



# 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)

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

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

**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 Thiruvottiur – 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 civil, structural & electrical works of RCC Chimney at Ennore SEZ (2 x 660 MW) TPP, as mentioned below, including supply of all materials (excluding Reinforcement steel & Structural steel), labour, tools and plants and hand over the structures to TANGEDCO in all respect as per BOQ, Specifications and drawings.

The scope of work is indicative but not limited to the following,

- i. Dismantling the existing balance slipform at 270 m level
- ii. Balance fabrication and entire erection of SS mini shell
- iii. Erection of intermediate structural platforms and staircase with gratings (Erection of structural roof beams at chimney top is completed and roof slab casting also completed)
- iv. Balance Fabrication of Flue Cans & entire erection, insulation, painting of the same
- v. Civil works of Outer RCC platforms
- vi. Civil work of Chimney grade slab and inside foundations
- vii. Chimney outside Painting works
- viii. Supply, installation and commissioning of Elevator
- ix. Electrical and Lighting works including design & drawings

Note: The above provided list is indicative only for the bidder's guideline. Any other work not mentioned above, but required for completion of the package in total, deemed to have been included in the bidder's scope under this contract. Such work will be executed under this contract by bidder as per the direction of Engineer in charge. If any item of work not available in the rate

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schedule of this contract, the rate will be fixed in line with clause 2.15.7 of GCC.

- 1.2.2 Reinforcement steel, structural steel for civil & structural works (as applicable) shall be provided by BHEL free of cost. Embedments/ inserts required, if any, for the works in general shall be supplied by the bidder and payment shall be made as per corresponding item in BOQ. If BHEL provides Structural Steel from scraps (if available) for inserts, payment shall be made as per corresponding item in BOQ.
- 1.2.3 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, concrete, 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.
- 1.2.4 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.
- 1.2.5 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.
- 1.2.6 The unit rates shall include all material equipment, fixtures, labour construction plant, temporary works and everything whether of permanent or temporary nature necessary for the completion of job in all respects.

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- 1.2.7 The unit rates for various items of B.O.Q shall include all the stipulations mentioned in technical specifications and nothing extra over B.O.Q rates shall be payable.
- 1.2.8 Drawings showing enough details for the construction as per the specification shall be furnished to the contractor in a phased manner.
- 1.2.9 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.
- 1.2.10 **Fusion bonded epoxy coating for the reinforcement steel issued by BHEL:**  
Scope of work also consists of providing fusion bonded epoxy coating by mechanized & qualified process including blast cleaning to white metal as per Swedish code, heating in induction heater, electrostatically spraying the epoxy powder, complete fusion to give minimum coating thickness of 200-300 microns, gradual cooling without affecting the properties of steel, testing as per ASTM 775 and IS:13620, flexibility & holiday test, proper packing, safe transportation, touchup at site, etc. complete to ensure proper resistance of FBE against corrosive environment including transport of the steel from BHEL site store to vendor plant and bringing back to site and special handling during straightening, cutting, bending, placing and providing PVC coating on binding wire. Payment for this work shall be made against relevant item of BOQ.
- 1.2.11 Bidder shall visit site for better clarification on present status of works in Chimney and assessment of pending works. 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.
- 1.2.12 Special arrangements to be made for tackling COVID-19 pandemic –

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- 1.2.12.1 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.
- 1.2.12.2 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 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  PART I	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 (to be specified whether chargeable or free)	YES		Chargeable to bidder as provided by TANGEDCO

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Sl.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
	<b>PART I</b>			
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	
<b>1.3.1.3.0</b>	<b>WATER SUPPLY</b>			
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

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Sl.No	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
	<b>PART I</b>			
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
1.3.1.3.2	Water supply for bidder's office, stores, canteen etc.		Yes	
<b>1.3.1.4.0</b>	<b>LIGHTING</b>			
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	
<b>1.3.1.5.0</b>	<b>COMMUNICATION FACILITIES for site operations of the bidder</b>			
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	
	<b>PART II</b>			
	<b>CONSTRUCTION FACILITIES</b>			
<b>1.3.2.1</b>	<b>Engineering works for construction</b>			
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

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Sl. No.	Description	Scope to be taken care by		Remarks
		BHEL	Bidder	
	<b>PART II</b>			
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
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	

### 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



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plant premises for batching plant, fabrication yard, office, storage area etc. for construction purpose shall be provided as per availability free of cost. The contractor will be responsible for handing back all lands, as handed over to him by BHEL.

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

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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,

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.

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

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 cement, aggregate (Coarse, fine) and all other materials required (except free supply materials i.e. reinforcement steel, structural steel for structural works, structural steel from scraps for inserts (if available), foundation bolts & inserts/ embedments supplied by manufacturing units of BHEL) for the work are in the scope of the contractor. BHEL shall provide reinforcement steel for civil works and structural steel for structural works only for incorporation in the permanent work AS FREE SUPPLY. In general, structural steel required for embedment/ inserts shall be supplied by the bidder and payment shall be made as per the relevant items of BOQ.

- The steel material will be issued from BHEL stores, within the plant premises. Collection and transporting to the place of work is in contractor's scope without any extra cost to BHEL. The steel will be issued to the agency in standard lengths. In some instances, for 8mm, 10mm & 12mm dia reinforcement steel will be supplied in coil form. No extra claims will be entertained against issue of Non-standard lengths of steel and de coiling of 8mm, 10mm & 12mm dia. steel.

If any matching sections of steel are not available with BHEL, contractor may arrange these sections from Customer approved agencies only on certification of BHEL and the same shall be paid against relevant BOQ item in the price bid.

1.3.6.2 Ordinary Portland Cement (OPC) shall be used for all structures except for foundations, underground structures & structures coming in contact with sea water including trenches & channels, wherein sulphate resistant cement with C3A content limited to 5% or Ordinary Portland cement with C3A content 5% to 8% shall be used depending on the presence of sulphate and chlorides in water/ soil. Grade of cement shall be 43 conforming to IS:269 (latest version).

1.3.6.3 Fine aggregate source shall be manufactured crushed stone or rock sand commonly known as M-sand, excluding fines which are by products/rejects of

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coarse aggregate production. The crushed stone sand shall be graded from fine to coarse with the coarse sizes predominating to give maximum density.

1.3.6.4 The amount of fine particles as ascertained by the laboratory sedimentation method shall not exceed 10% for crushed stone nor 4% for natural sand. The amount of material passing a 75 micron sieve (IS test sieve) shall not exceed the following limits:

- a) Crushed stone sand concrete subject to abrasion 1% by weight
- b) All other concrete 3% by weight.

There shall be no clay or fine silt present. The amount of hollow shells like to form voids or remain partially unfilled and present in material retained on a IS 2.36 mm sieve, determined by direct visual separation, shall not exceed 3% by weight of the entire sample. Fine aggregate shall not contain appreciable amounts of flaky and/or elongated particles. The water absorption of fine aggregate, determined in accordance with BS 812 shall not exceed 2.0% by weight. Fine aggregate subjected to five cycles of the soundness test, specified in IS:2386 (Part-5), shall not show a loss exceeding 10% when sodium sulphate solution is used and 15% when magnesium sulphate solution is used, except where approved otherwise. Tests are to be executed in accordance with IS:2386. The grading of fine aggregate for concrete work shall comply with the requirements of IS:383. The grading of the aggregates should be such as to produce a concrete of the specified proportions which will work readily into position without segregation and without the use of an excessive water content. The grading should be controlled throughout the work so that it conforms closely to that used for the preliminary tests. A check on the moisture content of sand should be made at least once a day before concreting. The amount of water to be added to the concrete mix should be adjusted accordingly. Any washing, screening, classifying and other operations on the fine aggregate required to

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meet this specification shall be done by the Contractor. Washing is required if the content of salt adhering to the aggregate is found to be unacceptably high.

### 1.3.7 **CONSUMABLE**

All consumables, like gas, electrodes, chemicals, lubricants etc. required for the scope of work, shall be arranged by the contractor at his cost unless otherwise specifically mentioned in the contract. 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. Dewatering by well point

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dewatering method (if any carried out for foundation or sub-structure work to maintain water table below the founding level as per the requirement of relevant drawing/ specification) shall be paid in relevant item of BOQ.

### 1.3.11 **BID DRAWINGS**

Bid drawings enclosed along with this tender is only for information is enclosed for information and may not be referred for scope of works and this may also get revised during execution.

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### 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

Sl. No.	Major T&P	Mobilizing time from the date of commencement of work
1.	Passenger lift cabin along with power winch for carrying min 6 person with safety block (safety devices)	As per BHEL requirement at site
2.	2 no.s Power winch min. capacity 3 MT for lifting concrete	As per BHEL requirement at site.
3.	2 no.s Power winch min. capacity 3 MT for structural erection	As per BHEL requirement at site.
4.	2 sets of strand jacks of required capacity (includes 2 nos standby jacks) with 2 nos power pack including strand rope of adequate thickness & length	As per site requirement ( to carry out both flue cans parallely)
5.	2 no. motorized MS plate bending machine (width capable of bending one standard width of the plate) along with angle bending device	As per BHEL requirement at site.
6.	2 no.s Power winch – 2.5 MT for Internal/ External Finishing	As per BHEL requirement at site.
7.	1nos- 40MT tyre/ crawler mounted crane	As per BHEL requirement at site.
Sl. No.	Other T&Ps	Mobilizing time from the date of commencement of work
8.	10 nos. welding rectifier (400 Amps to 600 Amps)	As per BHEL requirement at site.
9.	Shot blasting equipment	As per BHEL requirement at site.
10.	2 nos. pick & carry cranes (10/ 12 T cap)	As per BHEL requirement at site.
11.	Walky Talky – 4 Nos	As per BHEL requirement at site
12.	1 Nos. Radial drill machine	As per BHEL requirement at site.
13.	1 nos. magnetic base drill machine	As per BHEL requirement at site.
14.	1 nos. submerged arch welding machine	As per BHEL requirement at site.



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15.	1 no. trailer – 15T	As per BHEL requirement at site.
16.	1 no. power driven HSFG bolt tightening m/c	As per BHEL requirement at site.
17.	1 no. torque tightening m/c. ( Capacity up to 30mm dia HSFG bolt tightening)	As per BHEL requirement at site.
18.	Sufficient quantity of steel ladders for approach	As per BHEL requirement at site.
19.	1 no ultra-sonography testing machine with recording device for structural work.	As per BHEL requirement at site.
20.	1 nos. Painting equipment sets complete with compressor, hopper, screen, blasting hose pipe, nozzle airless/conventional spray ( within CGI temporary cover shed)	As per BHEL requirement at site.
21.	Ropes/slides including D-shackles	As per BHEL requirement at site.
22.	Grinding & Buffing machines	As per BHEL requirement at site.
23.	Steel jolly for temporary working platforms	As per BHEL requirement at site.
24.	1 No. back hoe cum loader like JCB	As per BHEL requirement at site.
25.	1 no. dumper (Min 15 cum each)	As per BHEL requirement at site.
26.	1 nos. diesel Mixer machine of 0.5 cum capacity	As per BHEL requirement at site.
27.	1 nos. self-priming dewatering pump 5 HP (diesel)	As per BHEL requirement at site
28.	1 nos. curing pump – 1.5 /2 HP (pump for curing at heights)	As per BHEL requirement at site
29.	1nos. reinforcement bending machine	As per BHEL requirement at site
30.	1 no. Vibromax (earth compactor)	As and when required at site.
31.	2 nos. reinforcement cutting machine	As per BHEL requirement at site
32.	1 nos. power driven earth rammer (Roller Type 1/2 T)	As per BHEL requirement at site
33.	Civil laboratory equipment's as per list in SI 1.4.4.2 with temporary building one AC lab size 4.5mtr x 6mtr and 1 non AC lab 4.5 mtr x 4.5 mtr.	As per BHEL requirement at site
34.	1 nos total station with adequate arrangement for Surveyors.	As per BHEL requirement at site
35.	1 no. auto level & staff	As per BHEL requirement at site

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

36.	30 nos concrete cube moulds	As per BHEL requirement at site
37.	Adequate no. of small trucks 2T/5T for shifting of reinforcement/cement/shuttering etc. within site	As per BHEL requirement at site
38.	Drinking water tank – 5000 lit.	As per site requirement
39.	Mobile toilet for labour use.	As per site requirement
40.	1 nos. truck mounted 125 KVA DG set	As per site requirement
41.	Construction power cable	As per site requirement
42.	Construction water Pipeline	As per site requirement
43.	5 nos. Concrete vibrator with adequate needle	As per BHEL requirement at site.
44.	Portable fire extinguishers as below: Soda acid – 5 sets. Dry chemical powder – 5 sets CO2 – 5 sets. Water & sand bucket (4 buckets in one stand) – 5 sets. Fire hose with nozzle (50 M length) – 3 sets.	As per BHEL requirement at site
45.	1 no. compression testing machine (200 T cap)	As per BHEL requirement at site

### **Note:**

- 1. For Chimney concreting works, Concrete may be arranged by having tie up with existing batching plants, supplied using transit mixer within the site premises or outside the site premises for the day to day requirement of RCC activities subject to supplies being made conforming to the standard/approved quality plan or bidder may directly establish mini batching plant with weigh batcher including necessary T&P for transporting and placing the concrete at site.**
- 2. It is contractor's responsibility to ensure continuous supply of the concrete depending upon the requirement and no delay in supply shall be accepted for any reason in case the concrete is taken from other batching plant agencies. In case of any interrupted supply due to any reasons, contractor will be insisted to mobilize their own batching plant and other T&Ps.**
- 3. T&P shown in the above mentioned list is tentative requirement considering parallel working in all areas mentioned in scope of work. However, mobilization schedule & quantity/ numbers 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 will give advance intimation & certification regarding capacity etc. prior to dispatch of heavy equipment's. Also on completion of the respective activity,**

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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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.

