	15990.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	20950.00	20060.00
13	LINKBELT LS- 24BH CRAWLER CRANE (180T)	15	18610.00	17710.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	24200.00	23020.00
15	CRAWLER CRANE SUMITOMO, 150T	15	12100.00	11510.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	14890.00	14170.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	12030.00	11580.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	11910.00	11330.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	9860.00	9380.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	11170.00	10620.00
20	CRAWLER CRANE 100 T (KH 500)	15	11170.00	10620.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	6010.00	5790.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6830.00	6540.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5970.00	5720.00
24	Mobile Crane, 55MT (TIL)	12	4900.00	4700.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3370.00	3240.00
26	MOBILE CRANE, 20MT (TIL)	10	2520.00	2430.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2520.00	2430.00
28	MOBILE CRANE ESCORTS- 14MT	10	790.00	760.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	430.00	410.00

**REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2019 to 31/8/2021 (BEYOND USEFUL LIFE)
30	FORK LIFT 5T	5	720.00	710.00
31	FORK LIFT 3T	5	600.00	590.00

**RATES FOR INTER REGIONAL HIRE CHARGES FOR CRANES OF CAPACITY
75 TON OR MORE FOR PERIOD 01-09-2021 TO 31-08-2023**

		Dt : 31/08/2021
SL NO.	ITEM DESCRIPTION	Rates (Rs./MONTH) valid from 01/09/2021 to 31/8/2023
I.	CRANES : -	
1	Portal Gantry Crane 500T	1243192
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	631183
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	2717358
4	PORTAL CRANE, 360T	679333
5	600MT Class Crawler Crane- Manitowoc Model 18000- UPGRADED	2676917
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Ungraded version)	3311783
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	1617475
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	1010917
9	MANITOWOC M-250T TRUCK CRANE	1455725
10	270 MT Class Crawler Crane- Manitowoc Model 2250	1528508
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	1273758
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	1754150
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	730283
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	915892
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	808733
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	1051358
15	CRAWLER CRANE SUMITOMO, 150T	525675
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	646983
17	CRAWLER CRANE, 120 T Fushun Model QUY120	601125
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	517592
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	428625
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	485242
20	CRAWLER CRANE 100 T (KH 500)	485242
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	300558
22	ROUGH TERRAIN CRANE 75T (RT880)	321758
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	281533

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	20930
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	310
3	MULTI SHEAVE PULLEY BLOCK 100T	630
4	MULTI SHEAVE PULLEY BLOCK 150T	1260
5	ELECTRIC WINCH 5T	1270
6	ELECTRIC WINCH 10T	2360
7	ELECTRIC WINCH 15 T	2150
8	PASSENGER CUM GOODS HOIST 1T	2270
9	FURNACE MAINTENANCE PLATFORM	5040
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2100
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	16380
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	8190
3	WELDING GENERATOR 320/300 A	300
4	WELDING RECTIFIER 400A/300A	300
5	WELDING RECTIFIER 600A	400
6	DIESEL WELDING GENERATOR 400A/300A	400
7	TRANSFORMER,600A	300
8	TRANSFORMER 300/400A	200
III	SERVICE PLANTS & ALLIED EQUIPT.	0
1	500KVA DIESEL GENERATOR	3800
2	TRANSFORMER OIL FILTRATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	6370
3	-DO- , WITH STORAGE TANK	7280
4	OIL FILTRATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	910
5	OIL FILTRATION M/C, 250GPH/1000LPH (OTHER THAN SILICON OIL)	1360
6	OIL FILTRATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	1820
7	OIL FILTRATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON OIL)	3640
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750 LPH	1270
9	Low Vacuum de-hydration unit	630
10	DIESEL GENERATING SET,250 KVA	1770
11	DIESEL GENERATING SET,25 KVA	500

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
12	VACUUM PUMP(ABSOLUTE V.C.)	540
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1090
14	ACID TRANSFER PUMP 20/50 T/HR	540
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	80
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4240
17	AIR COMPRESSORS 250/300/330/360/350 CFM	2730
18	AIR COMPRESSORS 140/150/190/210 CFM	910
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	1820
20	Industrial Blower 2000CFM	1270
21	Air Leak Test Blower (Flow: 40000 m ³ /Hr)	1160
22	Air Blower (Flow: 20000 m ³ /Hr)	940
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	630
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1630
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	1800
4	-do- Gun with nose Assembly only	540
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	36980
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	800
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1090
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1270
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1330
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2230
7	BOLT STRETCHING DEVICE	910
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	3640
9	ULTRASONIC FLAW DETECTOR	2730
10	MPI TEST KIT	360
11	GAS LEAK DETECTOR	270
12	VIBRATION/SOUND LEVEL METER IRD-306	360
13	VIBRATION/SOUND LEVEL METER IRD-308	360
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1450
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2540
16	SHOCK PULSE METER	630
17	HV.DC TEST KIT UPTO 50 KV	540
18	HV.DC TEST KIT ABOVE 50 KV	1000
19	HV.AC TEST KIT UPTO 50KV	810
20	HV.AC TEST KIT ABOVE 50KV	2910
21	MOTORISED MEGGER 2.5KV	400
22	MOTORISED MEGGAR 5KV	450
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	450
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1090
25	WAVEFORM ANALYSER	910
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1630
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1090
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	910

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
29	DIGITAL LOW RESISTANCE METER	630
30	DC POTENTIOMETER	180
31	PRECISION DEAD WEIGHT TESTER	1000
32	OPTICAL ALIGNMENT KIT	1360
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1200
34	VERNIER THEODOLITE,PRECISION	1200
35	VERNIER THEODOLITE,ORDINARY	200
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	120
37	ISKAMATIC 'A'	3200
38	CALIBRATOR '03'	1000
39	48 POLE EXTENDER CARD	200
40	MULTIJET NPM	400
41	OSCILLOMETER	10190
42	VOC EQUIPMENT	1400
43	BINARY SIGNAL GENERATOR	290
44	ELECTRIC COUNTER	690
45	FREQUENCY GENERATOR	1000
46	DBF 3 VIBRATION RECORDER/ANALYSER	3270
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	490
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1180
49	VIBROPORT 41/FFT ANALYSER	5460
50	ELCID kit	10010
51	UNIVERSAL CALIBRATION SYSTEM	2730
52	NATURAL FREQUENCY TESTER	2910
53	DIGITAL HARDNESS TESTER	360
54	ADRE 208 VIBRATION ANALYSER	7280
55	PCB DIAGNOSTIC REPAIR KIT	2000
56	SECONDARY INJECTION RELAY TEST KIT	5270
57	MICRO OHM METER	1450
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 $\mu\Omega$ TO 20K Ω	3230
59	PMI Machine OLYMPUS make	3350
60	Mobile Lighting Mast - 9 metres (4X400 W)	860
61	10KVA RESISTANCE BRAZING MACHINE	140
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	460
63	HYDROGEN GAS LEAK DETECTOR	50
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	4980
65	WEDGE DEFLECTION KIT	80
66	TILE PRESSING MACHINE FOR GAS TURBINE	270
67	INDUCTION BRAZING MACHINE	4870
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	3640
69	ULTRASONIC FLOW METER	180
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	40
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -14KG/SQ CM. ; FLOW 60 M3/HR	470
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. ; FLOW 15 M3/HR	430

**RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	1810
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1280
75	5KV Insulation Tester	450
76	4 Channel Digital Oscilloscope /Fast Recorder	1710
77	4 Channel Oscillographic Recorder	580
78	Sound Level Meter	230
79	Thermal Imaging Camera	770
80	Videoscope (Video Boroscope)	1510
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1310
82	Conductivity Meter	80
83	Core Flux Test Kit	7280
84	Primary Current Injection Kit (2000A)	870
85	3 Phase Secondary Injection Kit (Relay Test)	3760
86	FRF Filtration Kit	1330
87	FFT Analyser	2290
88	Flue Gas Analyser	1030
89	Oil Test Kit (Mineral Oil)-Transformer	1010
90	Winding Resistance kit (R L C Load)	880
91	SFRA test Kit	1190
92	Tan Delta test Kit	4080
93	PF Meter	330
94	Ultrasonic Flow Meter	830
95	Oil Particle Counter	360
96	Plasma Cutting Machine (With complete accessories)	310
97	JCB make DG Set 80 KVA	670
98	Diesel Generating Set 82.5 KVA	610
99	Portable Jacking Oil Pump	1080
100	Alloy Analyser	1770

**RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS
ETC. FOR OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
I	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	23250
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	350
3	MULTI SHEAVE PULLEY BLOCK 100T	700
4	MULTI SHEAVE PULLEY BLOCK 150T	1400
5	ELECTRIC WINCH 5T	1410
6	ELECTRIC WINCH 10T	2620
7	ELECTRIC WINCH 15 T	2390
8	PASSENGER CUM GOODS HOIST 1T	2520
9	FURNACE MAINTENANCE PLATFORM	5600
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2330
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	18190
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	9090
3	WELDING GENERATOR 320/300 A	330
4	WELDING RECTIFIER 400A/300A	330
5	WELDING RECTIFIER 600A	440
6	DIESEL WELDING GENERATOR 400A/300A	440
7	TRANSFORMER, 600A	330
8	TRANSFORMER 300/400A	220
III	SERVICE PLANTS & ALLIED EQUIPT.	
1	500KVA DIESEL GENERATOR	4220
2	TRANSFORMER OIL FILTRATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	7070
3	-DO-, WITH STORAGE TANK	8080
4	OIL FILTRATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	1010
5	OIL FILTRATION M/C, 250GPH/1000LPH (OTHER THAN SILICON OIL)	1510
6	OIL FILTRATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	2020
7	OIL FILTRATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON OIL)	4040
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750 LPH	1410
9	Low Vacuum de-hydration unit	700
10	DIESEL GENERATING SET, 250 KVA	1970
11	DIESEL GENERATING SET, 25 KVA	560
12	VACUUM PUMP (ABSOLUTE V.C.)	600
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1210
14	ACID TRANSFER PUMP 20/50 T/HR	600
15	DEWATERING PUMP (Kirloskar make, 11KW/15HP)	90
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4710
17	AIR COMPRESSORS 250/300/330/360/350 CFM	3030
18	AIR COMPRESSORS 140/150/190/210 CFM	1010

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	2020
20	Industrial Blower 2000CFM	1410
21	Air Leak Test Blower (Flow: 40000 m³/Hr)	1290
22	Air Blower (Flow: 20000 m³/Hr)	1040
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	700
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1810
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	2000
4	-do- Gun with nose Assembly only	600
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	41090
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	880
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1210
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1410
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1480
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2480
7	BOLT STRETCHING DEVICE	1010
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	4040
9	ULTRASONIC FLAW DETECTOR	3030
10	MPI TEST KIT	400
11	GAS LEAK DETECTOR	300
12	VIBRATION/SOUND LEVEL METER IRD-306	400
13	VIBRATION/SOUND LEVEL METER IRD-308	400
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1610
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2830
16	SHOCK PULSE METER	700
17	HV.DC TEST KIT UPTO 50 KV	600
18	HV.DC TEST KIT ABOVE 50 KV	1110
19	HV.AC TEST KIT UPTO 50KV	900
20	HV.AC TEST KIT ABOVE 50KV	3230
21	MOTORISED MEGGER 2.5KV	440
22	MOTORISED MEGGAR 5KV	500
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	500
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1210
25	WAVEFORM ANALYSER	1010
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1810
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1210
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	1010
29	DIGITAL LOW RESISTANCE METER	700
30	DC POTENTIOMETER	200
31	PRECISION DEAD WEIGHT TESTER	1110
32	OPTICAL ALIGNMENT KIT	1510
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1330
34	VERNIER THEODOLITE,PRECISION	1330
35	VERNIER THEODOLITE,ORDINARY	220

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

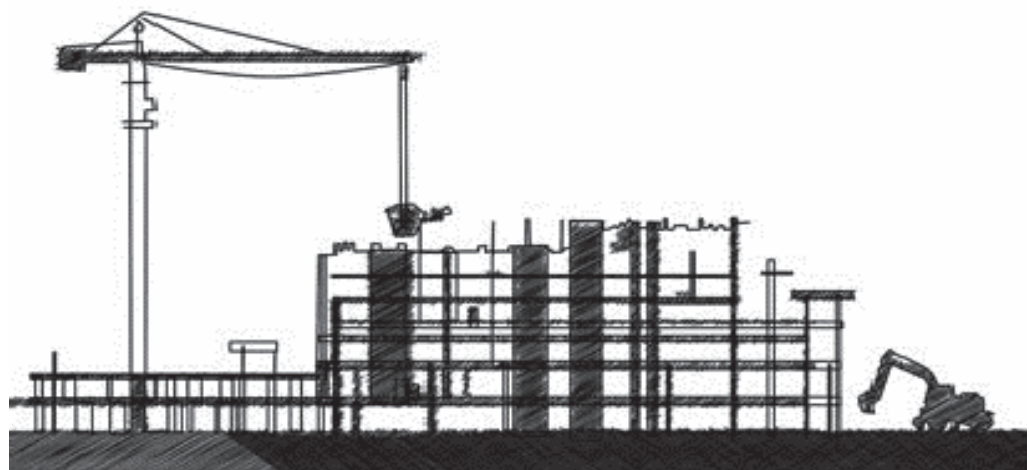
SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	130
37	ISKAMATIC 'A'	3550
38	CALIBRATOR '03'	1110
39	48 POLE EXTENDER CARD	220
40	MULTIJET NPM	440
41	OSCILLOMETER	11320
42	VOC EQUIPMENT	1550
43	BINARY SIGNAL GENERATOR	320
44	ELECTRIC COUNTER	760
45	FREQUENCY GENERATOR	1110
46	DBF 3 VIBRATION RECORDER/ANALYSER	3630
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	540
48	L&T GOULD OSCILLOGRAPH 8-CHANNEL	1310
49	VIBROPORT 41/FFT ANALYSER	6060
50	ELCID kit	11120
51	UNIVERSAL CALIBRATION SYSTEM	3030
52	NATURAL FREQUENCY TESTER	3230
53	DIGITAL HARDNESS TESTER	400
54	ADRE 208 VIBRATION ANALYSER	8080
55	PCB DIAGNOSTIC REPAIR KIT	2220
56	SECONDARY INJECTION RELAY TEST KIT	5860
57	MICRO OHM METER	1610
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 $\mu\Omega$ TO 20K Ω	3590
59	PMI Machine OLYMPUS make	3730
60	Mobile Lighting Mast - 9 metres (4X400 W)	960
61	10KVA RESISTANCE BRAZING MACHINE	160
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	510
63	HYDROGEN GAS LEAK DETECTOR	60
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	5530
65	WEDGE DEFLECTION KIT	90
66	TILE PRESSING MACHINE FOR GAS TURBINE	300
67	INDUCTION BRAZING MACHINE	5410
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	4040
69	ULTRASONIC FLOW METER	200
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	50
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -14KG/SQ CM. ; FLOW 60 M3/HR	520
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. ; FLOW 15 M3/HR	480
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	2010
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1400
75	5KV Insulation Tester	500

**RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS
ETC. FOR OUTSIDE AGENCIES**

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
76	4 Channel Digital Oscilloscope /Fast Recorder	1900
77	4 Channel Oscillographic Recorder	650
78	Sound Level Meter	260
79	Thermal Imaging Camera	860
80	Videoscope (Video Boroscope)	1680
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1460
82	Conductivity Meter	90
83	Core Flux Test Kit	8090
84	Primary Current Injection Kit (2000A)	960
85	3 Phase Secondary Injection Kit (Relay Test)	4180
86	FRF Filtration Kit	1480
87	FFT Analyser	2550
88	Flue Gas Analyser	1140
89	Oil Test Kit (Mineral Oil)-Transformer	1120
90	Winding Resistance kit (R L C Load)	970
91	SFRA test Kit	1320
92	Tan Delta test Kit	4510
93	PF Meter	360
94	Ultrasonic Flow Meter	920
95	Oil Particle Counter	400
96	Plasma Cutting Machine (With complete accessories)	340
97	JCB make DG Set 80 KVA	740
98	Diesel Generating Set 82.5 KVA	680
99	Portable Jacking Oil Pump	1200
100	Alloy Analyser	1970

**HSEP14**

Health, Safety & Environment Plan for Site Operations by Subcontractors



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D	ANNEXURE D: Specifications of Rest Sheds	
E	ANNEXURE E: Minimum Requirements of Labor Accommodation/ Colony	
F	ANNEXURE F: Specifications & Availability for Toilets at Site	
G	ANNEXURE G: Specifications for Numbers and Types of Fire Extinguishers	
H	ANNEXURE H: HSE Compliance Certificate Sample	
I	ANNEXURE I: Detailed Safety Requirements/ Precautions for Various Hazardous Activities/ Conditions	
J	ANNEXURE J: Details & Contents of First-Aid Box	
K	ANNEXURE K: Vertigo Test Procedure	

SECTION A

CRITICAL RESOURCES FOR HSE IMPLEMENTATION

1. SHARING OF OPERATING COSTS OF FACILITIES

TABLE A.1

SN	FACILITY
1	Ambulance with 24 hr. First Aid Trained Driver (Specs in Annexure A)
2	Operation of Medical center, Nurses, Medical Consumables etc. (Specs in Annexure A)
3	Training Center Consumables
4	Water sprinkling for dust suppression
	(Others:)

Note:

- Responsibility of operation of above facilities shall rest with BHEL
- Operating cost of the above shall be deducted from subcontractors on 'proportional to contract' value basis. Sample deduction table enclosed as Annexure A.1
- "Contract value" defined above & subsequently in the document shall be considered as "Awarded contract value".
- No overhead cost/ enabling cost of BHEL shall be levied on the contractors for common facilities.
- These running costs shall be recovered from all the available subcontractors at site for the complete operational duration of the site
- No overheads shall be charged on shared operating costs

2. RESOURCES TO BE PROVIDED SOLELY BY THE SUBCONTRACTOR

TABLE A.2

SN	ITEM	SPECIFICATIONS
1.	HSE DISPLAYS, Posters and signage	Annexure B
2.	HSE Tools/ Equipment/ Devices	Annexure C
3.	Rest Sheds for Workers	Annexure D
4.	Labor Colony	Annexure E
5.	Toilets (Latrines & Urinals) - in Site and Labor Colony	Annexure F
6.	Fire Extinguishers	Annexure G

Note:

In case subcontractor fails to provide the required resources, same will be procured and deployed by BHEL with applicable overhead on total procurement cost

3. ESTABLISHMENT OF COMMON FACILITIES

In green field projects BHEL shall arrange and provide the following facilities which shall be used by all subcontractors for their employees and workers. These shall be

- Medical Centre
- Safety park with facilities of audio-visual training & vertigo test center.
- No cost shall be deducted from the subcontractors for the structure part only.
- The running cost with basic inputs already mentioned at Point 1 above shall be shared by all contractors.
- The sub-contractors shall be required to ensure participation in trainings, medical checkup and vertigo test as per the guidelines laid in this document and required as per statutory HSE requirements.

- vi. However, in projects where in these facilities are not provided by BHEL, subcontractors shall ensure the training, medical/ vertigo test of all workers at site in consultation and guidance of BHEL HSE team at site in line with provisions of this document.
- vii. The overall onus of compliance to HSE practices pertaining to training, medical checkup including vertigo test shall lie on the subcontractor only.

4. CRITICAL REQUIREMENTS W.R.T. EQUIPMENT & PPES

- i. Conventional Hydra crane with carriage in front shall not be permitted. Pick & carry tyre mounted Front Cabin mobile crane (FX or TRX/ NextGen series of 'ESCORT' or equivalent make) shall only be permitted.
- ii. Any Heavy equipment (cranes, winch machines, etc.) shall be deployed only after pre-safety Inspection by safety dept. Valid AMCs/ Fitness/ other statutory clearances as per local rules shall be required to be submitted before mobilizing the equipment at site.
- iii. All other Hand tools and power tools should not be older than 5 years.
- iv. For Chimney passenger lift, winch to have double drum rope for passenger and double safety devices must be used. Winch should not more than 3 years old and winch rope must be inspected with valid certificate from competent authority within 6 months and should meet the IS standard 9507 provision of OLR and push back button arrangement or dead man switch.
- v. Gate pass for all the lifting T&Ps and construction machinery/ equipment shall be made after obtaining written acceptance (Pre-entry Safety Clearance) from BHEL Site Safety Department after physical verification and checking all requisite documents/ compliance to Safety norms
- vi. All motor vehicles should have valid registration certificate, insurance, Pollution under control (PUC) and fitness certificate as per Motor Vehicle Act 2020. The certificates should be pasted in the glass from inside.
- vii. PPEs shall be from reputed manufactures viz. 3M, Udyogi, Karam, Frontier, Freedom, Honeywell, Liberty, Bata, Nomex, Acme, Unicare, Life Gear or equivalent. In case Subcontractor recommends any other name the same can be approved at site level by the Construction manager & Site HSE
- viii. For height work, where fall could result in death or disability, a secondary means of fall protection (Safety Net, Retractable Fall Arrestor etc.) shall be mandatorily provided by the subcontractor, failing which, a penalty of INR 10000 per case will be imposed. In addition, there should be constant supervision for such critical height work. Any non-erection activities at height eg. Housekeeping etc. shall also fall under the category of height work
- ix. **Scaffold Tagging**

Scaffolds being erected, modified or dismantled must be tagged as suitable for use. Tagging shall be done with standard tag holder. Scaffolding tag should be certified by scaffolding inspector having valid certificate.

- **GREEN** scaffold tag- shall be fixed when scaffold is complete and safe for use, signed and dated by the scaffolding competent person daily.
- **RED** scaffold tag – to be fixed if scaffold is in some way defective and cannot be used or is still under erection.
- **YELLOW** scaffold tag – to be fixed if scaffold is in under construction/ maintenance.



FIG. A.4.1 SAMPLE SCAFFOLD TAGS AND TAG HOLDER

x. **T&P Color Coding:**

- a. Inspections and tests shall be documented by means of color coding which shall verify that inspections or testing are current and that all receptacles, portable Power tools, Lifting Tools & Tackles have been inspected and tested as required. The color codes used on the project shall be:

GREEN	BLUE	YELLOW	PURPLE
January	April	July	October
February	May	August	November
March	June	September	December

TABLE. A.4.2: T&P COLOR CODES

- b. The cycle of colors shall be Quarterly as a minimum or as decided by BHEL. The color code tape / Sticker shall be clearly visible to designate the period for which the inspections and tests were conducted.
- c. Following the initial inspection, the equipment must be color-coded quarterly as per color-coding instructions that will be issued by the subcontractor.
- d. Fire extinguisher with the current month color-coding inspection sticker must be provided and secured in the platform.
- e. All slings shall be regularly inspected in accordance with the requirement of the project for frequent and periodic inspections and discard immediately if they fail to meet the minimum requirements of the project.
- f. The Subcontractor's HSE Officer shall ensure that all PPE is inspected prior to its issue. He is to ensure all subcontractor personnel are using safe and proper PPE equipment.

inspections on the PPE shall be carried out and personnel not adhering to those inspections shall be removed immediately from the site.

- g. A Ten (10) day interval period shall be given into each monthly color code change. During this Ten (10) day period either color shall be acceptable.

xi. **T&P Tagging:**

All deployed Wire Rope Slings, Chain Pulley Blocks, Hooks, slings etc. shall be Tagged using aluminum or any other metal tag with punching.

5. HSE PERSONNEL TO BE PROVIDED SOLELY BY THE SUBCONTRACTOR

5.1. NUMBERS OF HSE PERSONNEL (APPLICABLE FOR EACH WORK SHIFT)

Number of HSE Officers and Supervisors shall be in proportion to number of workers as per Table A.6 below

TABLE A.5

No. of Workers	No. of HSE Supervisors	No. of HSE Officers
Up to 100	1	1
101 to 250	2	1
251 to 500	4	1
501 to 1000	6	2
1000 to 2000	6+ One additional supervisor up to every additional 250 workers	3
2000-3000	10+ One additional supervisor up to every additional 250 workers	4
3000-4000	14+ One additional supervisor up to every additional 250 workers	5

5.1.1. DEPLOYMENT PLAN

- Above requirement is for every shift for each unit.
- The dynamic deployment plan of Safety manpower at various locations containing names, areas, time periods, shifts etc. shall be submitted to BHEL for approval by subcontractor
- BHEL may modify the deployment plan based on nature and volume of jobs, Risks and hazards associated etc.
- For less than 20 workers HSE Officer is not mandatory. In case the number of workers exceed 20 for 3 consecutive months, HSE Officer is to be engaged. The HSE Officer shall be deployed for a minimum period of 6 months even if the number of workers fall below 20 in any month subsequent to deployment. If within that 6-month period, the number of workers is more than 20 for at least 3 months, the deployment duration of HSE Officer will extend further 6 months after completion of previous 6-month period.
- For Site Material Management/ Handling (Loading/ Unloading) contracts, 1 no. HSE Officer shall be required irrespective of the total manpower deployed.
- HSE Officers/Supervisors of all the vendors may be required to report directly to BHEL HSE Officer at site & shall comprise as a total team for handling all HSE issues. However, each safety officer/ agency shall be individually responsible for the safe execution of work in their respective areas.

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5.2. QUALIFICATION & EXPERIENCE REQUIREMENTS OF HSE PERSONNEL

5.2.1. HSE OFFICER

First HSE Officer to be mandatorily as per Option I as under and shall be designated Senior HSE Officer. In case of non-availability of HSE Officers with Option I configuration, the subsequent HSE Officers can be as per Option II below with recorded reasons and approval of Site Construction Manager of BHEL. All these deviations should be reported to Region HSE and PSHQ HSE.

A. Option I

- i. possesses a recognized degree in any branch of engineering or technology or architecture and had a practical experience of working in a building or other construction work in a supervisory capacity for a period of not less than two years or possesses a recognized diploma in any branch of engineering or technology and has had practical experience of building or other construction work in a supervisory capacity for a period of not less than five years;
- ii. possesses a recognized degree or diploma in industrial safety with at least one paper in construction safety (as an elective subject/ part thereof);
- iii. has adequate knowledge of the language spoken by majority of building workers from the construction site in which he is to be appointed.

B. Option II:

Graduation Degree in Science with Physics & Chemistry and degree or diploma in Industrial Safety (All Degrees/ Diploma from any Indian institutes recognized by AICTE or State Council of Technical Education of any Indian State) with practical experience of working in a building, plant or other construction works (as HSE Officer, in line with Indian Factories Act, 1958 or BOCW Act, 1996) for a period of not less than five years

Note:

- i. HSE Officer as per Option II shall be valid only on availability of Senior HSE Officer as per Option I at site.
- ii. In case of resignation of the Senior HSE Officer, the same has to be replaced within 15 days else all subsequent HSE Officers as per Option II (in case of multiple HSE Officers with a single agency) shall not be considered as valid.
- iii. The penalty shall be deducted considering non-availability of any HSE Officer at site.

5.2.2. HSE SUPERVISOR: EITHER OF X OR Y BELOW

X. Recognized Degree in any branch of Engineering OR Diploma in any branch of engineering with at least one-year construction experience

OR

Y. A recognized graduation Degree in Science (with Physics & Chemistry) or a recognized diploma in Engg. or Tech.

Additional requirements for option (Y) above

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- i. Trained in fire-fighting as well as in safety / occupational health related subjects, with:
- ii. Minimum Two years of practical experience in construction work environment or in the field of safety and

Note:

- i. Option a above is by default, b is under special approval from Site HSE & Construction manager
- ii. In both cases the candidate should possess requisite skills to deal with construction & fire safety related day-to-day issues.

5.3. HSE IN-CHARGE

In case there is more than one HSE Officer with any subcontractor, one of them, who is senior most by experience & meets qualification as per option 1 as mentioned in clause 2.1 A above (in HSE discipline), may be designated as HSE In-charge who will be the nodal point of contact on HSE matters.

5.4. SUPPORTING STAFF TO HSE TEAM

- i. Supporting Staff shall include scaffolders, scaffolding inspectors, riggers, skilled and unskilled manpower
- ii. Subcontractor shall provide adequate number of workers as and when required, in order to attend and comply to Safety observations raised by BHEL/ Customer.

5.5. AVAILABILITY AND PENALTY FOR NON-DEPLOYMENT

- i. The subcontractor shall submit the certificates of qualification & experience of HSE manpower before deployment for BHEL to assess suitability as per requirement detailed in this document
- ii. In case of rejection, subcontractor shall arrange additional candidates and submit resume to BHEL. Penalties will be applicable during the period of non-deployment in such cases as well.
- iii. Subcontractor shall ensure physical availability of safety personnel at the place of specific work locations.
- iv. The Subcontractor shall deploy the HSE Officers as per the site's requirement. Non-deployment shall lead to stoppage of the work and final decision shall rest with Site HSE & Construction manager.
- v. The Subcontractor shall prepare an organization chart identifying the areas of operations, responsibilities and reporting structure of all safety personnel for each shift and submit the same to BHEL.
- vi. The subcontractor shall deploy sufficient HSE Officers, supervisors, as per numbers & qualifications mandated in this Section since mobilization of first batch of manpower and add more in proportion to the added strength in work force. Any delay in deployment will attract a penalty at following rates:

Non-deployment of HSE Officer –	Rs. 75,000 per man-month
Non-deployment of HSE Supervisor –	Rs. 50,000 per man-month

- vii. Penalty shall be collected for the period of non-availability of safety personnel after allowing a grace period of 15 days for finding a replacement. The same shall be deducted on pro-rata basis till the required manpower is deployed.
- viii. In case of abnormal delay & frequent rejections of candidates proposed by the subcontractor, BHEL shall exercise the right to deploy the safety manpower & deduct the amount from subcontractor's running bill with applicable overheads. In such cases also, the provision of logistics, transportation, food and other logistical support to the HSE personnel shall be in the scope of subcontractor in addition to the salary. After deployment of manpower by BHEL, the penalty for non-deployment specified above shall not be applicable.

6. COMPETENCY OF OPERATORS/ DRIVERS OF CRANE, WINCH, LIFTING/ CONSTRUCTION EQUIPMENT ETC.

- i. The Operators/ Drivers of crane, winch, construction/ lifting equipment etc. shall be experienced and have valid driving license for the class of vehicle / machinery as applicable (like Crane/ Forklift/ Rig, Construction equipment driving license etc.).
- ii. Minimum HMV driving license is required for all heavy equipment/ heavy vehicle (trailer/ Hyva /dumper /TM) operators at site.
- iii. The subcontractor shall certify competence of these persons in writing as and when they are posted at site.
- iv. Crane, Winch, Construction & lifting equipment operator should have certificate on subject course or experience certificate in employer letterhead.
- v. Where state is providing license for operating crane, tractor and other construction vehicles, same to be ensured.

Note: In case the statutory requirements i.e. State or Central Acts and / or Rules as applicable like the Building and Other Construction Workers' Regulation of Employment and Conditions of Service- Act,1996 or State Rules (wherever notified), the Factories Act, 1948 or Rules (wherever notified), etc. are more stringent than above, the same shall be followed.

- 7. In case of any stringent requirement of BHEL's customer over and above the specifications mentioned in current document, the same shall also be required to be complied at site by subcontractor.

8. REFERENCES

The Safety Rules for Construction & Erection as outlined hereunder, while setting out a broad parameter of safety norms, are not exhaustive. The subcontractor and his agencies are advised to refer to the following statutory provisions as amended from time to time for details and strict compliance therewith.

8.1.FOR GREENFIELD PROJECTS

- a) Building and Other Construction Workers (regulation of employment and conditions of service) Act, 1996 (briefly referred to as BOCW Act),
- b) Building and other construction workers (regulation of employment and conditions of service) Central Rules, 1998 (briefly referred to as BOCW Rules) as adopted by the various State Governments,

8.2. FOR EXPANSION, MODIFICATION, ALTERATION AND, OR CONSTRUCTION ACTIVITY WITHIN AN EXISTING PLANT OPERATING AS PER APPROVED SITE PLAN UNDER THE FACTORIES ACT

- a) Factories Act, 1948,
- b) Factories Rules, as adopted by the various State Governments
- c) BOCW Act
- d) BOCW Rules
- e) In case a new act/ statutory guideline/ modification/ consolidation of acts is implemented the same shall be required to be adhered by the subcontractor.
- f) The latest amendment of the above-mentioned acts/ rules shall be followed at site.

9. BHEL POWER SECTOR HSE MANAGEMENT SYSTEM

The Systems and procedures of BHEL Power Sector HSE Management System shall be implemented by the subcontractor, including:

- HSE PROCEDURE FOR REGISTER OF OHS HAZARDS AND RISKS
- HSE PROCEDURE FOR REGISTER OF ENVIRONMENTAL ASPECTS AND IMPACTS
- HSE PROCEDURE FOR REGISTER OF REGULATIONS
- HSE PROCEDURE FOR TRAINING AND AWARENESS
- HSE PROCEDURE FOR EMERGENCY PREPAREDNESS AND RESPONSE PLAN
- HSE PROCEDURE FOR PERMIT TO WORK
- HSE INSPECTION AND OTHER FORMATS

Note:

- i. BHEL reserves the right to revise/ update these systems and procedure as per requirement to address any changing HSE needs
- ii. BHEL will provide hard / soft copies of applicable HSE Procedures, Work Permits, Operational Control Procedures, Inspection/ Other Formats etc. that are necessary for ensuring safe work to the successful bidder at Site. It is the responsibility of the subcontractor to ensure availability of these documents before commencing work at site.
- iii. The subcontractor can get soft copies of these documents from respective Region SCT/ HSE for reference. The signed hard copies of the same shall not be required to be submitted along with tender document
- iv. Subcontractor shall use the Digital (Web & App-Based) HSE management Software Systems provided by BHEL whenever provided. In case not provided, hard copy systems will continue to be used. All information technology resources (Computers, mobile phones, mobile data, internet access etc.) for the use of such systems shall be ensured by the subcontractor.

10. CLEARANCE OF MONTHLY RUNNING BILLS SUBJECT TO SAFETY COMPLIANCE

- The monthly running Bills of the subcontractor shall be released subject to compliance to HSE requirements as per checklist in Annexure H
- BHEL site HSE Head and Package In-charge shall be authorized to issue the clearance
- Site Construction Manager of BHEL shall be the final authority on the matter.

11. HSE PERFORMANCE EVALUATION

- Subcontractor shall be assessed on monthly basis for HSE Compliance by BHEL Safety In-charge at site.
- The HSE evaluation shall be based on HSE Performance Evaluation System of BHEL covering the contractual, statutory and regulatory requirements of HSE.
- BHEL shall reserve the right to use these performance scores for evaluating bidder's capacity for future tenders
- If safety record of the subcontractor in execution of the awarded job is to the satisfaction of safety department of BHEL, issue of an appropriate certificate to recognize the safety performance of the subcontractor may be considered by BHEL after completion of the job, provided the execution performance is satisfactory.

12. HSE PENALTIES

- Nonconformity of safety rules and safety appliances will be viewed seriously and BHEL has right to impose fines on the subcontractor for every instance of violation noticed.
- As per contractual provision HSE penalties shall be imposed on subcontractors for non-compliance on HSE requirement as per following format.
- Following are the applicable penalties for various Safety violations:

Sub: MEMO for Penalty for non-compliances in Safety

Following lapse (tick marked) was observed and penalty (in Rs.) is imposed as stated at the bottom of this memo. It is requested that such occurrences be please avoided in future.

S. No	Nature of Non - Compliance	Penalty (in INR)	Remarks
A. System Violations			
1	Working without valid Work Permit/ HIRA/ Method Statement / JSA	2000	Per case
2	Controls as per Work Permit/ HIRA/MS/JSA not ensured	2000	Per case
3	Reported Safety Violations Not Closed within Stipulated Time	1000-10000	Per case
4	Absence of required Subcontractor Officials (Site Head, HS Head) in Safety Reviews/Meetings	5000	Per case
5	Not providing required PPEs (Safety Harness, Lifeline, Safety Net, Fall arrestor, Safety Helmet, Gloves, Shoes etc.) for the work by subcontractor	2000	Per case
B. Competency/ Training/ Induction Violations			

1	Incompetent personnel deployed for specialized jobs like height work, hot work, rigging, vehicle operation etc. (without valid license/ certificate etc.)	3000	Per case
2	Work without induction training & medical check	2000	Per case
3	Height Work without Vertigo Test and height work training	2000	Per case
C. PPE Violations – Height Work			
1	Not wearing/ hooking Double Lanyard Safety Harness while working at height (> 1.2 meters) or not anchoring to lifeline	1000	Per case
2	Not Providing Lifeline for height work	3000	
3	Unsafe platforms – without Top, Mid Rails and Toe-Guards for Height Work	3000	
4	Not providing secondary means of fall protection for height work (Safety Nets, Retractable Fall Arrestors etc.)	3000	Per case
D. PPE Violations – General			
1	Not wearing safety helmet	1000	Per case
2	Wearing of helmets without chin straps	1000	Per case
3	Not Wearing safety shoes	500	Per case
4	Not wearing gloves	500	Per case
6	Not using grinding goggles/ face shield during grinding/ cutting	2000	Per case
E. Electrical Safety Violations			
1	Broken/ exposed wires/ cables	2000	Per case per day
2	Electrical plug not used for connection/ hand machines	1000	Per case per day
3	Not using proper ELCBs for electrical equipment	2000	Per case per day
4	Improper earthing of welding & Other electrical machines (Lack of double earthing, improper/ untested earth pit etc.)	2000	Per case per day
5	Not using 24 V supply for lighting in confined spaces	2000	Per case
6	Cables haphazard/ blocking way/ not organized properly	1000	Per case per day
F. Lifting & Rigging Violations			
1	Using Sling/ Chain Pulley Block and other Small T&Ps without proper, traceable Tag and Test Certificate	2000	Per T&P per day
2	Using damaged slings or not slinging properly	2000	Per T&P per day
3	Use of lifting equipment without having valid Test certificate	5000	Per equipment per seven days
4	Lifting hooks used without latches	2000	Per hook per day
5	Not effectively barricading area below lifting activity	5000	Per case
6	Using untrained/ unqualified rigger	5000	Per case
G. Housekeeping			
1	Non-removal of scrap from platforms	5000	Per Event Per location per 7 days
2	Not conducting scheduled housekeeping drives	5000	Per drive
H. Hot Work Safety Violations			
1	Gas cutting without flash back arrestor at both ends	5000	Per machine per incidence
2	Gas cutting at height without fire blanket	2000	Per event

3	Not keeping gas cylinders vertically	2000	Per event
4	Lifting cylinders without cage or rolling of cylinders	2000	Per incidence
5	Leakage in gas cylinder	2000	Per incidence
I. Vehicle Safety/ Operation			
1	Not having valid driving license for the type of vehicle/ T&P	2000	Per driver per incidence
2	Two-wheeler entry in construction area	2000	Per vehicle
3	Using Hydra for material movement at site in unsafe manner	2000	Per case
4	Using Two Hydra in Tandem for material movement without proper precautions as per OCP	2000	Per case
5	Vehicles, Hydras, Cranes, Dumpers and Earth Movers not having automatic back horns linked to gear	2000	Per Equipment per day
6	Not providing proper hard barricades around excavations/ unpermitted areas	5000	Per location per day
7	Not using guide rope while transporting material using Hydra or Cranes	2000	Per event
8	Over speeding	5000	Per case
9	Using Conventional Hydra crane	50000	Per day /crane
J. Accidents/ Incidents/ Near Misses			
1	Non-reporting of Near Miss/ Incident	20000	Per case
2	Major Accident – Worker unable to resume work within 48 hrs	100000	Per incident
3	Fatal Accident	500000	Per incident
K. Miscellaneous			
1.	Not providing the facility (drinking water, rest shed, labor colony etc. as per the specifications/ requirement)	5000	Per month per violation
2.	Not nominating the required number of workers for training as per plan	5000	Per incidence
3.	Lack of proper arrangement for disposal of sewage/ waste water/ effluents etc.	10000	Per incidence

Details (if any) related to non- compliance (Name of persons, Nature of deficiency, etc.):

Penalty Amount:

1. Rate as per above chart
2. No. of Persons/ machine/ event/ labor
3. No. of times the same error is repeated: Repetition factor
4. Total Penalty= 1. X 2. X 3. =

Witnessed by:

(Sub- Subcontractor representative)
representative)

(BHEL

Signature

Name

Bharat Heavy Electricals Limited, Power Sector

Regd. Office: BHEL House, Siri Fort, New Delhi-110049



Distribution: 1 Copy: to Sub- subcontractor Site In-charge,
1 Copy to Site Construction Manager (BHEL)
1 Copy to Site Finance

Note:

- i. In case the amount of penalty imposed by BHEL's Client on BHEL for Safety violation/ incident due to or in the area of the subcontractor is more than those indicated above, same shall be imposed back-to-back on the subcontractor. However, in case such an amount is less than the specified above, penalty amount indicated above shall be imposed on the subcontractor.
- ii. For same violation only one penalty (higher of the two mentioned below) shall be applicable
 - a. Penalty imposed by BHEL's Customer over BHEL.
 - b. Penalty as indicated in current document.
- iii. For repeated violation for the same equipment/ location, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.
- iv. For repeated fatal incident in the same Unit incremental penalty shall be imposed: The subcontractor will pay 2 times the previously paid penalty in case there is repeated major/ fatal incident under the same subcontractor for the same package in the same unit.
- v. Any other non-conformity noticed not listed above will also be fined as deemed fit by BHEL. The decision of BHEL engineer is final on the above.
- vi. If principal customer/statutory and regulatory bodies impose some penalty on HSE due to the non-compliance of the subcontractor the same shall be passed on to them.
- vii. The penalty amount shall be recovered by BHEL Finance department from subcontractors from the RA/Final bill.

13. PUNITIVE ACTIONS FOR "CRITICAL SAFETY VIOLATIONS":

"Critical Safety Violations" include:

- i. Not wearing required PPEs when provided and not following safe work procedure
- ii. Taking unnecessary risks especially in height work, hot work, radiation work, lifting activity
- iii. Coming to work under influence of sedatives like alcohol, drugs etc.
- iv. Coming to work without ID Card/ Gate Pass (if provided)
- v. Intimidating/ threatening at work
- vi. Using cell phones during height work, hot work, lifting activity, driving.

In case any worker carries out any of the critical safety violations as above, BHEL reserves the right to enforce punitive action in following manner:

First Offence:	1 Punch on Gate Pass/ Induction Card/ ID Card etc. and 1-hour HSE Training. With one day off from duty
Second Offence:	2 Punches and 2-hours HSE Training with one day off from duty

Third Offence:	3 Punches and the worker will be dismissed. Gate pass to be confiscated

In case any employee of subcontractor carries out any of the critical safety violations as above, subcontractor Site In-charge shall issue warning letter to concerned employee with copy to BHEL

Note:

- i. For above violations, guilt of the worker/ employee has to be established through appropriate evidences and records maintained.
- ii. If worker/ employee has not been given the required PPEs and safety equipment by the agency and/or not facilitated by the agency to follow safety rules, he/ she will not be considered liable but the agency will be penalized as per penalty provision in this document. In such cases, the subcontractor shall not pass the penalty over to the worker/ employee through wage deduction etc.
- iii. These critical safety violations and their consequences shall be shared with all workers and employees during induction and other training programs/ meetings, toolbox talks etc.
- iv. Gate Pass shall have provision of Tagging as indicated above
- v. The appellate authority (only for final dismissal) in this case shall be the BHEL Site In-charge whose decision shall be final on the matter and binding on all parties.

14. LEGAL IMPLICATIONS

Any legal Costs incurred by BHEL, on account of accidents taking place in the activities of the subcontractor, shall be debited to the subcontractor on actual cost basis.

For any accident occurring at site to any worker/ employee of the subcontractor leading to legal implications to BHEL Employee/ Management shall be safeguarded by BHEL legal department. All legal expenses incurred by BHEL on this account shall be recovered from the subcontractor. The accident also includes fire, loss of property or life at site.

15. HSE REVIEW MEETING

- i. Subcontractor Site In-charge and HSE In-charge shall attend the HSE Review Meeting as and when called by BHEL.

The indicative agenda points are given below:

- a) Implementation of earlier MOM points
- b) Compliance Status of HSE Observations
- c) Incidents & Near Misses, their Root Causes and Actions Taken
- d) HSE performance review
- e) HSE inspection findings
- f) HSE audit and CAPA
- g) HSE training
- h) Health check-up camp
- i) HSE planning for the erection and commissioning and installation activities in the coming month

- j) HSE reward and promotional activities
- ii. MOM on the discussion along with HSE observations will be circulated to the subcontractor for action.
- iii. The subcontractor shall close the observations to the satisfaction of BHEL within stipulated time frame

16. OTHER REQUIREMENTS

- i. If the subcontractor fails to improve the standards of safety in its operation to the satisfaction of BHEL after being given reasonable opportunity to do so and/or if the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instruction regarding safety issued by BHEL, BHEL shall have the right to take corrective steps and the cost shall be debited to the subcontractor with applicable overheads.
- ii. If the subcontractor succeeds in carrying out its job in time without any fatal or disabling injury incident and without any damage to property BHEL may, at its sole discretion, favorably consider to reward the subcontractor suitably for the performance.
- iii. In case of any damage to property due to lapses by the subcontractor, BHEL shall have the right to recover the cost of such damages from the subcontractor after holding an appropriate enquiry.
- iv. The subcontractor shall take all measures at the sites of the work to protect all persons from incidents and shall be bound to bear the expenses of defense of every suit, action or other proceeding of law that may be brought by any persons for injury sustained or death owing to neglect of the above precautions and to pay any such persons such compensation or which may with the consent of the subcontractor be paid to compromise any claim by any such person, should such claim proceeding be filed against BHEL, the subcontractor hereby agrees to indemnify BHEL against the same.
- v. The subcontractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.
- vi. The subcontractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard.
- vii. BHEL shall have the right to prescribe the conditions under which such equipment or materials may be handled and the subcontractor shall adhere to such instructions.
- viii. BHEL may prohibit the use of any construction machinery, which according to the organization is unsafe. No claim for compensation due to such prohibition will be entertained by BHEL.

17. MEMORANDUM OF UNDERSTANDING:

After award of work, subcontractors are required to enter into a memorandum of understanding as given below:

Memorandum of Understanding

BHEL, Power Sector Region is committed to Health, Safety and Environment Policy (HSE Policy).

M/s.....do hereby also commit to comply with the same HSE Policy while executing the Contract Number _____

M/s.....have gone through and understood all the HSE requirements of the contract including HSE manpower, tools & equipment, systems & procedures, and agree to fulfill the same as a minimum. Any additional resources and support required for ensuring fulfillment of HSE Objectives shall be provided by subcontractor at no extra cost.

M/s..... agree that in case they fail to comply to the HSE requirements as stipulated in the contract, BHEL shall have the right to implement the same and the cost shall be recovered from the subcontractor with applicable overheads.

M/s..... shall ensure that safe work practices as per the HSE plan. Spirit and content therein shall be imbibed in all workers and supervisors for compliance.

In addition to this, M/s.....shall comply to all applicable statutory and regulatory requirements which are in force in the place of project and any special requirement specified in the contract document of the principal customer.

M/s.....shall co-operate in HSE audits/inspections conducted by BHEL /customer/ third party and ensure to close any non-conformity observed/reported within prescribed time limit.

M/s..... agree that the subcontractor shall seek HSE clearance as per BHEL format before each RA bill as mentioned in clause no. 9. The penalty amounts for not providing Safety manpower and various Safety violations have also been reviewed and agreed.

M/s..... agree to share the HSE Costs (running costs) of common facilities created by BHEL on proportional to contract value basis as calculated at Site by BHEL.

Signed by authorized representative of M/s -----

Name :

Place & Date:

SECTION B

OPERATIONAL REQUIREMENTS

1. PURPOSE:

- 1.1. The purpose of this HSE Plan is to provide for the systematic identification, evaluation, prevention and control of general workplace hazards, specific job hazards, potential hazards and environmental impacts that may arise from foreseeable conditions during installation and servicing of industrial projects and power plants.
- 1.2. This document shall be followed by BHEL's subcontractors at all installation and servicing sites. In case customer specific documents are to be implemented, this document will be followed in conjunction with customer specific documents in complementary manner.
- 1.3. Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy wherein the relevant statutory guidelines supersedes this document, the same shall be followed.
- 1.4. In case there's any specific HSE requirement from BHEL's Client, not explicitly indicated in this document the same shall be required to be fulfilled as per the decision of BHEL Site construction manager.

2. SCOPE:

The document is applicable to BHEL's Subcontractors at all installation / servicing activities of BHEL Power Sector as per the relevant contractual obligations

3. OBJECTIVES AND TARGETS:

- i. To achieve "Zero Incident at Site"
- ii. 100% compliance to all legal/statutory requirements related to EHS.
- iii. 100% Health, Safety and Environmental Induction training attendance for all workers.
- iv. 100% High Risk activities to be carried out only after approved Method Statement, HIRA / Aspect-Impact / JSA / OCP and Permit to Work are implemented.
- v. 100% PPEs compliance in high and medium risk activities.
- vi. 100% incident reporting, recording and reviewing for corrective actions.
- vii. Regular Safety Reviews to assess HSE program compliance and closure of any recognized gaps to improve safety management and incident prevention
- viii. Prevent injury and ill health of all workers at site ('Workers' refers to all personnel including managerial, supervisory, professional, technical, clerical and other workers including contract laborers)
- ix. Prevent pollution to environment
- x. Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
- xi. Ensure protection of environment of the work site.
- xii. Comply at all times with the relevant statutory and contractual HSE requirements.
- xiii. Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
- xiv. Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.

- xv. Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
- xvi. Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
- xvii. Establish effective communication on HSE matters with all relevant parties involved in the Project works.
- xviii. Ensure that all work planning considers all persons that may be affected by the work.
- xix. Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
- xx. Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
- xxi. Ensure continual improvements in HSE performance.
- xxii. Ensure conservation of resources and reduction of wastage.
- xxiii. Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
- xxiv. Ensure timely implementation of correction, corrective action and preventive action.
The subcontractor shall also comply with HSE Targets stipulated by BHEL from time to time.

4. BHEL HEALTH, SAFETY & ENVIRONMENT POLICY:

In BHEL, Health, Safety and Environment (HSE) responsibilities are driven by our commitment to protect our employees and people we work with, community and environment. BHEL believes in zero tolerance for unsafe work/non-conformance to safety and in minimizing environmental footprint associated with all its business activities. We commit to continually improve our HSE performance by:

- ❖ Developing safety and sustainability culture through active leadership and by ensuring availability of required resources.
- ❖ Ensuring compliance with applicable legislation, regulations and BHEL systems.
- ❖ Taking up activities for conservation of resources and adopting sound waste management by following Reduce/Recycle/Reuse approach.
- ❖ Continually identifying, assessing and managing environmental impacts and Occupational Health & Safety risks of all activities, products and services adopting approach based on elimination/ substitution/reduction/control.
- ❖ Incorporating appropriate Occupational Health, Safety and Environment criteria into business decisions, design of products & systems and for selection of plants, technologies and services.
- ❖ Imparting appropriate structured training to all persons at workplace and promoting awareness amongst customers, subcontractors and suppliers on HSE issues.
- ❖ Reviewing periodically this policy and HSE Management Systems to ensure its relevance, appropriateness and effectiveness.
- ❖ Communicating this policy within BHEL and making it available to interested parties.

Chairman & Managing Director

Bharat Heavy Electricals Limited, Power Sector

Regd. Office: BHEL House, Siri Fort, New Delhi-110049



5. ILLUSTRATIVE RESPONSIBILITIES OF SUBCONTRACTOR EMPLOYEES

5.1 HSE - A LINE RESPONSIBILITY

- i. HSE is a "Line Responsibility".
- ii. The term "Line" includes management, Executives, Supervisors, Foremen, and Workers who are part of the workforce. Line is to be fully involved in HSE Planning & Implementation with the aid and advice of HSE organization.
- iii. "Line", having control of resources and manpower is responsible for overall implementation of HSE Systems and closure of HSE observations.

5.2 SITE IN -CHARGE:

- i. Shall sign Memorandum of Understanding (MoU)
- ii. Shall ensure availability of all necessary resources required for implementation of HSE at Site
- iii. Shall engage qualified HSE Officer(s) and supervisors (s)
- iv. Shall adhere to the rules and regulations mentioned in this code, practice very strictly in area of work in consultation with concerned engineer and the safety coordinator.
- v. Shall screen all workmen for health and competence requirement before engaging for the job and periodically thereafter as required.
- vi. Shall not engage any employee below 18 years.
- vii. Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job.
- viii. Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent person.
- ix. Shall ensure closure of all HSE non-conformities reported by BHEL or observed during internal inspection by providing appropriate resources in a timely manner.
- x. Shall ensure the implementation of provisions of applicable acts and rules pertaining to HSE.
- xi. Shall ensure availability of updated (Hazard Identification and Risk Assessment) Register for the area of activity
- xii. Shall ensure availability of Method Statements & Job Safety Analysis for all hazardous activities
- xiii. Shall ensure necessary controls to minimize risk in all applicable hazardous activities including Height Work, Hot Work, Lifting & Rigging, Confined Space, Maintenance, excavation, Radiography, Loading/ Unloading, Drilling/ Blasting etc.
- xiv. Shall ensure implementation of HSE requirements mentioned in this document and as specified in the BHEL HSE management System including training, inspection, awareness, reporting etc.
- xv. Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
- xvi. Shall ensure a secondary means of fall protection (Safety Net, Retractable Fall Arrestor etc.) for preventing fall from height
- xvii. Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.

- xviii. Shall report all incidents (Fatal/Major/Minor/Near Miss) to the Site engineer /HSE officer of BHEL.
- xix. Shall ensure that Horseplay is strictly forbidden.
- xx. Shall ensure that adequate illumination is arranged during night work.
- xxi. Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard to self and to others.
- xxii. Shall ensure display of adequate signage/posters on HSE.
- xxiii. Shall ensure that mobile phone is not used by workers while working.
- xxiv. Shall ensure conductance of HSE audit, mock drill, medical camps, induction training and training on HSE at site.
- xxv. Shall ensure full co-operation during HSE audits.
- xxvi. Shall ensure submission of look-ahead plan for procurement of HSE equipment's and PPEs as per work schedule.
- xxvii. Shall ensure good housekeeping.
- xxviii. Shall ensure adequate valid fire extinguishers are provided at the work site.
- xxix. Shall ensure availability of sufficient number of toilets (preferably bio-toilets) /restrooms and adequate drinking water at work site and labor colony.
- xxx. Shall ensure adequate emergency preparedness.
- xxxi. Shall be member of site HSE committee and attend all meetings of the committee
- xxxii. Power source for hand lamps shall be maximum of 24 v.
- xxxiii. Temporary fencing should be done for open edges if Hand – railings and Toe-guards are not available
- xxxiv. To record all incidents including near miss and report to BHEL and to ensure analysis & corrective actions for the same
- xxxv. Shall conduct weekly Safety Walks in the work area and record the findings.
- xxxvi. Construction of Canteen at Site, Office Infrastructure: Printer, PC, Fire Extinguishers etc.
- xxxvii. Shall analysis HSE Performance regularly in work area and take steps to improve the same
- xxxviii. Shall ensure stoppage of work in case of unacceptable Safety hazards

5.3 HSE OFFICER:

- i. Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, P&M and other tools and tackles.
- ii. Facilitate inclusion of safety elements into Work Method Statement and creation of Job Safety Analysis (JSA)
- iii. (HSE Head) To prepare deployment plan of HSE personnel for all shifts, so as to ensure constant supervision of all areas. The plan to be submitted to BHEL
- iv. Highlight the requirements of safety through Tool-box / other meetings.
- v. Help concerned HOS to prepare Job Specific instructions/ JSA for critical jobs.
- vi. Conduct investigation of all incident/dangerous occurrences & recommend appropriate safety measures.
- vii. Advice & co-ordinate for implementation of HSE Systems & Procedures.
- viii. To stop work in case of any critical safety violation until the violation is cleared
- ix. Convene HSE meeting & minute the proceeding for circulation & follow-up acti

- x. Plan procurement of PPE & Safety devices and inspect their healthiness.
- xi. Report to BHEL on all matters pertaining to status of safety and promotional program at site level.
- xii. Facilitate administration of First Aid
- xiii. Facilitate screening of workmen and safety induction.
- xiv. Conduct fire Drill and facilitate emergency preparedness
- xv. Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
- xvi. Apprise BHEL on safety related problems.
- xvii. Notify site personnel non-conformance to safety norms observed during site visits / site inspections.
- xviii. Recommend to Site In charge, immediate discontinuance of work until rectification, of such situations warranting immediate action in view of imminent danger to life or property or environment.
- xix. To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
- xx. Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.
- xxi. Shall work as interface between various agencies such customer, package-in-charges, subcontractors on HSE matters.

5.4 HSE SUPERVISOR:

- i. All requirements as per 5.1
- ii. To monitor allotted area for Safety violations, take required action and inform the concerned Safety Supervisor / Officer
- iii. To assist HSE Officer

5.5 PACKAGE IN-CHARGES, ENGINEERS & ALL EMPLOYEES:

- i. To be aware of, get involved in and ensure implementation of all HSE related Systems and Procedures including but not limited to:
 - a. BHEL HSE Management System including HSE Procedures and OCPs, HIRA, JSA etc.
 - b. Work Permit System
 - c. Emergency Preparedness Response Plans
 - d. Contractual HSE requirements
 - e. Legal Requirements
 - f. Penalty System
 - g. Training requirements
- ii. To ensure that the persons engaged in respective area follow the safety rules like using appropriate PPEs.
- iii. To develop Method Statements and ensure availability of Job Safety Analysis for all activities in scope
- iv. To ensure that the reported HSE non-conformities in the work area are resolved immediately before resuming work
- v. To record all incidents including near miss and report to BHEL.

- vi. To adopt safe working practices at all times and act as role model for Safety
- vii. To take immediate corrective action actions in case any non-conformity is observed on product / process / system with respect to Occupational Health, Safety and Environment.
- viii. In case any particular activity / work has extremely high consequential risk or high environmental impact, same shall be brought to the notice of BHEL Package In-charge before starting the work.
- ix. To interfere/ stop work as & when identified unsafe.
- x. To maintain & promote improved level of house-keeping all the time at site.
- xi. To support/co-operate with audit team members as & when safety audits are carried out.
- xii. To involve in investigation, if any incident occurs in his work area.
- xiii. To participate in safety promotional programs
- xiv. To attend the safety committee meeting, if member/invitee
- xv. To ensure that only fit T&Ps and qualified persons are engaged for all activities.
- xvi. Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
- xvii. Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.
- xviii. Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent authorities.

6. HSE PLANNING BY SUBCONTRACTOR:

6.1 HAZARD ANALYSIS & RISK ASSESSMENT (HIRA), METHOD STATEMENT (MS) & JOB SAFETY ANALYSIS (JSA):

- i. Subcontractor shall identify all OHS Hazards and Risks applicable to all activities in scope and plan & implement the required control measures. HIRA Register shall be maintained.
- ii. Subcontractor shall develop Method Statements & Job Safety Analysis documents for all hazardous activities in scope and ensure the required control measures. Job Safety Analysis is to be attached along with any Work Permit request

6.2 REGISTER OF REGULATIONS:

Subcontractor shall prepare a register of applicable rules and regulations in the scope and plan to ensure compliance.

HIRA Register, Method Statements, Job Safety Analysis and Register of Regulations are dynamic documents and shall be revised (as applicable):

- i. At fixed frequency of 3 months
- ii. Addition/ deletion/ modification of a process/ activity
- iii. After an accident/ incident
- iv. After any change in applicable rules/ regulations/ laws.

6.3 MONTHLY HSE PLAN COVERING THE FOLLOWING AS A MINIMUM SHALL BE PREPARED AND SUBMITTED TO BHEL FOR APPROVAL:

- i. HSE Trainings covering all activities/ hazards/ workers
- ii. HSE Inspection Plan covering all areas/ activities/ equipment/ hazards
- iii. HSE Activities: Safety walks, Awards, housekeeping, reviews etc.

Note: Online/ App-based system shall be used for HSE Planning and Implementation/ Update whenever provided by BHEL otherwise Hard-copy based system shall continue

6.4 MONTHLY HSE PLANNING & REVIEW OF HSE ACTIVITIES ALONG WITH BHEL:

Monthly planning and review of HSE activities shall be carried out by subcontractor as per provided **format** jointly along with BHEL

7. MOBILIZATION OF MACHINERY/EQUIPMENT/TOOLS BY SUBCONTRACTOR:

- i. Subcontractor shall notify the engineer, of his intention to bring on to site any equipment or any container, with liquid or gaseous fuel or other substance which may create a hazard. The Engineer shall have the right to prescribe the condition under which such equipment or container may be handled and used during the performance of the works and the subcontractor shall strictly adhere to such instructions. The Engineer shall have the right to inspect any construction tool and to forbid its use, if in his opinion it is unsafe. No claim due to such prohibition will be entertained.
- ii. As a measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and complies with legislative and owner requirement, inspection shall be arranged by in-house competent authority for acceptance as applicable. Inspection by Third Party competent person shall be arranged:
 - a. Before first time use at site
 - b. After carrying out any modification
 - c. After repairs subsequent to involvement in any accident/ incident
- iii. As a further measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and comply with legislative and owner requirement, inspection as per provided format shall be arranged by in-house expert / competent authority (preferable) for acceptance. The equipment considered for this purpose shall include all those in the T&P list in the tender document.

8. MOBILIZATION OF MANPOWER BY SUBCONTRACTOR:

- i. As a measure to ensure that manpower being mobilized to the construction site is fit and competent for safe working, screening arrangement shall be made by the sub-subcontractor to ensure competency and fitness through following measures:
 - a) **Medical Checkup:** Examination of medical fitness shall be conducted through qualified medical professional for all workers to be deployed as per provided **format**. For height workers, vertigo (height phobia) test to be carried out as qualification criteria as per Annexure K and recorded in provided **format**.

- b) **Induction Training:** Induction training of all workers to be ensured as per **provided procedure and format**. Training evaluation to be carried out and training to be repeated if not passed
- c) Only on successfully meeting above criteria, permanent gate passes to be issued
- ii. The subcontractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner.
- iii. The subcontractor shall take special care of the employees affected with occupational diseases under rule 230 and schedule II of BOCW Rules. The employees not meeting the fitness requirement should not be engaged for such job.
- iv. Ensure that the regulatory requirements of excessive weight limit (to carry/lift/ move weights beyond prescribed limits) for male and female workers are complied with.
- v. Appropriate accommodation to be arranged for all workmen in hygienic condition.
- vi. Cost of contractual, statutory and regulatory requirements like Training, medical checks, PPEs etc. shall not be transferred to the workers and such activities shall be considered as part of the job.

9. PROVISION OF PERSONAL PROTECTIVE EQUIPMENT (PPEs):

- i. Personnel Protective Equipment (PPEs), shall be provided by the subcontractor to all workers as per requirement of the job.
- ii. The choice of PPEs to ensure multiple (at least more than 1) means of protection against any hazard. All applicable safety precautions for a job shall be ensured notwithstanding the duration or perceived importance of the task.
- iii. The applicability of PPEs shall be as per the concept of Hierarchy of controls, i.e.:
- iv. Elimination->Substitution->EngineeringControls->AdministrativeControls-PPEs
- v. Relying solely on PPEs without ensuring necessary controls to be strictly avoided.
- vi. The following matrix recommends usage of minimum PPEs against the respective job.

Activity	Type of Protection						Remarks, if any
	Hand	Eye	Ear	Body	Respiratory	Others	
Gas Welding & Cutting	LG	WG	-	LA	*SCBA/ OLBA	-	* for confined space
Electric Arc Welding	LG	HMWS	-	LA	*SCBA/ OLBA	-	* for confined space
Rigging	CG	SG	-				--
Working at Height	-	SG	-	DLFBH	-	*FAS	* for vertical columns
Grinding & Chipping	CG	FS / SG	-	LA	-	-	--
Working in High Noise	-	-	EP / EM	-	-	-	--
Handling of Cement Concrete	RG	SG	-	-	DM	-	

Blasting	CG	SG	EP*	-	-	-	* at noise area
Excavation	CG	SG	-	-	DM	-	*Gum boot in place of Safety shoe for foot
Chemical Handling	PVCG	CSG	-	PVCA	-	-	*Full body rubber suit with hood
Electrical and C&I	ERG*	SG	-	-	-	-	*For high voltages
Sand/shot blasting	CG	-	EP/EM	CA	SAMH	-	

ABBREVIATIONS: FS: Face Shield, CSG: Chemical splash goggles, HMWS: Helmet mounted welder's shield, GB: gum boot, DLFBH: Double lanyard full body harness, SG: Safety goggles, DM: Dust mask, SAMH L Supplied air mask/hood, EP/EM: Ear plug/Ear Muff, CG: Cotton hand gloves, LG: Leather hand gloves, LA: Leather apron, RG: Rubber gloves, PVCG: PVC Gloves, PVCA: PVC Apron, SCBA: Self-contained breathing apparatus, WG: Welding goggles, ERG: Electrical Rubber Gloves. OLBA: Online breathing apparatus

The list is not exhaustive. Additional PPEs to ensure Safe Work may need to be deployed as per the requirement of the task at no additional cost.

- vii. The PPEs shall conform to the relevant standards as below (illustrative list) and bear ISI mark.

RELEVANT IS-CODES FOR PERSONAL PROTECTION

PPEs	IS Codes
Industrial Safety Helmets.	IS: 2925 – 1984
Rubber gloves for electrical purposes.	IS: 4770 – 1968
Industrial Safety Gloves (Leather & Cotton Gloves).	IS: 6994 – 1973 (Part-I)
Leather safety boots and shoes.	IS: 1989 – 1986 (Part-I-II)
Industrial and Safety rubber knee boots.	IS: 5557 – 1969
Code of practice for selections care and repair of Safety footwear.	IS: 6519 – 1971
Leather Safety footwear having direct molding sole.	IS: 11226 – 1985
Eye protectors.	IS: 5983 – 1978
Ear protectors.	IS: 9167 – 1979
Eye & Face protection during welding	IS: 1179-1967
Industrial Safety Belts and Harness	IS: 3521 – 1983
Guide for selection of industrial Safety equipment for body protection	IS: 8519 -1977
Respiratory Protective Devices	IS: 9473-2002, 14166-1994, 14746-1999

- viii. Where workers are employed in sewers and manholes, which are in use, the subcontractor shall ensure that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into manhole, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent incident to the public

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- ix. All the personnel and visitors shall mandatorily use safety helmet (with company logo), safety shoe and reflective vests, in addition to any other PPEs as deemed appropriate for the area of work/ visit.
- x. Following Color scheme for Helmets shall be followed:
 - a. Workmen: Yellow
 - b. Safety staff: Green or white with green band
 - c. Electrician: Red
 - d. Others including visitors: White
 - e. For height workers, special marking on helmets besides indication on Gate Pass/ ID Card
- xi. The subcontractor shall maintain register for issue and receipt of PPEs.
- xii. All the PPEs shall be checked for quality before issue and the same shall be periodically re-checked. The users shall be advised to check the PPEs themselves for any defect before putting on. The defective ones shall be replaced.
- xiii. The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the front.
- xiv. The body harnesses shall be serial numbered.

10. ARRANGEMENT OF INFRASTRUCTURE:

10.1 DRINKING WATER:

- i. Drinking water shall be provided and maintained at suitable places at different elevations such that minimum quantity of 5 liters is available for each worker during the day.
- ii. Drinking water tank shall be so installed so as to be available within 200 meters of each working area
- iii. Container should be labeled as "Drinking Water" in languages understood by the workers
- iv. Cleaning of the container shall be ensured at least once in a week. Mild cleaning detergents as used for cleaning vessels shall be applied and scrubbers (3M or equivalent) shall be used for removing scales and deposits on the inside surface. The tank shall be thoroughly cleaned with potable water only before it is refilled (also applicable to labor colony).
- v. Suitability of water source for drinking to be tested as per IS10500 at least once in six months.

10.2 WASHING FACILITIES:

- i. In every workplace, adequate and suitable facilities for washing shall be provided and maintained.
- ii. Separate and adequate cleaning facilities shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition and dully illuminated for night use.
- iii. Water suitable for washing and not for drinking shall be clearly indicated as "Not for Drinking" in language understood by workers.
- iv. Overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the painters and other workers to wash during the cessation of work.

10.3 LATRINES AND URINALS:

- i. Latrines and urinals shall be provided in every work place as indicated in Section A
- ii. Urinals shall also be provided at different elevations.
- iii. They shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times, by appointing designated person.
- iv. Separate facilities shall be provided for the use of male and female worker if any.

10.4 PROVISION OF REST SHEDS FOR WORKERS DURING REST PERIOD:

Proper Rest Shed (s) with shelter shall be provided for rest during break so as to accommodate all workers as indicated in Section A

10.5 MEDICAL FACILITIES:

10.5.1 GENERAL

- i. Provision of Medical Center, Ambulance etc. shall be as per Section A of this document
- ii. Medical waste shall be disposed as per prevailing legislation (Bio-Medical Waste – Management and Handling Rules, 1998)
- iii. Every injury shall be treated, recorded and reported.
- iv. All First Aid injuries shall be recorded as per provided Format
- v. List of qualified first aiders and their contact numbers to be displayed at conspicuous places.

10.5.2 FIRST AIDER/ FIRST AID BOX

- i. The first aider along with facilities should be available at a point nearest to the work location wherein majority of the workers are working.
- ii. The subcontractor shall provide necessary first aid facilities as per schedule III of BOCW. At every work place first aid facilities shall be provided and maintained.
- iii. The first aid box shall be kept by first aider who shall always be readily available during the working hours of the work place. His name and contact no to be displayed on the box.
- iv. The first aid boxes should be placed at various elevations so as to make them available within the reach and at the quickest possible time.
- v. The first aid box shall be distinctly marked with a Green Cross on white background.
- vi. Details of contents of first aid box is given in Annexure J
- vii. A slip of contents shall be pasted on the First Aid Box with following details
- viii. Monthly inspection of First Aid Box shall be carried out by the owner as per provided format
- ix. The subcontractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.

10.5.3 HEALTH CHECK UP

The persons engaged at the site shall undergo health check-up as per provided format before induction. In addition, the persons engaged in the following works shall undergo health check-up at least once in a year:

- i. Height workers
- ii. Drivers/crane operators/riggers
- iii. Confined space workers
- iv. Shot/sand blaster
- v. Welding and NDE personnel

10.5.4 HEIGHT PHOBIA/ VERTIGO TEST:

- i. The persons engaged in working at heights (above 2 meters) to be assessed for Vertigo and associated conditions and recorded as per provided format. Suggested Vertigo Test Procedure is given in Annexure K
- ii. Such workers are to be allowed only on successful completion of test, otherwise shall be allocated ground-based jobs.
- iii. IDs / Height passes shall be issued to such workers, besides special markings on helmets for easy identification.

10.5.5 PROVISION OF CANTEEN FACILITY:

- i. Canteen facilities shall be provided for the workmen of the project inside the project site where worker strength is 250 or more.
- ii. Proper cleaning and hygienic condition shall be maintained.
- iii. Proper care should be taken to prevent biological contamination.
- iv. Adequate drinking water should be available at canteen.
- v. Fire extinguisher shall be provided inside canteen.
- vi. Regular health check-up and medication to the canteen workers shall be ensured as per applicable regulations.
- vii. Canteen waste to be disposed of in hygienic manner

10.6 PROVISION OF ACCOMMODATION/LABOR COLONY FOR WORKFORCE:

- i. Proper accommodation for workforce to be provided in line with minimum requirements indicated in Section A
- ii. Labor colony shall be inspected each week by HSE Officer and report submitted to BHEL as per provided format

10.7 PEST CONTROL:

Regular pest control should be carried out at all offices, mainly laboratories, canteen, labor colony and stores.

10.8 SCRAPYARD:

- i. In consultation with customer, scrapyard shall be developed to store metal scrap, wooden scrap, waste, hazardous waste.
- ii. Scrap/Waste shall be segregated as Bio-degradable and non-bio-degradable and stored separately.

10.9 ILLUMINATION:

- i. The subcontractor shall arrange at his cost adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. at various levels for safe and proper working operations at dark places and during night hours at the work spot as well as at the pre-assembly area.
- ii. Lamp (hand held) shall not be powered by mains supply but either by 24V or dry cells.
- iii. Lamps shall be protected by suitable guards where necessary to prevent danger, in case of breakage of lamp.
- iv. Emergency lighting provision for night work shall be made to minimize danger in case of main supply failure.
- v. Adequate and suitable light shall be provided at all work places & their approaches including passage ways as per IS: 3646 (Part-II).

SUITABLE ILLUMINATION LEVELS FOR VARIOUS AREAS SHALL BE DECIDED BASED ON BROAD GUIDELINES INDICATED BELOW:

S. No.	Location	Lux Level (lumens/sqm)
A. Construction Site		
1	Outdoor areas like store yards, entrance and exit roads	20
2	Platforms	50
3	Entrances, corridors and stairs	100
4	General illumination of work area	150
5	Rough work like fabrication, assembly of major items	150
6	Medium work like assembly of small machined parts	300
7	Fine work like precision assembly, precision measurements etc.	700
8	Sheet metal works	200
9	Electrical and instrument labs	450
B. Office		
1	Outdoor area like entrance and exit roads	20
2	Entrance halls	150
3	Corridors and lift cars	70
4	Lift landing	150
5	Stairs	100
6	Office rooms, conference rooms, library reading tables	300
7	Drawing table	450
8	Manual telephone exchange	200

- vi. Illuminations shall be inspected on weekly basis as per provided **format** using a calibrated lux meter.

11. HSE TRAINING & AWARENESS:

11.1 TRAINING PLAN:

- i. All training programs to be carried out in a planned manner. Monthly/ Annual Training Calendar to be submitted to BHEL for approval and shall cover HSE Training requirements of all activities, workers, hazards applicable to the area(s) of work.
- ii. Subcontractor shall nominate workers as per the schedule of specific training plan, failing which, penalty shall be imposed.
- iii. Training records of all workers along with attendance, signatures, faculty details etc. shall be maintained in soft/ hard copy as per provided **formats**.
- iv. Each labor should undergo at least 0.5% of total man-hours worked in HSE training.

11.2 HSE INDUCTION TRAINING

- i. All persons entering into project site shall be given HSE induction training by the HSE officer of BHEL /subcontractor before being assigned to work.
- ii. The induction training shall be imparted through audio-visual medium (Classroom specialized training), and shall be minimum of 1 Complete Day.
- iii. Evaluation to be carried out after training and training shall be repeated in case of failure.
- iv. Safety Induction Card shall be printed by Subcontractor and provided to all trained workers. A Safety induction book shall also be printed and issued to each worker after induction training (Format for the same may be provided by BHEL).
- v. Induction training subjects shall include but not limited to:
 - a. Briefing of the Project details.
 - b. Safety objectives and targets.
 - c. Site HSE rules.
 - d. Critical Safety Violations and consequences
 - e. Site HSE hazards and aspects.
 - f. First aid facility.
 - g. Emergency Contact No.
 - h. Incident & Near Miss reporting.
 - i. Fire prevention and emergency response.
 - j. Rules to be followed in the labor colony (if applicable)
 - k. Accident case studies
- vi. General:
 - a. Proper safety wear & gear must be issued to all the workers being registered for the induction (i.e., Shoes/Helmets/Goggles/Leg guard/Apron etc.)
 - b. They must arrive fully dressed in safety wear & gear to attend the induction.
 - c. Any one failing to conform to this safety wear& gear requirement shall not qualify to attend.

- d. On completing attending subcontractor's in-house HSE induction, each employee shall sign an induction training form to declare that he had understood the content and shall abide to follow and comply with safe work practices.
- e. They may only then be qualified to be issued with a personal I.D. card, for access to the work site subject to clearing the medical fitness test.

SAFETY INDUCTED	
Name :	
Date :	
Sign By Trainer :	

ABOVE STICKER SHALL BE PASTED ON HELMET OF WORKERS AFTER SAFETY INDUCTION TRAINING

11.3 JOB-SPECIFIC SKILL BASED HSE TRAINING

The contracting agency shall also impart job specific skill-based safety training to all its employees (Minimum one day) on various related safety topics using internal/external safety professionals/consultants as per the matrix given below. Record of such trainings and attendance particulars shall be maintained in a register for ready reference to statutory authorities/engineer-in charge as per provided format.

TRAINING MATRIX

Name of topic	Executives	Supervisors	Skilled Workmen	Other Workers
Safety Induction	Y	Y	Y	Y
Accident_ Causes, factors, cost	Y	Y	Y	-
Industrial hazards & Accident Prevention	Y	Y	Y	-
Investigating, reporting, records	Y	Y	-	-
Personal Protective Equipment	-	Y	Y	Y
Construction Safety & Role of Supervisory personnel	-	Y	-	-
Permit to Work (PTW)	-	Y	Y	y
Statutory Provisions (BOCW Act/Rules, Factories Act 1948 etc.)	Y	Y	y	y
Material handling	-	y	Y	Y
Emergency Management	Y	Y	Y	-
Electrical Safety	-	Y	Y	-
Fire safety	Y	Y	Y	Y
First Aid & CPR (cardio pulmonary resuscitation)	-	Y	Y	Y (Selected)
Safety in Welding & Cutting	-	-	Y	-
Safety Audit	Y	Y	-	-
Safety in Lifting Tools & Tackles	-	Y	Y	y

Safety in Working at height	-	Y	Y	Y
Safety in Confined space work	-	Y	Y	Y
Defensive Driving	-	Y*	Y*	Y*

*for construction vehicle operators, helpers & crane operators

Y=YES

Note:

- Subcontractor shall prepare a training plan/ matrix covering all hazards and implement the same after approval of BHEL.
- It is to be ensured that every worker undergoes Job-Specific training once every 3 months.
- Records of training programmes along with attendance shall be maintained by the subcontractor
- Each worker to be issued a Card indicating the types of trainings undergone.