4. 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.
5. In the event of non-mobilisation of Tools, Plants, Machinery, Equipment, Material or non-availability of the same owing to breakdown and as a result progress of work suffered, BHEL reserves the right to make alternative arrangement (available or higher capacity) in line with SCC clause no. 4.2.1. 7 and hire charges shall be applicable as under:
  - A: BHEL provides its own Capital T&P: If BHEL provides owned T&P then BHEL, hire charges (as per BHEL norms) will be recovered from the contractor as per the prevailing BHEL Corporate hire charges applicable (as enclosed in Volume I Book I TCC- Volume 1A Part II) as per following cases:
    - In case the T&P is specifically listed in "T&Ps to be deployed by Contractor", 'Rates of hire charges applicable to outside agencies other than contractors working for BHEL' will apply.
    - In case the T&P is not specifically listed in "T&Ps to be deployed by Contractor", 'Rates of hire charges applicable to contractors 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.
  - B: BHEL provides hired T&P: In all cases other than that specified in "A" above, actual expenses incurred by BHEL along with applicable overheads will be back-charged to the contractor.
6. 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.
7. Clause no. 1.6.1 of this specification (i.e. TCC) shall 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.

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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 for the construction materials required 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:

CONCRETE TESTING EQUIPMENT				
SL NO	NAME OF TEST	NAME OF EQUIPMENT	SIZE OF EQUIPMENT	IS REF.
1	Initial & final setting time, Consistency of cement	Vicat Apparatus with desk pot	Standard	IS 5513
2	Shrinkage of cement, Auto Clave Test	Le Chatelier's apparatus Auto Clave Equipment	Standard	IS 5514
3	Abrasion value test	Los Angeles Abrasion testing machine	Standard	IS 2386
4	Aggregate Impact value test	Aggregate Impact value testing machine with blow counter	Standard	IS 9377
5	Aggregate crushing value test	Crushing value apparatus	Standard	IS 2386
6	Flakiness index	Thickness gauge for measuring flakiness index	Standard	IS 2386
7	Elongation Index	Elongation guage	Standard	IS 2386
8	Bulk density, voids and bulking apparatus	Measuring cylinders	3, 5,10 & 15 liters cylinders	
9	Workability of concrete	Slump cone	Standard, at least 04 no's	IS 456

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

10	Specific gravity of aggregates	Pycnometer	Standard, at least 02 no's	IS 383
11	Cement mortar cube vibrating	Motorised vibration machine for cement testing	Standard	IS 4031
12	Course aggregate Sieve analysis (Concrete & Road Works)	Sieve set	450mm dia GI Frames Size: 125 mm, 90 mm, 75 mm, 63 mm, 53 mm, 40 mm, 20 mm, 16 mm, 12.5 mm, 10 mm, 4.75 mm, Pan and cover	IS 383
13	Fine aggregate sieve analysis	Sieve set	200 mm dia Brass sieves; Size 4.75 mm, 2.36 mm, 1.18 mm 600 micron, 300 micron, 150 micron, 75 micron, 75 micron, Pan and cover	IS 383
14	Sieve Shaker	Motorized Sieve shaker	Mfg. Catalogue	
15	Silt content check	Sand silt content beaker	Standard	

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.

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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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.

1.4.9 In case, cement is bought by bidders through bulkers from manufacturer / stockiest, the same shall be emptied in cement silos of batching plant and necessary arrangement shall be made by contractor at his own cost without any additional financial implication to BHEL. Contractor to note that batching plant being established at site shall be as mentioned in the list of Tools & Plants to be deployed by the contractor.

# TECHNICAL CONDITIONS OF CONTRACT (TCC)

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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.

# TECHNICAL CONDITIONS OF CONTRACT (TCC)

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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 scope of work for as detailed in the Tender Specification shall be completed within **13 Months (Thirteen 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**

Guarantee period of 12 months shall commence from the date of completion of the whole work certified by the BHEL Engineer.

### **1.6.8 CONSTRUCTION SCHEDULE**

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

Sl.No	Area	Completion from Date of commencement of work
1	Completion of RCC works of Outer platform (including Handrail & Cage etc.)	Progressively by 5 <sup>th</sup> Month
2	Completion of Erection work of Flue can -1, intermediate Platforms, Staircase, and SS Mini shell, including Insulation and other Misc. works	Progressively by 6 <sup>th</sup> Month
3	Completion of Erection work of Flue can -2 including Insulation and other Misc. works	Progressively by 8 <sup>th</sup> Month
4	Completion of balance RCC works (Ground level Foundation & Slab)	Progressively by 12 <sup>th</sup> Month
5	Completion of Electrical works (Including Elevator Lift operation, Aviation lights, etc.)	Progressively by 12 <sup>th</sup> Month
6	Material Reconciliation & Final bill submission	Progressively by 13 <sup>th</sup> Month

### **1.6.8.2 INTERMEDIATE MILESTONES**

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Intermediate milestones are as below.

S No	Description	Completion month from the contractual date of start of the work	Intermediate Milestone
1	Completion of RCC works of Outer platform (including Handrail & Cage etc.)	5 <sup>th</sup> Month	M1
2	Completion of Structural Work : Flue can -2	8 <sup>th</sup> 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 In case 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 In case 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 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.

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- 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/fronfs 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 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.

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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- 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.

# TECHNICAL CONDITIONS OF CONTRACT (TCC)

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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**

- 1.7.2.1 Interest bearing advance for Mobilization, limited to 5% of the contract value will be paid against submission of bank guarantee of at least 110% of the advance valid for the contract period, which will be recovered from the first running bill onwards. The advance for mobilization shall be paid as under.
- 1.7.2.2 2% of contract value after receipt of initial Security Deposit as per relevant clauses in the GCC/TCC along with unqualified acceptance of detailed letter of intent.
- 1.7.2.3 1.5% of contract value on completion of site Mobilization of Machinery & T&P as given below and on certification by site in-charge for compliance provided clause no. 1.7.2.2 as mentioned above is also complied with.
1. Motorized MS plate bending machine (width capable of bending one standard width of the plate) – 1 nos.
  2. Strand jack system for flue can erection with all required assembly – 2 sets
- 1.7.2.4 1.5% of contract value on completion of site Mobilization of Machinery & T&P as given below in addition to the above, and on certification by site in-charge for compliance.
1. Power winch of capacity minimum 3MT - 2 nos.
  2. Welding rectifiers – 5 Nos.
  3. 40MT tyre/ crawler mounted crane -1 no.

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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- 1.7.2.5 Payment of the advance as specified herein and recovery of the advance will be as per clause 2.13 of GCC. Option of availing the interest bearing mobilization advance is left with the bidder.

### 1.7.3 Interim Payment

- 1.7.3.1 Interim bills in the form of monthly running bills prepared by the contractor in soft as well as hard copies shall be based on the quantities executed and measured.
- 1.7.3.2 95% item rate shall be released after completion of works certification by Engineer in charge.
- 1.7.3.3 5% of the item rate shall be released after submission of the quality check formats as per the quality plan for the quantum of work billed and duly certified by engineer.
- 1.7.3.4 Retention Amount shall be as per GCC.
- 1.7.3.5 BHEL Site Engineer, at his discretion, may operate the part rate of the items in line with GCC clause no. 2.23.1 (v). Payment for supply portion (subjected to approval of Engineer In-Charge) shall be made only after receipt of material at site.
- 1.7.3.6 Royalty for construction materials:

Payment of royalty for construction materials viz. coarse aggregates, fine aggregates, borrowed earth, etc. 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	Coarse aggregate	59.00	A. For RCC:	Rate mentioned

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

2	Fine aggregate	59.00	(As per approved design mix proportion + wastage as specified in IS 383) x (Total volume of concrete claimed in RA bill) B. For PCC: (As per DSR recommendation + wastage as specified in IS 383) x (Total volume of concrete claimed in RA bill)	herein is indicative and for information. Actual prevailing rate for 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.
3	Borrowed earth	26.00	Actual volume of filling shall be considered	

### 1.7.4 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.

### 1.7.5 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 1A PART-1 CHAPTER VIII

### TAXES AND DUTIES

#### **TAXES AND DUTIES**

##### **1.8.1 Goods and service Tax (GST) & Cess**

- 1.8.1.1 The successful bidder shall furnish proof of GST registration with GSTN Portal in the State in which the Project is being executed, covering the services under this contract. Registration should also bear endorsement for the premises from where the billing shall be done by the successful bidder on BHEL for this project/ work.
- 1.8.1.2 Contractor's price/rates shall be exclusive of GST & Cess (if applicable) (herein after termed as GST). Contractor shall submit to BHEL the GST compliant tax invoice/debit note/revised tax invoice on the basis of which BHEL will claim the input tax credit in its return. Since this is a works contract, the applicable rate shall be @ 18% GST, as applicable presently.
- 1.8.1.3 Bidder shall note that the GST Tax Invoice complying with GST Invoice Rules wherein the 'Bill To' details will as below:

BHEL GSTN - 33AAACB4146P2ZL

NAME - BHARAT HEAVY ELECTRICALS LIMITED

ADDRESS – 2 X 660 MW ENNORE SEZ STPP, VAYALUR BR PO MINJUR PO,  
TAMILNADU - 601203

- 1.8.1.4 GST charged in the tax invoice/debit note/revised tax invoice by the contractor shall be released separately to the contractor only after contractor files the outward supply details in GSTR-1 on GSTN portal and input tax credit of such invoice is matched with corresponding details of outward supply of the contractor and has paid the GST at the time of filing the monthly return.
- 1.8.1.5 In case BHEL has to incur any liability (like interest / penalty etc.) due to denial/reversal / delay of input tax credit in respect of the invoice submitted by the contractor, for the reasons attributable to the contractor, the same shall be recovered from the contractor.
- 1.8.1.6 Further, In case BHEL is deprived of the Input tax credit due to any reason attributable to contractor, the same shall not be paid or Recovered if already paid to the contractor.
- 1.8.1.7 Tax invoice/debit Note/revised tax invoice shall contain all such particulars as prescribed in GST law and comply to the timelines for issue of the same. Invoices shall be submitted on time to the concerned BHEL Engineer In Charge.



## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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- 1.8.1.8 TDS under GST (if/ as & when applicable) shall be deducted at prevailing rates on gross invoice value from the running bills.
- 1.8.1.9 E-way bills / Transit passes / Road Permits, if required for materials / T&P etc., bought into the project site is to be arranged by the Contractor only.
- 1.8.1.10 BHEL shall not reimburse any amounts towards any interest / penalty etc., incurred by contractor. Any additional claim at a later date due to issues such as wrong rates / wrong classification by contractor shall not be paid by BHEL.

### 1.8.2 All taxes and duty other than GST & Cess

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

### 1.8.3 Statutory Variations

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

### 1.8.4 New Taxes/Levies –

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

### 1.8.5 Direct Tax

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

# TECHNICAL CONDITIONS OF CONTRACT (TCC)

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## **VOLUME 1A PART-1 CHAPTER IX** **BILL OF QUANTITY**

1.9.1 As mentioned in the price bid.

# TECHNICAL CONDITIONS OF CONTRACT (TCC)

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## VOLUME 1A PART-1 CHAPTER X GENERAL

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

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

1.10.1 Successful Bidder is requested to furnish the following at PSSR-HQ Chennai immediately after release of Letter of Intent (LOI)

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

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

- i) PF Regn No.
- ii) Labour License No.
- iii) Workmen Insurance Policy No.

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

**1.10.3.1 BOCW Act & BOCW Welfare Cess Act**

1.10.3.1.1 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.

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

1.10.3.1.3 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.

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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- 1.10.3.1.4 The contractor irrespective of their nature of work and manpower (Civil, Mechanical, Electrical works etc) should register their establishment under BOCW Act 1996 and comply with BOCW Welfare Cess Act 1996.
- 1.10.3.1.5 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.
- 1.10.3.1.6 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

### **1.10.3.2 PROVIDENT FUND**

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

### **1.10.3.3 OTHER STATUTORY REQUIREMENTS**

- 1.10.3.3.1 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.
- 1.10.3.3.2 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

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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Rules, copies of monthly return of PF contribution with remittance Challans under Employees Provident Fund Act 1952 and copy of renewed WC Insurance policy or copies of monthly return of ESI contribution with Challans under ESI Act 1948 (if applicable) in respect of the workmen engaged by them.