11.4 HSE TOOL-BOX TALK:

- HSE tool Box talk shall be conducted by frontline foreman/supervisor of subcontractor to specific work groups prior to the start of work and shall be randomly attended by subcontractor engineers/ officials. The agenda shall consist of the following:
 - Details of the job being intended for immediate execution.
 - The relevant hazards and risks involved in executing the job and their control and mitigating measures.
 - Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
 - Recent non-compliances observed.
 - Appreciation of good work done by any person.
 - Any doubt clearing session at the end.
- Tool box talk to be conducted before start of work in every shift.
- During toolbox talk, visual check-up of workers regarding health, any signs of fatigue, intoxication etc. shall be conducted and any suspected workers to be acted upon.
- Record of Tool box talk shall be maintained as per provided **format**

11.5 TRAINING ON HEIGHT WORK:

- Training on height work shall be imparted to all workers working at height by in-house/external faculty at least once every 3 months.
- For Height Workers Separate pass shall be provided by the subcontractor.
- The training shall be of minimum 2-hour duration, through audio-visual medium and followed by evaluation. In case of poor scoring, training shall be repeated.
- The training shall include following topics:
 - Proper use of PPEs – safety harness, lanyard, fall arrester, retractable fall arrester, life line, safety nets etc.
 - Provision of secondary means of fall protection

- c. Safe climbing through monkey ladders.
- d. Inspection of PPEs.
- e. Medical fitness requirements.
- f. Mock drill on rescue at height.
- g. Dos & Don'ts during height work.
- h. Accident case Studies

11.6 RE-INDUCTION TRAINING

The induction training shall be repeated for every worker after at least 1 year and shall be a pre-requisite for renewal of Gate Pass/ ID card.

11.7 PENALTY TRAINING

The personnel involved in Safety Violations/ Incidents shall mandatorily undertake penalty training pertaining to the violation/ incident. Penalty training shall be at least half-day duration.

11.8 HSE PROMOTION-SIGNAGE, POSTERS, COMPETITION, AWARDS ETC.:

- i. HSE Displays shall be installed as indicated in Section A
- ii. Contracting agencies shall arrange for display of safety hoardings depicting suitable safety cartoons/messages/ cautionary notices at appropriate places of project site to remind the workers to perform their duties safely.
- iii. Apart from safety hoardings, each agency should maintain a safety bulletin board at all their work locations. Such safety bulletin boards should depict the activities being planned for the day, good practices, permit details etc.
- iv. Safety suggestion boxes shall be kept at each subcontractor's office at site for obtaining safety suggestions from the workers. Best suggestions should be implemented and may be rewarded suitably to encourage the workers for safety.
- v. Safety awareness campaigns, competitions, plays, movie shows, songs etc. to be organized for workers at Site and Labor colony from time to time to enhance Safety Awareness

11.9 HSE REWARDS & INCENTIVE SCHEME

Subcontractor shall implement a reward & incentive scheme for workers & supervisors displaying adherence to safety principles. Such workers shall be felicitated in a monthly function, attended by Subcontractor top management and BHEL representatives. Suitable gift shall be given to such workers for encouragement.

11.10 HSE AWARENESS PROGRAM FOR OFFICIALS:

Subcontractor shall arrange monthly HSE awareness program on different topics including medical awareness for all engineers/ supervisors / officials working at site. This program can be part of progress/ safety review meetings.

12. HSE COMMUNICATION AND PARTICIPATION:

12.1 HSE INCIDENT REPORTING, INVESTIGATION & CORRECTIVE ACTION:

- i. All incidents (near misses, property damage, first-aid cases, minor, major and fatal incidents) shall be reported to BHEL as they happen immediately through SMS and Hard/Soft copy as per provided format
- ii. All incidents including near miss, minor, major and fatal incidents shall be recorded
- iii. All incidents shall be investigated for Root Causes and corrective actions ensured to prevent recurrence shall be implemented.
- iv. Work shall be put on hold in the area till corrective actions are verified by BHEL
- v. The Root Cause Analyses and Corrective actions taken shall be recorded

12.2 HSE EVENT REPORTING:

- i. Important HSE events like HSE training, Medical camp etc. organized at site shall be reported to BHEL site management in detail with photographs for publication in different in-house magazines
- ii. Celebration of important days like National Safety Day, World Environment Day etc. shall also be reported as mentioned above.

12.3 MONTHLY HSE REPORTING:

- i. All routine and non-routine HSE activities shall be reported to BHEL on monthly basis by the subcontractor as per provided format. The reporting medium can be hard/soft as per BHEL requirement.
- ii. The period of reporting shall be 25th of the preceding month to 24th of the present month and shall be submitted by the end of the calendar month.
- iii. Report shall include good quality images of HSE Activities

12.4 DAILY HSE ACTIVITY REPORTING:

Daily HSE activities shall be reported by subcontractor to BHEL as per provided format

12.5 HSE SUGGESTIONS:

All workers and employees shall be encouraged to provide suggestions for improvement in Health, Safety & Environment performance at site. The suggestions shall be recorded in a "Suggestions Register" as per provided format. Suggestions found suitable for implementation shall be implemented and recognition / reward to be given to the submitter.

Suggestion Register to be placed at Site and Labor Colony and shall be reviewed on periodic basis

12.6 CLIENT COMMUNICATION:

All HSE related communication from BHEL, customer / external statutory and regulatory agencies to be handled on priority. Same to be recorded and issues to be resolved in expeditious manner

13. SAFETY DURING WORK EXECUTION:

Safety during work execution shall be ensured by following appropriate Safety Rules, providing adequate resources, deploying competent and trained manpower, regular training & inspection and non-conformity resolution. Main aspects are indicated as under:

13.1 OPERATIONAL CONTROL PROCEDURES:

In order to reduce the risk associated with hazardous activities, applicable OCPs (Operational control procedures) will be followed by subcontractor as per BHEL instructions, outcomes of Hazard Analysis & other requirements. This will be done as part of normal scope of work. Illustrative list of reference OCPs is given below.

TABLE 13.1 ILLUSTRATIVE LIST OF REFERENCE OCPs

No.	Topic	No.	Topic	No.	Topic
0	General Safety	22	Steam blowing	44	Material preservation
1	Handling of chemicals	23	Working in confined area	45	Electro-resistance heating
2	Electrical safety	24	Operation of passenger lift, material hoists & cages	46	Blasting
3	Energy conservation	25	Vehicle/ Crane maintenance	47	Transformer charging
4	Welding and gas cutting operation	26	Radiography	48	Handling of battery system
5	Fire safety	27	Waste disposal	49	DG set
6	Use of hand tools	28	Handling & storage of mineral wool	50	Sanitary maintenance
7	First aid	29	Working at night	51	Piling rig operation
8	Food safety at canteen	30	Computer operation	52	Passivation
9	Use of cranes	31	Storage in open yard	53	EDTA Cleaning
10	Storage and handling of gas cylinders	32	Drilling, reaming and grinding(machining)	54	Chemical cleaning of Pre boiler system
11	Manual arc welding	33	Stress relieving	55	Boiler Light up
12	Use of helmets	34	Hydraulic test	56	Rolling and Synchronization
13	Good house keeping	35	Trial run of rotary equipment	57	Loading of Unit

14	Safe excavation	36	Batching	58	Air compressor
15	Working at height	37	Cable laying/tray work	59	Hydra Operation
16	Filling of hydrogen in cylinder	38	Spray insulation	60	Duct Pre-assembly
17	Illumination	39	Compressor operation	61	Resumption of construction activities after lockdown and prevention of coronavirus infection during site operations
18	Handling and erection of heavy metals	40	Gas distribution test		
19	Acid cleaning	41	Cleaning of Hot well / Deaerator		
20	Oil flushing	42	Electrical maintenance	61A	Prevention of Covid-19 infection in labour colony
21	Alkali boil out	43	O&M of control of AC plant & system	62	Truss/ Structure fit-up and alignment

- The reference OCPs shall be suitably modified by subcontractor as per specific requirements to control the hazards.
- In case any other OCP is found to be applicable during the execution of work at site, then subcontractor will prepare and follow those as well.

13.2 WORK PERMIT SYSTEM:

- The following activities shall be carried out by the subcontractor strictly after obtaining Permit to Work from BHEL
 - Height working
 - Hot working
 - Confined space Work
 - Excavation more than 2-meter depth
 - Radiography
 - Heavy / Complex / Critical Lifting Activity
 - Night / Holiday Work
 - Material Loading / Unloading
 - Grating, Safety Net, Safety Facility Removal
 - Live Electrical Maintenance etc. - Lockout / Tagout
 - Beam / truss/ duct/ structure alignment
- The Work Permit Formats shall be provided by BHEL at Site. It is the responsibility of the subcontractor to ensure their availability
- The above list is not exhaustive. BHEL reserves right to introduce additional Permits or modify requirements for usage of existing Permits. The conditions for using the Permit are specified in the Format (General Requirements).
- Where customer is having separate Work Permit System the same shall be followed in conjunction / merged to ensure all activities and checks are covered in all systems.
- Details of working Group to be attached along with work permit request.

- vi. All the Permits along with JSA/HIRA must be initiated by Agency Execution Team
- vii. Permit applicant shall apply for work permit of particular work activity at particular location before starting of the work with Job Hazard Analysis.
- viii. All Permit signatories (including subcontractor's package in-charge and HSE Officer) shall physically visit the work area and check that all the safety control measures necessary for the activity are in place. Only then the permit shall be issued.
- ix. Signatory shall physically visit the area of work and ensure all required safeguards before signing the Permit
- x. Signatory shall periodically visit the area to confirm the availability of required safeguards throughout the currency of the permit
- xi. In case any Permit requirement is not available, work will be stopped till it is made available
- xii. Permit holder shall implement and maintain all control measures during the period of permit. The permit will be closed after completion of the work.
- xiii. Online Work Permit System shall be used whenever provided by BHEL, otherwise hard copy shall be used

13.3 ACTIVITY-SPECIFIC PRECAUTIONS/ CONTROLS

Detailed HSE precautions for various activities undertaken at Site by the subcontractors are specified in **Annexure I**. Same are to be ensured by the Sub-subcontractor while carrying out respective activities at Site

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14. ENVIRONMENTAL CONTROL & SOCIAL RESPONSIBILITY

- i. Environment protection has always been given prime importance by BHEL. Environmental damage is a major concern of the principal subcontractor and every effort shall be made, to have effective control measures in place to avoid pollution of Air, Water and Land and associated life. Banned substances like asbestos and Chlorofluorocarbons such as carbon tetrachloride and trichloroethylene shall not be used. Waste disposal shall be done in accordance with the guidelines laid down in the project specification.
- ii. Any chemical including solvents and paints, required for construction shall be stored in designated bonded areas around the site as per Material Safety Data Sheet (MSDS).
- iii. In the event of any spillage, the principle is to recover as much material as possible before it enters drainage system and to take all possible action to prevent spilled materials from running off the site. The subcontractor shall use appropriate MSDS for clean-up technique
- iv. All subcontractors shall be responsible for the cleanliness of their own areas
- v. Regular dust suppression using sprinklers shall be carried out in respective area
- vi. The subcontractors shall ensure that noise levels generated by plant or machinery are as low as reasonably practicable. Where the subcontractor anticipates the generation of excessive noise levels from his operations the subcontractor shall inform to Construction Manager of BHEL accordingly so that reasonable & practicable precautions can be taken to protect other persons who may be affected.
- vii. It is imperative on the part of the subcontractor to join and effectively contribute in joint measures such as tree plantation, environment protection, contributing towards social upliftment, conversion of packing woods to school furniture, enhancing good relation with local populace etc.
- viii. The subcontractor shall carry out periodic air and water quality check and illumination level checking in his area of work place and take suitable control measure.

15. HOUSEKEEPING

- i. Keeping the work area and access roads clean/ free from debris, removed scaffoldings, scraps, insulation/sheeting wastage /cut pieces, temporary structures, packing woods etc. will be in the scope of the subcontractor. Such cleanings have to be done by subcontractor within quoted rate, on daily basis.
- ii. If such activity is not carried out by subcontractor / BHEL is not satisfied, then BHEL may get it done by other agency and actual cost along with BHEL overheads will be deducted from subcontractor's bill. Such decisions of BHEL shall be binding on the subcontractor
- iii. Dedicated Housekeeping gangs shall be deployed, who shall be provided all required PPEs and safety training
- iv. Mass housekeeping shall be carried out for half a day in a week
- v. Proper housekeeping to be maintained at work place and the following are to be taken care of on daily basis.
- vi. All surplus earth and debris are removed/disposed off from the working areas to identified locations.
- vii. Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the working areas are removed to identified locations.
- viii. All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations.
- ix. Sufficient waste bins shall be provided at different work places for easy collection of scrap/waste. Scrap chute shall be installed to remove scrap from high locations.
- x. Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.
- xi. Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.
- xii. Labor camp area shall be kept clear and materials like pipes, steel, sand, concrete, chips and bricks, etc. shall not be allowed in the camp to obstruct free movement of men and machineries.
- xiii. Fabricated steel structures, pipes & piping materials shall be stacked properly.
- xiv. No parking of trucks/trolleys, cranes and trailers etc. shall be allowed in the camp, which may obstruct the traffic movement as well as below LT/HT power line.
- xv. Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas.

16. WASTE MANAGEMENT

- i. Take suitable measures for waste management and environment related laws/legislation as a part of normal construction activities. Compliance with the legal requirements on storage/ disposal of paint drums (including the empty ones), Lubricant containers, Chemical Containers, and transportation and storage of hazardous chemicals will be strictly maintained.
- ii. Details of E-Waste, Hazardous Waste, biomedical waste etc. and their disposal plan, shall be submitted to BHEL every 6 months as per provided **formats**.

16.1 BINS AT WORK PLACE

- i. Sufficient rubbish bins shall be provided close to workplaces.
- ii. Bins should be painted yellow and numbered.
- iii. Sufficient nos. of drip trays shall be provided to collect oil and grease.
- iv. Sufficient qty. of broomsticks with handle shall be provided.
- v. Adequate strength of employees should be deployed to ensure daily monitoring and service for waste management.

16.2 STORAGE AND COLLECTION

- i. Different types of rubbish/waste should be collected and stored separately.
- ii. Paper, oily rags, smoking material, flammable, metal pieces should be collected in separate bins with close fitting lids.
- iii. Rubbish should not be left or allowed to accumulate on construction and other work places.
- iv. Do not burn construction rubbish near working site.

16.3 SEGREGATION

- i. Earmark the scrap area for different types of waste.
- ii. Store wastes away from building.
- iii. Oil spill absorbed by non-combustible absorbent should be kept in separate bin.
- iv. Clinical and first aid waste stored and incinerated separately.

16.4 DISPOSAL

- i. Sufficient containers and scrap disposal area should be allocated.
- ii. All scrap bin and containers should be conveniently located.
- iii. Provide self-closing containers for flammable/spontaneously combustible material.
- iv. Keep drainage channels free from choking.
- v. Make schedule for collection and disposal of waste.

16.5 WARNING AND SIGNS

- i. Appropriate sign to be displayed at scrap storage area
- ii. No toxic, corrosive or flammable substance to be discarded into public sewage system.
- iii. Waste disposal shall be in accordance with best practice.
- iv. Comply with all the requirements of Pollution Control Board (PCB) for storage and disposal of hazardous waste.

17. TRAFFIC MANAGEMENT SYSTEM

17.1 SAFE WORKPLACE TRANSPORT SYSTEM

- i. Traffic routes in a work place shall be suitable for the persons or vehicles using them. This shall be sufficient in number and of sufficient size. This shall reflect the suitability of traffic routes for vehicles and pedestrians.

- ii. Where vehicles and pedestrians use the same traffic routes there shall be sufficient space between them. Where necessary all traffic routes must be suitably indicated. Pedestrians or vehicles must be able to use traffic routes without endangering those at work. There must be sufficient separation of traffic routes from doors, gates and pedestrian traffic routes.
- iii. For internal traffic, lines marked on roads / access routes and between buildings shall clearly indicate where vehicles are to pass.
- iv. Temporary obstacles shall be brought to the attention of drivers by warning signs or hazard cones.
- v. Speed limits shall be clearly displayed for each kind of vehicle.
- vi. Speed ramps preceded by a warning signs or marker are necessary.
- vii. The traffic route should be wide enough to allow vehicles to pass and re-pass oncoming or parked traffic and it may be advisable to introduce on-way system or parking restrictions.
- viii. Safest route shall be provided between places where vehicles have to call or deliver.
- ix. Avoid vulnerable areas/items such as fuel or chemicals tanks or pipes, open or unprotected edges and structures likely to collapse
- x. Safe areas shall be provided for loading and unloading.
- xi. Avoid sharp or blind bends. If this is not possible hazards should be indicated e.g. blind corner.
- xii. Ensure road crossings are minimum and clearly signed.
- xiii. Entrance and gateways shall be wide enough to accommodate a second vehicle without causing obstruction.
- xiv. Set sensible speed limits which are clearly sign posted.
- xv. Where necessary ramps should be used to retard speed. This shall be preceded by a warning sign or mark on the road.
- xvi. Forklift trucks shall not pass over road hump unless of a type capable of doing so.
- xvii. Overhead electric cable, pipes containing flammable hazardous chemical shall be shielded by using goal posts height gauge posts or barriers.
- xviii. Road traffic signs shall be provided on prominent locations for prevention of incidents and hazards and for quick guidance and warning to employees and public. Safety signs shall be displayed as per the project working requirement and guideline of the state in which project is done. Vehicles hired or used shall not be parked within the 15m radius of any working area. Any vehicle, that is required to be at the immediate/near the vicinity, shall be approved by the person in-charge of the site.

17.2 TRAFFIC ROUTE FOR PEDESTRIANS

- i. Where traffic routes are used by both pedestrians and vehicles road shall be wide enough to allow vehicles and pedestrians safely.
- ii. Separate routes shall be provided for pedestrians to keep them away from vehicles. Provide suitable barriers/guard at entrances/exit and the corners or buildings.
- iii. Where pedestrian and vehicle routes cross, appropriate crossing shall be provided.

- iv. Where crowd is likely to use roadway e.g. at the end of shift, stop vehicles from using them at such times.
- v. Provide high visibility clothing for people permitted in delivery area.

17.3 WORK VEHICLE

Work vehicle shall be as safe stable efficient and roadworthy as private vehicles on public roads. Site management shall ensure that drivers are suitably trained. All vehicle e.g. heavy motor vehicle forklift trucks dump trucks mobile cranes shall ensure that the work equipment conforms to the following:

- i. A high level of stability.
- ii. A safe means of access/egress.
- iii. Suitable and effective service and parking brakes.
- iv. Windscreens with wipers and external mirrors giving optimum all round visibility.
- v. Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
- vi. Provision of seat belts.
- vii. Guards on dangerous parts.
- viii. Driver protection - to prevent injury from overturning and from falling objects/materials.
- ix. Driver protection from adverse weather.
- x. No vehicle shall be parked below HT/LT power lines.
- xi. Valid Pollution Under Control certification for all vehicles
- xii. Wheel stopper shall be use during the parking of vehicle
- xiii. Helper to be deployed in each vehicle as per site requirement.

17.4 DAILY CHECK BY DRIVER

1. There should also be daily safety checks containing below mentioned points by the driver before the vehicle is used.

Brakes	Mirrors	Warning signals
Tires	Windscreen waters	Specific safety systems i.e. controls & interlocks
Steering	Wipers	

2. Management should ensure that drivers carry out these checks.

17.5 TRANSPORTATION OF PERSONNEL AND MATERIALS BY VEHICLES

- i. All drivers shall hold a valid driving License for the class of vehicle to be driven and be registered as an authorized BHEL driver with the Administration Department.
- ii. Securing of the load shall be by established and approved methods, i.e. chains with patented tightening equipment for steel/heavy loads. Sharp corners on loads shall be avoided when employing ropes for securing.
- iii. All overhangs shall be made clearly visible and restricted to acceptable limits
- iv. Load shall be checked before moving off and after traveling a suitable distance.
- v. On no account is construction site to be blocked by parked vehicles Drivers of vehicles shall only stop or park in the areas designate by the stringing foreman.

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- vi. Warning signs shall be displayed during transportation of material.
- vii. All vehicles used by BHEL shall be in worthy condition and in conformance to the Land Transport requirement.
- viii. Wheel stopper shall be use during the parking of vehicle
- ix. Helper to be deployed in each vehicle as per site requirement.

17.6 MAINTENANCE

All Vehicles used for transportation of man and material shall undergo scheduled inspections on frequent intervals to secure safe operation. Such inspections shall be conducted in particular for steering, brakes, lights, horn, doors etc. Site management shall ensure that work equipment is maintained in an efficient, working order and in good repair. Inspections and services carried out at regular intervals of time and or mileage. No maintenance shall be carried below HT/LT power lines.

18. EMERGENCY PREPAREDNESS AND RESPONSE

- i. Emergency preparedness and response capability of site shall be developed as per Emergency Preparedness and Response plan issued by BHEL
- ii. Availability of adequate number of first aiders and fire warden shall be ensured with BHEL and its subcontractors
- iii. All the subcontractor's supervisory personnel and sufficient number of workers shall be trained for fire protection systems. Enough number of such trained personnel must be available during the tenure of contract. Subcontractor should nominate his supervisor to coordinate and implement the safety measures.
- iv. Assembly point shall be earmarked and access to the same from different location shall be shown
- v. Fire exit shall be identified and pathway shall be clear for emergency escape.
- vi. Appropriate type and number of fire extinguisher shall be deployed as per Fire extinguisher deployment plan and validity shall be ensured periodically through inspection
- vii. Adequate number of first aid boxes shall be strategically placed at different work places to cater emergency need. Holder of the first aid box shall be identified on the box itself who will have the responsibility to maintain the same.
- viii. First aid center shall be developed at site with trained medical personnel and ambulance
- ix. Emergency contact numbers (format given in EPRP) of the site shall be displayed at prominent locations.
- x. Tie up with fire brigade shall be done in case customer is not having fire station.
- xi. Tie up with hospital shall be done in case customer is not having hospital.
- xii. Disaster Management group shall be formed at site
- xiii. Mock drill shall be arranged at regular intervals. Monthly report of the above to be given to BHEL HSE Officer as per prescribed BHEL formats
- xiv. Mock drill shall be conducted on different emergencies periodically to find out gaps in emergency preparedness and taking necessary corrective action

19. HSE INSPECTION

Inspection on HSE for different activities being carried out at site shall be done to ensure compliance to HSE requirements. The subcontractor shall maintain and ensure necessary safety measures as required for inspection and tests HV test, Pneumatic test, Hydraulic test, Spring test, Bend test as applicable, to enable inspection agency for performing Inspection. If any test equipment is found not complying with proper safety requirements then the Inspection Agency may withhold inspection, till such time the desired safety requirements are met.

Online/ App-based HSE Inspection system shall be used for inspection whenever provided by BHEL otherwise Hard-copy based system shall continue

 ☐ OK ☐ NOT OK	
Contractor Name:	
Equipment Identification No :	
Inspection Date :	
Next Inspection Date :	
Inspected By :	

Every Inspected Equipment shall display above sticker

19.1 INSPECTION PLAN

Subcontractor shall prepare an inspection plan covering all areas/ activities/ equipment/ hazards and implement the same after getting approval of BHEL. Responsibility to ensure coverage of all areas/ activities rests with the subcontractor.

All Inspections shall be witnessed by BHEL – only then they shall be considered as valid

19.2 INSPECTION REPORTS

Monthly inspection reports as per plan shall be submitted to BHEL HSE Head

19.3 NON-CONFORMANCES

Any non-conformances identified during inspection observed shall be addressed on priority.

The responsibility of resolution shall rest with the Subcontractor Site In-charge

In case immediate closure of non-conformities is not possible:

- work to be halted in the area
- non-conformance to be generated and submitted to responsible person and BHEL
- non-conformance to be resolved through responsible agency / person

Only after closure of non-conformances, work to be allowed to resume

19.4 DAILY HSE CHECKS

Both the Site Supervisors and HSE Officer of Subcontractor are to conduct daily site Safety inspection around work activities and premises to ensure that work methods and the sites

are maintained to an acceptable standard. The following are to form the common subjects of a daily safety inspection:

- i. Personal Safety wears & gear compliance.
- ii. Complying with site safety rules and permit-to-work (PTW).
- iii. Positions and postures of workers.
- iv. Use of tools and equipment etc. by the workers.

The inspection should be carried out just when work starts in beginning of the day, during peak activities period of the day and just before the day's work ends.

19.5 INDICATIVE LIST OF INSPECTIONS AND PERIODICITIES

Indicative list & periodicity of Inspections is given as under. It is the responsibility of the subcontractor to develop an inspection plan covering all areas & activities in the scope.

SL. No.	Format Name	Frequency of check (if applicable)
01	Inspection of First Aid Box	Weekly
02	Inspection of PPE	Weekly
03	Inspection of T&Ps	Monthly
04	Inspection of Cranes	Monthly
05	Inspection of Winches	Monthly
06	Inspection on Height Working	Weekly
07	Inspection on Welding & Gas Cutting	Monthly
08	Inspection on Electrical Installation	Monthly
09	Inspection on Elevator	Weekly
10	Inspection of Excavation	Weekly
11	Inspection of Labor Colony	Monthly
12	Inspection of Illumination Levels	Weekly

The checklists shall be provided by BHEL at Site. It is the responsibility of the subcontractor to ensure their availability before start of work

19.5.1 INSPECTION OF PPE

- i. PPEs shall be inspected by HSE officer at random once in a week as per provided **format** for its compliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.
- ii. The applicable PPEs for carrying out particular activities are listed below.

19.5.2 INSPECTION OF TOOLS & PLANTS (T&Ps)

- i. A master list of T&Ps shall be maintained by each subcontractor in provided **format**.
- ii. All T&Ps being used at site shall be inspected by HSE officer once in a month as per provided **format** for its healthiness and maintenance.
- iii. The T&Ps which require third party inspection shall be checked for its validity during inspection. The third-party test certificate should be accompanied with a copy of the concerned competent person's valid qualification record.

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- iv. BHEL shall be given advance intimation of Third-Party Inspection. BHEL shall associate with Inspection as per discretion.
- v. The validity of T&P shall be monitored as per provided **format**

19.5.3 INSPECTION OF CRANES AND WINCHES

- i. Cranes and winches shall be inspected by the operator through a daily checklist for its safe condition (as provided by the equipment manufacturer) before first use of the day.
- ii. Cranes and Winches shall be inspected by HSE officer once in a month as per provided **format** for healthiness, maintenance and validity of third-party inspection.
- iii. The date of third-party inspection and next due date shall be painted on cranes and winches.
- iv. The operators/drivers shall be authorized by sub-subcontractor based on their competency and experience and shall carry the I-card.
- v. The operator should be above 18 years of age and should be in possession of driving license of HMV man & goods), vision test certificate and should have minimum qualification so that he can read the instructions and check list.

19.5.4 INSPECTION OF HEIGHT WORKING

- i. Any activity carried out at more than 2 m height is classified as height work.
- ii. Inspection of height working shall be conducted daily by Supervisors before start of work to ensure safe working condition including provision of
 - a. Fall arrestor
 - b. Lifelines – connected to rigid & independent structure
 - c. Safety nets deployed below all height work activities
 - d. Fencing and barricading
 - e. Warning signage
 - f. Covering of opening
 - g. Proper scaffolding with access and egress.
 - h. Illumination
- iii. For full duration of height work, constant supervision to be maintained by dedicated HSE personnel
- iv. Inspection on height working shall be conducted once in a week by HSE officer as per provided **format**.
- v. Medical fitness of height worker shall be ensured.
- vi. Height working shall not be allowed during adverse weather.

19.5.5 INSPECTION OF WELDING AND GAS CUTTING OPERATION

- i. Supervisor shall ensure that no flammable items are available in near vicinity during welding and gas cutting activity.
- ii. Gas cylinders shall be kept upright.
- iii. Use of Flash back arrestor shall be ensured at both ends.

- iv. Inspection during welding and gas cutting operations shall be carried out by HSE officer once a month as per provided **format**.
- v. Use of fire blanket to be ensured to avoid falling of splatters during welding or gas cutting operation at height.
- vi. Availability of fire extinguisher at vicinity shall be ensured.

19.5.6 INSPECTION OF ELECTRICAL INSTALLATION / APPLIANCES

- i. Ensure proper earthing in electrical installation
- ii. Use ELCB at electrical booth
- iii. Electrical installation shall be properly covered at top where required
- iv. Use appropriate PPEs while working
- v. Use portable electrical light < 24 V in confined space and potentially wet area.
- vi. Inspection shall be carried out as per provided **format**.

19.5.7 INSPECTION OF ELEVATOR

- i. Elevators shall be inspected by concerned supervisors once in a week as per provided **format**
- ii. All elevators shall be inspected by competent person and validity shall be ensured.
- iii. The date of third-party inspection and next due date shall be painted on elevator.

19.5.8 INSPECTION OF EXCAVATION

Excavation activities shall be inspected as per provided **format**

19.5.9 INTERNAL/ EXTERNAL HSE AUDITS/INSPECTIONS

- i. All non-conformities and observations on HSE identified during internal or external HSE audit shall be disposed of by site in a time bound manner and reported back the implementation status.
- ii. Corrective action and Preventive action on HSE issues raised by certification body issued by BHEL shall be implemented by site and reported to Site management.

20. TERMS AND DEFINITIONS:

1. Incident

Work- related or natural event(s) in which an injury, or ill health (regardless of severity), damage to property or fatality occurred, or could have occurred.

2. Near Miss:

An incident where no ill health, injury, damage or other loss occurs, but it had a potential to cause, is referred to as "Near-Miss".

3. Man-Hours Worked:

The total number of man hours worked by all employees including subcontractors working in the premises. It includes managerial, supervisory, professional, technical, clerical and other workers including contract labors. Man-hours worked shall be calculated from the payroll or time clock recorded including overtime. When this is not feasible, the same shall be estimated by multiplying the total man-days worked

period covered by the number of hours worked per day. The total number of workdays for a period is the sum of the number of men at work on each day of period. If the daily hours vary from department to department separate estimate shall be made for each department and the result added together.

4. First Aid Cases:

First aids are not essentially all reportable cases, where the injured person is given medical treatment and discharged immediately for reporting on duty, without counting any lost time.

5. Lost Time Injury:

Any work injury which renders the injured person unable to perform his regular job or an alternative restricted work assignment on the next scheduled work day after the day on which the injury occurred.

6. Medical Cases:

Medical cases come under non-reportable cases, where owing to illness or other reason the employee was absent from work and seeks Medical treatment.

7. Type of Incidents & Their Reporting:

The three categories of Incident are as follows:

8. Non-Reportable Cases:

An incident, where the injured person is given medical help and discharged for work without counting any lost time.

9. Reportable Cases:

In this case the injured person is disable for 48 hours or more and is not able to perform his duty.

10. Injury Cases:

These are covered under the heading of non-reportable cases. In these cases, the incident caused injury to the person, but he still continues his duty.

11. Total Reportable Frequency Rate

Frequency rate is the number of Reportable Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula read as:

$$\text{Number of Reportable LTI} \times 1,000,000 / \text{Total Man Hours Worked}$$

12. Severity Rate:

Severity rate is the Number of days lost due to Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula reads as:

$$\text{Days lost due to LTI} \times 1,000,000 / \text{Total Man Hours Worked}$$

13. Incidence Rate:

Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as:

$$\text{Number of LTI} \times 1000 / \text{Average number of manpower deployed}$$

14. HIRA:

Hazard Identification and Risk Assessment (HIRA) is a process of identifying Hazards in work area and then assessing them properly

15. Method Statement:

A method statement is prepared by the Execution/ Engineering Department detailing the steps, equipment, competencies and safety precautions required for carrying out any activity

16. Job Safety Analysis:

A job safety analysis (JSA) is a procedure which helps integrate accepted safety and health principles and practices into a particular task or job operation. In a JSA, each basic step of the job is to identify potential hazards and to recommend the safest way to do the job. Other terms used to describe this procedure are job hazard analysis (JHA) and job hazard breakdown.

17. Safety Walk:

It's conducted periodically by an official - it's a walk through a portion or whole of a site as a HSE officer who notes down HSE observations, speak to concerned workmen and supervisor on observation, get the same corrected with personal follow up- this sends out a strong message on Management's commitment to safety.

18. Heavy & Complex Lifting:

A heavy and complex lifting activity includes:

1. Lifting above 20 Tons
2. Tandem Lifting using multiple cranes
Total load exceeding 75% of capacity of crane. Depending up the condition of cranes, hydra cranes, winch machines & other lifting accessories
3. Lift of unusual difficulty or geometry or rigging
4. Lift over operating units
5. Any other lift as decided by site HSE / Erection

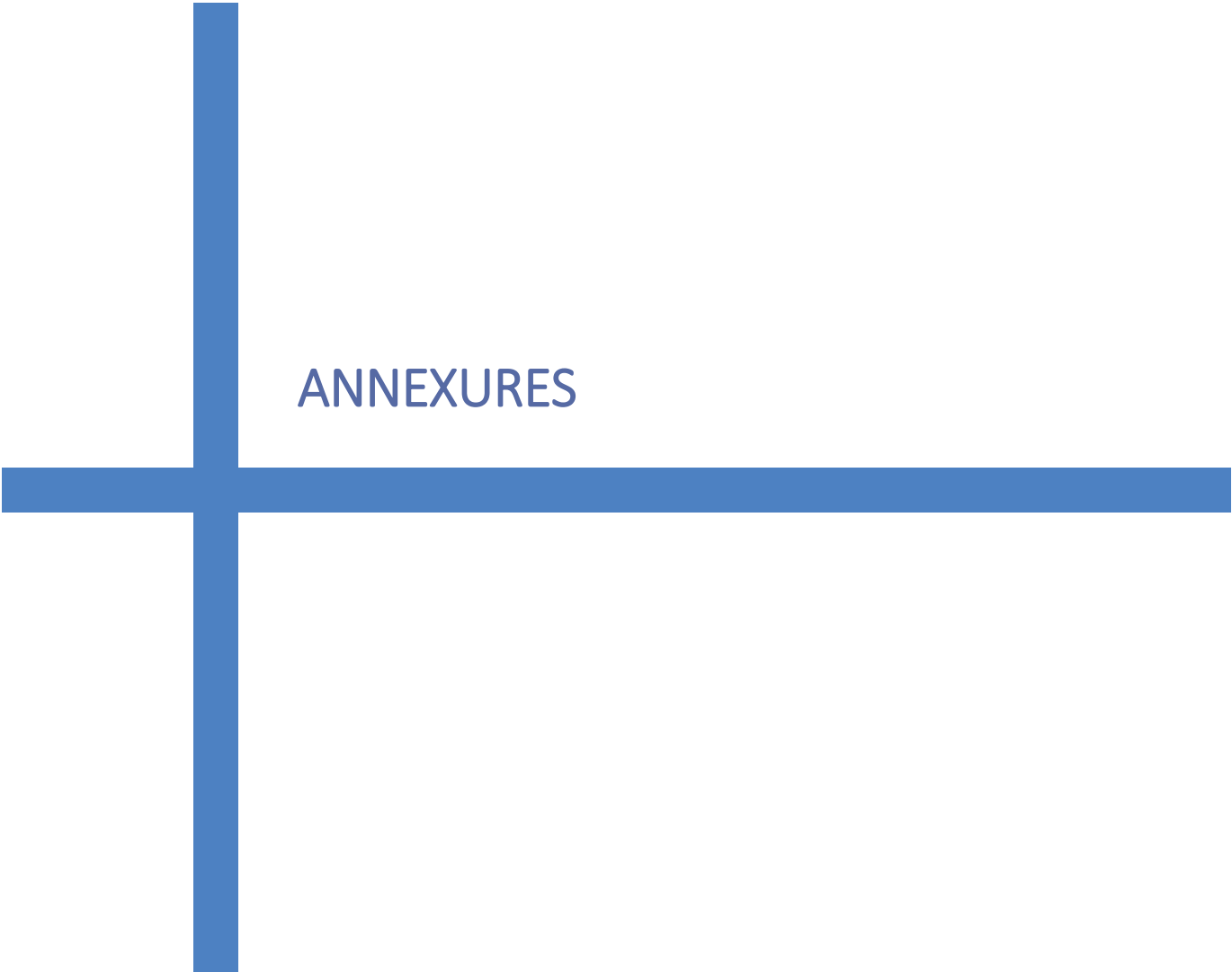
19. Safety Committee:

As per the BOCW, Safety Committee shall be constituted if there are more than five hundred or more construction workers are employed at any site. As per the Factories Act, 1948 it is for 250 workers. It shall be represented by equal number of representatives of employer and construction workers.

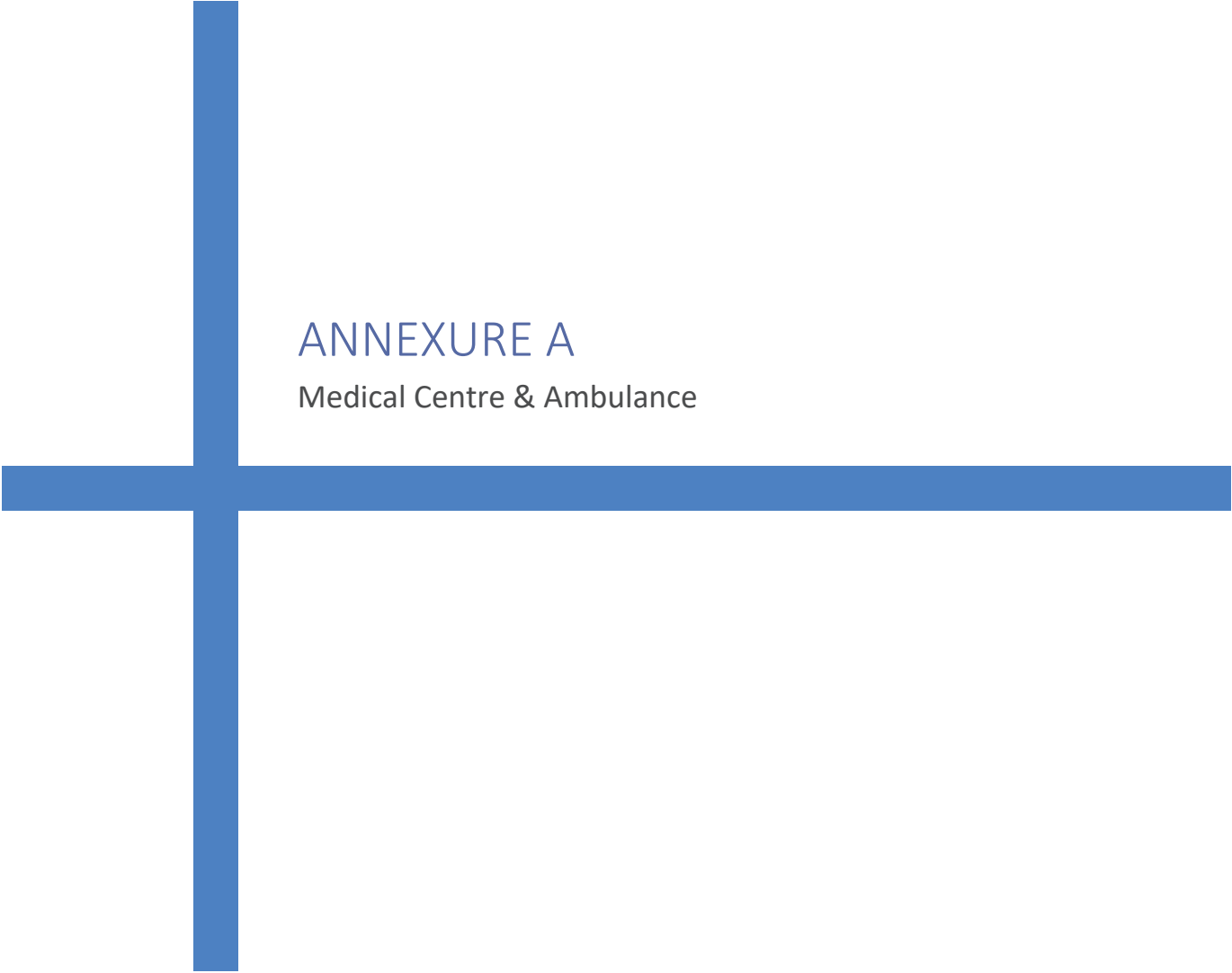
20. Night Work:

Work conducted after sunset when only a fraction of total manpower is available





ANNEXURES



ANNEXURE A

Medical Centre & Ambulance

Rk

A. Medical Centre

1. Paramedical staff
 - a. When < 500 workers, 1 Trained Male Nurse (round the clock deployment)
 - b. When >=500 workers*:
 - i. Registered Medical Practitioner (Qualified MBBS) to be deployed for at least 8 hours in a day, 5 days per week
 - ii. 2 Trained Male Nurses (round the clock deployment)
 2. All articles as per Schedule IV of BOCW Central Rules, 1998 to be made available in the Medical Centre (given under for convenience)
 3. Basic Facilities/ Requirements to be provided as per location eg. Refrigerator, Air Conditioner, Anti Venom Serums etc.
 4. Tie-ups with speciality hospitals to be ensured for referring serious patients
- * In case the number of workers is envisaged to exceed 500, a medical practitioner is to be engaged.