- 1.10.3.3.3 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.
- 1.10.3.3.4 The Contractor shall submit copies of Final Settlement statement of disbursement of retrenchment benefits on retrenchment of each workmen 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.
- 1.10.3.3.5 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 reserve the right to hold such amounts from the final bills of the Contractor which will be released on submission of proof of settlement of issues from the appropriate authority under the act.
- 1.10.3.3.6 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.

### **1.10.3.4 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-

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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skilled workers required in each trade at any stage of work. The contractor shall submit number of man days required in respect of each trade, its scheduling and the list of qualified tradesmen along with requisite certificate from recognized Institute to Engineer-in-Charge for approval. Notwithstanding such approval, if the tradesmen are found to have inadequate skill to execute the work of respective trade, the contractor shall substitute such tradesmen within two days of written notice from Engineer-in-Charge. Failure on the part of contractor to obtain approval of Engineer-in-Charge or failure to deploy qualified tradesmen will attract a compensation to be paid by contractor at the rate of Rs. 100 per such tradesman per day. Decision of Engineer-in-Charge as to whether particular tradesman possesses requisite skill and amount of compensation in case of default shall be final and binding.

### **1.10.3.5 Site Visit by the Bidder**

- 1.10.3.5.1 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.
- 1.10.3.5.2 The bidder shall satisfy themselves about the following factors:
- i) Site conditions including access to the site, existing and required roads and 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.

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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- 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.
- 1.10.3.5.3 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.
- 1.10.3.5.4 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.
- 1.10.3.5.5 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.
- 1.10.3.5.6 All works shall be carried out in proper workmen like manner. Items of works covered by the following specification shall be carried out as per the best practices and according to the direction of the Engineer In- charge / BHEL, Site Engineer and to his satisfaction. Unless otherwise specified in this section or in the description of item, the cost of stage of works mentioned here under shall be deemed to have been included in the rates of items provided in the schedule.



## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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- 1.10.3.5.7 Scope of work covered under this specification requires quality workmanship, engineering and green belt management along with the supply of all consumables, tools and tackles and testing instruments. The contractor shall ensure timely completion of work. The contractor shall have adequate tools, measuring instruments etc. in his possession. He shall also have adequate trained, qualified and experienced engineers, supervisory staff and skilled personnel. The manpower deployment identified by contractor shall match with above scope of works.
- 1.10.3.5.8 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.
- 1.10.3.5.9 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.
- 1.10.3.5.10 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.
- 1.10.3.5.11 The contractor shall carryout additional tests if any, which the Engineer feels necessary because of site conditions and also to meet system specification.
- 1.10.3.5.12 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.
- 1.10.3.5.13 Wherever work sequences are furnished by BHEL, the contractor shall follow the same sequence.
- 1.10.3.5.14 The Contractor may have to execute work in such a place and condition where other agencies also will be under such circumstances. The contractor shall co-operate with other contractors and agencies so that various activities can be carried out simultaneously in order to achieve an early completion.
- 1.10.3.5.15 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.
- 1.10.3.5.16 If required by BHEL, the contractor shall change the sequence of his operation so that work on priority sectors can be completed within the



## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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- projects schedule. The contractor shall afford maximum assistance to BHEL in this connection without causing delay to agreed completion date.
- 1.10.3.5.17 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.
- 1.10.3.5.18 Contractor shall retain all T&P / Testing instrument / Material handling equipments 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.
- 1.10.3.5.19 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.
- 1.10.3.5.20 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 work agreed will be subject to the condition that contractor's work is not hampered by the agencies.
- 1.10.3.5.21 Contractor has to work in close co-ordination with other work 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 work 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.
- 1.10.3.5.22 The contractor must obtain the signature and permission of the security personnel of the customer for bringing any of their materials inside the site premises. Without the Entry Gate Pass these materials will not be allowed to be taken outside.
- 1.10.3.5.23 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.
- 1.10.3.5.24 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

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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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.

- 1.10.3.5.25 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.
- 1.10.3.5.26 No member of the already erected structure / buildings, other component and auxiliaries should be removed / modified without specific approval of BHEL engineer.
- 1.10.3.5.27 Contractors shall ensure that all their Staff / Employees are exposed to periodical training programme conducted by qualified agencies/ personnel on ISO 9001 – 2008 Standards.
- 1.10.3.5.28 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.
- 1.10.3.5.29 Crane operators deployed by the contractor shall be tested by BHEL before he is allowed to operate the cranes.
- 1.10.3.5.30 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.
- 1.10.3.5.31 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.
- 1.10.3.5.32 If any item or equipment 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.
- 1.10.3.5.33 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

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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areas of overlap, the contractor shall work in coordination with other related contractors. Any damage by the landscape contractor's team to such utilities will be penalized and contractor shall be responsible for cost for such damages.

### **1.10.3.6 SITE INSPECTION**

- 1.10.3.6.1 BHEL 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 / employer without any extra cost to the owner / employer. No cost whatsoever such duplication of inspection of work be entertained.
- 1.10.3.6.2 BHEL 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 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 BHEL.
- 1.10.3.6.3 Wherever the performance of work by the contractor is not satisfactory in respect of workmanship, deployment of sufficient labour or equipment, leading to delay in execution of work or any other matter, BHEL shall have the right to engage labour at normal ruling rates and get the work executed through other agency and debit the cost to the contractor and the contractor shall have no right to claim compensation thereof. In such a case, BHEL shall have the right to utilize the materials and tools brought by the contractors for the same work.

### **1.10.3.7 DOCUMENTATION**

- 1.10.3.7.1 The following information shall be furnished by the bidder within two weeks of award of contract for purchaser's approval:
- 1.10.3.7.2 Bar chart covering planned activities at site
  - a) Detailed organization chart
  - b) Details of T&P available with contractors with documents proofs.

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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1.10.3.7.3 The following information shall be furnished by the bidder after testing and inspection:

Test certificates of various tests conducted at site. All inspection and test certificates shall be signed by BHEL representative also.

### **1.10.3.8 RECORDS TO BE MAINTAINED AT SITE:**

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

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

- a. Hindrance Register.
- b. Site Order Book.
- c. Test Check of measurements.
- d. Supply and Consumption Daily Register of Cement and Steel
- e. Records of Test reports of Field tests.
- f. Records of manufacture's test certificates.

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

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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:

## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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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 24<sup>th</sup> 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)

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- 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.

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## **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/fabrication yard at his own cost. Hard surfacing of the fabrication yard is already available shall be carried out by the contractor at his own cost within the quoted rate. Batching plant area, shall be provided nearer plant premises and contractor shall make use of the area for installation and operation of the Batching Plant at his own cost. The bidder shall make complete arrangement of necessary security personnel, to safeguard all such materials in his custody 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 construct waterproof cement store (capacity 400MT or as directed by engineer in-charge based on requirement at site) for initial period for storing and stacking of cement at his own cost, CGI/ asbestos roofing (slope) with brick masonry wall, PCC flooring. Materials required for the same shall be provided by contractor at his own cost. Cement has to be kept over wooden raised platform. Stacking of cement is to be done as per IS codes with proper illumination and locking arrangements.
- 1.12.5 The contractor shall in no case be entitled for any compensation or damages on account of any delay in supply or non-supply thereof for all or any such material.
- 1.12.6 Clotting of cement and excessive rusting of steel must be avoided. In case, due to any cause attributable to the contractor, rusting of steel for BHEL issued steel



## TECHNICAL CONDITIONS OF CONTRACT (TCC)

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occur rendering the same unusable, then such quantity of cement steel shall be recovered from the interim payment at the penal rate specified in the tender.

1.12.7 The contractor shall maintain proper store account for all the BHEL issued materials and shall give three copies of computerized reconciliation statement of such account to the BHEL with each running bill.

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

1.12.9 All structural steel shall be stacked plate size wise and thickness wise beams, channels and angles shall be stacked separately on sleepers.

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

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## 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 CEMENT**

Supply of cement is in the scope of contractor. BHEL shall not issue any cement.

#### **1.13.2 ISSUE OF STEEL, CONSUMPTION, WASTAGE & RETURN OF MATERIALS**

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

#### **1.13.3 SCRAP & SERVICEABLE MATERIALS**

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

#### **1.13.4 RECONCILIATION OF MATERIALS**

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

#### **1.13.5 RECOVERY OF MATERIAL**

Recovery of wastages 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.

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### 13.2.1 PENAL RATE OF MATERIALS

<b>A</b>	<b>REINFORCEMENT STEEL</b> Cold rolled steel, high strength, deformed bar or mild steel round bars including earthing rod	<b>Rs. 61,950/- per MT + GST and/or other taxes &amp; duties</b>
<b>B</b>	<b>STRUCTURAL STEEL</b> MS plates, MS flats, rolled steel beams, channels, and angles, MS pipes, Chequered Plates, etc. in sizes and lengths as available	<b>Rs. 72,755/- per MT + GST and/or other taxes &amp; duties</b>
<b>C</b>	<b>CORTEN-B MATERIAL FOR FLUE CAN WORKS</b> Corten-B plates in sizes and lengths as available	<b>Rs. 88,396/- + GST and/or other taxes &amp; duties</b>

# TECHNICAL CONDITIONS OF CONTRACT (TCC)

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## VOLUME-IA PART – II CHAPTER 1

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

#### S.no. 1

##### **Clause no. 6.3.4.1 is revised as under:**

**“6.3.4.1** The steel shall be issued to the contractor on the following basis:

- i. Structural Steel: Weighment basis (Unit – MT)
- ii. Reinforcement Steel: Weighment basis (Unit-MT)“

#### S.no. 2

##### **Clause no. 6.3.4.2 is revised as under:**

**“6.3.4.2** All the steel (structural, reinforcement steel etc.) issued by BHEL shall be properly accounted for. The total quantity of steel required for the work will be calculated from the approved Bar Bending schedule, fabrication drawings, approved laps, chairs and lugs etc. The measurement for payment as well as for accounting shall be based on the sectional weights as indicated in the following IS/BS/EN specifications.”

#### S.no. 3

##### **Clause no. 6.4.1 stands deleted.**

#### S.no. 4

##### **Heading of Clause no. 6.4.4 is revised as under:**

**“6.4.4** Steel Consumption and wastage”

#### S.no. 5

##### **Clause no. 6.4.4.1, 6.4.4.2 stands deleted**

#### S.no. 6

##### **Heading of Clause no. 6.4.4.3 is revised as under:**

**“6.4.4.3** Reinforcement Steel Consumption”

#### S.no. 7

##### **Heading of Clause no. 6.4.4.4 is revised as under:**

**“6.4.4.4** Reinforcement Steel Wastage”

# TECHNICAL CONDITIONS OF CONTRACT (TCC)

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## Following Clauses are added in the Special Conditions of Contract (SCC)

### S. no. 8

#### Following clauses are added

6.3.4.9 Bidder to note that steel materials required for embedded items other than those supplied by BHEL shall be supplied by the bidder. However, Bidder shall use the scrap materials for their use in the permanent works as embedment/inserts etc. after necessary store issue formalities and shall be accounted for monthly reconciliation.

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

<b>SL NO</b>	<b>ISSUE OF MATERIALS</b>	<b>MAX. QTY IN CONTRACTOR'S STORE</b>
1.	Reinforcement Steel	Requirement of one month
2.	Structural Steel	Requirement of one month

## Following Clauses are modified in the Special Conditions of Contract (SCC)

### S No. 9

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

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

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Next following pages

Vol IA	Part-II: Technical specifications		
1	Technical Specifications/data/drawings	Chapter-2	550
2	T&P Hire Charges	Chapter 3	13
3	"HSE Plan for Site Operations by Subcontractor" (Document No. HSEP: 14 Rev02)	Chapter 4	131



**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

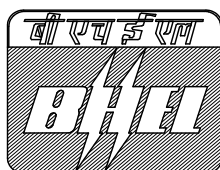
# **TAMILNADU GENERATION AND DISTRIBUTION CORPORATION**

## **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) |



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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



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- 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



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**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 |



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- 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)



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- |     |                     |   |  |
|-----|---------------------|---|--|
| 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<br>[Part-I] | : | “P” and “S” traps  |
| cc) | IS-772              | : | General requirements for enameled cast iron sanitary   |



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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



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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<br>[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   |



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			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)



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**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**

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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.



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**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**

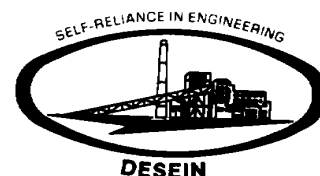
The reinforcement used shall be cold worked steel high strength deformed bars of grade Fe 415 / Fe 500 conforming to IS:1786 – latest.

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.



**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



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**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, reclaiming hooper pit, etc., shall be designed in accordance with IS:3370 (Part 1 to 4) . For underground 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  $2 \text{ T/M}^2$  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/cm<sup>2</sup> 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.



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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, CWPB forebay, raft & sump etc. |



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- 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.



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**11.00.00 DESCRIPTION OF BUILDINGS, STRUCTURES AND OTHER FACILITIES.**

**11.01.00 TEMPORARY STRUCTURES FOR EXECUTION**

**11.01.01 Construction water:**

The OWNER shall provide water at one point within the plant boundary or a limited purpose such as for construction. The Contractor may avail this facility. Necessary charges for drawing the water shall be borne by the CONTRACTOR.