SCHEDULE IV (BOCW CENTRAL RULES, 1998) ARTICLES FOR AMBULANCE ROOM [SEE RULE 226 (C)]

- i. A glazed sink with hot and cold water always available.
- ii. A table with a smooth top at least 180 cm x 105 cm.
- iii. Means for sterilising instruments.
- iv. A couch.
- v. Two stretchers.
- vi. Two buckets or containers with close fitting lids.
- vii. Two rubber hot water bags
- viii. A kettle and spirit stove or other suitable means of boiling water.
- ix. Twelve plain wooden splints 900 cm x 100 cm x 6 cm.
- x. Twelve plain wooden splints 350 cm x 75 cm x 6 cm.
- xi. Six plain wooden splints 250 cm x 50 cm x 12 cm.
- xii. Six woollen blankets.
- xiii. Three pairs of artery forceps.
- xiv. One bottle of spiritus annemia aremations (120 ml).
- xv. Smelling salt (60 gm).
- xvi. Two medium size sponges.
- xvii. Six hand towels.
- xviii. Four kidney trays.
- xix. Four cakes of toilet, preferably antiseptic soap.
- xx. Two glass tumblers and two wine glasses.
- xxi. Two clinical thermometers.
- xxii. Two tea spoons.
- xxiii. Two graduated (120 ml) measuring glasses.
- xxiv. Two minimum measuring glasses.
- xxv. One wash bottle (1000 cc) for washing eyes.
- xxvi. one bottle (one litre) carbolic lotion 1 to 20.
- xxvii. Three chairs.
- xxviii. One screen.
- xxix. One electric hand torch.
- xxx. Four first-aid boxes or cupboards stocked to the standards prescribed in
- xxxi. An adequate supply of tetanus toxoid.
- xxxii. Injections—morphia, pethidine, atrophine, adrenaline, coramine, novocaine (6 each).
- xxxiii. Cramine liquid (60 ml).
- xxxiv. Tablets—antihistaminic antispasmodic (25 each).
- xxxv. Syringes with needles—2 cc, 5 cc, 10 cc and 500 cc.

- xxxvi. Three surgical scissors.
- xxxvii. Two needle holders, big and small.
- xxxviii. Suturing needles and materials.
- xxxix. Three dissecting forceps
 - xl. Three dressing forceps
 - xli. Three scalpels.
 - xl.ii. One stethoscope and a B. P. apparatus.
- xliii. Rubber bandage—pressure bandage.
- xliv. Oxygen cylinder with necessary attachments.
- xlv. Atropine eye ointments.
- xlvi. I. V. Fluids and sets 10 nos.
- xlvi. Suitable, foot operated, covered, refuse containers.
- xlvi. Adequate number of sterilised, paired, latex hand gloves.

B. Ambulance

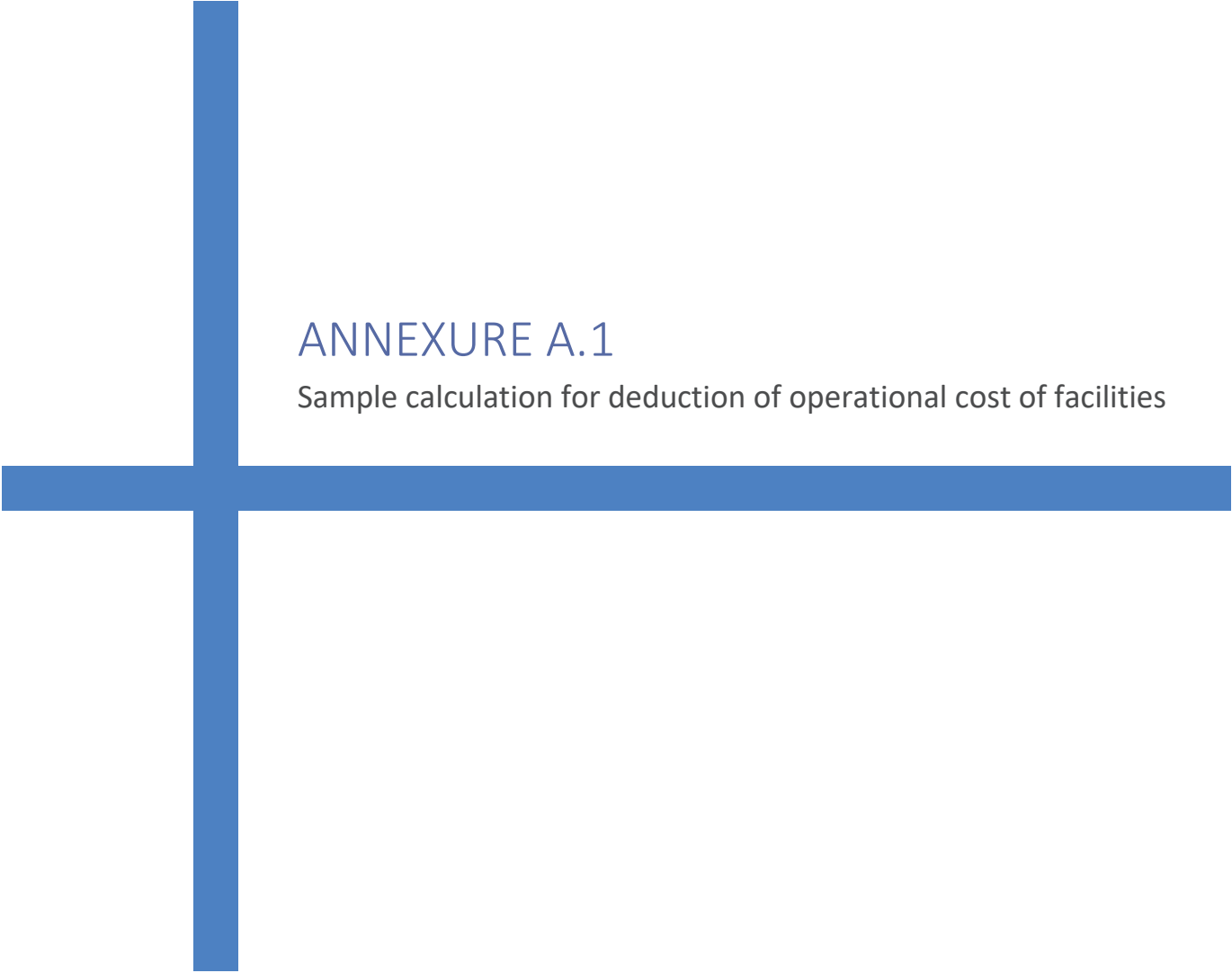
1. When number of workers is <500:
If the distance to a major hospital capable of handling critical injuries expected at Site is ≤ 50 KM from Site, then 1 BLS (Basic Life Support)/ Type B Ambulance otherwise ALS* (Advanced Life Support)/ Type D Ambulance
2. If no. of workers increases to >2000 workers one additional BLS Ambulance to be deployed
3. Minimum Articles as per Schedule V of BOCW Central Rules to be ensured in each Ambulance. (given under for convenience)

*Final call to be taken at Site in consultation with all the contractors

SCHEDULE V (BOCW CENTRAL RULES, 1998) CONTENTS OF AMBULANCE VAN OR CARRIAGE [SEE RULE 227]

The Ambulance Van shall have equipment prescribed as under:

- a) General—a portable stretcher with folding and adjusting devices with the Head of the stretcher capable of being tilted upward. Fixed suction unit with equipment. Fixed oxygen supply with equipment. Pillow with case, sheets, blankets, towels, emergency bag, bed pan, urinal glass.
- b) Safety Equipment—Flaros with life of three thousand minutes, floor lights, flash lights, fire extinguishers (dry power type), insulated guntlets.
- c) Emergency Care Equipment—
 - i. **Resuscitation**—Portable suction unit, portable oxygen unit, bag valve mask, hand operated artificial ventilation unit, airways, mouth gag tracheostomy adapters, short spine board, I.V. FLUIDS with administration unit, B. P. manometer cuff stethoscope.
 - ii. **Immobilisation**—Long and short padded boards, wire ladder splints, triangular bandage—long and short spine boards.
 - iii. **Dressing**—Gauze pads—100 m x 100 mm universal dressing 250 x 1000 mm, roll of aluminium foils—soft roller bandages 150 mm x 5 mm yards adhesive tape in 75 mm roll safety pins, bandage sheets, burn sheets.
 - iv. **Poisoning**—Syrup of Ipecac, activated charcoal pre packeted dose, snake bit kit, drinking water.
 - v. **Emergency Medicines**—As per requirement (under the advice of construction Medical Officer).



ANNEXURE A.1

Sample calculation for deduction of operational cost of facilities

Annexure A.1**Cost Calculation Methodology of Operation of Facilities (Data is indicative only)**

(Period of 48 months is considered - shall be on actual basis)

A. Project Info:

Total time of Project	48 months
Project cost	1000 Crore
No. of packages	10 (A1-A10)

B. Item-wise Calculation:

Item	Nos.	Rate	Unit	Amount
Ambulance with Driver	2		Monthly/Unit	170000
Nurse/First aider	2 X 2 shifts	15000	Per month	30000
Training center one time cost	1	100000	Once	100000
Medical center one time cost	1	200000	Once	200000
Medicines at medical center	1	10000	Monthly	10000
Dust suppression water tank	2	2000	Monthly	4000
Doctor	1	70000	Monthly	70000
Cleaning staff	1	12000	Monthly	12000
Recurring monthly expenditure				296000
Total one-time expenditure				300000

C. Package-wise Deduction Plan for a period of 48 months

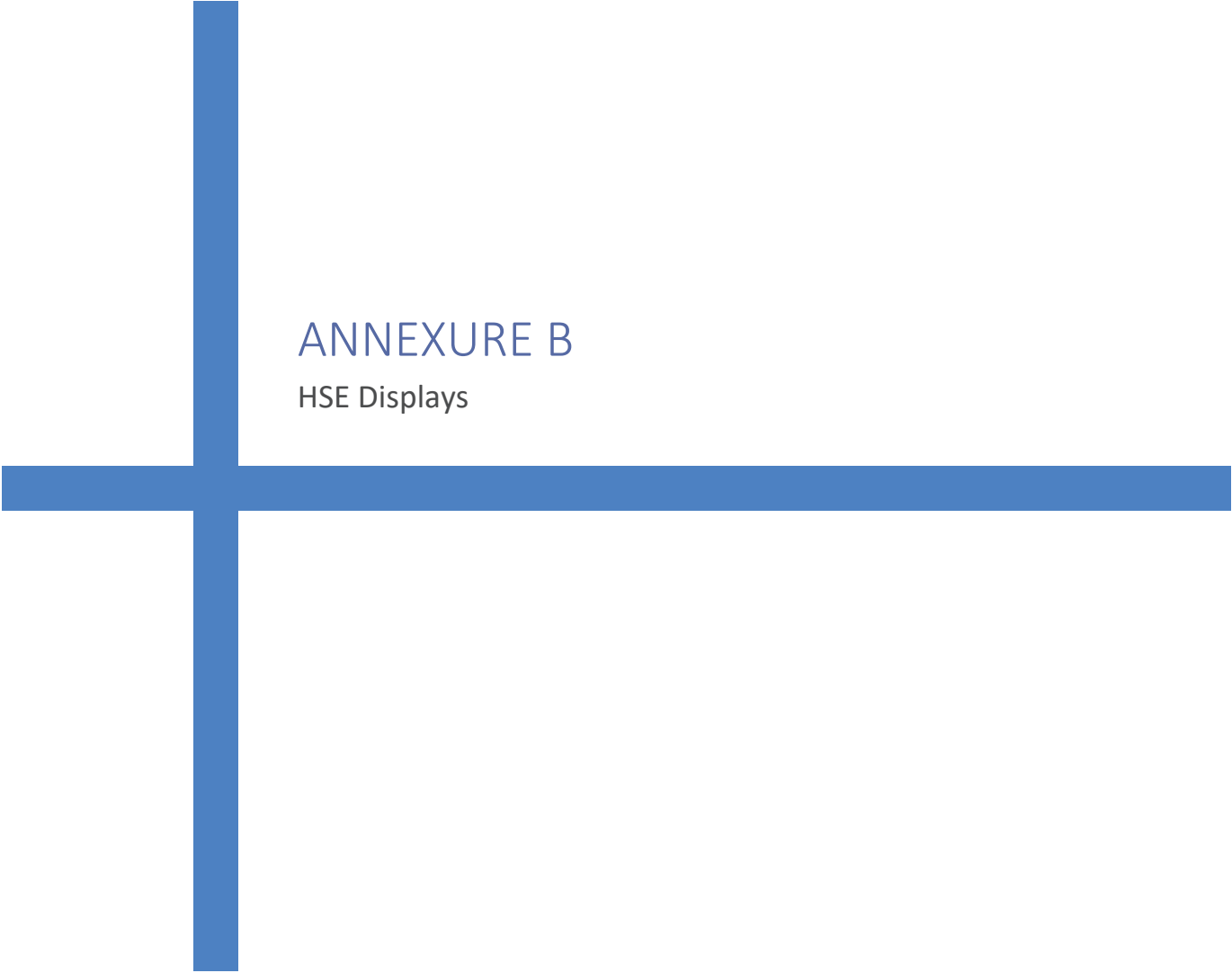
Period (In Months)	6	36	6
	For 1-6 months	For 7-42 months	For 43-48 months
Cost to be incurred from contractors	7%	81%	12%
	1.17% per month	2.25% per month	2.00% per month

D. Calculation For One-Time Running Cost

Packages/ Contracts	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10				
Contract Values (in Thousands)	100000	250000	2000000	200000	500000	1500000	1000000	1000000	250000	200000	7000000			
Share of common facilities one time running cost (in Thousands)	4	11	86	9	21	64	43	43	11	9	Individual Pkg value X Total one time running cost / All Pkg award values			
Timeline of work	1-6	1-8	2-48	6-36	7-15	10-48	6-48	7-40	40-48	41-48				
Month Count of work	6	8	47	31	9	39	43	34	9	8				
Deduction per month (in Thousands)	1	1	2	0	2	2	1	1	1	1	Total of One time Running cost (in thousands)	% deduction share of one time running cost per month	Nos. of active packages in month	
Month No.														
1	1	1									2	1%	2	
2	1	1	2								4	1%	3	
3	1	1	2								4	1%	3	
4	1	1	2								4	1%	3	
5	1	1	2								4	1%	3	
6	1	1	2	0			1				5	2%	5	
7		1	2	0	2		1	1			8	3%	6	
8		1	2	0	2		1	1			8	3%	6	
9			2	0	2		1	1			7	2%	5	
10			2	0	2	2	1	1			8	3%	6	
11			2	0	2	2	1	1			8	3%	6	
12			2	0	2	2	1	1			8	3%	6	
13			2	0	2	2	1	1			8	3%	6	
14			2	0	2	2	1	1			8	3%	6	
15			2	0	2	2	1	1			8	3%	6	
16			2	0		2	1	1			6	2%	5	
17			2	0		2	1	1			6	2%	5	
18			2	0		2	1	1			6	2%	5	
19			2	0		2	1	1			6	2%	5	
20			2	0		2	1	1			6	2%	5	
21			2	0		2	1	1			6	2%	5	
22			2	0		2	1	1			6	2%	5	
23			2	0		2	1	1			6	2%	5	
24			2	0		2	1	1			6	2%	5	
25			2	0		2	1	1			6	2%	5	
26			2	0		2	1	1			6	2%	5	
27			2	0		2	1	1			6	2%	5	
28			2	0		2	1	1			6	2%	5	
29			2	0		2	1	1			6	2%	5	
30			2	0		2	1	1			6	2%	5	
31			2	0		2	1	1			6	2%	5	
32			2	0		2	1	1			6	2%	5	
33			2	0		2	1	1			6	2%	5	
34			2	0		2	1	1			6	2%	5	
35			2	0		2	1	1			6	2%	5	
36			2	0		2	1	1			6	2%	5	
37			2			2	1	1			6	2%	4	
38			2			2	1	1			6	2%	4	
39			2			2	1	1			6	2%	4	
40			2			2	1	1	1		7	2%	5	
41			2			2	1		1	1	7	2%	5	
42			2			2	1		1	1	7	2%	5	
43			2			2	1		1	1	7	2%	5	
44			2			2	1		1	1	7	2%	5	
45			2			2	1		1	1	7	2%	5	
46			2			2	1		1	1	7	2%	5	
47			2			2	1		1	1	7	2%	5	
48			2			2	1		1	1	7	2%	5	
Total	4	11	86	9	21	64	43	43	11	9	300	100%		

D. Calculation For Recurring Running Cost

Packages/ Contracts	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10		
Contract Values (in Thousands)	100000	250000	2000000	200000	500000	1500000	1000000	1000000	250000	200000	7000000	
Timeline of work	1-6	1-8	2-48	6-36	7-15	10-48	6-48	7-40	40-48	41-48	Total of Recurring cost (in thousands)	Nos. of active packages in month
Month No.	6	8	47	31	9	39	43	34	9	8		
1	85	211									296	2
2	13	31	252								296	3
3	13	31	252								296	3
4	13	31	252								296	3
5	13	31	252								296	3
6	8	21	167	17			83				296	5
7		15	120	12	30		60	60			296	6
8		15	120	12	30		60	60			296	6
9			126	13	31		63	63			296	5
10			95	10	24	72	48	48			296	6
11			95	10	24	72	48	48			296	6
12			95	10	24	72	48	48			296	6
13			95	10	24	72	48	48			296	6
14			95	10	24	72	48	48			296	6
15			95	10	24	72	48	48			296	6
16			104	10		78	52	52			296	5
17			104	10		78	52	52			296	5
18			104	10		78	52	52			296	5
19			104	10		78	52	52			296	5
20			104	10		78	52	52			296	5
21			104	10		78	52	52			296	5
22			104	10		78	52	52			296	5
23			104	10		78	52	52			296	5
24			104	10		78	52	52			296	5
25			104	10		78	52	52			296	5
26			104	10		78	52	52			296	5
27			104	10		78	52	52			296	5
28			104	10		78	52	52			296	5
29			104	10		78	52	52			296	5
30			104	10		78	52	52			296	5
31			104	10		78	52	52			296	5
32			104	10		78	52	52			296	5
33			104	10		78	52	52			296	5
34			104	10		78	52	52			296	5
35			104	10		78	52	52			296	5
36			104	10		78	52	52			296	5
37			108			81	54	54			296	4
38			108			81	54	54			296	4
39			108			81	54	54			296	4
40			103			77	51	51	13		296	5
41			120			90	60		15	12	296	5
42			120			90	60		15	12	296	5
43			120			90	60		15	12	296	5
44			120			90	60		15	12	296	5
45			120			90	60		15	12	296	5
46			120			90	60		15	12	296	5
47			120			90	60		15	12	296	5
48			120			90	60		15	12	296	5
Total	143	388	5676	329	235	3102	2334	1772	132	96	14208	



ANNEXURE B

HSE Displays

Rk

A. Types of Displays**1. Based on Content**

SN	Type
1.	HSE Hazards & Precautions Height Work, Housekeeping, Fire Safety, PPEs, Hot Work, Lifting & Rigging Activity, Site-specific Hazards – eg. for Refineries, Nuclear plants etc.; COVID Precautions; Environment Protection etc.
2.	Other Displays, Signage etc. HSE Policy, ISO Certificate, Safety Statistics, Assembly Area Location/ Route, Emergency Contact Numbers, Site Safety Rules & Regulations, Speed Limit, Work in Progress, Lock-Out Tag-Out (LOTO) Boards etc.

2. Based on Mounting

[Type 1]	[Type 2]	[Type 3]
Flex Sign Boards of Wooden Frame – directly mounted on Structures (walls, stairs, railings etc.)	Flex Sign Boards with Wooden Frame – mounted on metallic/ wooden legs – preferably double-sided	Coloured weather-proof Paintings on Walls (after due concurrence of BHEL/ Customer – Type 1 in case of no concurrence/ space)

B. General Requirements:

- Displays should be weather-proof as per installation location, i.e. rain-proof, wind-proof and sun-proof.
- Installation location and size to ensure visibility for the intended viewers (workers and moving personnel)
- Displays to have at least 50% graphical elements preferably (as applicable). Language should be understandable by majority of the workers
- Displays to be relevant to the hazards in the area
- Proper installation to ensure boards don't obstruct activities and should not be prone to fall so as to pose danger
- In case of multiple elevations (eg. Boiler, Power-house etc.), each elevation to have displays for applicable hazards including Height-Work, Housekeeping
- For temporary work locations, posters/ boards may be erected and shifted after task is over
- Minimum size of displays should be A1 unless otherwise specified
- In case of damage, displays shall be reviewed and repaired/ replaced
- In areas where night work is envisaged, fluorescent displays shall be installed and these should comprise of at least 20-30% of total displays
- Total Number of displays to be not less than 1 per 10 workers and are to be dynamically updated based on number of workers

C. Area-wise Displays

Below is list of Area-wise displays that are to be installed at Sites (Numbers, locations may be adjusted for specific requirements)

SN	Area	Suggested Subjects	Minimum Size	Minimum Quantity	Locations
1	Walls/ Foundations/ Cement Structures etc. belonging to the package area	Safety Hazards Prevention and other HSE Awareness content	[Type 3]	As per BHEL assessment from time to time	
2	Site Interior Roads belonging to the package area	At least every 20 meters: 1. Speed Limit Indication, Safe Driving board 2. Boards for hazard awareness	1.As needed [Type 2] 2. A1 or equivalent each [Type 2]	As indicated	Sides of Roads; Height to ensure good visibility
3	Specific Package Areas	A. Common At entry to respective Package/ Work Area, each contractor to put up daily updated board with following for each shift: 1. Scope of work and start date 2. Emergency Contact Numbers 3. Emergency Assembly Location, Escape Plan 4. Locations and supervisors of various gangs in the area, 5. Current Work permit Details 6. Safety Supervisor Location assignments - Names, Mobile Nos., Assigned Locations 7. Details (Name, Contact No. etc.) of Package In-charge - Contractor & BHEL 8. Details (Name, Contact No. etc.) of Safety In-charge - Contractor & BHEL 9. LTI Free Man-days & details of last LTI also to be indicated In addition, Area-Specific Displays as indicated in Table 1	A0 [Type 2]	1 per Package Area	Entry/ Ground Level

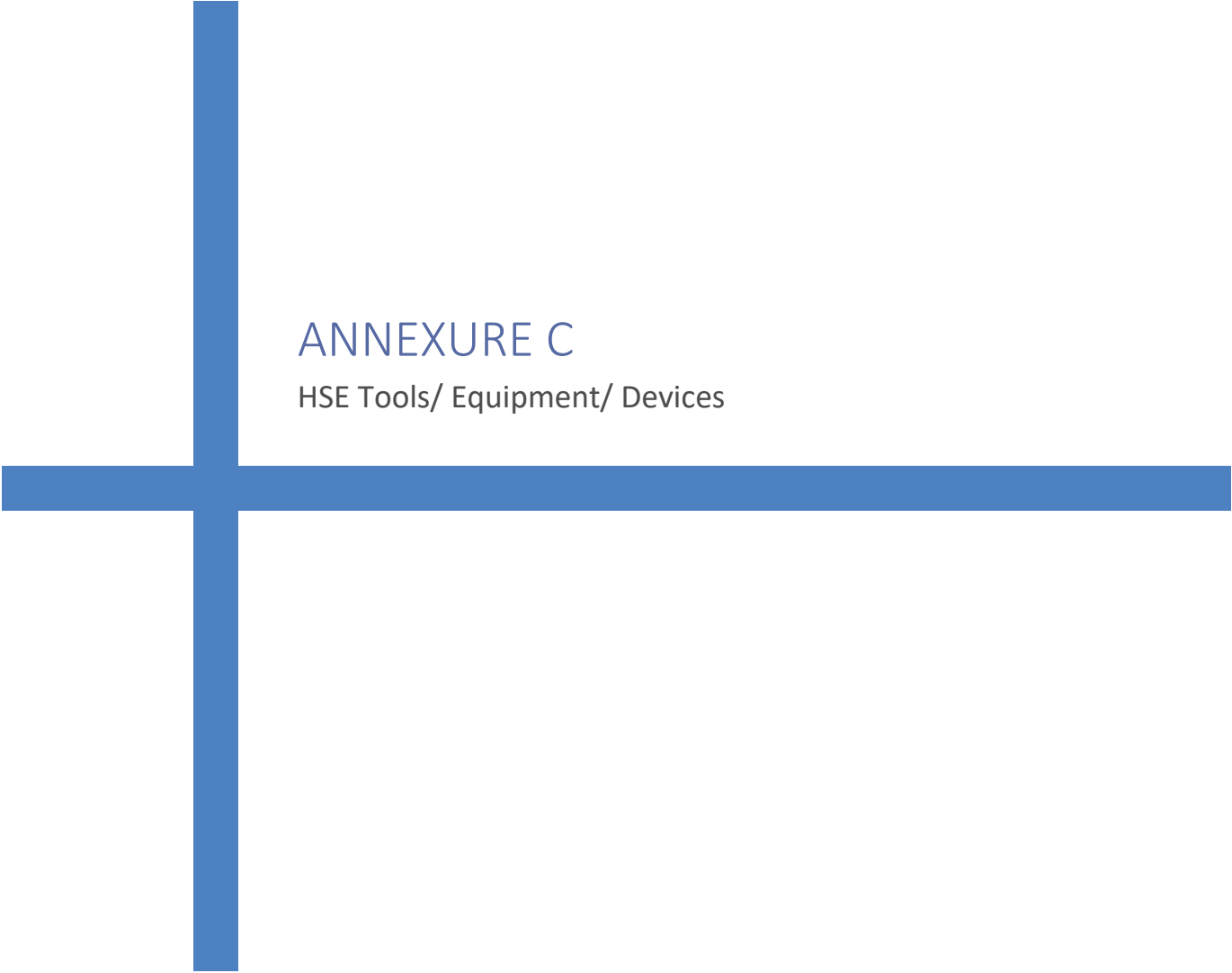
Table 1
(Area/ Package-wise HSE Display Plan – As applicable)

Prepared By (Subcontractor)				
S. No.	Area	Suggested Minimum No. of Displays & Types	Type	Numbers Installed
1	Boiler	3 per working elevation	[Type 1]	
2	Powerhouse	5 per elevation	[Type 1]	
3	ESP	5 Per Pass	[Type 1]	
4	Buildings	5 per elevation	[Type 1]	
5	Cooling Tower (NDCT/ IDCT/ ACC)	20 per Structure	[Type 1]	
6	Chimney	20 per Structure	[Type 1]	
7	Fabrication Yard	10 per Yard	[Type 2]	
8	Batching Plant	5 per Plant	[Type 1]	
9	Material Storage Yard – Open	20 per Yard	[Type 2]	
10	Material Storage Shed – Semi-Closed/ Closed	10 per Shed	[Type 1]	
11	Electrical Booths	2 per booth + Line diagram, Emergency contact details	[Type 1]	
12	Medical & First Aid Centre	2 per Centre	[Type 1]	
13	Rest Shed	2 per Shed	[Type 1]	
14	Canteen	2 per Canteen	[Type 1]	
15	Drinking Water Area	1 Per Outlet	[Type 1]	
16	Washing Water Area	1 Per Outlet	[Type 1]	
17	Training Centre	10 per room	[Type 1/2]	
18	Assembly Area	5	[Type 1/2]	
19	Stairs	1 per landing elevation	[Type 1]	
20	Cylinder Storage Area	5 + Signage: Type of Gas, Empty, Filled etc.	[Type 1/2]	
21	Labor Colony	Electrical Safety with Distribution Plan/ Line Diagram - 1 COVID Precautions Posters – 5 Safety Awareness Posters – 10 Hygiene awareness posters - 2	[Type 1]	
22	Others	As per requirement	[Type 1/2]	

Date:

Sign (Contractor)

Sign (BHEL)



ANNEXURE C

HSE Tools/ Equipment/ Devices

Rk

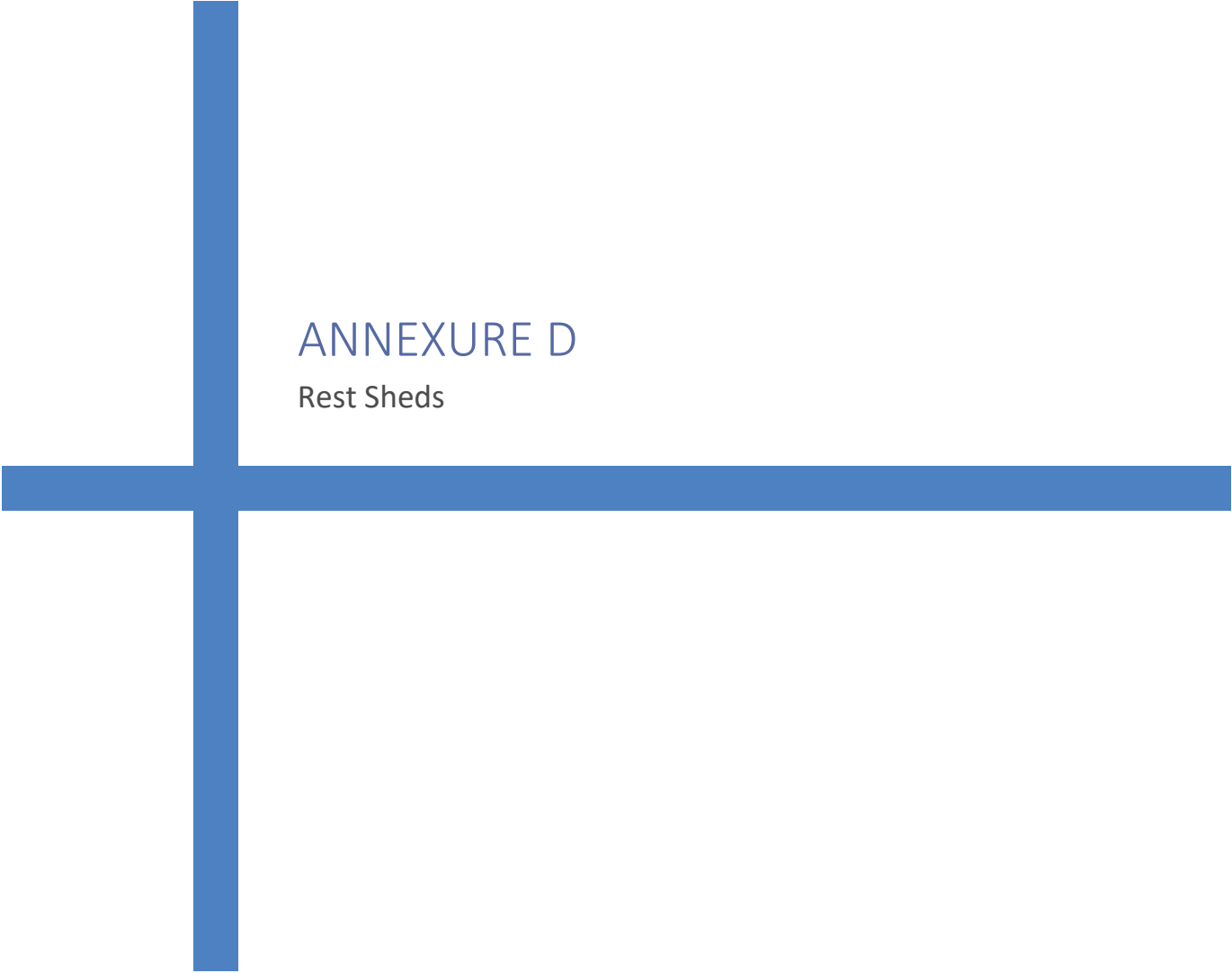
Following equipment conforming to relevant IS/ISO/BS Codes/ Standards in indicated quantities shall be ensured by subcontractor. This list is tentative, not exhaustive. Quantity and date/ period of deployment shall be as per site requirement.

A. HSE Tools/ Equipment/ Devices

SN	Item
1	Lifelines
2	Retractable Fall Arrestors
3	Safety Nets (10m X 5m) fire proof double mesh
4	Sky Climbers
5	Fire Blanket
6	Honey Bee Removal Suit & Kit
7	Scaffolding Pipes
8	Flashback Arrestors
9	Barricading Tape
10	Binoculars
11	Walkie-Talkies
12	LOTO kit
13	24-Volt light
14	Sand Buckets
15	Hard barricading Pipes
16	Standby Fire kits
17	Hand-held Megaphone
18	Small Public Address System
19	Foldable Stretcher
20	Height Rescue Kit (Non-Motorized)
	(Others:)

B. Test & Measurement Devices

SN	Device
1	ELCB Tester
2	Multi meter (Light cables)
3	Earth Resistance Meter
4	Lux Meter
5	Sound Meter
6	Anemometer
7	Breath Analyzer (Alcohol)
8	Multi-gas dozi-meter/ detector
9	Gas leakage detector / alarm
10	Gas monitor (confined space)
11	Radiation meter & Badges
12	Blood Pressure Monitor
13	Fire detectors
14	Hand held signaling light
	(Others:)



ANNEXURE D

Rest Sheds

Rk

1. Determining the Number, Sizes and Locations of Rest Shelters

i. **Numbers:**

The number of rest shelters shall be determined based on maximum number of workers at any one time (across all shifts). Formula is:

W_{max} = Maximum number of workers at any time in the Site

Space per worker = 1.1 sq meter

Total space required, $T_{space} = W_{max} \times 1.1$

Based on total space requirement calculated above, the number of rest sheds can be decided according to availability of locations and concentration of workers – so as to ensure the required space.

ii. **Locations:**

The rest sheds should be so located so as to minimize the distance to be travelled by the workers from their locations of work considering all the practical constraints

iii. **Other:**

The Rest shelter should be fenced so that it cannot be used as parking area.

2. Design & Construction of Rest Sheds

a. **Permanent/ Long duration Rest Sheds**

- i. For locations where, permanent rest sheds can be constructed without possibility of removal for relatively long period of time, a semi-closed shed can be constructed covered with tin roof and supported with well-grouted beams. The floor of the shed to be preferably cemented/ solidified.
- ii. Adequate structural requirements suitable to the local weather (wind/ rain etc.) to be ensured.
- iii. The design of the rest shed to be approved by Civil Engineering Department of BHEL Site before commencing work

b. **Temporary/ Movable/ Portable Rest Sheds**

- i. For locations where, permanent rest sheds cannot be constructed either due to non-availability of permanent location or other reasons, temporary rest shed shall be constructed.
- ii. Temporary rest sheds shall comprise of Tent arrangement carried out by professional agencies

3. Amenities in Rest Sheds

a. **Essential Amenities**

Following amenities shall be essentially ensured in a rest shed:

- i. Hygienic environment with regular cleaning and housekeeping (with records)
- ii. Adequate illumination
- iii. Adequate ventilation/ heating as per weather conditions
- iv. Clean Drinking water source
- v. Hand Washing area
- vi. Toilets & Urinals
- vii. Benches/ mats for sitting/ lying
- viii. Any other essential requirement deemed necessary by the Site
- ix. Dust bins of sufficient quantity/ size that are vacated each day/ as per requirement

b. **Additional/ Optional Amenities**

Following amenities are optional but are recommended to enhance the level of satisfaction of work force:

- i. Hot/ Cold drinks (Tea, Coffee, Glucose etc.) as per requirement
- ii. Snacks
- iii. Fans/ Coolers/ Heating arrangements as per requirement and weather conditions
- iv. A nice, welcoming interior design, music etc.
- v. Water cooler

4. Health & Safety Requirements of Rest Sheds

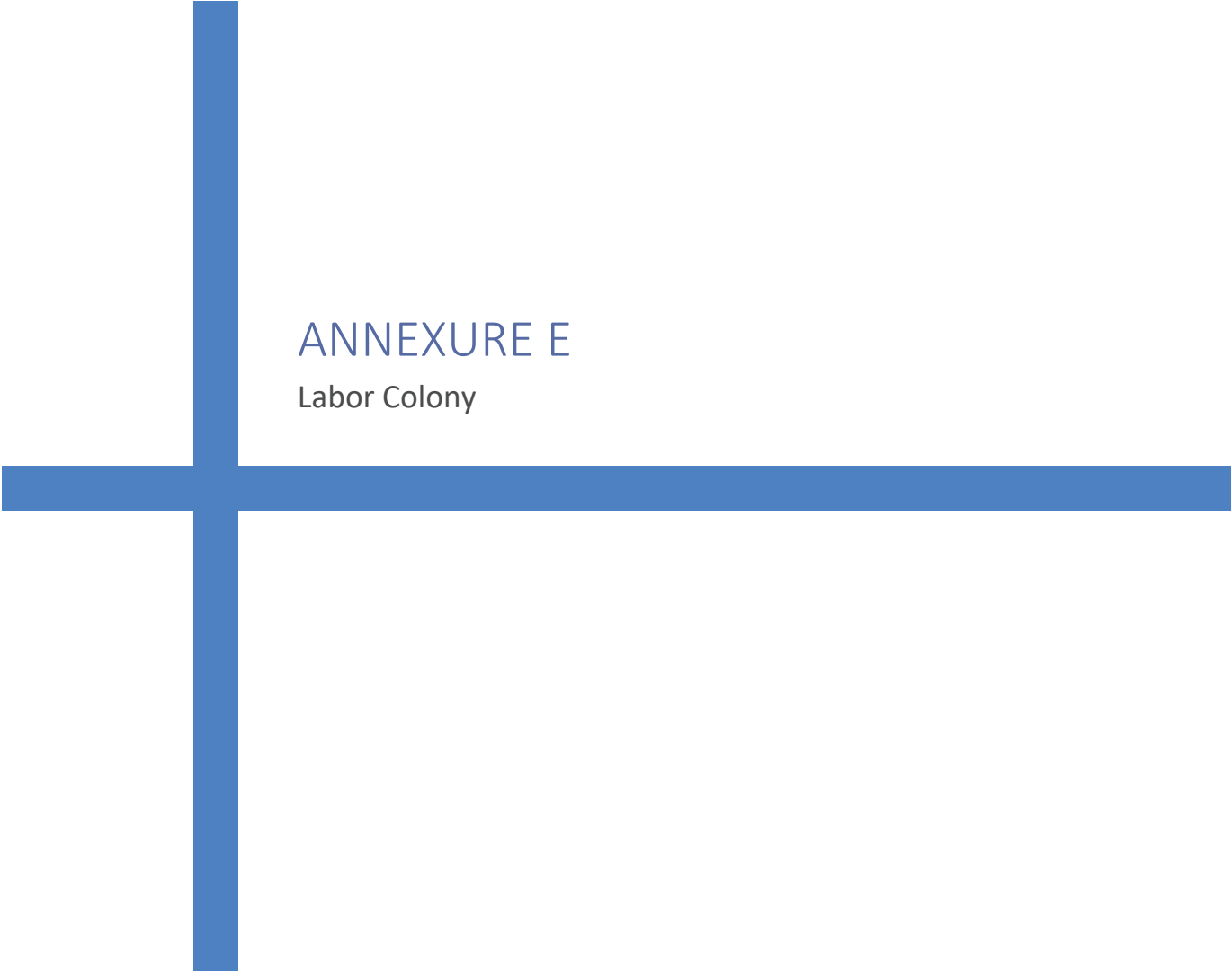
Use of asbestos in construction is banned and shall not be used.