**11.01.02 Construction Power**

Construction power will be made available at a single point, metered and supplied on chargeable base by the owner. Further extension of power line to the various locations required shall be executed by Contractor at his cost. Contractor has to make provision of D.G sets as standby power source. This is especially in the case of structure involving deep dewatering as well as where uninterrupted concreting has to be resorted to. The bidder along with his bid shall indicate his average and peak power demand.

**11.01.03 Temporary site buildings**

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

**a) Site office for Owner**

The site office shall make a provision of about 700 sqm of office area with A/C and false ceiling for the use of Owner / Owner's representative in addition to the Contractor's requirement. Additionally an A/C Conference room to accommodate about 70 people shall also be provided in the site office complex for the Owner's use. In addition to these, basic facilities like toilet for gents and ladies, potable water tanks, soak pit and septic tank for sewage disposal shall also be provided. Covered parking area for parking 10 cars shall also be provided for Owner's use. EPC Contractor to ensure that finished site office is handed over to owner within 3 months from the date of taken over the site by Contractor

**b) Stores**

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

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



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

Storage yard paved or unpaved shall be provided with in the stores complex for storage of other material.

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

Contractor may consider using the existing building in the site with necessary repairs and restoration for use of this facility, provided the same does not interfere with construction of Permanent works.

#### **11.01.04 Fabrication yard**

Depending on the extent of fabrication envisaged at site, the CONTRACTOR shall establish a full fledged structural fabrication yard with adequate handling facility during and after the fabrication. A fully equipped testing laboratory providing radiography, ultrasonic, dye penetration, magnetic particle test facilities shall be ensured adjacent to the fabrication yard to enforce strict quality control. Portion of the yard shall have covered shed with H.O.T / E.O.T cranes so that fabrication work can proceed even during inclement weather.

#### **11.01.05 Quality control laboratory**

A fully equipped quality control laboratory shall be established at site with qualified personnel to conduct acceptance test on all construction material, weldments, concrete cubes etc. This laboratory shall be housed in a covered building with A/C facility as required by the testing facility. All testing equipment shall be periodically calibrated to the satisfaction of the OWNER. All testing shall be carried out in presence of OWNER. Finally the laboratory shall be handed over to OWNER in good condition after completion of project.

#### **11.01.06 Fuel storage area**

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

#### **11.01.07 Staff Welfare facility**

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

Necessary approach roads to the construction facility complex and internal roads within the complex as well as proper drainage of the area shall be the CONTRACTOR's responsibility.

CONTRACTOR shall also provide for proper disposal of sewage and other wastewater to



meet with the requirement of Pollution Board.

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

#### 11.02.00

#### TURBINE GENERATOR BUILDING

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

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

Crane capacity and crane rail level shall be fixed based on the equipment to be lifted and the method of lifting generator stator. At crane girder top flange level a crane walkway shall be provided in line with factory rules. Access shall be provided to crane walkway through staircase from operating floor in addition to cage ladder at two ends. Bottom level of roof framing shall be decided by the crane clearance requirement duly taking into account clearance required for mounting light fixtures. Roofing shall consist of in-situ RCC slab of minimum 150 mm thickness laid to a slope of 1 in 100, constructed over permanently colour coated galvanized MS troughed metal sheet of approved profile supported on steel purlins and trusses. TG bay roof shall be provided with exhaust system.

Permanent colour coated sandwiched insulated metal cladding system from 3m (approx) above ground floor up to roof shall be provided on gable end and A row. Brickwork shall generally be provided from ground floor to 3m (approx) height. On other rows brickwork shall be provided upto roof level. Wall in front of transformers shall be of adequate thickness to satisfy "fire rating" as per TAC regulations. On the heater bay side the brick wall shall be provided upto 1m above deaerator floor level. Cladding beyond the above level shall of permanent colour coated sandwiched insulated metal cladding system.

Windows shall be side-hung steel glazed using 6mm thick wired glass generally. However in areas where cladding is of sheeting fixed glazing in anodized aluminium framework and in accessible areas sliding windows in anodized aluminium framework using 6mm thick wired glass shall be provided. All the doors on external walls shall be of double plate flush steel doors. For equipment entry into the service bay specially designed steel sliding cum / folding / rolling shutters shall be provided with appropriate operating mechanism. Rolling shutter shall also be provided in front of condenser to facilitate tube removal.

Staircase protected on all sides with fireproof enclosure shall be provided to satisfy LPA regulations. All the doors leading to the inside of the power house from staircase shall be automatically closing fire proof door satisfying LPA regulations. Access staircase shall be provided to TG building roof.





**12.00.00 REINFORCED CONCRETE CHIMNEY****12.01.00 Scope**

This specification covers the general requirements for design and construction of reinforced concrete twin flue chimney of circular cross section including RCC shell, steel flue, internal platforms, staircase, appurtenances, fixtures, fittings, conduit and other embedment, lift (inside windshield), natural ventilation etc. complete.

**12.02.00 Codes and Standards**

- |    |  |   |   |
|----|--|---|---|
| a) | IS:456-2000                                | : | Code of practice and reinforced concrete  |
| b) | IS:4998                                    | : | Criteria for design of reinforced concrete chimneys – Part 1 Design Criteria -1975                                      |
| c) | IS:4998                                    | : | Criteria for design of reinforced concrete Part 1 Assessment of loads - 1992  |
| d) | IS:875<br>(All Parts)                      | : | Code of Practice for Design loads for buildings & Structures  |
| e) | IS:1893-2002<br>(Part-1)<br>Fifth revision | : | Criteria for earthquake resistant design of structures  |
| f) | IS:1893-2002<br>(Part-4)                   | : | Criteria for earthquake resistant design of structures: Part 4- Industrial structures including Stack like structures   |
| g) | IS:432 (Part 1)                            | : | Mild steel and tensile medium steel bars  |
| h) | IS:1786                                    | : | Cold twisted steel bars for concrete reinforcement  |
| i) | IS:800                                     | : | Code of Practice for general building construction steel.   |
| j) | IS:158                                     | : | Ready mixed paint, brushing, bituminous, black. lead free, acid, alkali, water and heat resisting for general purposes. |
| k) | IS:1239                                    | : | Mild steel tubes, tubulars and other wrought steel fittings, Part-1 – Mild steel tubes                                  |
| l) | IS:1904                                    | : | Code of practice for design and construction of foundations in soils : General requirements                             |
| m) | IS:2062                                    | : | Hot Rolled low, medium & high tensile structural steel.   |
| n) | IS:3043                                    | : | Code of practice for earthing   |



- o) IS:3346 : Method for the determination of thermal conductivity of thermal insulation materials (two slab guarded hot plate method)
- p) IS:3677 : Un-bonded rock and slag wool for thermal insulation.
- q) IS:8183 : Bonded mineral wool.
- r) ASCE-1975 : Design and construction of steel chimney liners. Task committee on steel chimney liners, Fossil Power Committee, Power Division, ASCE.
- s) IS: 6533 : Design construction of steel chimney- code of Practice  
(Part1 &2)
- t) Vickery, B.J “Wind Induced Loads on Reinforced Concrete Chimneys” Paper presented at National Seminar on Tall Reinforced Concrete Chimneys, 25-27 April, 1985, New Delhi.
- u) Vickery, B.J. and Basu, “The response of reinforced concrete chimneys to vortex shedding”, R I Journal of Engineering Structures, 1984, Volume-6.
- v) Manohar, S.N. “Tall Chimneys – Design and Construction”, Tata McGraw Hill Publishing Company limited, New Delhi.
- w) Pinfold, G.M, “Reinforced Concrete Chimneys and Towers”, View Point Publication, cement and concrete association, U.K.
- x) The requirements of department of Civil Aviation, Government of India.
- y) Reference may also be made to ACI:307-1979 “ Specification for design and construction of RC Chimney”, if some items are not covered in India Codes.

### 12.03.00 Design Parameters and Requirements

#### 12.03.01 General

- a) General parameters of the chimney:
  - 1) Total height of the chimney above grade level : 275 M
  - 2) Number of flues : 2
  - 3) No. of boilers : 2
  - 4) Exit velocity of gas at top :
  - 5) Density of gases :



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- |     |  |   |  |
|-----|--|---|--|
| 6)  | Volume of gases  | : |  |
| 7)  | Temperature of flue gases                                  | : |  |
| 8)  | Inlet duct center line elevation                           | : | As per Boiler manufacturer's drg.                      |
| 9)  | Inlet duct opening dimensions                              | : | As per Boiler manufacturer's drg.                      |
| 10) | Internal diameter of flue                                  | : | As per design.   |
| 11) | Maximum ambient temperature                                | : |  |
| 12) | Minimum ambient temperature                                | : |  |
| 13) | External diameter of windshield :<br>at top of raft (min.) | : |  |
| 14) | Minimum top shell thickness                                | : | 400 mm   |
| 15) | Minimum bottom shell thickness:                            | : | As per design requirement,<br>but not less than 950mm. |
| 16) | Chimney foundation type                                    | : |  |
| 17) | Flue gas pressure at chimney<br>entry level                | : |  |

#### 12.04.00 Grades of concrete and steel

Concrete grade to be used for foundation and shell shall be M30 (minimum). Cement content in concrete shall not be less than  $400\text{kg/m}^3$ .

Cement to be used for pile cap and below grade level shall be sulphate resistant cement with  $C_3A$  content 5 to 8%. For above grade level 43 grade ordinary port land cement shall be used. Only one grade of cement shall be used throughout the height of shell.

HYSD bars of grade Fe 415/ Fe 500 bars conforming to IS 1786 shall be used as reinforcement. All the reinforcement bars to be used for below grade and above grade structure shall be fusion bonded epoxy coated only.

Structural steel sections to be used for flue shall be corrosion resistant steel type "COR-TEN-B" having an yield stress 250MPa conforming to IS 2062 (E250) of minimum thickness 10mm unless noted.

#### 12.05.00 Design Criteria

##### 12.05.01 Dead Load



All permanent loads due to the weight of chimney shell, internal platforms and lining supported on them, ladders, flue ducts, staircases, other accessories etc.

#### 12.05.02 Imposed Load

- i) Imposed load on service platform around Chimney shall, shall be taken as 500 Kg/m<sup>2</sup>. Design live load during construction / erection shall be considered as 1000 Kg/m<sup>2</sup>.
- ii) Imposed loads from duct joining the Chimney shall be considered.

#### 12.05.03 Wind Load

Wind load calculation will be done as per IS:4998 (Part-1) and IS:875 (Part-3) Dynamic analysis will be carried out and stability ensured under such condition.

Wind parameters to be considered for calculating design wind speed and pressure shall be as follows.

Basic wind speed = 50 m/s (upto 10m above normal ground level) as per IS:875 (Part-3) : 1987.

K1	=	1.08
K2	=	(Table 2 & Table 33, Category = 1, Class-B)
K3	=	1.0

A provision of 10% increase in the wind load forces (due to dynamic interference effect) as calculated based on relevant codes, shall be considered in the initial designs. However, for final designs, the increase can be as per the recommendations of the agency carrying out wind tunnel studies.

#### 12.05.04 Seismic / Earthquake Load

Earthquake forces acting on the Chimney and analysis for the same shall be carried out as per IS: 1893-2005 using the Response Spectrum Method and 5% damping shall be considered for the analysis. The analysis shall be furnished for a combination of five modes.

#### 12.05.05 Thermal Effect

Due to the effect of temperature gradient  $\Delta T$ , vertical and circumferential stresses are developed. These stresses induced in the concrete shall not exceed values given in IS:4998.

Flue gas temperature at inlet / exit 127<sup>0</sup>C (approx.)

The temperature gradient  $\Delta T$  across the shell thickness of windshield shall be calculated as per IS: 4998 (Part-I) – 1975 but subject to a minimum of 20<sup>0</sup>C. Temperature stresses will be calculated according to the procedures given in ACI-307 and IS: 4998.

#### 12.05.06 Local Loads

Effect of local loads such as moment produced by corbels, platforms, ovaling, oscillation and thermal gradient in addition to other if any shall also be considered.



**12.05.07 Load Combination**

Various load combination for calculation of stresses shall be as under.

- a) Dead load.
- b) Dead load + Wind Load
- c) Dead load + Earthquake forces.
- d) Dead load + Temperature effect.
- e) Dead load + Wind load + Temperature effect.
- f) Dead load + Earthquake force + Temperature effect.
- g) Circumferential stresses due to temperature effect.
- h) Circumferential tensile stresses due to wind inducing ring moment.
- i) Circumferential compressive stress due to wind induced ring moment combined with temperature.

In Load combinations (a) to (f) above, dead load considered shall be with or without the weight of steel lining for flues & platforms, whichever condition is more critical shall be adopted for design. Across wind loads shall be combined with co-exiting along wind loads. The combined design moment at any section shall be taken as SRSS of the moments due to across wind loads and co-exiting along wind loads.

**12.06.00 Permissible Stresses for Chimney Shell**

The Stress in Steel reinforcement and concrete shall not exceed the limits as prescribed in clause 7.0 of IS:4998 (Part-1) – 1975 for various combination of loads. Except for case of (dead load + wind load), the maximum permissible stress in concrete in this case shall not exceed  $0.275 F_{ck}$ .

Where  $F_{ck}$  – Characteristic compressive strength of concrete

**12.07.00 Analysis****12.07.01 Wind Analysis**

The “gust factor” will be calculated according to the method given in IS:4998 (Part-I) – 1992. Dynamic modulus of Elasticity of concrete as recommended in IS:4998 (Part-1) – 1992 will be used for calculating the natural frequencies of the chimney.

$C_d$  will be taken as 0.8 for the concrete shell in general. It will be increased to 0.96 as per IS:4998 over the portion covered with strakes, if required.

Along wind response of chimney shall be calculated both by gust factor method in A-5.1 and simplified method in A-4.1 of IS:4998 Part-1, 1992. For design, higher of the along wind loads shall be used.

The across wind response of the Chimney will be evaluated as per IS:4998 (Part-1)/ACI307-98. Whether strakes will be provided or not will be decided only after wind tunnel test results.

#### 12.07.02 Ring Moments Due to Wind

The circumferential ring moment due to wind will be calculated in accordance with clause 5.4 of IS:4998 (Part-I) – 1992. The wind induced stresses in concrete and steel shall be calculated in accordance with Cl. No. D-2.2.7, D-2.2.8 and D-2.2.9 of IS:4998 (Part-I) – 1975.

#### 12.07.03 Seismic Analysis

The Seismic Analysis will be carried out using the Response Spectrum Method according to IS: 1893-2002 taking the first 5 modes of vibration in the account.

#### 12.08.00 Component Design Criteria

##### 12.08.01 Shell

The design conditions for the concrete shell shall be as follows:

- 1) The concrete shall be designed for natural phenomena and loads and loads combinations as specified in CL-18.5.7. Working stress method shall be used for design of shell. The modular ratio shall be calculated as per Annexure – B of IS-456 – 2000.
- 2) The permissible stress in concrete and steel reinforcement shall not exceed the specified in CL-7.0 of IS:4998-1975 for various load combinations. Permissible stresses in concrete shall be taken as .275Fck for the load case (dead load + wind load) against the value specified in CL-7.1.1(a), IS:4998 (Part-1)-1975. The stress in concrete at the junction of shell and foundation will be limited to 0.275Fck where Fck is the characteristic compressive strength of the weaker concrete between shell and foundation.
- 3) The thickness of RCC shell shall be provided as required by stress calculations. However, the thickness of the shell has also to be determined on the basis of wind tunnel model studies and any increase, in the thickness of shell or quantities required to be made as per report shall be followed without any extra cost.



- 4) Stresses in the shell shall be checked at 10metre intervals along the height of the shell or at every corbel location or whichever distance is less these stresses shall be within permissible limits.
- 5) The maximum deflection at the top of the chimney for both static and dynamic cases shall not be more than  $H/500$  where H is the total height of the windshield above top of the pile cap.
- 6) The dynamic modulus or elasticity of concrete for various concrete grades shall be taken as lower values in the range of values specified in IS:4998 (Part-I) – 1992.
- 7) The static modulus of elasticity of concrete shall be taken as under.  
 $5000\sqrt{f_{ck}}$  for instantaneous loadings. Where  $f_{ck}$  is the characteristic compressive strength of concrete as per clause 6.2.3 of IS: 456-2000.
- 8) Minimum thickness of the shell at top shall be 400mm.
- 9) Reinforcement in the shell shall be provided as per IS:4998 (Part-I) – 1975. Minimum 0.125% reinforcement shall be provided on either face and on either side of foundation. However, the maximum spacing of reinforcement shall not be more than 250mm both ways in the shell and 300mm for foundation pile cap.

While providing vertical reinforcement steel in the shell, the total number of vertical bars shall be continued till such height when alternative bars can be discontinued. However, reduction of bar diameter along the height is permissible. At any section of the shell vertical bars shall be uniformly spaced. Non uniform spacing of vertical bars is not acceptable.

One third of the vertical bars can only be lapped at one section.

However, for a height from the top equal to half the shell outer diameter or 3 metres whichever is more, the quantity of circumferential reinforcement shall be twice that arrived at as stated above due to design considerations.

Circumferential reinforcement shall be placed around the exterior of and securely wired or welded to the vertical bars at an interval of not more than 600mm.

- 10) Openings in the shell shall be provided for ductworks, access doors, ash channel and ventilation system etc. The maximum width of opening shall be limited to an angle of not more than  $30^\circ$  subtended at the centre of the concrete shell.

The total plan area of the openings at a particular section shall not be more than 15% of the plan area of concrete shell at that location. The opening size for the purpose of stress calculations shall be taken as 1.1 times the actual width of the opening. The extra reinforcement around opening shall satisfy the requirements given in the following documents and the highest shall be provided.

- a) IS:4998 (Part-I)
- b) ACI 307.



- c) Reinforced concrete chimney and tower by M.G. Pinfold. The value of K1 as given in the book by M.G. Pinfold on page no. 186 shall be taken as 0.11.
- d) Minimum half number of extra horizontal bars in shell around the openings to continue for complete circle all round for both faces and both sides.
- 11) Embedments to support the stair case shall be provided in the shell
- 12) Expansion anchors shall be used to attach conduit, lightning and protection equipments, lighting fixtures and other lightweight appurtenances.

**12.08.02****Foundation**

The chimney foundation will be resting on piles. A circular pile cap preferably annular shall be provided. The pile cap (min. M-30) shall be designed as rigid member with uniform thickness and no tapering of thickness shall be allowed. Minimum thickness of pile cap shall neither be less 0.09 times the diameter of pile cap or 0.4 times the overhang of the foundation beyond shell whichever is greater. Foundation diameter to depth ratio shall not exceed 12. Minimum reinforcement shall not be less than 0.12% in either face and in each direction. Wind and earthquake shall be treated as normal load and no enhancement of stress is permitted on this account in soil, concrete and steel. No tension will be allowed under the pile cap during earthquake and wind. Working stress method shall be adopted for design of foundation. Foundation will be designed for SRSS of moments of along wind response and across wind response.

**12.08.03****Steel Liner (Flue)****1. General**

Liners shall essentially be constructed from structural steel and shall be of the hung type (i.e. of tension type). The liners shall be provided with externally wrapped thermal insulation. The portion of the liners projecting above the chimney roof shall be constructed of stainless steel. Stainless steel liner shall commence immediately above the flue supporting platform but below the roof supporting platform.

The liner shall be of corrosion resistant steel type "COR-TEN B" of minimum 10 mm thick. Top 10m length or length equal to 2 times flue diameter whichever is larger shall be provided using material confirming to AISI:316L or BS:1449. The liner shall be supported atleast at five different levels, and restrained laterally at several levels, with a small length at the bottom near breach elevation supported from the bottom with a suitable expansion compensator in between.

The structural steel transition inlet ducting shall be bottom supported. The transition ducting shall be suitably profiled from a rectangular shape at the chimney inlet to a circular shape up inside the chimney where it shall be connected to the suspended circular steel liners through suitable (non-metallic) fluoroelastomeric fabric expansion compensator.

**2. Design of Steel Liners**



Steel liners shall, in general, be designed meeting the requirements of the document, "Design and construction of steel chimney liners", prepared by Task committee on steel chimney liners, Fossil power committee, Power division published by ASCE-1975.

The flue diameter shall be so sized to ensure that the flue gas exit velocity is of the order of 20 to 25 meters/second at the normal continuous operating load. It should be ensured that the flue gas exit velocity at the lowest continuous unit load is high enough (of the order of 15 meters/second) to enable adequate dispersion of the flue gases. For this purpose, 100% turbine MCR condition with design coal firing shall be considered as normal continuous operating condition, and 60% turbine MCR condition with design coal / worst coal firing (whichever yields lesser flue gas quantity) shall be considered as the lowest continuous load condition.

The supporting / restraining arrangement of the liners should be such that expansion of the liners longitudinally or circumferentially is not restrained.

Clear space between flues in multi-flue stake shall be 1000mm after insulation is installed.

### 3. Insulation

#### (a) On exterior surface of flue.

The flue shall be insulated externally. The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS:8183. Blanket type insulation shall not be used. The density of insulation shall not be less than 64 kg/cum for resin bonded rock wool. Maximum coefficient of thermal conductivity shall be 0.062 Kcal/m/hr/ $^{\circ}$ C at a mean temperature of 150 $^{\circ}$ C.

The insulation thickness shall be determined based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 60 $^{\circ}$ C. The draught of air in the annular space shall be the natural draught by the heating of air by the flue liner and the air being vented out through the openings in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness. However, a minimum of 50 mm thick (2 layers of 25 mm) insulation shall be provided on the external face of flue.

The insulation shall be tightly secured to the exterior surface of the liner by impaling them on studs welded to the surface at 450mm c/c both horizontally and vertically. The studs shall be galvanized plated and be of a minimum thickness of 10 gauge and 75 mm wide. The studs shall extend a minimum of 25 mm beyond the thickness of insulation. Circular or square metal plate speed washers of standard thickness shall be placed on the extended portion of the studs to hold the impaled insulation material well in place. Further, 20 gauge galvanized wire mesh with a 25 mm hexagonal pattern conforming to IS:3150 shall be wrapped around. Where the wire mesh is jointed, a minimum 150 mm overlap shall be provided. The mesh shall be bound and tied in place with a 16 gauge GI wire at 300 mm centers. Any form of lacing the mesh fibres together will not be permitted.



Insulation for the exposed portion of flue at the top shall consist of 6 layers of insulation material each of a minimum thickness of 25 mm and all joints shall be staggered. The material shall have a minimum density of 200 kg/cum. This shall be protected from the elements by means of a stainless steel cladding, flashing and hood of grade 316 L stainless steel.

Testing of insulation material to satisfy the specific requirements and properties as outlined in this specification IS: 8183 and in the relevant drawings by the contractor shall be carried out.

Insulation materials shall be added to walls where necessary to reduce cooling loads. Also, insulation shall be used for sound absorption on walls which enclose equipment that has been determined as generating excessive noise. This sound insulation shall be provided in interior concrete block, sound block, or insulated metal wall panel liners as appropriate. The liner panels shall be as described above, except they shall include perforations and insulation enclosed in plastic bags. The overall noise Reduction Coefficient shall be 0.80 or better.

**(b) Load Bearing and Side Restraints of Flues**

Load bearing insulation assembly to have (i) a properly machined mild steel plate with recess at its top for seating PTFE (Poly Tetra Fluoro Ethylene) sheets conforming to BS:5400 (ii) saddle plate (MS) in the middle having stainless steel plate fixed at its bottom surface and lead / elastomeric sheet at top, and (iii) top plate formed of two numbers insulation blocks each made of minimum 50 mm thick rigid, non-combustible asbestos fibre reinforced lime-silica board (SINDANYO BLOCKS NATURAL GRADE CS-51) or equivalent bonded to mild steel plates at top and bottom. For side restraints assembly of insulation blocks of SINDANYO Natural Grade CS-51 or equivalent and stainless steel plate shall be used. All stainless steel in these assemblies shall conform to AISI-316L and mild steel to IS:2062. SINDANYO BLOCKS or equivalent shall be suitable for operation at 320°C and shall primarily satisfy the following physical properties:

- i) Minimum compressive stress prior to onset of compression yield of not less than 12 N/sq.mm.
- ii) Minimum shear strength of 30 N/sq.mm when tested in accordance with BS:3497-1979.
- iii) Thermal conductivity shall not exceed 0.67 W/m Deg.C at a mean temperature of 200°C and its coeff. of linear expansion not to exceed  $1.2 \times 10^{-5}$  per Deg.C.
- iv) Adhesive used for bonding purposes shall be of material with equivalent high temperature properties as approved Foundation Engineer. It may be of "Fortafix Fiborclad Adhesive" as manufactured by Fortafix Ltd., England or equivalent.

The insulation thickness shall be determined based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the





annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 55°C. The draught of air in the annular space shall be the natural draught created by the heating of air by the flue liner and the air being vented out through the openings in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness. The insulation thickness shall not be less than 100 mm, in any case, and shall be provided in two layers with the second layer of insulation covering the joints of the first layer. The insulation shall be wrapped on the outer most surface with galvanized wire mesh.

#### 4. Liner Hood:

The liner hood provided at top of flue shall be fabricated from 6mm thick (minimum) stainless steel sheets of grade 316L. The hood shall completely cover the annular area packed with insulation material between the stainless steel flue and cladding. All sections of the hood shall be anchored in places with stainless steel bolts / nuts. Slot holes shall be provided to make allowances for differential expansions / movements.

#### 12.08.04

#### Internal Platforms

Internal platforms shall be provided (minimum 5 numbers excluding roof platform) unless indicated otherwise in Data Sheet-A.

The platform shall be supported on a grid work of structural steel beams supported from the wind shield. Topmost grid work shall support RCC roof slab, where as other grid work shall support M.S. gratings as required from functional requirement. Corrosion allowance of 2 mm (minimum) shall be kept in the design of girders. Live load for the design of platform shall be 5 kN/sqm.