In addition, following essential Safety features shall be ensured in Rest sheds:

- i. Availability of Fire extinguishers (preferably CO2 type)
- ii. Display of Safety Posters
- iii. Pest/ reptile protection
- iv. Mosquito prevention measures

5. Note:

Any suitable closed spaces/ newly constructed buildings etc. available at project may also be used for the purpose of rest shed with due concurrence of BHEL



ANNEXURE E

Labor Colony

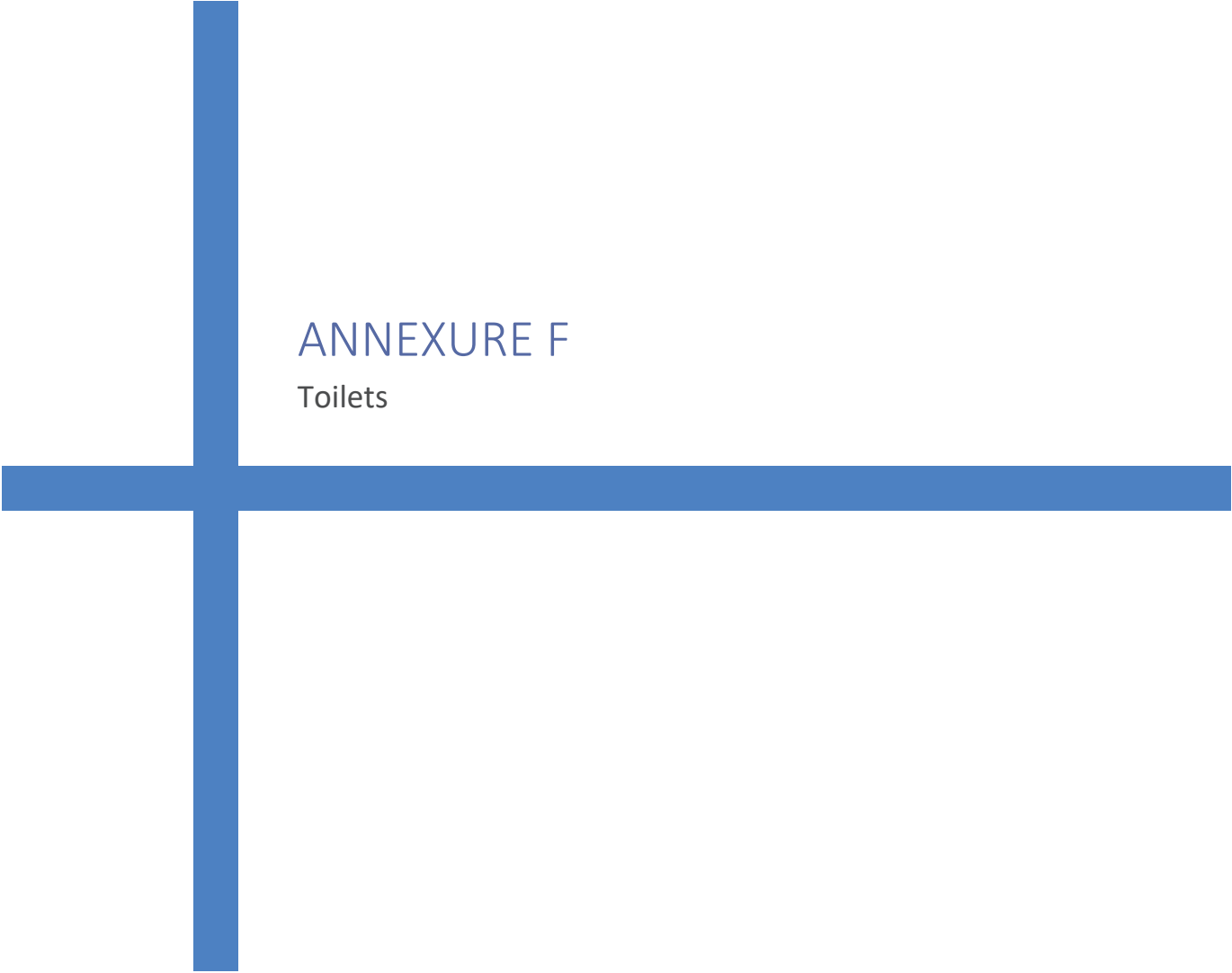
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1. These Guidelines suggest minimum requirements. However, additional requirements based on feasibility and circumstances, while adhering to directions of GOI/District Administration/Local Authority guidelines to be considered
2. Norms for social distancing, training/ awareness, face masks, disinfection, sanitization, gate entry, quarantine, medical, action in case of suspect cases of COVID and other communicable diseases etc. to be followed as per Govt. and BHEL guidelines issued from time to time
3. Labor colony to be developed as close to the Site as possible to avoid lengthy commute
4. A "Suggestion Register" shall be made available at the labor colony for residents. The feedback shall be reviewed on weekly basis and acted upon by concerned Contractor. Same shall be reviewed periodically by authorized BHEL Site Official.
5. **Canteens, Latrines & Urinals, Washing Facilities, Creches, Residential Accommodation and other infrastructure/ facilities:**
Numbers/ Quantities and Features of these facilities shall be in line with the following as applicable:
 - a. BOCW Act & State Rules
 - b. The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act & State Rules
 - c. Factories Act & State Rules
 - d. Other Relevant Acts & Rules
6. **Cleanliness & Hygiene/ Housekeeping:**
 - a. Regular cleaning of the labor colony to be ensured.
 - b. Daily cleaning of Sanitary facilities.
 - c. Proper drainage system to prevent water-logging
 - d. Regular fogging to prevent spread of mosquitoes
 - e. Prevention of foul smell through necessary interventions
 - f. Dust suppression as per requirement
 - g. Cutting of Grass at regular intervals and other necessary measures to prevent pests & reptiles
 - h. Stray animals to be banned from labor colony.
 - i. Outside every common facility, eg. Toilet, washroom, food hall/ canteen etc., provision of washbasin with flowing water and soap (preferably liquid soap) to be ensured
7. **Power Supply Layout:**
Electrical supply Layout of Labor Colony shall have the provision of Safety devices like MCBs, ELCBs etc. and to be clearly displayed
8. **Washing & Drinking Water Availability**
 - a. Adequate water to be provided in line with: "Estimation of Water Requirements for Drinking and Domestic Use (Source: National Building Code 2016, BIS)"
 - b. Drinking water tank to be cleaned every week and sticker for the same pasted on the tank
 - c. Drinking water source should be tested as per IS 10500
9. **Waste Disposal:** Separate bins for dry, wet and biomedical waste to be installed. These bins to be evacuated regularly
10. **Training & Awareness/ Displays**
 - a. **HSE Awareness Displays:** Posters/ banners/ boards to be displayed in labor colony. Subjects of displays shall be precautions for applicable hazards at work site.
 - b. **Emergency Contact Numbers** including that of Doctor, Hospital, Labor Colony Supervisor, HSE Officials to be displayed prominently

11. Doctor Visits:

Regular and need-based visits by Doctors to be ensured through tie-ups etc.

12. Inspection & Review: Regular inspection of labor accommodation to be carried out by the Contractor as per prescribed format. Last inspection date, inspector and next due date to be prominently indicated near main gate**13.** Provision of a Fair Price shop in the premises to be ensured as per requirement**14.** Adequate arrangements to be ensured in case of children/ families



ANNEXURE F

Toilets

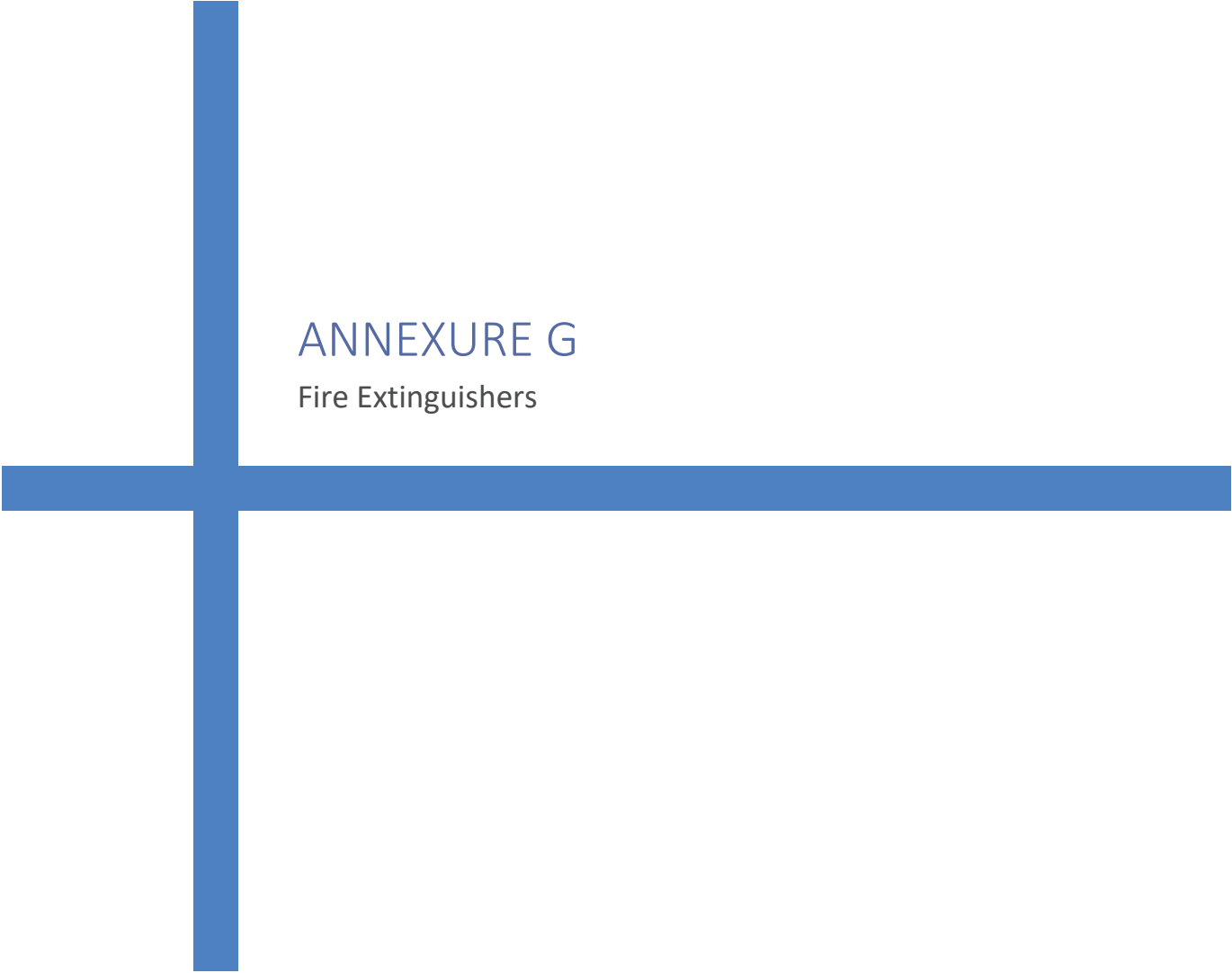
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Toilets (Latrines and urinals shall be ensured at Site and Labor Colony in accordance with the Inter-State Migrant Workmen Act, 1979 as given below:

LATRINES	URINALS
1. Latrines shall be provided in every establishment on the following scale, namely: - a. Where females are employed, there shall be at least one latrine for every 25 females; b. Where males are employed, there shall be at least one latrine for every 25 males: Provided that where the number of males or females exceeds 190, it shall be sufficient if there is one latrine for 25 males or females, as the case may be, up to the first 100, and one for every 30 thereafter 2. Every latrine shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings.	1. There shall be at least one urinal for male workers up to fifty and one for female up to fifty employed at a time: Provided that where the number of male or female workmen, as the case may be, exceeds 500 it shall be sufficient if there is one urinal for every fifty females up to the first 500 and one for every 100 or part thereof thereafter. 2. The urinals shall be designed and located so as to ensure privacy.

Important:

- Where workers of both sexes are employed there shall be displayed outside each block of latrine and urinal a notice in the language understood by the majority of the workers '**For Men Only**', or '**For Women Only**', as the case may be.
- The notice shall also bear the figure of a man or of a woman, as the case may be.
- The latrines and urinals shall be conveniently situated and accessible to workers at all times at the establishment.
- The latrines and urinals shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times.
- Latrines and urinals other than those connected with a flush sewage system shall comply with the requirements of the public health authorities.
- Water shall be provided by the means of tap or otherwise so as to be conveniently accessible in or near the latrines and urinals.
- At Site, on ground, **Modular Bio-toilets** as per industry standard specifications and regular professional cleaning shall be ensured. The toilets should be sufficient in number and easily accessible to workers from every work area
- At Site, in various elevations, suitable urinals with proper drainage to be ensured at each elevation in line with IS 2064 (1993). Same to be cleaned regularly



ANNEXURE G

Fire Extinguishers

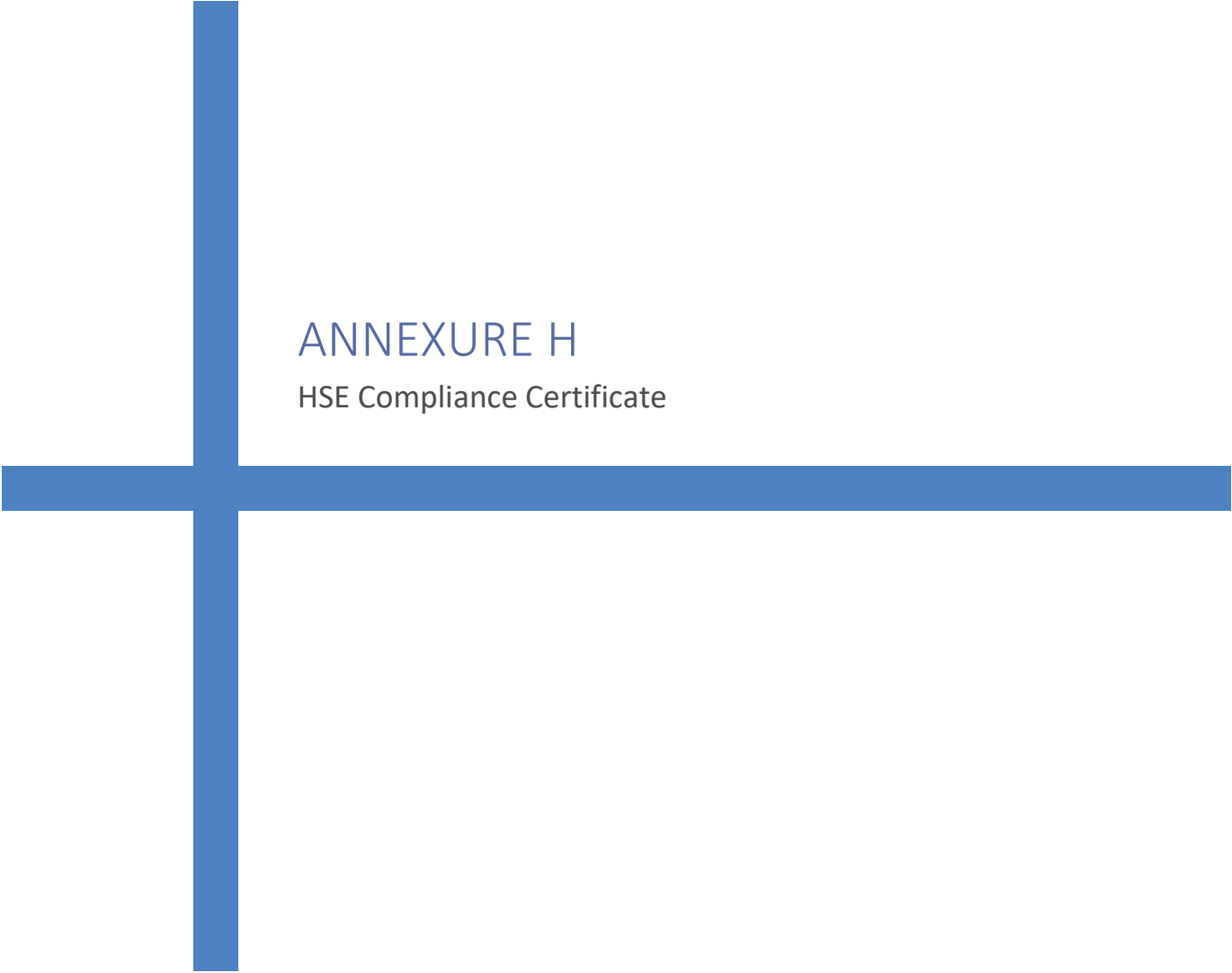
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SN	Type of Fire Risk (Class of Fire)	Extinguishing Medium & Relevant INDIAN STANDARD	Scale of Equipment (Minimum recommended)
1.	CLASS 'A' Fires involving ordinary combustible materials like wood, paper, textiles, rubber etc. (Ordinary hazard or low fire load)	WATER Soda acid type, water type (gas pressure) and water type (constant air pressure) IS: 934 -1976; IS: 940 -1976; IS: 6234 -1971	For every 600 square meter floor area or part, one 9-litre capacity. Minimum 4 numbers per floor or room; should not be required to travel more than 15 meter to reach any extinguisher.
2.	CLASS 'A' (Extra hazard & high fire load)	-do	-do – (Also, consult local fire authority).
3.	CLASS 'A' (Special hazards)	-do	-do – Extra provision For every 100 square meter floor area or part, one 4.5 Kg. CO ₂ ; minimum 2 numbers per room; should not be required to travel more than 10 meter to reach any extinguisher.
4.	CLASS 'B' (Fires in flammable liquids like oils, solvents, petroleum, products, varnishes, paints, etc. where blanketing effect is essential) (Storage and handling in small quantities)	FOAM / CARBON DIOXIDE / DRY CHEMICAL POWDER IS: 933 -1976; IS: 2878 1976; IS: 2171 1976; IS: 4308 -1982	For every 50 square meter floor area or part, 2 numbers 9 -liters foam or 5 kg dry powder; should not be required to travel more than 10 m in the area of storage to reach any extinguisher.
5.	CLASS 'B' (Bulk storage other than in tank form))	-do -	-do- (but minimum 3 numbers per room)
6.	CLASS 'C' (Fires involving gaseous substances under pressure where it is necessary to dilute the burning gas at a very fast rate with an inert gas or powder) (storage and handling of gas cylinders)	CARBON DIOXIDE / DRY CHEM. POWDER. The best way to extinguish such fire is by stopping the flow of fuel gas to the fire. Container is kept cool with water spray. IS: 2878 1976; IS: 2171 -1976; IS: 4308 -1982	For every 100 square meter floor area or part; 2 numbers, 10 kg powder extinguisher or 6 kg CO ₂ ; minimum 3 nos. per room; should not be required to travel more than 10 meter to reach any extinguisher.
7.	CLASS 'D' Fires involving metals like magnesium, aluminum, zinc, potassium etc. where the burning metal is reactive to water and which require special extinguishing media or technique	SPECIAL DRY POWDER IS: 2171 -1976 IS: 4861 -1968	For every 50 square meter floor area or part, 2 nos. 5 kg special dry powder; minimum 3 nos. per room; should not be required to travel more than 10 meter to reach any extinguisher.
8.	MIXED OCCUPANCY (electrical); Generators; Transformers; etc.	CARBON DIOXIDE DRY POWDER, IS: 2878 1976; IS: 2171 -1976	For every 100 square meter floor area or part one 10 kg CO ₂ . Minimum 2 numbers for every location should not be required to travel more than 10 meter to reach an extinguisher.

Note: Due to peculiarities of the power plant construction sites, there would be locations in the construction areas of Boiler, Turbine, Generator, Transformer, etc. where different types of fire risk (classes of fire) may co-exist. Special care shall be taken while selecting and installing portable fire extinguishers for such locations so that all types of fire risk that may co-exist, are adequately covered. Similar special care shall be taken for storage areas.

a. All Electrical welding booths shall be equipped with appropriate Fire Extinguisher

- b. Appropriate Fire Extinguishers shall be made within easy reach of all welding operations
- c. Fire extinguishers shall be regularly tested and last checked date to be indicated on each. Master list shall be prepared with location and details
- d. Providing appropriate fire-fighting equipment at designated work place and nominate a fire officer/warden adequately trained for his job.
- e. Subcontractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporary structure in labour colony etc. Such fire protection equipment shall be easy and kept open at all times.
- f. The fire extinguishers shall be properly refilled and kept ready which should be certified at periodic intervals. The date of changing should be marked on the Cylinders.
- g. All other fire safety measures as laid down in the “codes for fire safety at construction site” issued by safety coordinator of BHEL shall be followed.
- h. Non-compliance of the above requirement under fire protection shall in no way relieve the subcontractor of any of his responsibility and liabilities to fire incident occurring either to his materials or equipment or those of others.
- i. Emergency contacts nos. must be displayed at prominent locations
- j. Tarpaulin being inflammable should not be used (instead, only non-infusible covering materials shall be used) as protective cover while preheating, welding, stress relieving etc. at site.



ANNEXURE H

HSE Compliance Certificate

Rk

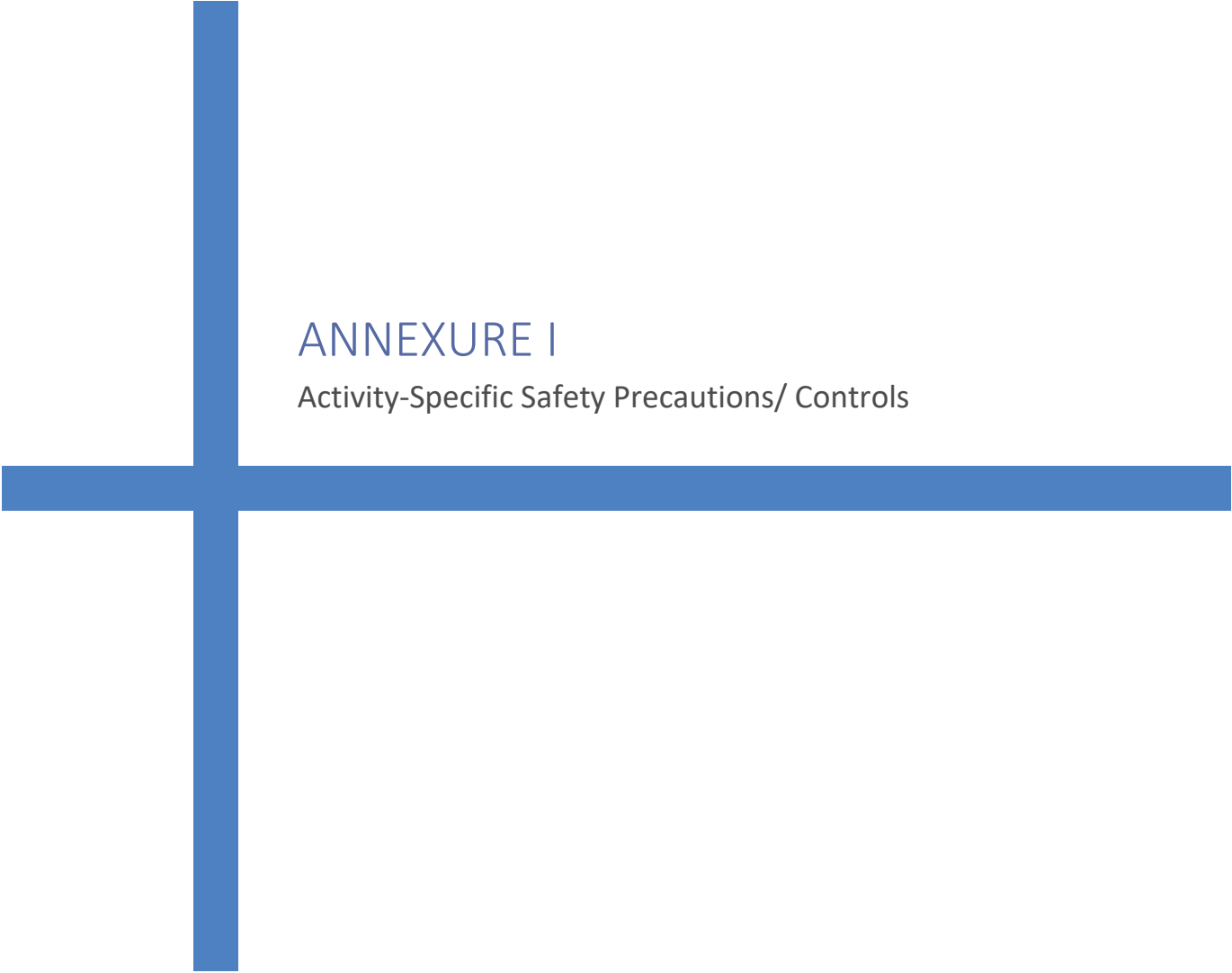
Bill Ref no: _____ Date: _____

NAME OF THE AGENCY: _____ Work-Area/Package: _____

Sl. No.	Description	Remarks
1	<u>HOUSE KEEPING:</u>	
1.1	All working areas at site (specific to the agency) are free from garbage's, scraps & any other undesired non-plant materials. There is no encroachment in safe passage of man, material & T&P to carry out activities safely	
1.2	All the plant materials under the custody of the agency are stacked & stored properly.	
2	<u>GENERAL ILLUMINATION:</u>	
2.1	ALL the working areas at site & office of the agency including passages are having proper & sufficient illumination.	
3	<u>STATUTORY & REGULATORY REQUIREMENT:</u>	
3.1	Sufficient water for drinking & other purposes and sanitation in work area and labour colony are available.	
3.2	Periodical Medical check-up of workers & staff done regularly & report submitted to BHEL	
3.3	Regular EYE testing is done for Crane operators/Welders and data's are available with agency	
3.4	All the T&P, Cranes etc used by the agency are having proper T.Cs & Fitness certificate available from competent authority.	
4	<u>SAFETY COMPLIANCE:</u>	
4.1	Number of Tool box meetings between Safety officers, erection staff & workers of the agency held in this month with location mentioned	
4.2	All precautions & Safety measures including PPE compliances are taken before working at HEIGHT	
4.3	Permit for working at Height is taken & complied accordingly	
4.4	ELCB is used in Construction Power Supply source by the agency & Proper Distribution board and electrical cabling has been used by the agency and regularly checked by electrician & safety officer of the agency	
4.5	Unsafe areas barricaded properly & unsafe opening closed properly	
4.6	Proper Platforms & Hand-rails used In areas earmarked earlier	
4.7	Proper safety signage's, Slogans & Emergency contact phone numbers including FIRE contact nos. are made available by the agency in locations mentioned	
5	Whether any penalty imposed by BHEL towards non-compliance of above points.	

<u>VENDOR'S SIGNATURE</u>	
Erection Engineer	
HSE Officer	
Site-in-Charge	

<u>BHEL'S SIGNATURE</u>	
Erection Engineer	
HSE Officer	
Package-in-Charge	



ANNEXURE I

Activity-Specific Safety Precautions/ Controls

Rk

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General

The philosophy of hierarchy of controls as below shall be followed

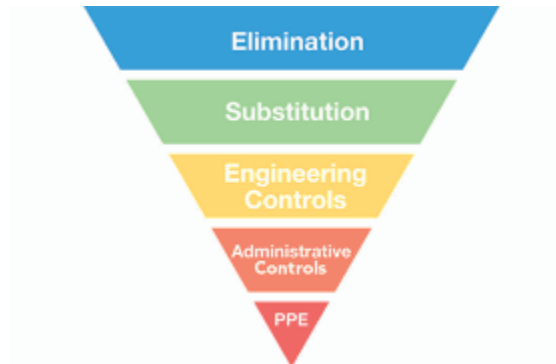


Fig. 1.1

It shall be ensured that there are multiple protections against any accident/ incident. For example, for height work there shall be safe platforms and walkways, Safety Nets and Lifelines for hooking double lanyard Safety harness by workers.

Monitoring and modifying worker behavior shall be part of ensuring safety. All personnel should be competent and trained for the job

Brief Safety guidelines for various hazardous activities are indicated below, besides the mandatory requirements based on Hazard Identification studies, HSE Procedures, Operational Control Procedures, Work Permits, applicable Indian Standard Codes and other provisions detailed in this document. Constant supervision at all times to be maintained by Execution & Safety Team to ensure implementation of these provisions.

1. WORK AT HEIGHT:

- a. All work at height above 2 meter above ground level without complete platforms, handrails and other related fall protection shall require a work permit in the prescribed form. This shall require approval by the competent authority. The HSE officer of sub-contractors shall follow the checklist religiously by physically verifying the condition of the work area before recommending for approval.
- b. Prior to the start of work at elevation, the HSE Officer involved with the work must meet the work supervisor to review the scope of work, and must review all the possible fall hazards and effective safety responses. The evaluation / analysis must be documented and kept on file and on site by the HSE Officer.
- c. Whenever a fall hazard or other exposure exists for working at heights more than 2.0m/6ft, the nature and scope of work will be evaluated for conditions and environmental factors before selecting the appropriate fall protection system (active, passive or a combination of measures, as appropriate).
- d. All Engineering and Administrative Controls including barricading, safe platform, Safety Nets etc. shall be made available at work location. Under no circumstances, there shall be total reliance on PPEs only
- e. **Safety Nets**
 - i. Contractor shall maintain sufficient stock of Safety Nets for deployment
 - ii. Safety Nets as per IS: 11057:1984 should be used extensively for prevention / arrest men and materials falling from height.
 - iii. The safety nets shall be fire resistant, duly tested and shall be of ISI marked.

- iv. Safety Nets shall be deployed below all platforms where height work is envisaged. Duration of work, delay shall be no excuses for non-installation of Safety Net
- f. Reaching beyond barricaded area without lifeline support, moving with support of bracings, walking on beams without support, jumping from one level to another, throwing objects and taking shortcut must be discouraged.
- g. Monkey Ladder shall be fitted with cages. Rope ladder should be discouraged.
- h. In case of pipe-rack, persons should not walk on pipes and walk on platforms only.
- i. In case of roof work, walking ladder/ platform should be provided along with lifeline and/ or fall arrestor.
- j. For chimney or structure painting, both hanging platform and men should be anchored separately to a firm structure along with separate fall arrestor.
- k. The procedures for the safety response to identified fall hazards developed and rescue plans must be reviewed with all individuals exposed to the hazards.
- l. The HSE Officer must establish an inspection process of fall protection systems. Some equipment requires documented inspections by its manufacture on a regular schedule. Such equipment must have evidence of the inspection and re-certification process on it. This information must be reviewed before the equipment is actually used. Individuals must visually inspect the fall protection equipment before each use. Failure to complete this inspection process could result in serious injury or death.
- m. Immediately remove from service any fall protection equipment that is identified as defective, damaged, or has been subjected to an impact. Damaged fall protective equipment must be destroyed to prevent re-use and not be discarded into trash containers, as the worn or damaged equipment could be unintentionally re-used.
- n. Aerial lifting devices, excluding scissor lifts require the use of full body harnesses and lanyards in any elevated position.
- o. Where Height related works are applicable then rescue team (consist of 5- 10 person) shall be identified and trained for potential rescue.

1.1 Personnel fall protection system must include:

a. Safety Harness

All height workers must use Full Body Safety harness with double lanyards with shock absorber (only). The primary lanyard is never unhooked until the secondary lanyard is secure. The design of the working platform should be such that under no circumstances, worker should have both lanyards unhooked while at height.

b. Lanyard

- i. The type of work and the environment conditions determine lanyard and lifeline selection. If welding, chemical cleaning that may damage lanyards, connectors or lifelines, sandblasting, etc., either protect the components or use more appropriate type of system.
- ii. Lanyards and lifelines must incorporate, or be used with, an appropriate deceleration (shock absorbing) device. Deceleration devices include rope grabs, rip-stitch lanyards, specially woven lanyards, tearing, or deforming lanyards, automatic self-retracting lifelines and lanyards which dissipate or limit the energy imposed on the employee during fall arrest.
- iii. Once in use, the system's effectiveness is to be monitored. In some cases, a program for cleaning and maintaining the system may be necessary. Lanyard and lifelines must use locking snap hooks only and under

no circumstances must two lanyard snap hooks be connected.

c. Lifeline

All lifelines in general are to be made of min 12mm dia. steel rope (plastic coated) and tied to columns with 3 clamps at each end. Wherever columns are not available to tie the lifelines, the vertical posts as per the design below are to be provided after carrying out drop load test initially. A load of 240kg to be dropped off the mid-point of lifeline in this test.

d. Lifeline Post

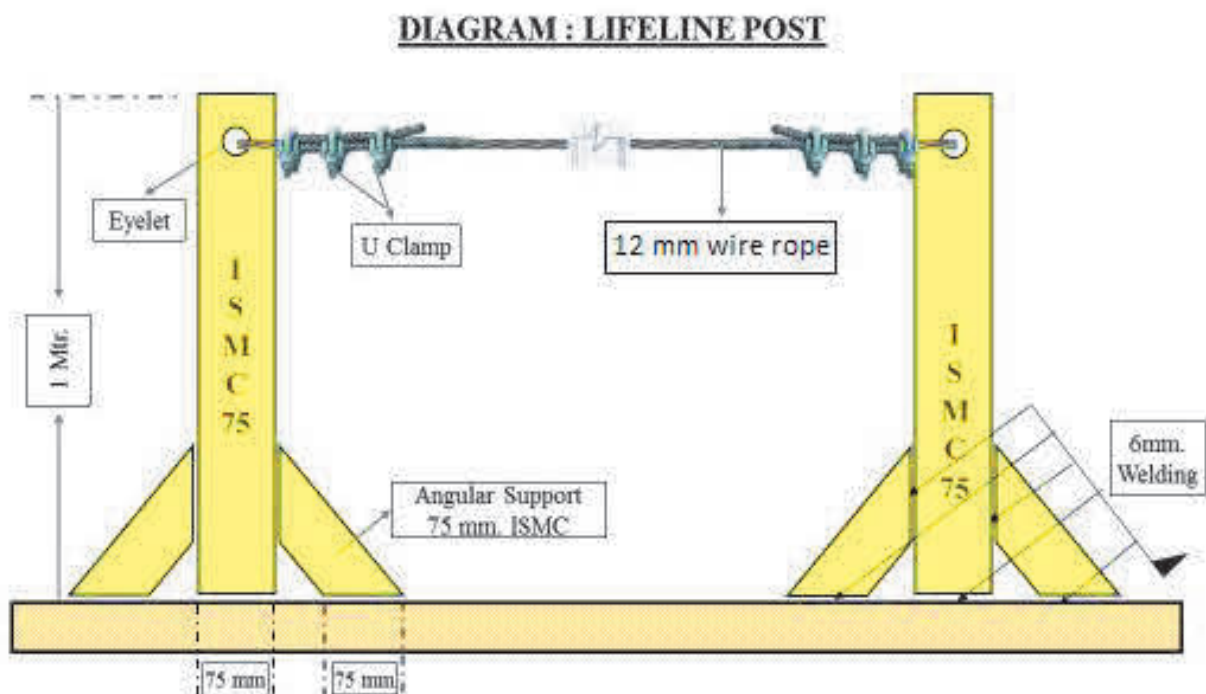


Fig. 2.1 Lifeline Post

- i. The support at vertical post shall be fixed at end-to-end (welded/ bolted). The maximum length of one end to another end shall be 6 meters
- ii. If the length of a lifeline is more than 6 meters, then intermediate vertical post(s) are to be used. Such intermediate post(s) will act as supports and the lifeline rope should simply pass through the eyelets (holes) of such supports without being anchored
- iii. The lifeline need not be wrapped / clamped to any intermediate post
- iv. Such intermediate posts must be used at an interval of every 6 meters
- v. The post(s) in which the original lifeline is to be installed should be capable of sustaining a tensile stress of 2268 Kgs.
- vi. In a horizontal lifeline installation, maximum allowable sagging is 500-600 mm
- vii. For a single spun lifeline, no more than 3(Three Nos.) persons are allowed to work; for more than two workers, another lifeline should be installed
- viii. Horizontal lifeline should be so installed that it does not impede safe movement of workers
- ix. All the installation work must be carried out by competent person with adequate knowledge

1.2 Working Platform

- a. Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if the height of the platform gangways provided is more than 3.6 m above ground level or

floor level, they shall be closely boarded and shall have adequate width, which shall not be less than 750 mm and be suitably fenced.

b. Precautions against the fall of Materials, Persons and Collapse of Structures:

- i. Every opening in the floor or a building or in a working platform shall be suitably barricaded to prevent the fall of persons by providing suitable fencing or railing whose minimum height shall be 90 cm.
- ii. Adequate precautions should be taken such as the provision of fencing, or barriers to protect any person who might be injured by the fall of materials, or tools or equipment being raised or lowered. Hard barricading shall be made at such places made of scaffolding pipe & clamps covered with reflective net. Cradle may be used for lifting materials - however this shall be made of MS angles and flats only and duly certified by the HSE officer. Operators may also use designed containers for lifting small tools.
- iii. Guardrails (including scaffolding) erected over/adjacent working areas must have the guardrails screened (opening < 0.5), to prevent material from falling outside the platform/decking.
- iv. Guardrails must be able to withstand a 200-pound force exerted in any one direction.
- v. Where necessary to prevent danger, guys, stays or supports should be used or other effective precautions should be taken to prevent the collapse of structures or parts of structures that are being erected, maintained, repaired, dismantled or demolished.
- vi. All openings through which workers are liable to fall should be kept effectively covered or fenced and indicated in the most appropriate manner.
- vii. Guardrails and toe-board/barricades and sound platform conforming to IS: 4912-1978 and other Indian laws and regulations as depicted below should be provided.