The members of the beam grid shall be assembled by high precision bolted connections only. The member dimensions shall be made to suit the as built dimension within the wind shield. The beams shall be painted with 2 coats of zinc silicate primer and 2 coats of heat & acid resistant epoxy paint of approved brand and shade after surface preparation as per IS:1477.

The support of the beams on the R.C.C. shell shall be so designed that only vertical load is transferred to the wind shield without any temperature effect and local torsional / local bending moment.

After fabricating, the members of the individual platforms shall be pre-assembled at ground level and checked for trueness with respect to dimensions and orientation.

The gratings shall be fabricated from M.S. flats comprising of 40x5 thick bracing bars spaced at 40 c/c and 25x4 thick space bar. The grating shall be hot dip galvanized.

Handrails shall be provided with kick plates 65x8 mm along the platform edges. Openings for the elevator shall also be surrounded by a handrail as above, with a hinged gate section on the elevator door side only. The same arrangements shall be provided at all stair case landing/ladder access points, stopper plates shall be provided to prevent gates from swinging outwards. 32mm galvanized steel pipe posts at not more than 1500mm spacing shall be provided for handrail. Height of hand railing shall not be less



than 1250mm. There shall be minimum of three handrails at 450mm, 850mm, & 1250mm above platform level. 32mm dia G.I. drainage spouts shall be provided in the platform for drainage of water.

Maximum deflection of main plate girders supporting flues and gratings shall be restricted to L/600, however maximum deflection for secondary beams supported on main girder shall be L/325. The beams shall be provided with heat and acid resistant epoxy paint and as such no corrosion allowance will be considered.

#### 12.08.05 External Platform

External platform if required, shall be provided as per directorate of air routes and aerodromes (DARA) circular for locating aviation warning lights. The platforms shall be equally spaced at a spacing of 40m (maximum)

The minimum clear width of platform shall be 1200mm and a minimum live load of 500 kg per m<sup>2</sup> shall be considered for design in addition to dead loads and incidental loads.

Hand railing shall be provided all around external platforms including hood platforms using 32 NP GI pipes. The spacing of railing of posts shall not be more than 1500mm center to centre. Height shall be 1250mm. There shall be 3 hand rails at about 450mm, 850mm & 1250mm respectively above platform level.

32mm GI drainage spouts shall be provided in platforms for drainage of rain water.

#### 12.08.06 Design of Transition Ducting

The number, size and location of flue opening in the shell shall be as per the requirement of boiler supplier. The Contractor shall make arrangement for the proper support of ducting on the shell and provision of restraint / support arrangement as required.

The CONTRACTOR shall be responsible for furnishing, fabricating, shop painting and delivery of ducting which shall run from the chimney liner to the flange of the boiler vendor's duct including all necessary auxiliary ducting as well as soot collecting hoppers located outside the chimney shell. Soot hoppers shall be lined with SS grade AISI 304. Suitable flange connection shall be provided at the exit of the hopper to provide SS / CI pipe connection to drain ash / condensed acid mixed water.

The duct work profile and the guide vanes shall be so configured and sized to achieve the desired flue gas flow characteristic and to minimize flue gas pressure losses.

The plate thickness of the ducts shall be arrived at from minimum (i.e. code) requirements, structural considerations and corrosion allowances. Material of construction shall be COR-TEN steel conforming to IS:2062. Minimum thickness shall be 10 mm.

The duct work shall be insulated with 75 mm thick insulation (3 layers of 25 thick sheets) as per requirements of clause 18.11 and protected with aluminium foil of minimum 1mm thickness. Access doors shall be provided for the ducting where required for inspection and cleaning.



The duct work and its supporting structures shall be designed for the most onerous of the possible combinations of gravity loading (accounting for ash accumulation), seismic loading, wind loading, flue gas pressure loading and thermal loading.

#### 12.08.07 Expansion Compensator

The suspended portion of the liner shall be connected to the bottom supported portion of the liner by an expansion joint. The joint shall be able to compensate for the large thermal movements of the steel flue, gas tight, acid resistant, heat resistant and provide an adequate insulating medium to avoid excessive overheating in the access void.

The materials used for the fabrication of the expansion joints shall be suitable for the flue gas conditions specified herein, and shall not deteriorate during transit, site handling, storage and installation.

The expansion joint shall be manufactured by a specialist for similar type of joints. The BIDDER shall furnish outline proposals for the expansion joint during the bid stage along with the manufacturer's qualifications and experience for the EMPLOYER's review. On award of contract, full details of materials to be supplied along with fabrication drawings shall be supplied by the CONTRACTOR for the EMPLOYER'S approval. The CONTRACTOR shall procure the units only after obtaining the EMPLOYER'S approval.

The expansion joints shall be made of flexible fibre. They should be air tight and impermeable and should withstand the maximum serviceable temperatures of the flue gas.

The CONTRACTOR shall furnish in complete an installation, dismantling and maintenance user handbook. A draft of the handbook shall be submitted to the EMPLOYER for his approval well before the installation commences.

The CONTRACTOR shall also supply spare expansion joints complete with instructions for storage, fitting, instructions, spare accessories, tools for installation, etc., to replace faulty / used expansion joints at a later date. The spares should withstand a storage period of not less than 10 years.

The fabric for expansion compensator shall comprise several layers of materials given below in order from the gas side:

- a) Two layers of insulation, each consisting of heavy weight glass cloth impregnated with graphite suspension, having an approximate weight of 1.00 kg/sqm.
- b) A continuous filament glass cloth coated both sides with a fluoro-elastomer having an approximate weight of 1.5 kg/sq.m.
- c) Two layers of PTFE (Poly Tetra Fluoro-Ethylene) film of minimum thickness 0.15 mm each.
- d) A layer of glass felt of minimum thickness 10 mm and an approximate weight of 1.5 kg/sq.m.

#### 12.08.08 Liner Test Ports



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Gas sampling ports fabricated from stainless steel with flanged ends shall be provided for liner at platform levels where indicated including proper insulation, blank plates, nuts, bolts, etc. The location, orientation and level of ports shall be as per Central Pollution Control Board regulations. Two opacity measurement ports fabricated from stainless steel pipe shall also be provided in each liner at the same platform level of the gas sampling ports.

Bidder shall provide for the purposes of instrumentation other than the sampling ports mentioned above required number of 38 NB conduits including pull wires, junction boxes and pull boxes, all securely tacked / anchored to internal of shell and S 316 L plates below each pipe insert for fixing of measuring instruments.

#### 12.08.09 Staircase

A structural steel staircase shall be provided inside the wind shield, connecting the grade slab to the topmost platform below the roof slab. The staircase shall be supported by a structural steel framework supported from platform to platform independently of the wind shield. Connection of the structural support to the platform beam shall be so chosen as to permit unrestrained deflection of the platform supporting beam. Clear width of the stair treads inside stringers shall be 750 mm. Tread shall be of 25 mm thick M.S. gratings hot dip galvanized with anti-skid nosing. Tread shall be minimum 250 mm wide. Maximum riser shall be 175 mm. Handrail shall be of M.S. pipe type medium of 32 mm NB as per IS:1161 with toe protection of 65x8 mm flats, the complete handrail being hot dip galvanized. 32mm galvanized steel pipes posts at not more than 2000 mm spacing shall be provided for handrail. Height of hand railing shall not be less than 1250 mm. There shall be minimum of three handrails at 450 mm, 850 mm & 1250 mm above platform level. All structural steel work other than stair treads shall be provided with 2 coats of zinc chromate red oxide primer followed by 3 coats of synthetic enamel painting of approved brand and shade. All field connection shall be by bolting only. The arrangement of staircase shall ensure easy accessibility to elevators. Staircase and its connection shall be designed for a live load of 5 kN/sqm.

#### 12.08.10 Ladder

Steel cage ladder hot dip galvanized shall be provided from the last platform to the roof slab. Stringers shall be of flat 75x10 with a clear distance of 400 mm in between; rungs shall be of 20 mm diameter mild steel rods spaced at 300 mm centres. Ladder stringers shall be provided with suitable stays connected to the platform supporting framework. The ladder and its connection shall be designed for a load of 175 kg at any location.

#### 12.08.11 Lift

Lift shall be provided for the chimney inside the wind shield. The lift shall be of open cage type and suitable for corrosive and dusty atmosphere that generally exists in thermal power stations/industrial complexes. It shall generally conform to the provisions of IS:1860 and IS:4289 unless otherwise specified.

The lift shall have a minimum carrying capacity of 400 kg at a speed of 0.70 metre per second. The lift shall be of rack and pinion driven service type of approved make.



All the control devices inside the car shall be housed in a dust free and water proof enclosure. Only copper conductor FRLS insulated armoured cable of suitable size shall be included in BIDDER's scope.

Landing at all locations of platforms shall be provided unless otherwise specified in Data Sheet-A.

Construction of guard cage and supply of other accessories required for satisfactory and safe operation of lift shall be included in BIDDER's scope. BIDDER shall also supply and install safety devices such as automatic stop equipment, over speed governor etc. all complete as per Manufacturer's recommendation.

All the embedments for the lift structure, approach platforms at landing levels and the lift supporting structure including lift car shall be hot dip galvanized.

**12.08.12****Doors****(a) Clean Outdoors**

Steel flue shall be provided with clean outdoor having clear dimension of 650 mm x 825 mm at appropriate location with proper access for operating the door. The edges of the doors shall be of hollow steel construction with inner plate of 8 mm and outer plate of 6 mm with suitable infill of stiffeners. The hollow space shall be filled up with insulation of the type used around flues. In addition around the door openings, removable type of insulation similar to the insulation provided around flue shall be provided. The door shall be of hinged type and provided with locking device in addition to Swivel studs with wing nuts on the remaining 3 edges. The door shall be openable both from inside and outside.

**(b) Removable Cladding / Access Door**

Opening provided near the base of the wind shield for the purposes of flue can erection shall be closed using a removable type of colour coated galvanized aluminium sheet min. 0.6 mm thick on structural steel framing which also can be dismantled if required. Within the cladding area, an access door of size 2100x1000 mm shall be provided with sill level at 300 mm from paved level. This door shall be similar to hollow steel doors provided in other buildings. The door shall be provided with a minimum two coats of acid and alkali resistant paint conforming to IS:158 type I to give a DFT of 75 microns. The outside surface shall be provided with 2 coats of zinc red oxide primer and two coats of synthetic enamel paint. The door shall be provided with suitable locking arrangement.

**12.08.13****Chimney Roof & Roof Drainage**

The chimney roof shall be of RCC slab suitably supported on MS beams. The roof shall be sloped towards rain water down take catch pits covered with CI gratings. The roof shall be designed to cater for differential movement between the shell and the liners including circumferential expansion and contraction due to temperature variation. 1200 mm high RCC parapet formed by windshield shall be provided at roof level.

The roof shall be provided with a hatch for access from the flue support platform. The hatch shall have a single leaf door with a minimum thickness of 6 mm to cover a clear





opening of 750 mm x 1000 mm. The hatch shall include the door, metal curb, draft seal, spring latch, hold-open device and all hardware. All joints shall be welded and ground smooth. The curb shall be 300 mm in height with a suitable lip which shall include a continuous neoprene seal strip to make the hatch air-tight when the cover is closed. The hatch shall be openable from both inside and outside and shall be provided with automatic hold open arm, easy one hand release and spring latch. All the items of the door shall be of stainless steel of grade 316 L and then painted with heavy duty acid and heat resistant paint as per requirement of IS:158.

The roof slab and the inside surfaces of the wind shield shall be lined with 20 mm thick acid proof tiles conforming to IS: 4457. Bedding mortar (of average thickness 10 mm) shall conform to IS: 4832 Part I and shall be of potassium silicate base.

Roof slab structure shall be designed to serve as a lifting platform for supporting the weight of flues during erection.

The tiles shall be pointed using a phenolic based resin cement mortar conforming to IS:4832 (Part-2).

The bedding mortar and phenolic based resin mortar should be acid-proof, chemical resistant and water-proof. They shall in particular be resistant to sulphuric acid and hydrochloric acid.

CI/UPVC rain water pipes shall be provided within the interior of the shell to remove rain water collected on the roof. Rain water inlet into the pipes at roof level shall be provided with CI grating. The rain water down take pipe shall be led to a manhole chamber inside wind shield suitably lined with acid / alkali resistant brick lining. From the manhole the drainage water shall be led out of the chimney wind shield through CI pipe to a manhole chamber outside wind shield and from there to Effluent Treatment Plant.

#### 12.08.14 Acid Drains and Manholes

In the event of flue gas condensation within the flues acids may be drained out at the base with the provision of stainless steel pipes connected to the soot hopper outlets in each flue located outside the wind shield.

The stainless steel pipes, bends, bolts, fixing sleeves, collecting sumps, etc., shall conform to relevant IS codes or BS:3605, and shall be procured, supplied, fabricated and erected in position by the BIDDER.

The sumps shall be of adequate size suitable lined with acid resistant bricks and provided with a RC roof and a heavy duty manhole cover. The effluent shall be led by means of stoneware pipe to the nearest manhole of effluent treatment system.

#### 12.08.15 Louvres

Air outlet louvers shall be provided as per the requirement of this specification near the top. The louver fins shall be of Z-shape in cross section and made from anodized aluminium plates of a minimum thickness of 4 mm. The frame work supporting the louver fins shall be made from extruded aluminium sections of minimum thickness 6 mm. The louvers shall be mounted in the form of panels. The fins shall be closely spaced to cut off any driving rain entering the chimney wind shield. All panels must be



approved by the EMPLOYER before installation. To outside face of louvers ST mesh on SST mesh frame work shall be provided.

#### 12.08.16 Enclosure Walls

Reinforced concrete walls shall be provided at grade level around staircase & elevator to make the enclosed space air tight and free from ash & dust for the comfort & safety of personal, who are required to go into the chimney for maintenance and inspection purpose. Height of enclosure wall shall be 10m (minimum) or as per the requirement of client. All materials for the design of walls shall be as per relevant IS codes.

#### 12.08.17 Maintenance Provisions

The outer face of the chimney wind shield shall be provided with adequate number of stainless steel insert plates of grade 316 L at the top to enable fixing and supporting painter's trolleys and other accessories. The insert plates shall be provided with suitable number of threaded holes and nuts welded at the rear end to enable bolting of the assembly when desired.

Similar arrangement shall be made at each platform level but to fix the painting trolley arrangement directly on the platforms for the purpose of painting the internals of the chimney.

A lifting beam shall be provided at platform level to cater for lifting of materials during maintenance and painting. The size and capacity of the lifting beams shall be as indicated in relevant drawings.

#### 12.08.18 Chimney Painting

The entire inside surface of the shell for full height shall be painted with two coats of acid and heat resistant black bitumen paint over a coat of compatible primer as per IS:158 with total DFT 150microns.

The top 50m of the outside surface of the shell shall be painted with 4-coats of acid and heat resistant paint (Polyurethane) over a coat of primer with total DFT 150 microns in alternate bands of signal red and white colour.

The remaining portion of the outside surface of the shell shall be painted with 4-coats of Synthetic enamel paint (IS:5410) with total DFT 150 microns over a coat of primer in alternate bands of signal red and white colour.

#### 12.08.19 Pressurised Ventilation

Pressurised ventilation shall be provided in the annular space between concrete shell windshield and flue to maintain positive pressure with respect to flue gas by means of centrifugal fans, filters, gravity dampers, short ducting etc. Positive pressure shall be not less than 1mmWC. Pressure equalisation chambers with all necessary accessories shall be provided wherever doors / hatches are provided in the shell.

Design, supply and Construction of ventilation system including supply of other accessories, spares etc, required for satisfactory and safe functioning of ventilation system shall be included in BIDDER's scope.



**17.00.00 OUT DOOR CIVIL WORKS****17.01.00 Roads**

Access within the plant site shall be provided by a system of roadways.

All building shall be approached by access road, which shall either be single or double lane road depending upon the functional requirement. Access roads shall also be provided to areas such as transformer areas, steam generator area and other equipment area shown in the plot plan, where access is necessary for inspection, operation and maintenance.

Roads shall be three types: Type I, Type II and Type III. All the roads shall be of reinforced cement concrete with M30 grade concrete.

Type I roads shall consist of 7.5 metres wide RCC paved carriageway with 2.5m wide hard shoulders. The main plant access road and a portion of the main plant complex circumferential road shall be Type I.

Type II roads shall consist of one 4.0 metre wide RCC paved carriageway with 1.5m wide hard shoulders with drains on either side. A turning area at blind ends shall be provided. Plant areas where infrequent access is needed shall be served by Type II roads. Examples of Type II roads are the lay-down area roads.

Type III roads shall be 3.0m wide with 1.0m wide hard shoulders on either side. Type III roads shall be provided along the plant boundary for access for security and maintenance.

Top of all the shoulders shall be finished with interlocking tiles. 80 mm thick M20 grade PCC with minimum 100 mm thick screed sand cushion layer shall be provided below the interlocking tiles.

Road leading to main gate of power house shall be double lane road with suitable berm. Minimum thickness of road shall be 25 cm and width of 7.5m each.

All Type I roads shall have a minimum turning radius of 25 meters and for Type II and Type III roads shall have a minimum turning radius of 7 meter.

Bollards shall be provided along side of all type of roads near equipment which requires protection. Spare duct bank shall be provided under all type roads spaced at 100m intervals.

Sign Boards shall be provided for vehicle management and shall meet the Indian standards. All sign boards shall be dual worded in both English and the local Indian language. Finished top (crest) of roads shall be 250 mm above the surrounding grade level. Geometric design of road shall be in accordance with IRC:73. The ruling gradient for roads in longitudinal direction shall not exceed 1 in 25.

Main roads shall be designed for movement of heaviest equipment of the plant.

The shoulder shall be laid with slope of 1 in 30.





Top level of parking area shall be flushed with crown connecting roads with cross slope. Parking area shall be provided rigid pavements & shall be provided with anti skid tiles.

On either side of type I and type II roads and on one side of type III roads, open drains shall be provided. Minimum clear width of drains shall be 600mm. The drains shall be designed and built using RCC. Drainage lines and other underground services shall be located at least 1m clear from the edge of the roads. All service and utility lines crossing the roads shall be taken through NP3 class RCC pipe designed for impact loading. All culverts carrying storm water shall be cast in place RCC box culverts.

No underground service piping except for drainage and sewage system shall run directly below the road (including upto 1 m. from edge of road) along its longitudinal direction.

Surface drainage of roads shall be provided by giving proper longitudinal slopes and cross falls.

The Minimum thickness of RCC road pavement, Sub-base and minimum reinforcements shall be as follows.

#### **Type I & II roads –**

250mm thick with 8mm TOR at 250mm c/c both ways at top and bottom ( double layer)  
Sub – base : 2 layers of granular sub base plus 100mm thick PCC.

#### **Type III roads –**

150mm thick with 8mm TOR at 250mm c/c both ways ( Single layer) Sub – base : 250mm thick granular sub base plus 100mm thick PCC The sub-grade shall be compacted to atleast 98% Proctor Dry Density. The actual thickness road pavement, sub-base thickness, reinforcement etc., shall be provided as per design and functional requirements.

Roads shall be designed for IRC and MOST standards (MORTH). Minimum thickness of basement slab and walls and drains to be 200mm thick with 2 layers of reinforcement.

A Separation membrane shall be used between Concrete and sub-base. Membrane shall be impermeable. Plastic sheeting shall be 125microns thick laid flat without creases.

The drainage system shall be designed for precipitation intensity of minimum 80mm per hour.

The joints, dowel bars, tie bars, joint pillars, ceiling compounds tolerances curing shall be as per latest IRC MOST standards.

**17.02.00**

#### **Surface Drainage**

- a) All the paved and unpaved areas shall be adequately drained. The surface drainage system shall be designed for surface washings and / or rain / fire water as the case may be. Unpaved open areas shall be drained through RCC drains and connected to main storm drains.
- b) The paved area shall be sloped towards the drains with a minimum slope of 1 in 100. The maximum drainage travel extent shall be limited to 10 metres.



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- c) The surface drainage from uncontaminated area shall be connected to nearest open storm water drains through rectangular drains. Contaminated area surface drainage shall be collected through separate network.
- d) The interconnecting pipes and rectangular drains shall be sized for carrying the design discharge when running full.
- e) The rectangular drains shall be minimum 450 mm wide of RCC construction. The pipes for water drainage system shall be of RCC class NP2 conforming to IS:458 with minimum size of 150 mm NB. However, for road crossings etc., pipe of class NP3 SHALL BE PROVIDED. For rail crossings, pipes conforming to railway loading standards shall be provided. If sufficient clearance cannot be provided between the top of the pipe and road top, the pipes shall be encased in RCC. Minimum clear width of drain shall be 300 mm.
- f) The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However, minimum velocity for self cleansing of 0.6m/sec shall be ensured. Slope of drain shall not be milder than 1 in 1000.
- g) Minimum earth cover of 450 mm shall be provided over drainage pipes in paved areas.
- h) RCC Garland drains minimum 300mm wide shall be provided allround the building to lead away roof drainage to plant drainage system. Plinth protection in PCC grade 1:2:4 shall be provided between brick wall and drain with appropriate slope.

**17.03.00****Storm Water Drainage System**

- a) The plant storm water drainage system shall take into account the topography of the plant area, area drainage patterns and intensity of rainfall etc. The drainage system shall be designed for a precipitation intensity equal to hourly rainfall for a return period of 1 in 50 years. However, storm frequency of 100 years return period shall be applied for Coal Storage area. These values shall be based on the recommendations of Indian metrological department (IMD).
- b) All storm water drainage shall preferably be through open storm water drains. These shall be provided on both sides of the roads and shall be designed to drain the appropriate catchment area including road surface, open and covered area etc. The drains shall be minimum 300 mm wide at the base.
- c) All open drains shall be rectangular in cross section & in RCC. In the main plant block, rectangular section RCC drains in minimum M25 grade concrete shall be provided. The thickness of side and bottom shall be minimum 125 mm or as per design considerations whichever is higher.
- d) The pipes for water drainage system shall be concrete pipes of class NP2 conforming to IS:458. However, for road crossings etc. higher strength pipe of class NP3 shall be provided. Diameter of pipes used for drainage / culverts shall be between 300 mm to 600mm. Beyond 600mm, box drains / culverts shall be provided. Water way RCC culvert shall not be less than 1m.



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- e) Surface drains shall normally have a bed slope not milder than 1 in 1000 along longitudinal direction and RCC pipes shall have such slopes so as to have effective discharge. The maximum velocity for pipe drains and open drains shall be limited to 2.4 m/sec and 1.8 m/sec respectively. However, minimum velocity for self cleansing of 0.6m/sec shall be ensured at peak flow condition (i.e. 3 times average flow) for pipes flowing at half full.
- f) Suitable manholes shall be provided to piped drainage lines at every 30m intervals, at junctions and at change of gradient, alignment and diameter of pipe and shall be of masonry or RCC construction. Minimum size of manholes shall be 1.0m x 1.0m. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.
- g) The cushion over the pipes for storm culverts shall be minimum 600mm. Where less cushion is available, pipe shall be cased in RCC m-15. Suitable RCC or masonry structures shall be provided at drops / falls to prevent scouring or damage to surface.
- h) Invert of drainage pipe / drain shall be decided in such a way that the water can easily be discharged above the high water level in water course outside the plant boundary to which the storm water is to be led.
- i) The storm water drainage for the contaminated area such as coal stack pile, fuel oil area, oil skids etc. shall be designed separately and the discharge shall be led separately for treatment and disposal.

**17.04.00****Paving**

Sufficient pavement areas adjacent to administrative building, canteen building, service building, fire station and first aid centre shall be provided for parking facilities.

Concrete paving of grade M-20 with suitable underbed shall be provided in the entire area from Transformer yard to full length up to 5m beyond chimney.

The inside area of fuel oil dyke shall be provided with concrete paving.

The transformer yard, covering area between A row of the turbine building upto the fencing of transformer yard shall be provided with minimum 100 mm thick PCC paving of nominal mix 1 : 2 : 4 of grade M-20. Paving shall be laid over 150mm thick compacted rubble soling and laid to slope towards drains.

Entire switch yard shall be provided with 75mm paving of 20 to 40mm size stone aggregate on top and 75mm paving of 20 mm stone aggregate below. Before laying the paving, the ground surface shall be treated with antiweed chemicals as per manufacturer recommendations.

For auxiliary transformer yard, paving of stone aggregate of 75 mm thick using 20 mm size aggregate shall be provided after compacting the under bed and treating with anti-weed chemicals.



The RCC paving in specified areas shall comprise of following layers :

1. 255 mm thick approved quality boulders shall be placed on well compacted soil underneath. The interstices of the boulders shall be filled with sand. This layer shall be compacted to the satisfaction of engineer.
2. 100 mm thick M15 grade plain cement concrete on layer mentioned (1) above.
3. M20 grade reinforced concrete with nominal reinforcement 8 tor @ 250 c/c both ways top and bottom having thickness 200mm shall be laid over the layer mentioned (2) above.

#### 17.05.00

#### Security cum Time Office Complex :

Approximate area of this complex shall be a minimum of 400 sqm. The dormitory shall be constructed in the first floor for security persons.

One dormitory of 100 sqm for security personnel to be provided in the time office.

The complete security gate complex consisting of Gates, Guard House, Wicket gate, time and security office, speed breakers, traffic barriers and parking/waiting space shall be carefully planned such that they function smoothly, specifically at the time of Change of shift.

The whole complex shall be aesthetically pleasing merging with the architecture of the compound wall.

Time and Security Office shall have adequate area to house the security staff and time office staff in addition to the record room, waiting rooms, toilet facilities etc.

In Time office, separate dress change rooms shall be provided for ladies and gents.

In addition to inside toilet, another toilet with entry from outside shall be provided for the use of visitors.

Speed brakers shall be provided both out side and inside the compound with manually operated traffic barriers.