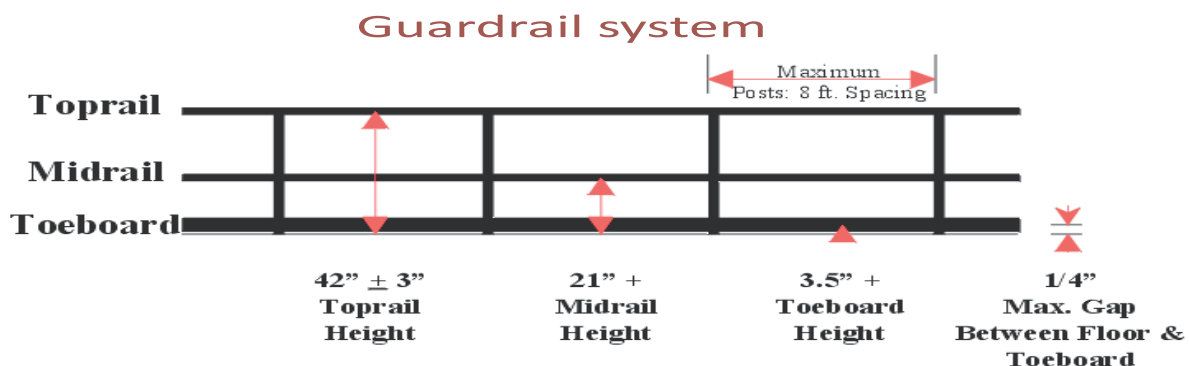


Fig. 2.2 Guard Rail System

- viii. Guardrails shall be provided to protect workers from falling from elevated work places. The rails are generally made of MS pipes of suitable dia. Rebar shall not be used for any handrails, ladder or cover purpose. Wherever the guard-rails and toe-boards cannot be provided:
 - a. adequate safety nets or safety sheets shall be erected and maintained; or
 - b. adequate safety harnesses shall be provided and used and / or
 - c. adequate fall arrestor shall be provided and used.

As mentioned under PPE clause, all these PPEs shall be defect free and regularly inspected for any defect. The full body safety harness shall have double lanyard only with max 1.8m length.

- ix. The monkey ladders shall have sufficient fall arrestors. Adequate lifelines of 8mm steel wire rope shall be provided across the work area.
- x. The HSE officer shall recommend appropriate PPEs after analyzing hazards and risks involved.

1.3 Scaffolding

All scaffolds shall be conformant to the relevant standards including IS 3696 and IS 4014 as applicable. A sketch of the scaffolds proposed to be used shall be prepared and approval of the BHEL Engineer obtained prior to construction / use. Only cup lock type scaffoldings will be allowed in site. Where cup lock type scaffolding arrangement is not feasible by the virtue of the location, in that case only pipe and clamp type scaffolding will be allowed.

- a. The scaffolding work must be carried out by a competent person, who shall train the scaffold users on safety aspects
- b. All scaffolds shall be erected / dismantled by scaffolding crew under direct supervision of competent scaffolding supervisors.
- c. All scaffolds shall be capable of supporting 4 times maximum intended load and erected on sound, rigid footing, capable of carrying the maximum intended load without settling or displacement. Bamboo scaffolding is not permitted for use on site.
- d. Each employee on the scaffold shall use an approved safety harness attached to an independent lifeline. The lifeline is to be securely attached to substantial members of the structure (not the scaffold itself) or to securely rigged lines, which shall safely suspend a worker in event of a fall.
- e. Guard rails and toe boards shall be installed on all open sides and ends of platforms more than (2) meters above ground or floor
- f. Scaffold planks must be at least 5 cm x 25 cm (2" x 10") full thickness lumber scaffold grade or better.
- g. Scaffold planks shall not span distances greater than 2.5 meters (8 feet).
- h. Scaffold planks shall extend over end supports not less than 6 inches nor more than 12 inches and be secured to the scaffold. Scaffolding and accessories with defective parts shall be immediately repaired or replaced.
- i. All scaffolding must be a minimum of two planks wide. No one may work from a single plank.
- j. Scaffold planks must be inspected before use. Planks that have been damaged must be removed from the site.
- k. Access ladders must be provided for each scaffold. Climbing the end frames is prohibited unless the design incorporates an approved ladder.
- l. Adequate mudsills or other rigid footing capable of withstanding the maximum intended load must be provided.
- m. Scaffolds more the 6 meters (20 feet) in height must be tied to the building or structure at intervals which do not exceed 4 meters (13 feet) vertically and 6 meters (20 feet) horizontally.
- n. Do not overload scaffolds. Material should be brought up as needed. Scaffolding must not be loaded in excess of its rated capacity.
- o. Barrels, boxes, kegs, blocks or similar unstable object must never be used as work platforms or to support scaffold.
- p. Where persons must work under or pass under a scaffold then a 18 gauge wire mesh screen must be installed between the toe board and guard rail.
- q. Employees exposed to overhead hazards while working on a scaffold will be protected by 5 cm (2") thick planks.
- r. Wooden/bamboo ladders shall not be allowed at any cost. Ladder's rungs shall be fitted /welded

properly. Before every use the rungs should be checked for safe use.

- s. Wooden scaffolds shall not be used in areas where fire / fire products are expected
- t. Ropes made of jute / Plastic and other fire prone material shall not be used to tie up scaffolding components together
- u. The platform should have permanent hand rail and mid rail with Toe board without fail.
- v. All platforms are to be tightly planked for the full width of the scaffold, except as may be necessary for entrance openings. Platforms shall be secured in place.
- w. On suspension scaffolds designed for a working load of 500 pounds, no more than two workers are permitted to work on the scaffold simultaneously. On suspension scaffolds with a working load of 750 pounds, no more than three workers are permitted on the scaffold simultaneously.

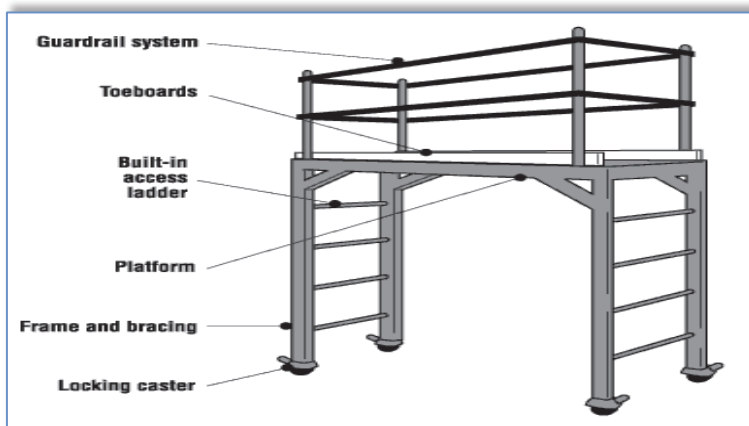
x. Requirements for different types of Scaffolds:

A. Suspended Scaffold

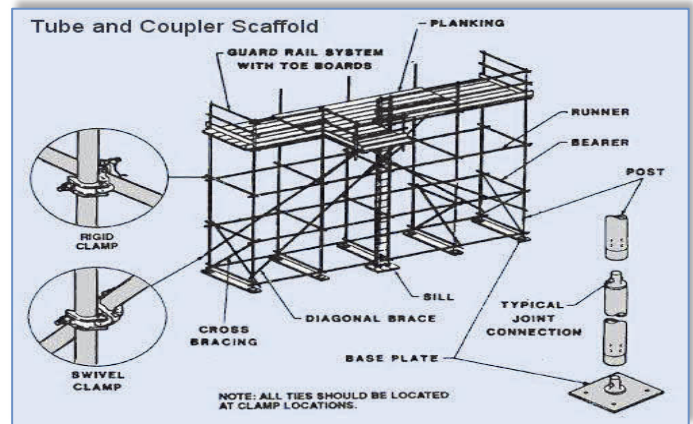
- i. Suspended scaffolds are platforms suspended by ropes, or other non-rigid means, from an overhead structure.
- ii. Requirements for use are to be preapproved by HSE Head, under a specific Permit to Work.

B. Rolling Scaffolds

- i. The height of rolling scaffolds shall not exceed three times the minimum base dimension.
- ii. The minimum base dimension of rolling scaffold will be 1.25 meters (4 feet).
- iii. Adequate help must be provided when moving a rolling scaffold.
- iv. Secure or remove all loose materials, equipment and tools before moving a rolling scaffold.
- v. No one is permitted to ride a rolling scaffold when it is being moved. Castor brakes must be locked-on when the scaffold is not being moved.



Rolling Scaffold



Tube & Coupler Scaffold

Fig. 2.3 Types of Scaffolds

1.4 Ladder Safety

A sketch of the ladders proposed to be used shall be prepared and approval of the BHEL Engineer obtained prior to construction / use

a. Safe Use of Ladders:

- i. Fall protection is required when working on a ladder above 2 meters and when climbing above nearby guardrails.

- ii. Ladders must be inspected prior to use and by a competent person quarterly, with documentation.
- iii. Use portable ladders for height up to 4 M only
- iv. Provide fixed ladders for height above 4 M
- v. Place the ladder at an angle of 75 degrees (approx.) from the horizontal (1:4)
- vi. Extend ladder at least 1 M above the top landing
- vii. Secure top and bottom of the ladder firmly to prevent displacement- anti skid lining at the bottom
- viii. Ensure that the width of the ladder is not less than 300 mm and distance between rungs is not more than 300 mm
- ix. Provide landings of minimum size 600 x 600 mm at intervals not more than 6 M for fixed ladders. Check the ladders daily for any defects
- x. Ensure that the areas around base and top of the ladder are clear. Getting on and off the ladder is more hazardous than using it. Use a mudsill if the ladder is to rest on soft, loose or rough soil
- xi. Do not use ladders of conducting material near power lines, and only use ladders near power line or other energized system with exposed parts if they are confirmed locked-out and de-energized.
- xii. Stand no higher than the fourth rung from the top for carrying out any job standing on a ladder.
- xiii. Never reach out from a ladder to perform work where your belt buckle protrudes past the ladder rung.
- xiv. Always face the ladder while climbing up or down
- xv. Maintain three-point contact while climbing up or down a ladder i.e. two hands and one foot or two feet and one hand on the ladder at all the times.
- xvi. Avoid climbing up or down a ladder while carrying anything in hands. Lift tools, equipment and materials with a rope.
- xvii. Work from portable and extension ladders near guardrail where fall exposure exists over the guardrail regardless of height, and above 2.0 mtr. heights from the working/walking surface will require the use of personal fall arrest equipment

2. EXCAVATION & CIVIL WORKS

All safety precautions shall be taken for foundation and other excavation works as per IS-3764.

2.1 Excavation

The following safety measures are to be ensured before and during excavation:

- a. All Excavation activities more than with depth of 1.22 meter or more shall require an Excavation Work Permit
- b. Check for underground utilities like electrical / telephone cables, sewage, water lines and proper care has to be exercised to protect and prevent damage to it.
- c. Electrical cables and service lines to be identified using cable detector/locator device before carrying out the excavation work
- d. Proper and adequate slope is maintained while excavating
- e. Adequate shoring or sheeting is done wherever required to prevent soil sliding
- f. Safe access through ladder or steps for exit & entry to excavation
- g. No material /excavated soil is kept within one meter from the edge
- h. Safe way is planned and provided for movement of HEM /transport equipment near excavation
- i. Safety helmet and shoes/gum boots are provided and worn by the workmen at excavation works

- j. Dewatering arrangement is made where water seepage is prevailed.
- k. Stop blocks are provided to avoid vehicles reversing into the excavated trenches
- l. Danger signs /Caution boards are displayed at work spot
- m. Hard Barricading is provided at excavated pits. It should be made of scaffolding pipe and clamp with reflective nets.
- n. All Excavated area of depth 3mtr or more is to be hard barricaded with pipe.

Soil Type	Height/Depth ratio	Slope Angle
Stable Rock	Vertical	90 deg.
Type A	¾ : 1	53 deg.
Type B	1 : 1	45 deg.
Type C	1½ : 1	34 deg.

Determining Soil Type		
Type	Description	Examples
A	Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot or greater.	Clay, silty clay, sandy clay, clay loam and in some cases: silty clay loam and sandy clay loam.
B	Cohesive soils with unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf.	Angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases silty clay loam and sandy clay loam.
C	Cohesive soils with unconfined compressive strength greater than 0.5 tsf or less.	Granular soils such as gravel, sand and loamy sand; submerged soil or soil from which water is freely seeping; submerged rock that is not stable.

Fig. 3.1 Excavation Reference

2.2 Piling

Ensure the following precautionary measures before starting piling works:

- a. Inspection of piling equipment by responsible person for its condition before initiating piling operation.
- b. Checklist and OCP for piling to be prepared using manufacturer's instructions and used
- c. Testing and its certification wire rope, slings, D-shackles, chain pulley blocks using in the process of piling work by competent person
- d. Adequate support and secured foundation of the piling equipment to avoid toppling
- e. Hoses should be lashed and adequately secured
- f. Proper work platform is to be provided on piling frame
- g. Safe work procedures and close supervision to prevent unsafe acts of operators/any unsafe conditions that may arise
- h. Only experienced and trained operators are engaged for the piling operation
- i. Provision of Personal Protective Equipment (PPE) like safety shoes/gumshoes/safety helmet/safety belt etc. and its use by their workmen.
- j. Special care and precautions If work is near electrical live cables/ electrical equipment
- k. Cordoning of work area to prevent un authorized entry
- l. Guarding of revolving parts
- m. Specific measures to prevent over turning of pile driver/missing of hammer/ hammer movement out of range

2.3 Batching Plant Operation

Following Safety considerations for batching plant are to be ensured:

- 1. Modern type batching plant should be used in which all the moving parts are protected and emergency

and safety features are incorporated.

2. Installation of external Electric moto-vibrators in the feeding hopper of all batching plants to reduce human intervention.
3. Installation of safety devices like pull-chord on both the sides of conveyor for stopping the conveyor in emergency
4. Workers carrying cement / sand to be given appropriate PPEs like respiratory masks & gloves.
5. Conveyor belt/rotating parts must be guarded properly.
6. Safety awareness shall be inculcated in workmen about the risk involved in rotating parts.
7. The agency shall ensure to erect the batching plant as per drawing including installation of all safety devices as provided by manufacturer and witnessed by BHEL Engineer in charge before starting of machine in future.
8. Safety audit to also focus on Batching plant.
9. The site shall impose penalty on the agency who has violated the safety norms as per contract.

2.4 Mobile Plant

Mobile plant includes tractors, trailers, dumpers, excavators, bulldozers, road rollers etc. for earthmoving purpose and concrete mixers, concrete transit mixtures, concrete pumps etc for concreting purpose. Due to the very nature of their function and movement in difficult terrains, congested areas, working in tandem with manual work and other operations the danger is inherent.

Automatic reverse camera with reverse horn connected with reverse gear is compulsory for all moving machineries.

Following Safety measures to be ensured for Mobile Plant:

- a. Where movement around site is involved, routes should be planned, obstruction free and well maintained
- b. Observe specified speed limits
- c. Operating personnel should be aware of associated risks and its preventive measures
- d. Only experienced, trained and authorized persons with valid license (wherever applicable) should operate the mobile equipment/vehicles
- e. Provide and use Warning lights and reverse horn for cautioning the people around
- f. Operation should be on level and stable ground with adequate working clearance.
- g. Loading of out riggers/stabilizers should be well within safe ground bearing capacity
- h. No person should be on equipment or vehicle during loading and unloading of material
- i. Operators should be protected by warning barriers or switching off power when working in close proximity of overhead power lines
- j. The equipment /vehicles should be well maintained and provided with effective brake system and other safety devices (wherever require)
- k. Rotating parts of equipment should be adequately guarded
- l. Provide necessary personal protective appliances and ensure its use by the operating personnel Ensure effective measures at source to control harmful emissions, dust, fumes contaminating atmosphere and cause health hazards to the operators and people in the vicinity.
- m. No overloading/over stressing of vehicles/plant is allowed
- n. Hoses, pipes, receivers, gauges and valves involved in carrying out hydraulic fluid/ compressed air should be checked for leaks and tested prior to operation.

- o. Adequate safe clearance for swing and movement is to be judged during operation of Concrete mixer
- p. Setting of machines on firm and level ground with wheel locked to prevent movement of machine
- q. Proper instructions and Special precautions are to be ensured to prevent entry in to the danger zone of projectile of bucket while dropping bucket
- r. Operator leaving work spot should ensure that the equipment/vehicle is kept in neutral position and place on firm and level ground.
- s. The hand brake should be kept in position and block road wheels as additional safety measure
- t. Blades/buckets should be kept low while moving
- u. The dozer blades should not be used as brakes except in emergency
- v. The ground should be examined for its bearing capacity and general safety especially when operating road roller at the edges of slopes, embankments.
- w. The roller should not be moved downhill with the engine out of gear
- x. If operating near excavations the following precautionary measures are to be ensured
- y. Barricading, edge protection to prevent fall of persons/vehicles over running while reversing etc.
- z. Suitable support system and adequate allowance to avoid the danger of side collapsing
- aa. Experienced signaller /attendant should be always accompanied with operator/driver for proper direction /signal and also to caution others in the working Zone during operation of mobile plant

2.5 Concrete Vibrators

- a. Revolving parts/belt drives should be adequately guarded and Vibrating unit shall be completely enclosed and have suitable overload relays and effectively earthed
- b. Ensure sufficient length of cable to the Vibrator.
- c. Ensure electric starters and other accessories are firmly fixed adequately supported
- d. Ensure locking of needle load while inserting needle in to the vibrator,
- e. Ensure periodical lubrication and maintenance

2.6 Concrete Mixers

- a. Setting of machines on firm and level ground with wheel locked to prevent movement of machine
- b. Proper instructions and Special precautions are to be ensured to prevent entry in to the danger zone of projectile of bucket while dropping bucket

3. WELDING & GAS CUTTING SAFETY (HOT WORK)

- a. All Hot Work shall require a Hot Work Permit
- b. Inbuilt Voltage Reduction Device (VRD) equipped arc welding machine will only be allowed for work.
- c. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced.
- d. All safety precautions shall be taken for welding and cutting operations as per IS-818.
- e. When possible, items to be welded, cut, heated, etc. shall be moved to a safe location free of combustible or flammable material. If this is not possible, then all combustibles/ flammables that can be removed from the area shall be removed within a 35-foot circumference and a positive means of confining arcs and sparks generated by the process shall be ensured and additional person(s) shall be stationed as fire-watch for the area(s) still exposed, along with obtaining the Hot Work Permit as applicable.
- f. Appropriate fire-fighting equipment is to be available in close proximity of any welding and gas cutting operations at all times suitable for the type of Fire.

- g. Drums, tanks, and similar containers that have contained flammable or toxic material shall not be welded, cut, or heated until they have been made safe by water filling, thorough cleansing or similar accepted practices. The container shall also be ventilated during the welding, cutting, or heating process.
- h. Proper ventilation is required for any welding or torch operations performed in a confined space.
- i. Any welding or gas cutting operations performed on metals of toxic compounds or coating such as zinc, stainless steel, lead, cadmium, chromium, and beryllium shall be properly ventilated and/or proper respiratory protection shall be worn by any person that could be exposed to fumes, vapors, and gasses created by the welding and gas cutting processes.
- j. Wherever it is practical, all arc welding operations shall be shielded to prevent direct light rays or sparks from contacting persons in the vicinity or from reaching areas normally used to travel through or into the vicinity. Where this is not practical, persons who shall be in the area are to use proper eye and skin protection. Other persons who are not participating in the welding or gas cutting operations are not to be allowed into the hazard zone.
- k. Welders and other employees who are exposed to arc welding radiation shall wear suitable clothing and protective apparel to prevent burns and other types of ultraviolet radiation damage to the skin.
- l. Arc welding machines shall be shut down when being moved or when they are not in continuous use. Electrode holders left unattended shall have electrodes removed and shall not be left where they might contact employees or conducting objects.
- m. Arc welding power supply cable shall be of proper rating and material, e.g. copper.
- n. Welders shall guard against allowing materials adjacent to or behind them to reflect radiation back toward them or towards others in the area. Reflected radiation can cause skin burns and eye flash burns.
- o. Valve caps shall be in place when cylinders are not in use. Valve caps shall never be used for lifting the cylinder vertically.
- p. Torches shall only be lit by approved strikers; never with matches, cigarette lighters, or hot-work.
- q. **Splatter / Slag Collector:**

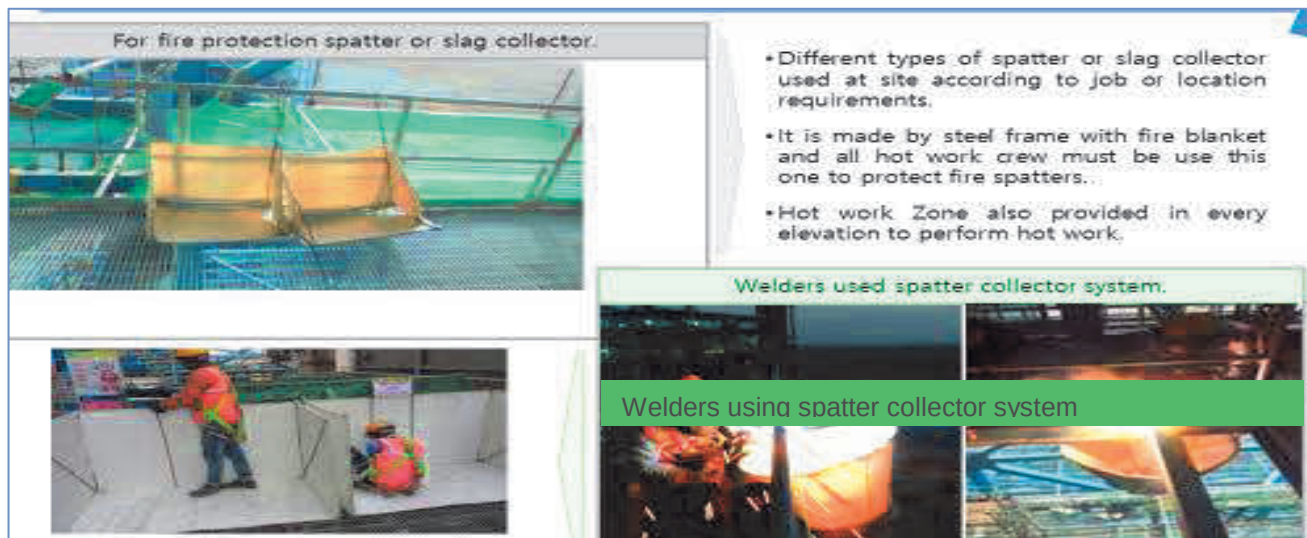


Fig. 4.1 Splatter / Slag Collector

While carrying out job at height, the sparks or molten slag shall be prevented from falling down by putting a fire-resistant (non-asbestos) sheet or patter/ slag collector or even MS Sheet. The passage of falling sparks

or molten slag shall be barricaded till ground floor and any cable/ tubes/ any other objects interfering in the passages shall either be removed or covered with Fire-resistant sheet or MS Sheet.

r. COMPRESSED GAS

- i. All cylinder valves shall be closed when any work is finished and when any Cylinders are empty or being moved. Valve protection caps shall be placed and secured properly before gas cylinders are transported, moved or stored.
- ii. Compressed gas cylinders shall be secured in an upright position with chain or appropriate means during storage & use. However, a trolley shall be used for transportation.
- iii. Compressed gas cylinders shall always be secured from tipping or falling, whether in use, in storage or in transit. The cylinders shall always be secured upright, except during times when actually being hoisted or carried.
- iv. When cylinders are transported by powered vehicle they shall be secured in a vertical position.
- v. Regulators shall be removed when cylinders are not in use or are in transit, unless the cylinder is firmly secured on a special carrier designed for this purpose.
- vi. Gas cylinders are not allowed to be used in man-basket when occupied.
- vii. Cylinders containing oxygen or fuel gasses shall not be taken into confined spaces.
- viii. Oxygen cylinders shall be stored a minimum of 6 meters from fuel gas cylinders or shall have an approved firewall between them.
- ix. All cylinders shall be kept at a safe distance from welding or cutting operations or shielded from arc/sparks / slag.
- x. All cylinders shall be placed where they cannot become part of the electrical circuit.
- xi. Oxygen and acetylene shall not be stored together. Oxygen must be separated from acetylene (or ANY fuel gas) or combustible material by at least 20ft or a barrier with a 30-minute fire resistance rating.
- xii. All Cylinders should be stored upright in a designated area with labels for the type of gas. All applicable precautions to be ensured during storage
- xiii. Oxygen and fuel gas regulators, hoses and associated equipment shall not be altered and shall be in proper working order while in use.
- xiv. Compressed air can be extremely dangerous if allowed to penetrate the skin. As such, the use of compressed air to clean off yourself or other workers shall be strictly prohibited.
- xv. All gas cylinders shall be stored in upright position. Suitable trolley shall be used for cylinder movement, the design of which shall be submitted to BHEL Engineer for approval.
- xvi. No of cylinders shall not exceed the specified quantity as per OCP
- xvii. Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dragged, struck or permitted to strike each other violently.
- xviii. All cylinder should be kept only in cylinder trolley.
- xix. Cylinder shall be transported in upright vertical position by suitable mean.

4. LIFTING & RIGGING SAFETY

- a. All Heavy / Complex Lifting operations as defined in Clause 6.12 shall require a Lifting Work Permit. A written rigging procedure and plan must be prepared for all individual heavy/ complex lifting operations.

- b. All the cranes and lifting tools & tackles shall be inspected on daily / weekly basis as well as monthly by expert as per applicable formats.
- c. In addition, inspection / certification as mandated by law shall be carried out wherein these shall be tested and certificates of fitness shall be obtained from 3rd party State Govt. approved competent agency before deploying at site and later periodically. BHEL shall be given advance intimation of any such inspections
- d. The last date of Third-Party Inspection and the next Due date shall be conspicuously displayed on all cranes. A copy of certificate shall be pasted on operator's cabin of all the lifting equipment.
- e. Specifically designed heavy steel plates lifting clamps shall be used for lifting heavy metal sheets. Manmade lifting clamp chapa shall not be used for lifting/shifting of plates.
- f. Following requirements shall be mandatorily followed, wherever applicable:
 - i. The manufacturer's instruction for maintenance shall also be followed. All safety measures shall be followed.
 - ii. All tools tackles, lifting appliances; material-handling equipment etc. used by the subcontractor shall be of safe design and construction.
 - iii. The operators, slingers and signalers shall be qualified as per IS 13367 (part-1):2003 "Safe use of cranes- code of practices".
 - iv. There shall be a person responsible for co-ordination among cranes where multiple cranes are used, and lifting over load chart of the crane to be avoided.
 - v. Mobile phone should be banned for crane operator and lifting operation. Only walkie talkie shall be allowed in rigging/Lifting purpose.
- g. Lifts/Movements between 5 Tons and 20 Tons:
 - i. Shall include a rigging plan, detailing schematic representation of the handling/lifting operations that must be included on the Method Statement.
 - ii. When performing similar lifts of identical items, only one rigging plan need be prepared, provided each of the lifts can be performed in accordance with the rigging plan.
- h. Lifts/Movements Less Than 5 Tons:
 - i. An equipment rigging plan is not required for lifts less than 5 tons, safety measures are covered in the JSA. This could change as per BHEL requirement

i. Personnel Lifts (Man-Basket / Jhoola):

The design of personnel man basket shall be submitted to BHEL Engineer for approval before use. Relevant permit (Height work & others as applicable) shall be completed prior to lifting any people, along with a rigging plan.

- i. A separate Lifeline / fall arrestor anchored to a fixed structure outside of Jhoola shall be provided for the workers inside the basket. All occupants of the basket shall have Safety Harnesses equipped with rope grabs, which are to be hooked to the vertical lifeline.
- ii. Man-basket shall be used where access through ladders or scaffolding is not feasible.
- iii. Man-baskets shall be designed and engineered by a manufacturer (job made man-baskets are not allowed, unless designed and tested by a certified engineer), and built robust with MS Angles and flats or plates or channels only.
- iv. Guard rails top and mid, must be in place and screened-in to avoid material from falling out of

basket. The factor of safety shall be 200%.

- v. It shall have a door with double latches and shall open inside. Anchor points shall be identified within the man-basket.
- vi. The man-basket shall be thoroughly inspected and load tested and a trial run performed without personnel before being put to job.
- vii. It shall be treated as a lifting tool (T&P Item) and shall undergo same certification cycle and inspection as other lifting equipment.
- viii. An additional sling of required lifting capacity shall be fixed the man-basket main lifting point and attached to the crane above the ball or block.
- ix. While lifting man-basket, the crane shall maintain a uniform speed of lift without any swing.
- x. Once man-basket reaches the destination, the lift brakes shall be locked as long as the basket
 - a. remains at that point. The same care shall be taken in its descent.
- xi. As for hanging man-basket, the same shall be hung off a rigid structure with help U-shaped handle welded to man-basket. This shall be tested once in a year by a competent person.
- xii. Use of Rebar steel for making and monkey-ladder must be avoided.

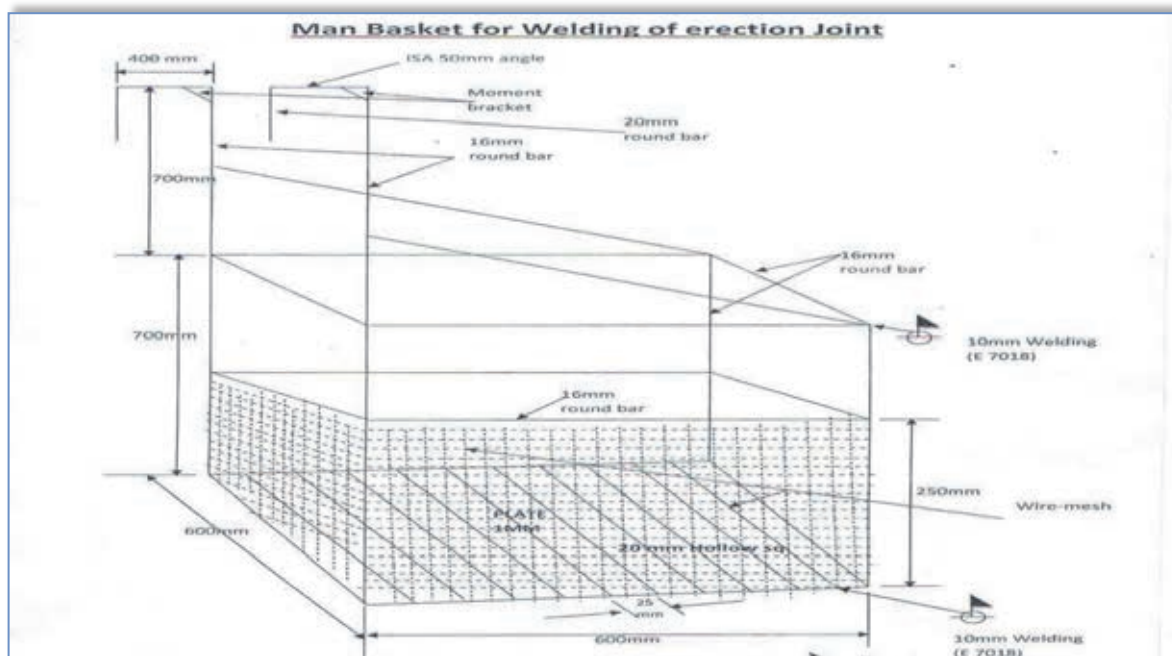


Fig. 5.1 Man Basket for Welding Erection Joint

4.1 Cranes & Hoisting Equipment:

This section provides the guidelines to ensure proper rigging and lifting activities are accomplished safely and in accordance with applicable specifications, codes, and regulations.

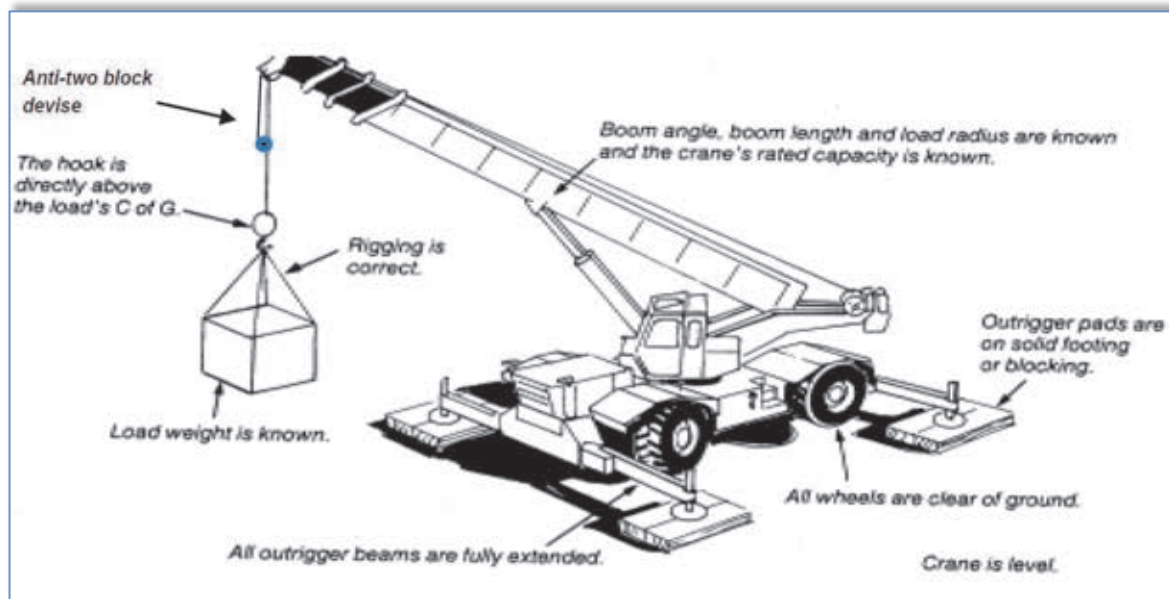


Fig. 5.2 Proper Crane Setup

- a. On every crane or piece of hoisting equipment notices of all rated load capacities, recommended operating speeds, and any hazard warnings or special instructions shall be conspicuously posted. All instructions and warning shall be visible from the equipment operator's station.
- b. Cranes shall have an Anti-Two-block safety device installed
- c. All mobile cranes shall have overload and backup alarms, load angle indicators and limit switches
- d. All areas within swing radius of cranes that are potentially accessible by pedestrian, vehicular, or equipment movement shall be barricaded to prevent anyone or any vehicle or equipment from being struck by the crane or hoisting equipment, or its load(s).
- e. No part of the lifting equipment or its load shall be within the distance as specified in the Indian Electricity Act from an energized power line
- f. Cranes shall have annual certified third-party inspection and be inspected before use by the operator. Any defects shall be corrected before use. Logs of crane inspection shall be kept with the crane.
- g. Make certain that the rigging personnel, material, and equipment have the necessary capabilities for the job and are in safe condition.
- h. Communicate with person(s) directly responsible for accomplishing the work and / or work area to establish requirements/responsibilities and make certain that all preparatory work is complete.
- i. Mats/Pads must be used on all lifting equipment, equipped with out riggers.
- j. Pick and carry must have the load secured to the rig in front.
- k. Only BHEL Approved Plate Lifting Spreader Beam configuration shall be used (Sample in Fig. 11.3.5.3)
- l. Crane operators must follow the following:
 - i. Pass an annual Operator's Physical examination
 - ii. Carry a valid training certification card at all time while operating issued by the Govt. or other recognized institute.

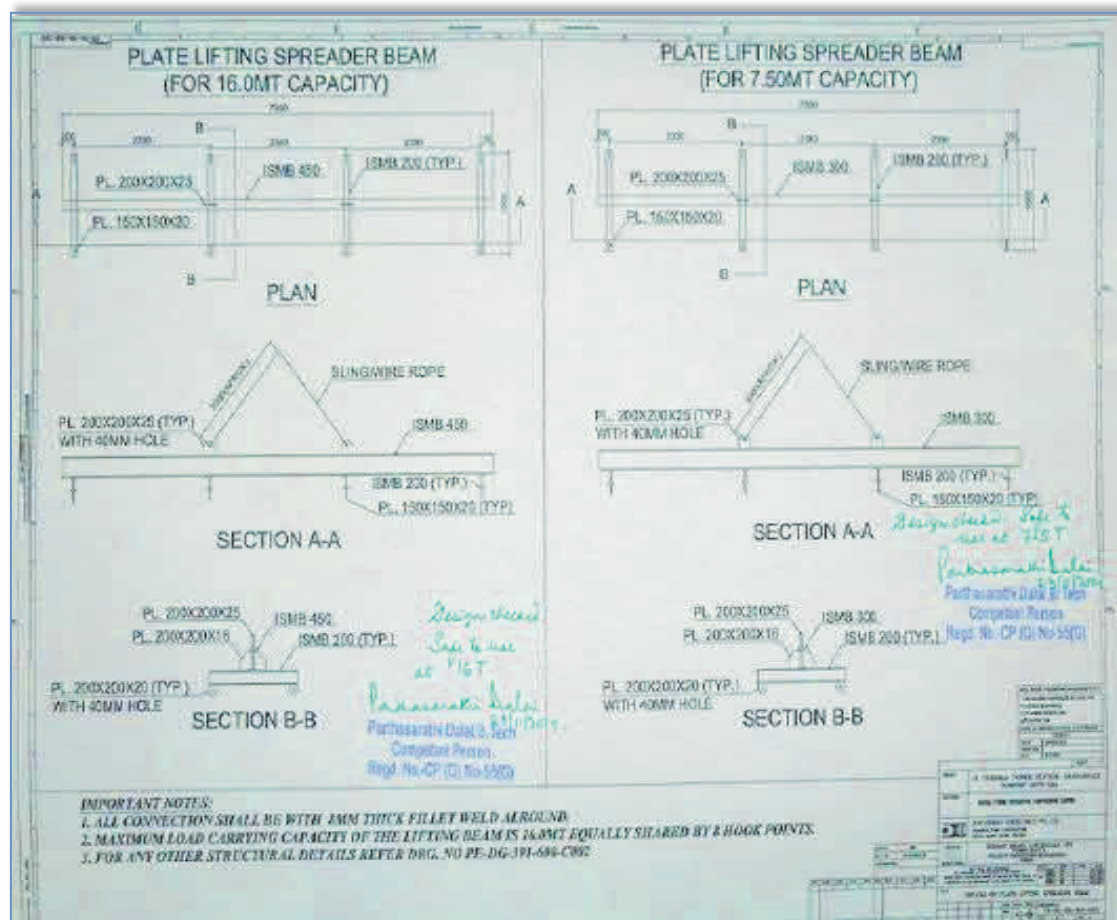


Fig. 5.3 Typical Plate Lifting Spreader Beam Configuration for 7.5 MT and 15 MT Loads

m. Safe Rigging Practices

- Review the planned operation and requirements with the operator and rigging crew.
- Ensure a pre-lift meeting is conducted with crane operator, tagline operator, signal personnel, and Safety Manager.
- Designate a qualified person from the rigging crew to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means.
- Clear the lift area of all unnecessary personnel.
- Hydras shall only be allowed for loading & unloading works & shall not be allowed to move with load

n. Rules for Safe Rigging

- Use loops, thimbles and corner pads to prevent damage to slings when used around corners or on cutting edges.
- Never allow wire rope to lie on the ground for any length of time or on rusty steel or near solvents, chemicals or corrosive substances.
- Slings must not be pulled from between or under loads with load resting on the sling.
- Keep all rope away from flame cutting or welding operations.
- Never use rope as sling material.
- Never wrap a wire rope completely around a hook.

- vii. Do not bend wire rope near any attached fitting.
- viii. The sling must be selected to suite the most heavily loaded leg rather than the total weight when using multi-legged sling to lift loads in which one end is heavier than the other.
- ix. When using 3 and 4-legged sling configurations, any two legs must be capable of supporting the entire load.
- x. Where possible, wire rope choker hitches must include a shackle with the eye around the shackle pin to prevent breaking wires of the choke. The choker hitch must be “snugged down” prior to lifting, not after tension is applied.
- xi. Unless authorized by the hook manufacturer when more than two rope eyes are placed over a hook, install a shackle, pin resting in the hook, and place the rope eyes in the bowl of the shackle.
- xii. Properly rig all loads to prevent dislodgment of any part.
- xiii. Use guide ropes or tag lines to prevent the rotation or uncontrolled motion of the load when necessary.
- xiv. Loads must be safely landed and properly blocked before being unhooked and unslung. Tag lines must not be used in situations that jeopardize the safety of the lift.
- xv. Lifting beams must be plainly marked with their weight and designed working load and must only be used in the manner for which they were designed.
- xvi. The hoist rope or chain must never be wrapped around the load. The load must be attached to the hook by slings or other rigging devices that are adequate for the load being lifted.
- xvii. Multiple part lines must not be twisted around each other.
- xviii. The hook must be brought over the center of gravity of load before the lift is started.
- xix. If there has been a slack rope condition, determine that the rope is properly seated on the drum and in the sheaves prior to lifting.
- xx. Keep hands away from pinch points as the slack is being taken up.
- xxi. Leather gloves are recommended when handling wire rope.
- xxii. Avoid impact loading caused by sudden jerking when lifting or lowering. Lift the load gradually until the slack is eliminated.
- xxiii. Never ride on a load that is suspended.
- xxiv. Avoid allowing the load to be carried over the heads of any personnel.
- xxv. Never work under a suspended load until the load has been adequately supported from the floor and all conditions have been approved by the supervisor in charge of the operation.
- xxvi. Never leave a load suspended unless emergency evacuation is required.
- xxvii. Never make temporary repairs to sling.
- xxviii. The capacity of a sling is determined by its angle, construction, type of hitch and size.
- xxix. Never lift loads with one leg of a multi-leg sling until the unused legs are made secure.
- xxx. Never point load a hook unless it is especially designed and rated for such use.
- xxxi. Make certain that the load is broken free before lifting and that all legs are taking the load.
- xxxii. When using two or more slings on a load make certain all slings are made from the same materials.
- xxxiii. Lower the loads on to adequate blocking to prevent damage to the slings.
- xxxiv. Materials and equipment being hoisted must be loaded and secured to prevent any movement which could create a hazard in transit.

- xxxv. The weight of the hook, load block and any material handling devices must be included when determining crane capacity.
- xxxvi. Calculated weights cannot exceed load chart without written approval.
- xxxvii. Personnel must be completely clear of loads being picked up or set down by crane. Tag lines will be used to control the loads. Loads must not be touched by hand while placing/ moving.

o. Slings

The following are rules for safe use of synthetic slings:

- i. Synthetic slings must be marked to show the rated capacity for each type of hitch and type of web material.
- ii. Nylon web slings must not be used where fumes, vapors, sprays or mists or liquids of acids or phenolic are present. Web slings with aluminum fittings must apply in this category.
- iii. **Synthetic web slings must be removed from service and destroyed if any of the following conditions are present:**
 - a. Acid or caustic burns
 - b. Melting or charring of any part of the sling surface
 - c. Snags, punctures, tears or cuts
 - d. Broken stitches
 - e. Distortion of fittings
 - f. Synthetic web slings of polyester or nylon must not be used at or come in contact with temperatures in excess of 82°C
 - g. Polypropylene web slings must not be used at or come in contact with temperatures in excess of 93°C
 - h. Insulated hooks must be tested yearly to ensure insulation integrity to at least manufacturer's specifications.

p. Wire Rope Slings must be removed from service and destroyed if any of the following conditions are present:

- i. In (10) randomly distributed wires broken in one (1) rope lay, or five (5) broken wires in one (1) strand in one (1) rope lay.
- ii. Wear or scraping of one-third the original diameter of outside wires.
- iii. Kinking, crushing, bird caging or any other damage resulting in distortion of the wire rope structure such as:
- iv. Evidence of heat damage.
- v. End attachments that are cracked, deformed worn.
- vi. Corrosion of the rope or end attachments.

q. Metal mesh slings must be immediately removed from service if any of the following conditions are present:

- i. A broken weld or broken brazed joint along the sling edge.
- ii. Reduction in wire diameter of 25 percent due to abrasion or 15 percent due to corrosion.
- iii. Lack of flexibility due to distortion or corrosion.

r. Requirements of Plate Clamps:

- i. The rated load of the plate clamp must be marked on the main structure.

- ii. Care must be taken to make certain the load is correctly distributed for the plate clamp being used.
- iii. Do not allow load or plate clamp to come into contact with any obstruction.
- iv. The plate clamp must not be used for side pulls or sliding the load.
- v. When lifting stainless steel or special alloys, ensure plate clamp is designed for use on the specific metal.

s. **Signaling Practices:**

- The "slinger" is responsible for attaching and detaching the load to and from the crane. He shall:
 - have received appropriate training on general safe lifting operations;
 - be capable of selecting lifting gears suitable for the loads;
 - liaise with the operator and direct the movement of the crane safely.
- The "signaller" is responsible for relaying the signal from the slinger to the crane operator. He shall:
 - have received appropriate training on general safe lifting operations;
 - be able to direct the movement of the crane and loads.

Suggested hand signals



Note: During the lifting operation, either the slinger or signaller shall communicate with the operator. Other communication methods (e.g., wireless walkie-talkies, telephones, etc.) may also be used.

Fig. 5.4 Recommended Signaling Practices

5. DEMOLITION WORK

Before any demolition work is commenced and also during the process of the work the following shall be ensured, besides using the Work Permit:

- a. All roads and open areas adjacent to the work site shall either be closed, suitably protected or restricted for movement
- b. No electric cable or apparatus which is liable to be a source of danger nor a cable or an apparatus used by the operator shall remain electrically charged.

- c. All practical steps shall be taken to prevent danger to persons employed from the risks of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render them unsafe.

6. T&PS GENERAL

- a. All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test /calibration certificates bearing endorsement from competent authority of BHEL.
- b. Subcontractor to also submit monthly reports of T&Ps deployed and validity test certificates to BHEL safety Officer as per the format/procedure of BHEL.
- c. Tagging and punching in all lifting tool is compulsory with SWL, sr. no. and due date.
- d. All T&Ps shall be inspected by authorized Third Party agency as per applicable frequency. BHEL shall be kept informed of any such scheduled inspection
- e. All T&Ps shall be internally inspected in each quarter and colour coded.

7. CHEMICAL HANDLING

- a. Displaying safe handling procedures & MSDS for all chemicals such as lube oil, acid, alkali, sealing compounds etc. at work place.
- b. Where it is necessary to provide and/or store petroleum products or petroleum mixture & explosives, the subcontractor shall be responsible for carrying out such provision / storage in accordance with the rules & regulations laid down in the relevant petroleum act, explosive act and petroleum and carbide of calcium manual, published by the chief inspector of explosives of India. All such storage shall have prior approval if necessary from the chief inspector of explosives or any other statutory authority. The subcontractor shall be responsible for obtaining the same.
- c. The used containers of chemicals shall be segregated and disposed of suitably
- d. In case the used containers need to be re-used, all traces of the chemical to be removed by thorough cleaning with detergents etc. under trained supervision

8. ELECTRICAL SAFETY

- a. Only electricians licensed by appropriate statutory authority shall be employed by the subcontractor to carry out all types of electrical works. The subcontractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installations.
- b. No PDB or any other distribution board shall be more than 03 (three) years of purchase. Only modern PDB with industrial sockets as shown in layout below to be allowed to use at site.
- c. Power supply to all equipment at site to be routed through MCBs of appropriate rating. A 'Power Supply Distribution Plan' shall be prepared and submitted to BHEL Engineer for approval
- d. All power supplies through cables shall be underground or overhead with height > 3mtrs.
- e. All power distribution boxes shall be locked and the key controlled by site management of concerned subcontractor.
- f. All individual equipment & tools at site shall be powered through Earth Leakage Circuit Breakers of 30 mA sensitivity.
- g. These MCBs and ELCBs shall be regularly tested as per Clause 14
- h. All fuses and fuse wires shall be of standard size and rating.
- i. All electrical appliances used in the work shall be in good working condition and shall be properly double earthed other than armour earthing.

- j. All extension boards shall have separate switches for all sockets / connections.
- k. All portable electric tools used by the subcontractor shall have safe plugging system (industrial top & socket) to source of power and be appropriately earthed.
- l. Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts especially in confined spaces like inside water boxes, turbine casings, condensers etc.
- m. Electrical appliance shall have proper earthing and for appliances equal to & more than 415V shall have two separate earthing (as per IS-3043-1987)

n. Portable Electric Lights

- i. Portable electric lights used in wet or potentially wet locations must be either low voltage type (24 volts or less) or protected by a GFI (ground fault interrupter).
- ii. They must be visually checked before each use and periodically while in use to assure their original integrity is maintained.
- iii. Cords with cuts, breaks, deep abrasions, etc. shall be taken out of service immediately.
- iv. Repairs to extension cords shall only be performed by qualified/ licensed electricians.
- v. Must not be allowed to lie in wet or potentially wet areas.

o. Underground Cables:

- i. Every electric line or cable of unknown origin that is discovered or exposed during a digging, drilling, probing, or similar operation is to be considered as energized and life threatening.
 - ii. The senior company employee on the site will ensure that all necessary safety precautions are taken in order to isolate the line from all workers and the public.
 - iii. Such precautions may include halting the operation if appropriate.
 - iv. The senior company employee on the site is to then contact the proper authorities to have the line identified and either confirmed to be abandoned and/or made safe for continuing the work.
 - v. Any and all underground lines that are discovered or become severed must be considered energized on both sides, and be treated accordingly.
- p. Details of earth resource and their test date to be given to BHEL safety officer as per the prescribed formats of BHEL
- q. The subcontractor shall use only properly insulated and armoured cables and conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.
- r. BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the risk & cost of the subcontractor.
- s. No maintenance work shall be carried out on live equipment
- t. Adequate precautions shall be taken to prevent danger for electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public
- u. The subcontractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltages used in critical areas.
- v. Wiring and Branch Circuits Must be protected by a proper amperage over-current device such as a HRC fuse or circuit breaker. Such installations must be located so as to prevent physical damage to the wire conductors & panels.

- w. The sub-contractor shall supply modern power distribution board of different combination (1-phase & 3-phase). All the distribution of power should be through modern PDB. Equipment drawing is mentioned below.

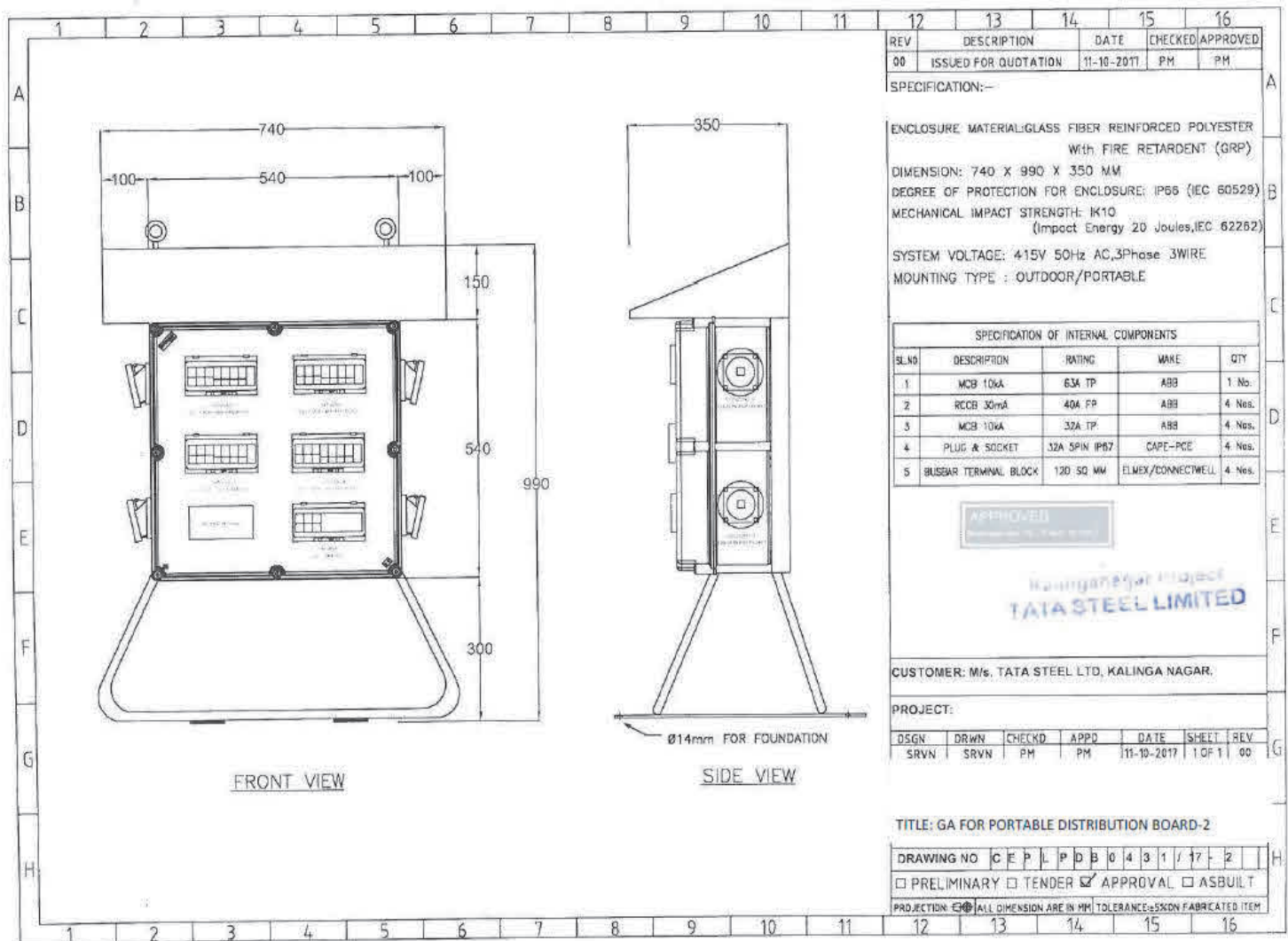


Fig. 9.1 Layout of a modern Power Distribution Board

x. General Electrical Safety

- In general, equipment or machinery being moved or transported must maintain minimum clearances of 25 ft. to all power lines.
- TAG IN/ TAG OUT must be in force in Switch Room and all Distribution Boxes for live power line. The authorized person's name and contact no shall be displayed
- Ensure "double insulated" three - core cables and three pin connectors are used and are properly ground "all insulated" types, all electrical tools and appliances must be manufactured for industrial use.
- All connections shall be electrically and mechanically sound and properly insulated. Taped joints are not permitted. Connections to socket outlets must be made with proper plugs (industrial top and socket).
- Splices in electrical cords are not permitted. Repairs must be made at the socket connection and retain the same mechanical and dielectric condition of the original connection.

- vi. Damaged or defective electric tools, equipment and extension cords, etc. must not be used and shall be tagged out of service, removed from the work area and taken back to stores.
- vii. Only licensed electricians are authorized to repair and work on electrical equipment. Tampering with electric tools or equipment by others could result in termination.
- viii. Temporary electric cabling should be elevated 2.2 meters above the floor/ground or covered for protection. It must be kept clear of walkways and other locations where it may be exposed to damage or create a tripping hazard.
- ix. Energized wiring in junction boxes, circuit breaker panels and similar places must be covered and locked at all times.
- x. Areas with live high voltage wires or terminals must be barricaded against entry and warning signs posted Danger – High Voltage and Authorized Personnel Only.
- xi. Personnel should never work on energized equipment, de-energizing (lockout/tag out) the equipment is always the first requirement.
- xii. The lockout and tag out procedure will be used when testing or working on, or around, energized installation.
- xiii. Working around energized equipment should never be done alone. A second electrician must always be available for assistance.
- xiv. If lockout/tag out of the work is infeasible (must be demonstrated), work on energized electrical circuits must be approved by the Site In-charge. All safety precautions necessary must be taken, PPE use must be evaluated per the exposure and used, i.e high/low voltage gloves, insulated shoes, overcoats/aprons, face shields, and other protective equipment like insulated tools, blankets, mats, etc. must be used.
- xv. The welding machines earth leads shall be properly fixed without loose contacts. The earth cable only has to be used. No steel members shall be used as earth leads.
- xvi. Electrical crews must be qualified for the equipment and tools they work on, including being trained in Cardio-Pulmonary Resuscitation (CPR) methods and First Aid for rendering help in the event of electric shock.

y. Qualified Persons for Electrical Works

(One who is trained and wiremen licensed to Govt. of Respective State and familiar with the construction, operation and safety hazards of the equipment upon which they are permitted to work.)

- i. Qualified persons are intended to be only those who are well acquainted/experienced with and thoroughly conversant in the electric equipment and electrical hazards involved with work being performed.
- ii. Only qualified persons may be permitted to work on or near exposed energized parts. Such persons are required to have been trained in three specific areas:
- iii. Qualified persons must be capable of working safely on energized circuits;
- iv. Must be familiar with the proper use of special precautionary techniques and procedures bases on equipment and exposure; and
- v. Must be familiar with required personal protective equipment, insulating and shielding materials, and insulated tools.

- vi. Qualified persons are expected to be able to evaluate unknown situations and adjust their activities in such a way that only safe work practices are used. Such behavior is the responsibility of the qualified person.
- vii. It is possible and likely for an individual to be 'qualified' with regard to certain equipment in the work place, and unqualified on other equipment they must know their limitation and stop work if not qualified on what equipment they were to work on.
- viii. An employee who is undergoing on-the-job training, who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training, and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties. The process must be documented as proof.

z. Mandatory PPEs of electrical work on LV & HV

- i. HV arc flash suit with protective hood (for protection of face and head) as specified for hazard risk category-4 in NFPA-70E or similar IS specification for working on HT switch gear (for all voltage >690 V) to the concerned licensed electrician or competent person.
- ii. LV arc flash jacket/FR as specified for hazard risk category-4 in NFPA-70E or similar IS specification having ATPV rating of 8.5 to 9 cal/cm² for working on LV (>260V and ≤690V) to the concerned licensed electrician or competent person.



- iii. The LV arc flash jacket as shown above shall be worn continuously while working on LV (>260V and ≤690V). The color specification of LV arc flash jacket should be blue.
- iv. Electrical hand gloves should have following specification: Flame resistance, arc flash and cut protection of voltage rating (>260V and ≤690V).
- v. Electrical safety over shoe of relevant IS make for foot protection of licensed electrician or competent person while working in HV & LV line or equipment.

9. USE OF HAND TOOLS AND POWER-OPERATED TOOLS

a. General Provisions

- i. All hands and power tools and similar equipment, shall be maintained in safe condition.
- ii. When power operated tools are designed to accommodate guards, they shall be equipped
- iii. with such guards, when in use;
- iv. Belts, gears, shafts, pulleys, sprockets, spindles, drums, fly wheels, chains and other reciprocating, rotating or moving parts of the equipment shall be similarly guarded;
- v. Personnel using hand and power tools and exposed to the hazard of falling, flying, abrasive, and splashing objects, or exposed to harmful dusts, fumes, mists, vapors, or gases shall be provided with the particular personal protective equipment necessary to protect them from the hazards;

- vi. All hand-held powered platen sanders, grinders, grinders with wheels of 5 cm or less, routers, planers, laminate trimmers, nibblers, shears, scroll saws and jigsaws with blade shanks of 0.5 cm wide or less shall be equipped with only a positive on-off control.
- vii. All hand-held powered drills, tappers, fastener drivers, horizontal, vertical or angle grinders with wheels greater than 5 cm in diameter, disc sanders, belt sanders, reciprocating saws, saber saws and other operating powered tools shall be equipped with a momentary contact on control provided that turnoff can be accomplished by a single motion of the same finger or fingers that turn it on.

b. Hand Tools

- i. The subcontractor shall not issue or permit the use of unsafe hand tools;
- ii. Wrenches including adjustable pipe end and socket wrenches shall not be used when saws are sprung to the point that slippage occurs;
- iii. Impact tools such as drift pins, wedges and chisels shall be kept free of mushroomed heads;
- iv. The wooden handles of tools shall be kept free of splinters or cracks and shall be kept tight on the tools.

c. Power Operated Tools

- i. Electric power operated tools shall be either of the approved double-insulated type or shall be grounded;
- ii. The use of electric cords for hoisting or lowering loads shall not be permitted;
- iii. Pneumatic power tools shall be secured to the hose or whip by some positive means to prevent the tool from becoming incidentally disconnected;
- iv. Safety clips or retainers shall be securely installed or maintained on pneumatic impact (percussion) tools to prevent attachments from being incidentally expelled;
- v. All pneumatically riveting machine staplers and other similar equipment provided with automatic fastener feed, which operate at more than 7 kg/cm² pressure at the tool a safety device on the muzzle to prevent the tool from ejecting the fasteners unless the muzzle is in contact with the work surface;
- vi. Compressed air shall not be used for cleaning purposes except when the pressure is reduced to less than 2 kg/cm² and that too with effective chip guarding. The 2 kg/cm² pressure requirement does not apply to concrete form, mill scale and similar cleaning purposes;
- vii. The manufacturer's safe operating for hoses, pipes, valves, filters and other fittings shall not be exceeded;
- viii. Only personnel who has been trained in the operation of the particular tool shall be allowed to operate power-actuated tools;
- ix. The tool shall be tested each day before loading to see that the safety devices are in proper working condition. The method of testing shall be accordance with the manufacturer's recommended procedure;
- x. Any tool found not in proper working order, or that which develops a defect during use, shall be immediately removed from service and not used until properly repaired;
- xi. Tools shall not be loaded until just prior to the intended firing time. Neither loaded nor empty tools are to be pointed at any other person. Hands shall be kept clear of the open barrel end;
- xii. Loaded tools shall not be left unattended;
- xiii. Fasteners shall not be driven into very hard or brittle materials including, but not limited to, cast iron, glazed tiles, surface hardened steel, glass block, live rock, face brick or hollow tiles;

- xiv. Driving into materials that can be easily penetrated shall be avoided unless backed by a
- xv. substance that will prevent the pin or fastener from passing completely through and creating a flying missile hazard on the other side;
- xvi. No fastener shall be driven into a palled area caused by an unsatisfactory fastening;
- xvii. Only non-sparking tools shall be used in an explosive or flammable atmosphere;
- xviii. All tools shall be used with the correct shield, guard or attachment as recommended by the manufacturer.

d. Abrasive Wheels and Tools

- i. All grinding wheel must be ISO certified only.
- ii. All grinding machines shall be supplied with sufficient power to maintain the spindle speed at safe levels under all conditions of normal operation;
- iii. Grinding machines shall be equipped with suitable safety guards;
- iv. The maximum angular exposure of the grinding wheel periphery and sides shall not be more than 900, except that when the work requires contact with the wheel below the horizontal plane of the spindle, the angular exposure shall not exceed 1200. In either case, the exposure shall begin not more than 8.650 above the horizontal plane of the spindle. Safety guards shall be strong enough to withstand the bursting of the wheel;
- v. Floor and bench-mounted grinders shall be work-rests, which shall be rigidly supported and readily adjustable. Such work-rests shall be kept at a distance not to exceed 5 mm from the surface of the wheel;
- vi. Cup type wheels used for external grinding shall be protected by either revolving cup guard or a band type guard;
- vii. When safety guards are required, they shall be mounted as to maintain proper alignment with the wheel and the guard and the guard and its fastening shall be adequate strength to retain the fragments of the wheel in case of incidental breakage. The maximum angular exposure of the grinding wheel periphery and sides shall not exceed 1800;
- viii. Portable abrasive wheel used for internal grinding shall be provided with suitable safety flanges;
- ix. When safety flanges are required, they shall be used only with wheels designed to fit the flanges. Only safety flanges, of a type and design and properly assembled so as to ensure that the pieces of the wheel will be retained in case of incidental breakage, shall be used;
- x. All abrasive wheels shall be closely inspected and ring tested before mounting to ensure that they are free from cracks or defects;
- xi. Grinding wheels shall fit freely on the spindle and shall not be forced on. The spindle nut shall be tightened only enough to hold the wheel in place;
- xii. All employees using abrasive wheels shall be protected by suitable eye protection equipment.

e. Wood Working Tools

- i. All fixed power-driven woodworking tools shall be provided with a disconnect switch that can either be locked or tagged in the off-position;
- ii. The operating speed shall be attached or otherwise permanently marked on all circular saws over 0.5 m in diameter or operating at over 3000 peripheral rpm. Any saw so marked shall not be operated at a speed other than that marked on the blade. When a marked saw is re-tensioned for a different speed,

- the marking shall be corrected to show the new speed;
- iii. Automatic feeding devices shall be installed on machines wherever the nature of the work will permit. Feeder attachments shall have the feed rolls or other moving parts covered or guarded so as to protect the operator from hazardous points;
 - iv. All portable power-driven circular saws shall be equipped with guards above and below the base plate or shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth, except for the minimum arc required to allow proper retraction and contact with the work. When the tool is withdrawn from the work, the lower guard shall automatically and instantly return to the covering position.

10. START UP, COMMISSIONING AND TESTING:

There are various activities involved prior to commissioning- the major ones are -Hydraulic Test, Steam Blowing, Transformers Charging, Boiler Light Up, Rolling and Synchronisation and Full loading of unit.

- a. These activities shall be personally supervised by the site executive along with the commissioning engineer.
- b. Appropriate Work Permits shall be taken as applicable
- c. The readiness of upstream and downstream system shall be ensured before taking up.
- d. These shall be handled strictly by the authorized persons only and the team shall be suitably briefed about the activity including hazards & risks involved and control plan by the concerned executive-in-charge before start.
- e. Entry of persons to the area of activity shall be suitably restricted and the emergency functions like Ambulance, first aid center and Fire station shall be intimated about the plan well in advance.
- f. Tag-in/ Tag-out shall be in place while charging transformer and whenever necessary.
- g. Electricians with valid wiremen license only shall be permitted to work on power lines.
- h. The area and the passage shall be adequately illuminated.

11. FIRE SAFETY

- a. The Fire Prevention, Protection and Preparedness Program is an integral part of the overall HSE Program. Effort and consideration must be given to safety, life and potential for delays in construction schedules and plant startup, as well as protection of property on a given project. The purpose of which is to prevent
 - i. Inception of fire
 - ii. Loss of life or personal injury
 - iii. Loss of Property
 - iv. Interruption of operations
- b. Site-in-charge / Safety Officer will make periodical review of the site Fire Protection, Prevention Preparedness Programme, Site conditions and available fire protection equipment. It is very imperative that the Sub-contractors along with BHEL to establish good contact with Local fire station for availability of Fire tender in case of emergencies, in addition to their own fire equipment.
- c. Fire Protection, Prevention and Preparedness Inspections - The Contractor /Sub-Contractor will be required to make frequent fire prevention inspections of his work site and operating facilities. Deficiencies will be corrected at once.
- d. Area where Hot work activities are carried out (Gas cutting / Welding/ any other spark producing work)

above a working spot, a GI / fire-resistant non-asbestos sheet or suitable material shall be placed to prevent the fall of hot sparks. A bucket of water shall be kept nearby while doing hot work

- e. Hot work shall be preferably carried out in a designated area with a standing Hot Work Permit, to be renewed monthly. The designated area shall have fire extinguishers.
- f. Any hot work outside designated area shall require a Hot Work permit and fire watch. No flammable material shall be stored within 35 feet from any fire load.

12. PAINTING:

- a. Requirements provide a detailed procedure to be implemented by all concerned employees and sub-contractors involved in painting activities.
- b. Significant Environmental Hazards:
 - i. Chemical hazard due to inhalation of lead fumes (lead containing paint)
 - ii. Chemical hazard due to inhalation of VOC's from painting operations
 - iii. VOC's from painting and coating operation
 - iv. Disposal of paints and coats drums
- c. Control Procedure for Painting:
 - i. Chemical products used in painting and coating operation shall have proper MSDS sheet in place. Whenever any doubt arises with respect to handling and safety point of view it should be accessed to all concerned.
 - ii. Toxic substances and hazards relate the toxic chemicals shall be identified.
 - iii. Proper PPE shall be used including plastic gloves appropriate overall etc.,
 - iv. Arrangement for cleaning of spillage shall be ensured
- d. Only trained workers shall be allowed and proper training should be imparted to the works.
- e. Exposure limits of the toxic substances shall be checked before starting the work and nobody shall be allowed to carry the work beyond the permissible limit.
- f. Ventilation or exhaust facility shall be provided at place where painting and coating operations are carried out.
- g. Overalls shall be supplied by the contractors/subcontractors to the workmen and adequate facilities shall be provided to enable the painters to wash at the cessation of work.
- h. Smoking, open flames or sources of ignition shall not be allowed in places where paints and other flammable substances are stored.
- i. A caution board in national /regional language "**smoking strictly prohibited**" shall be displayed in the vicinity.
- j. Suitable fire extinguishers/sand buckets shall be kept available at places where flammable paints are stored, handled or used.
- k. In case of indoor painting or painting in confined spaces, exhaust ventilating shall be provided. If adequate ventilation is not provided a proper respirator shall be provided and used by persons who are trained and fit tested.
- l. The VOC's from painting and coating operations shall not exceed the permissible level of CPCB/ SPCB norms. The paints and coats must be selected as per the guidelines.
- m. Workers shall thoroughly wash their hands and feet before leaving the work.

13. “HAZARDOUS ENERGY” CONTROL PROCEDURE/ LOCKOUT/TAGOUT (LOTO)

Hazardous Energy Control Procedures, known as "Lockout/Tagout (LOTO)" refers to specific practices and procedures to safeguard employees from the unexpected energization or startup of machinery and equipment, or the release of hazardous energy during service or maintenance activities.

Contractors must develop and submit a written LOTO program. This requires that a designated qualified individual turns off and disconnects the machinery or equipment from its energy source(s) before performing service or maintenance and that the authorized employee(s) either lock and tag the energy- isolating device(s) to prevent the release of hazardous energy and test the machine or equipment to verify that the energy has been isolated effectively.

a. Minimum Requirements:

The following are minimum requirements that must be included in the Contractor's LOTO program:

- i. Inspection of equipment by a trained individual who is thoroughly familiar with the equipment operation and associated hazards.
- ii. Identification and labeling of lockout devices. Purchase of locks, tags, and blocks. Development of a standard written operating procedure, permitted through a controlling authority that is followed by all workers.

b. General Requirements

The following steps must be taken to protect workers that install or service equipment and systems:

Follow the hazardous energy procedures and statutory regulations. Follow the manufacturer's service/repair instructions. Identify and label all sources of hazardous energy. Before beginning work, accomplish the following:

- i. De-energize all sources of hazardous energy:
 - ii. Disconnect or shut down engines or motors.
 - iii. De-energize electrical circuits.
 - iv. Block fluid (gas or liquid) flow in hydraulic or pneumatic systems.
 - v. Block or secure machine parts against motion.
 - vi. Block or dissipate stored energy.
 - vii. Discharge capacitors.
 - viii. Release or block springs that are under compression or tension.
 - ix. Vent fluids from pressure vessels, tanks, or accumulators—but never vent toxic, flammable, or explosive substances directly into the atmosphere.
- c. Lockout and tag out all forms of hazardous energy including electrical breaker panels, control valves, etc. Make sure that only one key exists for each of your assigned locks and that access to the key is controlled. Verify by test and/or observation that all energy sources are de- energized.
- d. After completion of the work, accomplish the following:
- i. Inspect repair work before removing the lock and activating the equipment.
 - ii. Make sure that only the worker that installed the lock removes his/her assigned lock.
 - iii. Make sure that all workers are clear of danger points before re-energizing the system.

e. LOTO Procedure**PURPOSE AND SUMMARY**

This procedure provides the requirements and responsibilities of Hazardous Energy Control and the process for Lockout / Tag out (LOTO) of energy isolating devices (valves, circuit breakers, disconnect, etc.). Its use

shall ensure that machinery, equipment, or systems are isolated from all potentially hazardous energy to prevent unexpected energization, startup, or release of stored energy which may cause personnel injury or property damage.

This procedure applies to all BHEL personnel and subcontractors working on the WBPDC (1X660MW) STAGE-III projects where equipment must be taken out of service for the performance of work activities such as installation, maintenance, repair, construction, or equipment removal. The procedure may also be used to isolate equipment of which the energization or operation may present danger to personnel or property. Lockout / tag out are not required for electrical equipment that can be unplugged from the source and the person performing the work has control of the plug.

This procedure shall be applied to prevent injury or damage caused by the unexpected release of active or stored energy. Hazardous energy sources could be in the form of the following:

- Electrical
- Hydraulic
- Chemical
- Thermal
- Mechanical
- Pneumatic

Preplanning of work activities includes the identification of all potential hazardous energy sources so that they may be properly controlled and isolated, locked, and tagged out.

Prior to initiating work activities on or around locked out / tagged out equipment, the equipment must be tested and tried by or in the presence of the person(s) performing the work activities.

RESPONSIBILITIES

- The Engineers in Charge is responsible for implementing and enforcing this procedure and approving lockouts /tag outs that impact the operation of the project.
- The Engineer in Charges responsible for authorizing Lockout /Tag out Requests.
- The Lockout / Tag out Coordinator is responsible for maintaining the Lockout / Tag out Log. Each shift should have a designated Lockout / Tag out Coordinator.
- The Isolator is responsible for determining the proper isolation devices and device positions required to isolate all potential energy sources so that the work stated on the Lockout /Tag out Request Permit may be safely performed. The Isolator must be familiar with the equipment and energy type(s) that require isolation. For this reason, in some cases the Isolator may be more than one person (i.e. Engineer, System Operator and/or Electrician). The Isolator shall position the specified device points, and apply locks and tags, and sign the tags and the LOTO Permit isolation point blocks.
- The Safety Manager is responsible for conducting an annual audit that is documented to ensure all procedures and requirements are current and being followed as written.

DEFINITIONS

Affected Employee: -

An employee whose job requires him/her to operate or use machinery or equipment on which servicing or maintenance is being performed under a lock out/tag out procedure or whose job requires him/her to work in an area in which servicing or maintenance is being performed under a lockout/tag out procedure

Authorized Employee: -

An employee who implements a lockout/tag out procedure on machinery, equipment, or systems in order that servicing or maintenance may be performed. Often an authorized employee and an affected employee may be the same person.

Danger “Do Not Operate” Tag

A tag used to identify energy isolation devices and specify the required position of the device. The tag should be affixed to the isolation device such that it is in plain view of anyone attempting to operate the device. The tags shall be sequentially numbered and shall specify the lockout/ tag out request number. The tag shall also state the purpose, and the expected duration of the lockout /tag out

Isolation Device

A device that is designed and intended to prevent the passage of energy. These devices, usually located at the energy source, are typically valves, circuit breakers, etc. Isolation devices should have a means of being locked in position

Lockout Device

A device that uses a positive physical means such as a lock, either key or combination type to maintain an energy isolation device in the safe position and prevent the inadvertent energization of machinery, equipment, or systems. Device locks should serve no other purpose other than hazardous energy control isolation

Lockout Tag out Request Permit

A pre-numbered form used to request that machinery, equipment or systems be taken out of service. A Lockout/Tagout Request Permit may be initiated by any one requiring energy isolation for work activities or for taking faulty equipment out of service

Lockout / Tag out Request Log

A record of all Lockout /Tag out Request Permits shall be maintained by the Lockout /Tag out Coordinator.

PROCEDURE**1. REQUESTING A LOCKOUT / TAGOUT PERMIT**

When machinery, equipment, or systems are partially or completely taken out of service for work activities or equipment protection, a lockout / tag out shall be requested. The requestor shall be familiar with scope of work required and shall provide a brief description of the work on the Lockout / Tag out Request Permit. The requestor shall also provide the proposed start time and estimated duration of lockout / tag out. If familiar with the machinery, equipment, or system to be taken out of service, the requestor may identify the devices that are required to be isolated. The LOTO Request Permit shall be forwarded to the Authorized Lockout / Tag out Coordinator for reviewed and signature, along with Permit to Work number to be entered on the LOTO Request Permit.

- a. The Lockout / Tag out Coordinator shall record the necessary information on the Lockout / Tag out Request Log and forward the request to the Engineer in Charge for approval.
- b. The Safety Manager or Engineer in Charge shall review the Lockout / Tagout Request Permit for impact on project operations. Project operations could be impacted by the equipment being taken out of service or by the required isolation to take the equipment out of service. If project operations are impacted by the Lockout / Tagout, the request shall be forwarded to the Engineer in Charge for approval.
- c. The Engineer in Charge shall provide the lockout / tag out isolation points necessary to perform the task stated on the request. The device identification, device location, device position, and locking mechanism

shall be entered into the appropriate blocks on the Lockout / Tag out Request Permit.

- d. The Engineer in Charge indicates approval of the Lockout / Tagout Request Permit by signing in the appropriate space on the request. If the Lockout /Tag out Request Permit is rejected, the Engineer in Charge shall return it to the requestor, via the Lockout / Tagout Coordinator with a written explanation of the rejection.
- e. Once approved, the Lockout / Tag out Request Permit shall be forwarded to the Lockout / Tag out Coordinator to assign tags and locks.
- f. The log shall show current status of all Lockout / Tag out Request Permits from submittal to approval, through lifting of locks and tags to final closeout. The log shall be maintained by the Lockout / Tag out Coordinator in their office.

2. PLACEMENT OF LOCKS AND TAGS

- a. The tags shall be filled out to match the information on the LOTO Request Permit. Appropriate locks for the types of isolation devices specified shall be collected and placed with the tags and the Lockout / Tag out Request Permit.
- b. The isolator(s) shall take the device locks, tags, and the Lockout / Tagout Request Permit to position the specified isolation devices, sign and hang the tags, and place the locks. If the isolator does not agree with or understand the Lockout / Tagout Request Permit, or has a problem performing the isolation, the problem should be brought to the attention of the Safety Representative or Area Supervisor immediately and the lockout / tag out should be postponed until the situation is resolved.
- c. Once the Isolator has placed all “locks” on isolation points, they will “test ”and “try” the machinery, equipment, or system to ensure all hazardous energy has been completely removed and the isolation is one totally accomplished, and has initialed and signed the Lockout /Tag out Request Permit indicating all isolation points have been confirmed. Examples of “lock”, “test” and “try”:
 - by checking that all locks on the LOTO Request Permit have been applied and are in the specified position open/closed, on/off, etc.; metering test of electrical circuits, opening of drain valves, checking pressure gauges or indicators; and try by pushing start buttons and on/off switches, etc.
 - Testing shall be performed by person(s) knowledgeable of the energy source(s) being isolated (e.g., an electrician should meter electrical circuits).
- d. A copy of the completed Lockout /Tag out Request Permit shall remain with the Work Package and used as part of the daily Pre-Job Briefings

3. WORKING UNDER A LOCKOUT / TAGOUT REQUEST

- a. Prior to starting the work activity, the person(s) performing the work shall review the Lockout / Tag out Request Permit and place the necessary tags and personal locks on the identified isolation devices. Personal locks may be placed only on devices that have already been locked and tagged in accordance with the Lockout / Tag out Request Permit.
 - All personal locks shall be accompanied by a tag that is signed and dated by the worker(s) and specifies the work activity being performed.
 - Personal locks should be of a different color than device locks for ready identification.
- b. Verification of the effectiveness of the isolation by the Isolator shall be performed for Worker’s working under the lockout / tag out, by demonstrating the checks on “lock”, “test” and “try”,
- c. When the work activity is finished, personal locks and tags shall be removed and the Safety Representative

shall be notified that the Lockout / Tagout is no longer required. If work under a lockout / tag out is to be delayed or interrupted for a period in excess of 24 hours, personal locks shall be removed until the work restarts. Personal locks shall be removed prior to the worker(s) leaving the project at the end of shift unless the key(s) are maintained at the project.

4. REMOVAL OF LOCKS AND TAGS

- a. When the lockout / tag out is no longer required, the Safety Representative or Area Supervisor shall obtain the Lockout / Tagout Request Permit from the work package for LOTO removal. Prior to removing locks or tags that may allow equipment to be energized, a check shall be made to verify that the equipment is free to safely operate (i.e., will not cause damage or injury). The locks and tags shall be removed and returned to the Lockout / Tagout Coordinator. Isolation devices may be repositioned at the discretion of the Engineer in Charge according to operational requirements. The Isolator shall complete the Lockout / Tagout Request Permit indicating each lock and tag has been removed and the Safety Representative or Area Supervisor forward to the Lockout / Tagout Coordinator.
- b. The Lockout / Tagout Coordinator shall discard the tags and maintain the completed Lockout / Tagout Request Permit for future reference.
- c. In the event that an employee leaves the job site without removing the personal lock I tag, the following measures shall be taken and documented. The measures listed below are a minimum set of guidelines and under all circumstances, refer to the site-specific safe work plan for detailed procedures:
 - Attempt calling / contacting the employee to return to the site for removal.
 - In the event an employee cannot be contacted, the Site Manager and Safety Manager shall sign an Emergency Lockout/Tagout Removal Form, which has been completed by the Area Supervisor.
 - Employee shall be notified upon returning to the site, prior to beginning any work.

5. INTERRUPTION OF A LOCKOUT / TAGOUT

Operational Emergency

The Engineer in Charge / Safety Manager /Area Supervisor may deem it necessary to temporarily remove the locks and tags from isolation devices, prior to the end of the work activity. The standard procedure for removal of locks and tags shall be followed. Extreme caution shall be taken by the Isolator removing the locks and tags to prevent personnel injury.

Testing

When the performance of a work activity requires the functional testing of a machine, component, or system, the locks and tags may be temporarily removed in accordance with the tag removal, to perform the test. As a result of the testing, if it is determined that the equipment needs further work, the locks and tags shall be positioned back on to the device. If it is not necessary to replace all the locks and tags, then the unnecessary locks and tags may be returned to the Lockout / Tagout Coordinator. The Engineer in Charge shall initial the Lockout / Tag out Request Permit in the removal block to indicate that these locks and tags have been removed. When testing has been satisfactorily completed, the locks and tags shall be removed.

ISOLATION DEVICES

- In most industrial applications, there are isolation devices that were not designed to accommodate a locking device. In these instances, an acceptable alternative that physically obstructs or prevents the use of the isolation device shall be found. Chains shall be placed on valves or electrical panels. Wires shall be determinate, pulled back, taped, and secured.

- If an isolation device does not accept a lock, a tag only is acceptable; however, all possible precautions shall be undertaken to provide a level of safety for the workers. The tag shall be readily visible to anyone attempting to operate the device.
- If more than one Lockout / Tagout Request Permit requires that a single isolation device be locked and tagged, a lock and tag for each request shall be placed. Each lock in itself prevents the inadvertent operation of the device.

GROUP / COMPLEX LOCKOUT

In a multiple lockout / tag out procedure, each person working on the machinery or equipment must place a lock or tag on the energy isolating device. If the energy isolating device will not accept multiple locks or tags, a hasp (a multiple lockout device, may be used. The locks or tags must be placed in such a way that energy cannot be restored to the machinery or equipment until every lock or tag is removed. As each employee involved no longer needs to maintain lockout / tag out protection that employee removes his - her lock and/or tag. The employee attaching the lock or tag is the only person authorized to remove the lock or tag.

6. TRAINING

The training must include recognition of hazardous energy source, type and magnitude of energy available, methods and means necessary for energy isolation and control. Each authorized employee shall receive adequate training. The training should address that all affected employees are instructed in the purpose and use of the energy control procedure. There should be training provisions included for any other employee whose work operations are or may be in an area where energy control procedures may be utilized. The employee training should also address when tag out systems are used including the limitations of a tag (tags are warning devices and do not provide physical restraint). The training should also include that a tag is not to be removed without authorization. The tag is never to be ignored or defeated in any way. Retraining is required when there is a change in job assignments, in machines, a change in the energy control procedures, or a new hazard is introduced. All training and I or retraining must be documented with employee's name and dates of training.

7. PROGRAM REVIEW

The lockout / tag out program must be reviewed at least annually. The review must ensure that procedures are being followed and that they are effective. A documented review of the inspection must include the date, the equipment, employees involved & the inspector. The inspector must be someone other than those actually using the lockout / tag out in progress.

ATTACHMENTS

#1. Danger (DO NOT OPERATE) Tags



#2. Device & Personal Locks and Multi Lock Hasp:



#3. Lockout / Tagout Request Permit

		LOCKOUT / TAGOUT REQUEST PERMIT			LOTO Request Permit No.:	
					Work Permit No.:	
Equip. Out of Service:	LOTO Date Required by: ____/____/____	Estimated Duration:		LOTO Requested Date:		
Scope of Work:				LOTO Authorization Signed by:		
				Date:		
				LOTO Removal Authorization Signed by:		
				Date: Time:		
Tag No.	Device to be Tagged / Locked I.D. No.	Device Location	Device Position OPEN / CLOSE D -	Lock No.	Tag/Lock Placed by Print/Sign - Date/Time	Tag /Lock Removed by Print/Sign - Date/Time
Comments Instructions: Attachment 3.Lockout / Tag out Request Permit:						

#4. Lockout / Tag out Request Log

LOTO Permit No.	Request or Name	Equipment & Location	Est. Work Completed Date	Approval Date	LOTO Placed Date	LOTO Removed Date	Comments

14. RISK ASSESSMENT

Risk and Hazard Analysis

In order to produce an overall Project EHS Plan, a project must be assessed for its risks. There are two components to the risk and hazard analysis. The procedure used to examine and plan for the identified risks and hazards is called a General Hazard and Risk Assessment.

JSA/HIRA review

Prior to commence the following activities Method statement and JSA/HIRA to be prepared by the concern engineer in coordination with EHS officer and submit to the client for review and approval. After getting approval the work will be started under PTW after clearance. For HIRA and criteria for the defining the high, medium & low risk the relevant annexure be referred. In case any deviations required in the approved method statement the concerned engineer/supervisor has to prepare additional HIRA/JSA to cover the new activities and associated risk. Following activities to be covered,

- Deep excavation (more than 5 feet)
- Significant concrete pouring (like heavy foundation, TG deck, Slab casting etc.)
- Confined entry
- Blasting
- Working on electrical/ energized equipment's
- Steel erection more than 5-Ton weight
- Working at height prior to completion of stairs/ladders/hand railing etc.

Definition:

HAZARD - Any potential or present danger to persons or property within the project site, e.g., oil on the floor is a hazard.

INCIDENT - An unintended happening that may result in injury, loss or damage, e.g., Slipping on the oil is an Incident.

INJURY – Physical harm, the result of an Incident, e.g., a sprained wrist from the fall would be an injury.

Hazard Analysis Document

- For high risk and dangerous work identified, the Applicant shall complete and submit a Hazard Analysis Document together with the PTW request. It will be a JSA (Job Safety Analysis) or Preliminary Hazard Analysis Checklist. And it shall be reviewed and approved by respective Construction and HSE Representatives.
- Issues such as work interface, coordination, drawings, toolbox meetings and work type/duration shall be detailed and included with supporting documentation for the Applicant's request for PTW.
- If applicable, Hazard Analysis Document shall be used as the foundation for development of Safe Work Method Statement. Each hazard identified shall be addressed in the Safe Work Method Statement and be submitted as part of the Applicant's submittal package.

Evaluation of Sub-contractor Risk Assessments includes

- Experience and expertise in performing similar type work.
- Duration of work performed
- Location of the work to be performed.

- Nature of the work to be performed.
- Potential for a subcontractor performing the work to expose themselves, other persons or employees, to hazards.
- Potential for exposure to work site hazards.

Review of Subcontractor specific issues

Preventive and protective measures must be introduced according to the following order of priority

- Eliminating the hazard by removing the activity from the work process. Examples include substitution with less hazardous chemicals, using different manufacturing processes, etc.
- Controlling the hazard at its source through use of engineering controls. Examples include local exhaust ventilation, isolation rooms, machine guarding, acoustic insulating, etc.
- Minimizing the hazard through design of safe work systems and administrative or institutional control measures. Examples include job rotation, training safe work procedures, lock-out and tag-out, workplace monitoring, limiting exposure or work duration, etc.
- Providing appropriate personal protective equipment (PPE) in conjunction with training, use, and maintenance of the PPE.

15. HSE PREPAREDNESS FOR ADVERSE CLIMATES AND WEATHER

All Preventive and Precautionary measures to ensure Health & Safety of workers in all possible adverse weather conditions based on the analysis of the local area conditions to be taken by the subcontractor

15.1 SUMMER

1. The Working Time and Lunch Hour will be as per instruction of Statutory Authorities (no work between 11am to 3:30pm). However, in case temp comes down due to rain/cloudy weather work will continue as per normal routine.
2. During long lunch break, worker will be allowed to go back home for rest. Those who will like to stay back will avail at the facility of rest shed or other designed area.
3. They will be allowed to take small break during work as per their need.
4. Water sprinkling will be done on roads to reduce dust concentration.
5. Workers will be provided with adequate cool drinking water and Butter milk/Lemon water etc.
6. Adequate ORS stock will be made available at the work location in the First-Aid Box for use as needed and at First-aid Centre for emergency need.
7. Fire prevention shall be on high alert, with removal of dry grass and bushes, etc, inside and outside the surrounding work areas. No smoking, and control of open flame/sparks shall be maintained and monitored.
8. Worker will be informed about the Do's and Don'ts to be followed during summer in the Pre Job Brief.

Dos & Don'ts

1. Drink plenty of cool water and other non-alcoholic fluid and keep body well hydrated.
2. Eat salt in food to replenish loss of salt through sweating.
3. Avoid over physical exercise.
4. Have adequate sleep at night.
5. Eat light and less spicy food
6. Avoid eating food which was cooked long time ago.

7. Nobody should use small water bodies such as pits, running rain water through crevices etc. for drinking and cleaning purpose as it may be unhygienic.

Emergency Handling

In case of emergency due to heat disorder:

1. Rescue the victim from workplace and place under shed.
2. If to be rescued from height, use stoke basket or rescue kit.
3. Inform Ambulance immediately.
4. If nearby any air conditioned room/shed is available, place him inside the room/shed.
5. Administer First aid by trained First aider for Heat Disorder
6. If conscious, give him ORS solution to drink.
7. If required send the victim hospital immediately.

15.2 MONSOON**A. Height Work & Structural Safety:**

1. Ensure that all height work platforms are barricaded and avoid any highly hazardous
2. Height work.
3. Ensure that all personnel have good quality and intact safety shoes
4. Stop all dangerous height work during rain
5. Explain Do's and Don'ts to workers during Tool Box Meetings
6. Ensure that there are no weak structures, boards etc. that can fall during high winds
7. Do not allow any loose material (e.g. GI sheet, Ply board, empty cement bag, aluminium foil, foam sheets etc.) on roof sheds or top of structures.
8. Do not permit any one to ride up or come down scaffolds frame work during heavy wind or rain.
9. Provide "anchor" of adequate strength to scaffolds and other high-rise structures.
10. All rest sheds and GI sheds will be anchored into the round and wall and roof panels will be secured with J hook to prevent shed from blowing over or parts/pieces becoming airborne. Proper earthing per IS standard is also to be installed.
11. Do not go alone nor permit anyone to stay at tower-tops, roof-tops, high structures or on electrical poles during the course of stormy weather or heavy rain.

B. Electrical:

1. All electrical connections / loads have to be routed through ELCB / RCCB (residual current circuit breaker) whose rating should be 30mA.
2. RCCB operational checks need to be done DAILY / WEEKLY during monsoon season.
3. Avoid joints on power cables which need to be laid over-head or under-ground, better not to have any joint at all. In case joints become essential, such cables must be housed rigidly and insulation must be provided as per approved standard. The joint shall be suitable for outdoor use.
4. All electrical distribution board shall be properly covered at top and sides to protect from rain water. Extension boards shall be protected from rain water.
5. Ensure proper "earthing" for each and every electrical appliance.
6. Double earthing need to be provided for 3-phase power supply and for voltage more than 220V.

7. Provide lightening arrestors at the top of Boiler 3 and boiler 4 and rest sheds which are not covered by existing lightening arrestor of other installation.

C. Others:

1. Maintain smooth flow on open drains. i.e. no obstruction or blockade shall be made on storm water drains. If required, make temporary drains.
2. Arrange back-filling of excavated pits on war-footing basis.
3. Arrange bringing down booms of all cranes, hydra machines during stormy weather (wind speed 40-50 km/hr)
4. Confirm that all gantry cranes are effectively choked to prevent rolling and toppling.
5. Do not forget to deep ready a dew battery operated lights at site-offices during rainy season.
6. Avoid using wet damp clothes.
7. Hard Barricade excavated zone filled with water with scaffolding pipe & clamp with reflective net
8. Engage diesel operated water pump to dewater work area. For electrically operated water pump, the starter shall be protected from rain water. All rotating parts shall be guarded. Ensure availability of sufficient water pumps.

D. Health and hygiene:

1. Monsoon reduces the immunity of our body and makes us vulnerable to many diseases which are commonly associated with this season. It is time for us to keep our body challenging against disease by boosting our immunity and taking safety measures against these diseases.
2. The diseases associated with monsoon are Malaria, Jaundice, Gastro-intestinal infections, like typhoid, cholera etc. apart from these viral infections like cold and cough also make their presence felt. Majority of above said diseases are on account of:
3. Puddle of water formed due to rain become breeding grounds for mosquitoes which spread disease like, malaria and dengue fever. As a precautionary measure against mosquito-bite disease one can use mosquito net around the end which is better choice to mosquito repellents like mats and coils.
4. Pollution of drinking water during monsoon is very common. It is very necessary to drink clean and pure water when water-borne monsoon diseases like diarrhoea and gastro-intestinal infections threaten us.
5. Walking in dirty water during rainy season leads of numerous fungal infection which affect toes and nails. Diabetic patients have to take a special care about their feet. Keeping feet always dry and clean is very necessary. Avoid walking in dirty water. Keep shoes socks and raincoats dry and clean.

E. Workmen will be made aware of following Do's and Don'ts:

1. Do not sleep in daytime.
2. Avoid over physical exertion.
3. During lightning and thunder storm, do not take shelter under tree. Take shelter inside rest shed or store room.
4. Wash vegetables with clean water and steam them well to kill germs.
5. Avoid eating un-cooked foods and salads should be washed properly before consumption.
6. Drink plenty of water and keep body well-hydrated.
7. Always keep the surrounding area dry and clean. Don't allow to get water accumulated around.
8. Keep body warm as viruses attack immediately when body temperature goes down.

9. Do not enter air conditioned room with wet hair and damp cloths.
10. Dry your feet and webs with soft dry cloth whenever they are wet.
11. Eat light and less spicy food.
12. Avoid eating food which was cooked long time ago.
13. Eat salt in food to replenish loss of salt through sweating.

15.3 EMERGENCY WEATHER CONDITIONS

Cyclone/Severe thunder storm

In the event of Cyclone/Severe thunder storm, alert will be issued by subcontractor on notification received by Govt. authorities/Metrological departments Customer or BHEL.

The actions required during cyclone/rough weather:

1. Check and advice subcontractors to clean-up work area. Pick up all loose and unused material of respective supervisor's area.
2. Tie to secure all gas cylinders to avoid displacement and unsafe conditions which could be due to wind pressure.
3. Secure portable electricity generating sets and other equipment, pumps, hoses etc.
4. Make preparation for removal of water logging.
5. Take review of work activity and make preparation for removal of equipment and material from vulnerable areas.
6. Isolate/turn off all electrical power form the main panel/switches. Secure and anchor panels properly.
7. Recheck anchorage/tie of all temporary structures/sheds, tall objects, cranes, rigs, scaffolds etc. to avoid toppling due to wind force.
8. Cranes boom shall be secured, either locked or lowered the booms as reasonably and practicably possible and rigs to safe position for the safety point of view.
9. Group up all trash barrels, wooden pallets, forms; wooden decks etc. and anchor properly.
10. Welding machines, air compressors and such equipment are to be grouped together and secured to the stable objects. Welding leads, electrical cables, hoses are to be rolled up and secured properly.
11. Set on site vehicles on high ground in the site area with brakes set firmly.
12. Anchor all tanks, vessels, gas cylinders that may be moved by high wind and water.
13. Evacuate job site.

Personnel Evacuation:

1. Personnel Evacuation will be required if predicted wind speed and storm surge heights are beyond acceptable limits as per the instructions from Govt. Authorities/ Metrological departments or Customer.
2. Once the warning is received for personnel evacuation, an emergency response team shall be formed. The team will work with local authorities and other agencies formed/deployed to evacuate and transport all personnel involved in the project to the cyclone shelter.
3. Cyclone may be followed by the calm "EYE", be aware of it. If the wind suddenly drops, don't assume the cyclone is over. Violent wind may resume from the opposite side direction. Wait for the official "All clear Signal".

4. After the cyclone, do not go outside until officially communicated about safe situation outside. Use recommended routes for returning. Do not panic or rush while returning.
5. Checking of gas leaks and well-being of electrical appliances is essential before leaving the site.
6. Follow local communications for official warning and advice. The construction Manager shall also obtain updates from customer/metrological departments and communicate to the personnel on project site.

15.4 PREVENTION OF COVID-19 (COVID-19 HERE TO BE READ AS COVID-19 AND OTHER PANDEMICS/ COMMUNICABLE DISEASES) AT PROJECT SITE & LABOUR COLONY:

Resumption of Construction Activities after Lock Down and Prevention of Coronavirus Infection during Site Operations and OCP 61A: Prevention of COVID-19 Infection in Labor Colony will be strictly followed.

A. Preventive measures at project site:

- BHEL and Agencies shall nominate COVID Marshalls, who will be responsible for monitoring the COVID prevention measures and apprising management on the same.
- Mandatory health check-up for every worker/ official joining the site
- All activities to be carried out using least amount of paperwork and physical proximity as far as possible.
- **HSE Observer App** to be used to monitor HSE Activities and follow up with agencies for closure of non-conformities.

a. Strict Control at the Gate/ Banning Entry to Anyone Not Wearing Masks

- i. Security personnel at the gate may erect a barricade preferably approx. 10 meters from the gate and only allow personnel who are wearing proper masks inside.
- ii. Public address system may be used to warn any non-compliant visitors
- iii. Near entry gate, round markers at minimum 1-meter distance to be ensured so that distancing is ensured
- iv. A hand-wash or hand sanitiser facility is preferable at the gate to allow entry after hand wash or hand sanitisation. These are also to be provided at key locations to enable hand wash / hand sanitisation before starting work, before eating, etc.
- v. Gutkha, Paan, tobacco etc. to be banned from the site. Spitting to be strictly prohibited.

b. Screening at Gate with Contactless Thermometer & Action on Suspected Cases

- i. Security Personnel at the Gate to screen each person entering the premises using a non-contact infrared thermometer, which is duly serial numbered and calibrated.
 - ii. In case any site worker/ official is found to have fever more than 99 Degrees Fahrenheit or found coughing/ sneezing, he/she may be advised rest till recovery and entry to be permitted after obtaining clearance from medical officer/assistance/attendants.
- Parcel to be collected from gate by concerned person preferably with provision of Special Box
 - Any construction material received at site, unless properly sanitized, to be kept undisturbed for at least 3 days and to be used only after that period.
 - During Toolbox Talks, minimum 1-meter distance between any two workers to be ensured

c. During site execution activities:

For all site execution activities, social distancing is to be maintained. In case this is not possible due to nature of work, speciality of work, etc, ensure sensitisation of the labour/staff involved and use of appropriate PPEs, especially mandatory face mask. In any case, close working to be allowed only in special

circumstances and ensuring these activities are preferably time staggered to the extent possible

d. In office premises:

- i. Sharing of items like pens, water bottles etc. in office premises to be avoided
- ii. Doors preferably to be in open condition to avoid contact
- iii. All common touch points to be frequently disinfected in a day.

e. Regular disinfection of all Areas, Equipment and facilities

- i. A dedicated disinfectant gang to be identified for the task by each agency. The disinfectant gang to be provided full body suits for the task.
- ii. All areas (including office premises, site areas, chairs, tables, furniture etc.), tools & equipment to preferably be disinfected by dedicated gang every day before resumption of work.
- iv. Common touch points like handrails, lift buttons, door/window knobs or handles, vehicle door handles, taps, conference room & dining hall tables/chairs, common sofas/chairs, visitor sofa/chairs, files & folders, etc to preferably be disinfected regularly at frequent intervals every day.
- v. Pool vehicles, to be disinfected after every use. Social distancing to be maintained inside the common pool vehicles as per Govt./ statutory body guidelines.

f. Disinfecting the operator/driver touch points of Vehicles/cranes, T&Ps etc.

Disinfection to also be carried out for all Cranes, Vehicles, Equipment, consoles, T&Ps etc. which come into contact with operating personnel.

g. Posters on COVID-19

Sufficient Posters on COVID-19 to be ensured across the site in languages understood by most workers.

h. Brief guidelines for hand washing are as below:

- i. Soap to be provided at each wash basin and replenished regularly.
- ii. Washing with soap for at least 20 seconds is recommended.
- iii. As a general guideline, for every 100 workers, 1 wash-basin may be provided at site areas.
- iv. Close queue to be avoided near wash-basins and 1-meter distance to be maintained. Round markers at 1-meter distance can be ensured as guidance

Composition of Disinfectant:

- i. Readily available 1% hypochlorite solution or 4%
- ii. Liquid chlorine-1% solution
- lii. Surgical spirit-95% alcohol content
- iv. Hand sanitizer should have: Isopropyl alcohol-75%, Glycerol-1.45%, Hydrogen Peroxide-0.125%

B. Prevention of COVID-19 Infection in Labor Colony:

- Spacing of minimum 2 meters between living areas of workers inside a room may be maintained. Preferably, the living area of each worker may be partitioned using sheet of cloth, plastic etc.
- Rooms to be properly ventilated as far as possible
- Sanitation to be given prime importance and personal hygiene to be promoted
- Face masks shall be worn by everyone inside the colony premises
- Spitting of Pan. Gutkha etc. inside the colony and urinating etc. outside the toilets to be strictly avoided
- Regular visits by Doctors to the labor colony can be arranged on non-working day for check-up of all workers
- **Identification of "COVID Wardens" (CWs) by each agency for maintaining the following:**
 - i. Keeping an eye on the health of workers and report any suspected cases of fever, coughing etc. to the

management

- ii. Keeping an eye on the social distancing measures in the labor colony and report any non-conformances to the management.
- iii. Educate the workers about social distancing and COVID prevention measures.
- Training/ Awareness regarding COVID-19 to be provided to workers regularly.
- Workers to be instructed to maintain social distancing of minimum 1 m at all time
- **Posters on COVID-19:** Sufficient Posters on COVID-19 to be ensured across the labor colony in languages understood by most workers.
- All workers to be instructed to inform any suspected cases of illness (individual or others) to an emergency contact number of CW, the emergency contact numbers and CW contact numbers to be displayed at prominent locations
- **Inspection & Review**
 - i. Daily Inspection by concerned COVID Wardens and reporting to Agency
 - ii. Regular inspection by Agency & BHEL

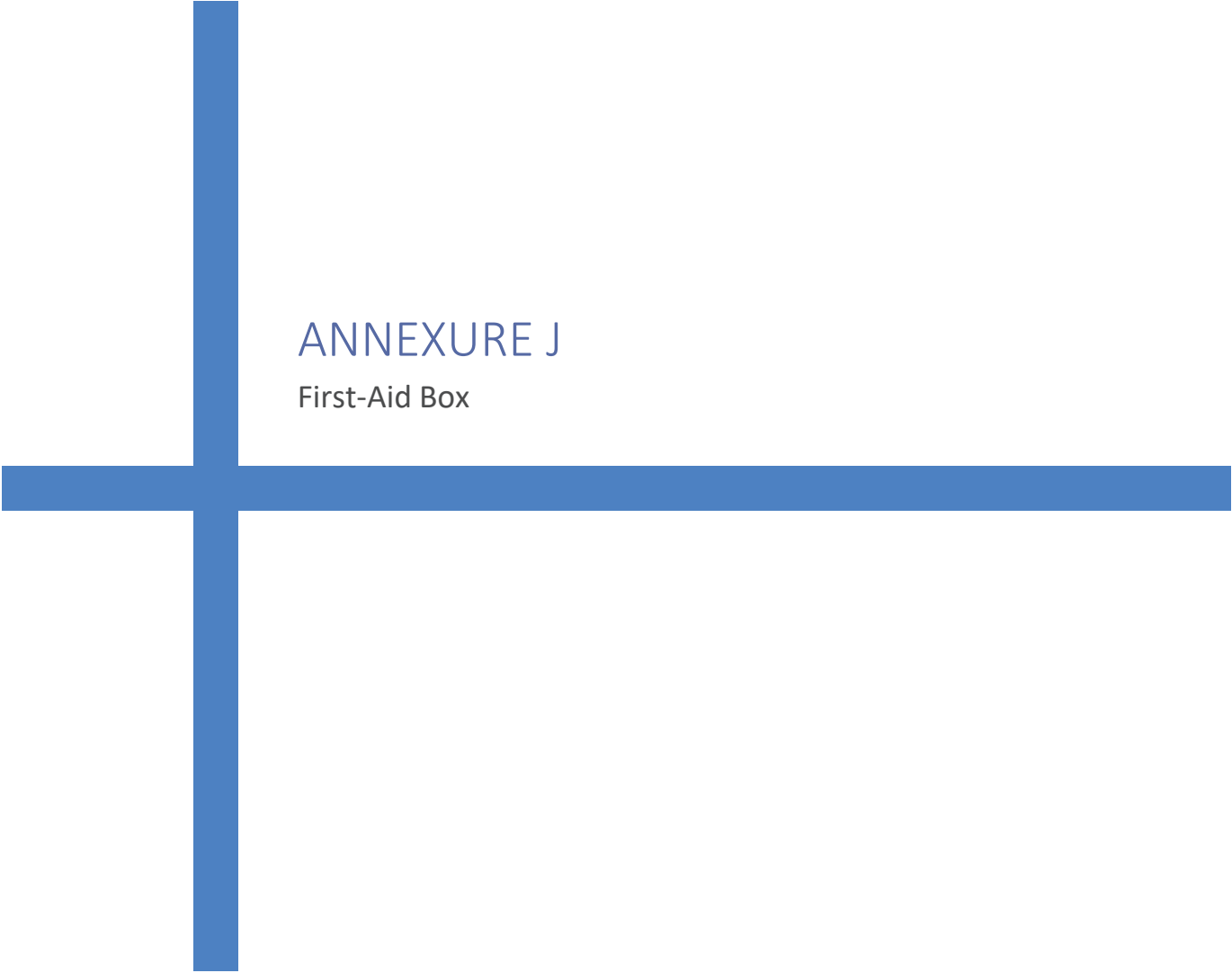
15.5 Noise Mitigation

High noise is harmful to the human health and it can cause impairment if exposed for long duration at regular intervals, and also cause disruption in nearby communities.

- Noise monitoring shall be carried out in all construction locations periodically.
- Use of silent DG is allowed at site during construction.
- Low noise generation equipment's to be preferred.
- Work areas where noise levels exceed the 85db shall be posted as hearing protection required.
- Use of PPEs / ear plug/ear muff for personnel entering into high noise area.
- Activities generation High noise will be planned in day shift.

Noise Level Chart

Parameter	Night Noise level dBA	Daytime Noise Level dBA
At 1-meter from each piece of equipment	85	85
At Property boundary	70	70



ANNEXURE J

First-Aid Box

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Details & Contents of First Aid Box as per Contract Labor (Regulation & Abolition Act), Central Rules, 1971

- (1) The first-aid box shall be distinctively marked with a Red Cross on a white background and shall contain the following items, namely:

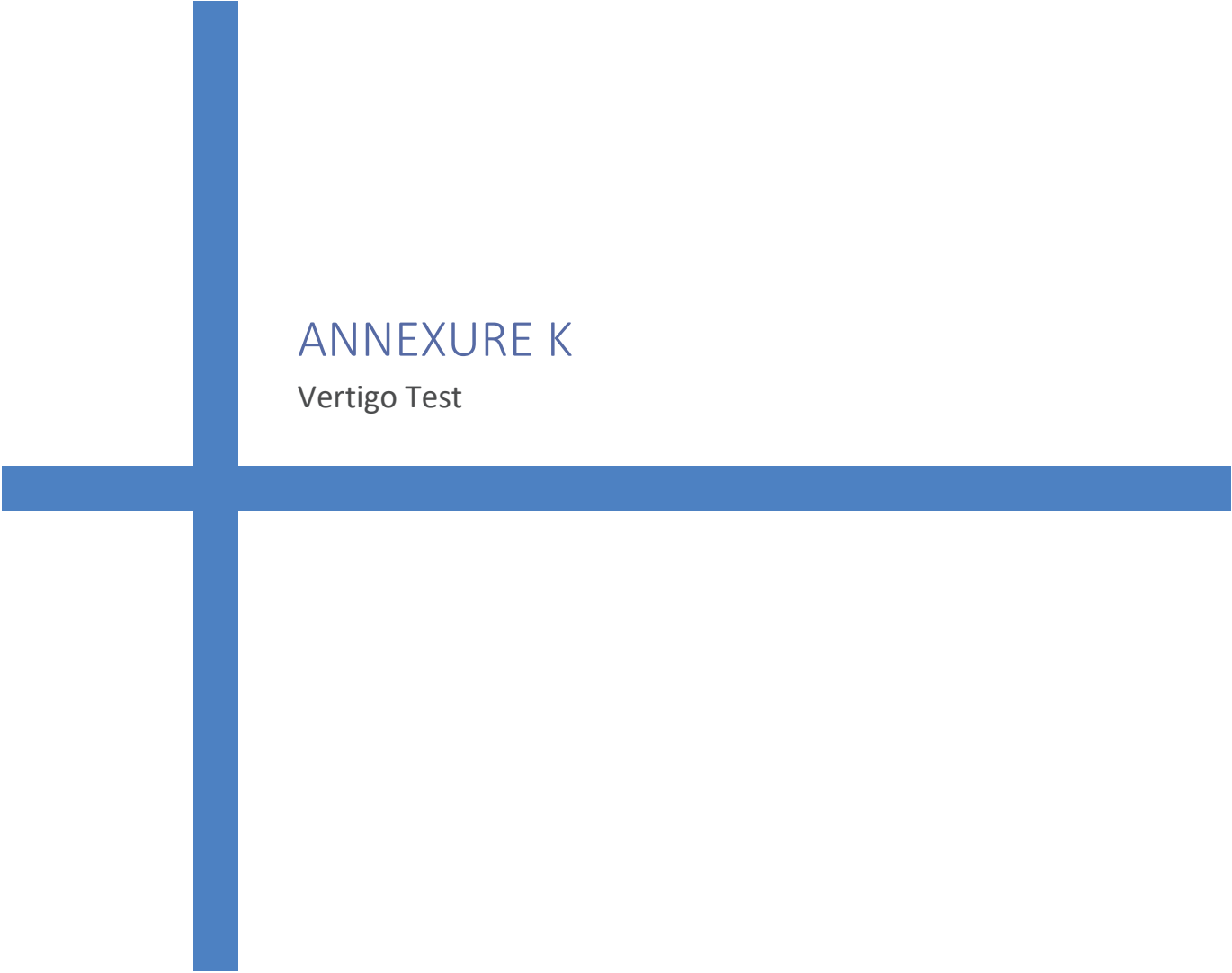
(a) For establishments in which the number of contract labor employed does not exceed fifty, each first aid box shall contain the following equipment:

(i)	6 small sterilized dressings
(ii)	3 medium size sterilized dressings
(iii)	3 large size sterilized dressings
(iv)	6 pieces of sterilized eye pads in separate sealed packets.
(v)	6 roller bandages 10 cm wide.
(vi)	6 roller bandages 5 cm wide.
(vii)	One tourniquet
(viii)	A supply of suitable splints
(ix)	Three packets of safety pins.
(x)	Kidney tray.
(xi)	3 large sterilized burn dressings.
(xii)	1 (30ml) bottle containing a two percent alcoholic solution of iodine
(xiii)	1 (30 ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label
(xiv)	1 snake bite lancet
(xv)	1 (30gms) bottle of potassium permanganate crystals.
(xvi)	1 pair scissors
(xvii)	1 copy of the First-Aid leaflet issued by the Director General, Factory Advice Service and Labor Institutes, Government of India.
(xviii)	A bottle containing 100 tablets (each of 5 grains) of aspirin
(xix)	Ointment for burns
(xx)	A bottle of suitable surgical anti-septic solution

(b) For establishment in which the number of contract labor exceeds fifty each first-aid box shall contain the following equipment:

(i)	12 small sterilized dressings
(ii)	6 medium size sterilized dressings
(iii)	6 large size sterilized dressings.
(iv)	6 large size sterilized burn dressings
(v)	6 (15 grams) packets sterilized cotton wool
(vi)	12 pieces of sterilized eye pads in separate sealed packets.
(vii)	12 roller bandages 10 cm wide.
(viii)	12 roller bandages 5 cm wide.
(ix)	One tourniquet.
(x)	A supply of suitable splints.
(xi)	Three packets of safety pins.
(xii)	Kidney tray.
(xiii)	Sufficient number of eye washes bottles filled with distilled water or suitable liquid clearly indicated by a distinctive sign which shall be visible at all times.
(xiv)	4 per cent Xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops.
(xv)	1 (60ml) bottle containing a two percent alcoholic solution of iodine
(xvi)	One (two hundred ml) bottle of mercurochrome (2 per cent) solution in water.
(xvii)	1 (120ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label.
(xviii)	1 roll of adhesive plaster (6 cmX1 meter)
(xix)	2 rolls of adhesive plaster (2 cmX1 meter)
(xx)	A snake bite lancet.
(xxi)	1 (30 grams) bottle of potassium permanganate crystals.
(xxii)	1 pair scissors
(xxiii)	1 copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labor Institutes, Government of India.
(xxiv)	a bottle containing 100 tablets (each of 5 grains) of aspirin
(xxv)	Ointment for burns
(xxvi)	A bottle of a suitable surgical anti septic solution.

- (2) Adequate arrangement shall be made for immediate recoupment of the equipment when necessary.



ANNEXURE K

Vertigo Test

Rk

Vertigo Test Procedure/ Guidelines

This document specifies minimum requirements for vertigo test. These may be supplemented by any additional requirements deemed fit by the medical examiner/ HSE department)

Fear of height may be physiological or psychological. Therefore, to rule out any possibility of physiological factor, detailed medical check-up of workers is carried out before vertigo test. Medical check-up of workers includes the following:

history of past illnesses (like epilepsy, drug allergy, diabetics/ hypertension, unconsciousness etc.), general physical examination (like height, weight, BMI, build and nourishment etc.), measurement of pulse rate, Blood Pressure, respiratory rate.

After this check-up, those who are found suitable for height work by examining doctor, are allowed to undergo vertigo test.

During this health check-up, psychology of workers is also studied. If any worker finds it extremely difficult/ frightening to climb the monkey ladder & walk on the beam, during/after performing vertigo test or even before performing, then he is treated as disqualified.

As per standard, during vertigo test, worker is allowed to climb on a foundation through monkey ladder, walk on a beam, then steps down at the other end of beam, through monkey ladder. Height of the beam should be at least six feet from ground level. All necessary safety precautions are taken during this test. Worker has to wear full body harness with double lanyard. A horizontal lifeline is run parallel to the beam and worker has to put his lanyards into the lifeline. Additionally, a safety net is also put below the beam for rescue of the victim in case of a fall from beam.

Following activities are suggested to be carried out during testing:**1. Walking Bench Training:**

- a. Person should walk over the channel. He should maintain balance & walk without much problem.
- b. If the person has problem to balances himself on repeated chances, he may be having flat foot or some other problem. So, he may not be fit for height work.

2. Rope Climb Training:

Person should be able to climb the rope up to the top channel for ensuring that in case of fall, a person hanging on the safety harness, will be able to safely climb back to the platform within minimum time period before the safety harness start breaking down under the load.

3. Height Work Training:

Person should walk freely on the middle channel while holding the top channel with the help of safety harness.

4. Ladder for Vertical fall arrestor Training:

Vertical fall arrestor rope is fixed from top to bottom of the ladder. It will ensure:

- Usage of vertical fall arrestor.
- Usage of two lanyards of a safety harness.
- Ensure 3-point contact on the ladder while climb.

5. Chair for work at height Training:

- Climb though vertical ladder with two lanyard ropes.
- Hooking of two lanyard ropes to life line. With this safe arrangement, he can walk to chair.
- Sits in the chair safely, comes out & walks back to the vertical ladder & come down from vertical ladder. After completion of vertigo test, blood pressure of worker is again measured. If it is not within acceptable limits for any worker, concerned worker is denied height pass.

Only those who pass the above training are to be considered as fit for height work.