Emergency Gate shall be provided in addition to the main gate. Main Gate shall have two separate entry one for project site and other for fly ash silo trucks movement. Gate latches shall be arranged for padlocking with the padlock accessible from both sides of the gate. Padlocks shall be provided and the key shall be in accordance with the Purchaser's requirements.

Cantilever type motorized sliding gate shall be furnished at the main plant entrance. The gate shall be operable by push button at both the guard house and the security office in the Administration / Plant Service area, and by card reader or key switches.

The road near the main entrance to be widened additionally by 7.5 m on either sides of the road for parking of vehicles for security check.

Suitable median arrangements to be made.

Security cabin to be provided on either sides of the road near the main gate.



Elevated platform either in steel structure / Brick work or RCC to carry out checking on Lorries/Tippers by security personnel while the vehicles getting in or going out from the premises.

#### 17.06.00 Fencing

- a. Minimum 3m height fencing above toe wall shall be provided around transformer yard and other areas where fencing is necessary due to statutory requirements.
- b. Fencing shall comprise 3.0m height PVC coated galvanized chain link fencing of minimum 8 gauge including PVC coating of mesh size 75 mm and galvanized concertina.
- c. Galvanized barbed of a height of 0.6m shall be provided above the chain link fence. The diameter of steel wire for chain link fencing excluding PVC coating shall not be less than 12 gauges.
- d. MS entry gate shall be provided for all fenced areas. Top of toe wall shall be min. 200 mm above formation level.
- e. Removable type of fencing shall be provided at suitable location to permit entry and exit of equipment.

#### 17.07.00 Watch Tower

Watch Tower shall be constructed with RCC frame work. Floor of tower shall be at least 6m above graded level.

Covered area for each tower shall be approx. 25 sqm. Number of towers shall be such that the complete periphery of the plant can be watched from the towers but in no case the number of towers shall be less than twelve.

Walking platform of 1.5m wide with hand rails shall be provided all round of watch cabin.

#### 17.08.00 Plinth Protection

All buildings shall be provided with 1000 mm wide and 100 mm thick PCC of grade M-20 for plinth protection all round with surface drain of required size and slope, to suite storm water quantity. Plinth protection shall be laid over prepared subgrade and base formed with broken brickbats or rubble laid to a thickness of 150 mm.

#### 17.09.00 Waste Water Treatment and Drainage System

Waste water treatment plant will receive plant waste water except RO plant reject and CT blow down. The treated water and the solid waste will be used within the plant.

Guard pond will hold the RO Stage-I reject, clarifier sludge treated water from oil water separator and this will be pumped to the sea. For this return water to the sea temperature shall not exceed 5°C over the inlet temperature of cold water.





The cooling tower blow down shall be pumped to sea with the help of blow down pumps installed in the CW pump house.

All necessary civil / structural works for waste water treatment plant shall be under scope of contractor. The major source of plant waste water are Boiler blow down, coal mill area drainage, PH and boiler area oily effluent drain, F.O. pump house oil drainage, boiler and ESP area floor washing drains, water pre-treatment plant effluent, fly ash silo area effluent, transformer yard waste water etc. Design and construction of channels / settling pits / sumps / pipe lines / separators shall be done by the Bidder.

The description of some of the major structures / components covered under the waste water system package is given below:

Coal pile area run-off will be led to settling pond. Earthen settling pond with two (2) compartments will be provided. Top of earthen dyke shall be 500 mm above surrounding finished grade level to restrict ingress of storm water from adjacent areas. Capacity of pond shall be determined on the basis of inlet drain invert. The side slopes and bottom will be protected with PCC blocks of minimum 75 mm thickness with suitable under-bed having interstices filled with cement-sand mortar. At the downstream of pond RCC overflow weir and sump shall be provided. Design and detailing of pond shall be as per good engineering practice so as to satisfy functional requirement as specified in the specification. Necessary sluice gates with hoisting arrangement shall be provided in inlet drain carrying coal pile area run-off so that one settling pond can be operative while the other one under maintenance.

The Power House and boiler area service water waste shall be collected in a RCC underground oily waste retention pit. Necessary pumps and supporting floor / maintenance area shall be provided. This effluent will finally be treated in TPI (tilted plate interceptor). Foundation from TPI shall be designed as per IS:456. RO Stage-II reject shall be led to fire water sump and green belt development. In case the fire sump is full then arrangement shall also be made to lead this to the guard pond.

Oil storage and handling area run-off will be collected to a conventional baffled oil water separator. This oil water separator will be an underground RCC structure having RCC baffle wall and overflow sump for collecting water at outlet end. An oil collection pit shall be provided on sidewall of oil water separator. This structure shall be designed as un-cracked section as per IS:3370. The structure shall project at least 300 mm above finished grade level. Handrail shall also be provided around the pit. The overflow sump shall be covered at top over which pumps will be installed.

RCC sump for collecting boiler blow down and ESP area floor washing is included in scope of bidder. Civil work for outlet of this effluent shall also be under scope of this package.

Guard Pond (effluent monitoring pond and equalization basin) sized for holding waste water from RO Stage-I reject, clarifier sludge, treated water from oil water separator and boiler blow down as per capacity indicated in Vol. III & Composite Water Scheme. The guard pond (earthen) shall have adequate capacity as per design requirement with 750 mm free board. Top of earthen dyke shall be 500 mm above finished grade level. The pond shall be of such construction as to prevent pollution of ground water by seepage of



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any wastewater having side slopes and bottom lined with minimum 250 micron LDPE for minimizing seepage loss. Over the LDPE lining, PCC blocks of minimum 75 mm thickness having interstices filled with cement-sand mortar shall be provided. Filter media shall be suitably designed and provided below liner.

#### 17.10.00 Sanitary Sewerage System

Sanitary Sewerage System shall be carried out as specified in VOL – III (Mechanical Spec.).

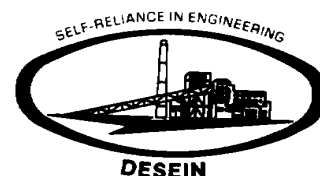
The treated water to be provided with necessary pumps and distribution lines for reutilization for Horticulture / Green belt development.

The sewerage system of foul water from toilet shall include layout and laying of sewers up to a sewage treatment plant together with all fittings and fixture and inclusive of ancillary works such as connections, installation of man-hole and inspection chambers. The construction of a sewage treatment plant of adequate capacity including settling tank, lifting stations, pump house and all other necessary provisions shall be made for treating the sewage water by using the latest CAACO technology developed by M/s. Central Leather Research Institute, Taramani, Chennai.

The domestic effluent from the plant shall be collected and treated in proper STP to meet the prescribed BIS standard before being discharged or reutilized for green belt development.

#### 17.10.01 Sanitary Sewer Drains

- a) Sanitary sewers shall be designed for a minimum self cleansing velocity of 0.75 m/sec. and the maximum velocity shall not exceed 2.5m/sec.
- b) Very hot (over 60<sup>0</sup>C) water shall be first cooled down to less than 60<sup>0</sup>C in collecting basin by mixing with cold water before connecting to storm drainage system.
- c) The maximum temperature, quality, quantity and location of drain water of individual equipment shall be tabulated and furnished to the Owner's representative.
- d) All underground piping below concrete slab shall be cast iron of minimum 100mm dia and for outdoors it shall be reinforced concrete pipe of minimum 200mm diameter. In buried piping system manholes shall be placed at every change in direction and at every SOM (max.) interval in straight run. Suitable clean outs shall be provided for buried piping under floor slab.
- e) Following minimum drainage slope shall be provided:
  - Pipes of diameter less than 200mm : 1 (vertical) : 100 (horizontal)
  - Pipes of diameter 200mm & more: 1 (vertical): 200 (horizontal).



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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             |



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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.



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- 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.



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**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.



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- 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



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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



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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  |



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- properties.
- h) Batching & Mixing : 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



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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 - 20  
mm

Ordinary Plain concrete and Reinforced concrete foundations - 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 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



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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



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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.



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- 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.



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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



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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.



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**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 $40^{\circ}\text{C}$	$40^{\circ}\text{C}$ to $20^{\circ}\text{C}$	$20^{\circ}\text{C}$ to $5^{\circ}\text{C}$	Below $5^{\circ}\text{C}$	Above $40^{\circ}\text{C}$	$40^{\circ}\text{C}$ to $20^{\circ}\text{C}$	$20^{\circ}\text{C}$ to $5^{\circ}\text{C}$	Below $5^{\circ}\text{C}$
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1	Do not remove forms until	1	1	1	Do not remove forms
b) Beam sides	3	2	3		2	1	1	



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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 | - | $\pm 5$ mm                         |
| ii)  | Plumb               | - | 1 in 1000 of height                |
| iii) | Levels              | - | $\pm 3$ mm before any<br>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.



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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



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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
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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



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- 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.



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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:-



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- 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.



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- 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/m<sup>2</sup>.
- vii) Unit weight of green concrete shall be considered as 2500kg/m<sup>3</sup> 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.



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**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.



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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



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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



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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.



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- 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.



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- 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.



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**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.



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- 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/mm<sup>2</sup>; 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.



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**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.



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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.



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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.



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- ii) 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 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



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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



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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



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- 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



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- 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.



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**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:



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- 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



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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.



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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.



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**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
<b>a</b>	<b>For Buildings Containing Cranes</b>		
	i) Main Column	a) Shifting of column axis at foundation level with respect 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>b For Buildings without Cranes</b>		
The maximum tolerances for line and level of the steel work shall be $\pm 3$ 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.		



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**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



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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.



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**TECHNICAL SPECIFICATION FOR**  
**EARTHWORK IN EXCAVATION AND**  
**BACKFILLING**

SPECIFICATION NO. PE-TS-635-600-C001

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## EARTHWORK IN EXCAVATION AND BACKFILLING


**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**



 BHEL Maharatna Company	<b>TITLE:</b> <b>TECHNICAL SPECIFICATION FOR</b> <b>EARTHWORK IN EXCAVATION AND</b> <b>BACKFILLING</b>	SPECIFICATION NO. PE-TS-635-600-C001 VOLUME - SECTION - D   SUB-SECTION - D1 REV.NO. 00 DATE 13/02/2018 SHEET 2 OF 23																					
<p style="text-align: center;"><b>C O N T E N T</b></p> <table> <tr> <th>CLAUSE NO.</th><th>DESCRIPTION</th><th>SHEET NO.</th></tr> <tr> <td>1.00.0</td><td>SCOPE</td><td>3</td></tr> <tr> <td>2.00.00</td><td>GENERAL</td><td>3</td></tr> <tr> <td>3.00.00</td><td>EXECUTION</td><td>6</td></tr> <tr> <td>4.00.00</td><td>TESTING AND ACCEPTANCE CRITERIA</td><td>19</td></tr> <tr> <td>5.00.00</td><td>RATES AND MEASUREMENTS</td><td>19</td></tr> <tr> <td>6.00.00</td><td>INFORMATION TO BE SUBMITTED BY THE BIDDER</td><td>20</td></tr> </table>			CLAUSE NO.	DESCRIPTION	SHEET NO.	1.00.0	SCOPE	3	2.00.00	GENERAL	3	3.00.00	EXECUTION	6	4.00.00	TESTING AND ACCEPTANCE CRITERIA	19	5.00.00	RATES AND MEASUREMENTS	19	6.00.00	INFORMATION TO BE SUBMITTED BY THE BIDDER	20
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<p style="text-align: center;"><b>STANDARD TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING</b></p> <p><b>1.0.0 SCOPE</b></p> <p>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.</p> <p><b>2.0.0 GENERAL</b></p> <p><b>2.1.0 Work to be provided for by the Contractor</b></p> <p>The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p><b>2.2.0 Work to be provided by others</b></p> <p>No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.</p>		

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<b>2.3.0</b>	<b>Codes and Standards</b>  <p>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.</p> <p>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</p> <p>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.</p>	
<b>2.4.0</b>	<b>Conformity with Designs</b>	
	<p>The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.</p>	
<b>2.5.0</b>	<b>Materials</b>	
<b>2.5.1</b>	<b>General</b>	
	<p>All materials required for the work shall be of the best commercial variety and approved by the engineer.</p>	
<b>2.5.2</b>	<b>Material for Excavation</b>	
	<p>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.</p>	
<b>2.5.3</b>	<b>Material for Filling</b>	
	<p>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</p>	



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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 confirm 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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<b>3.0.0</b>	<p>likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.</p> <p><b>EXECUTION</b></p> <p>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.</p> <p><b>3.1.0 Setting out</b></p> <p>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.</p> <p><b>3.2.0 Initial Levels</b></p> <p>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.</p> <p><b>3.3.0 Clearing and Grubbing</b></p> <p>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</p>	


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	<p>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.</p> <p><b>3.4.0 Classification</b></p> <p>All earthwork shall be classified under the following categories:</p> <p>No distinction will be made whether the material is dry or wet.</p> <p>a) <b>Ordinary Soil</b></p> <p>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.</p> <p>b) <b>Hard Soil</b></p> <p>This shall include :</p> <ul style="list-style-type: none"> <li>i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;</li> <li>ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;</li> <li>iii) soling of roads, paths, etc., and hard core ;</li> <li>iv) macadam surfaces such as water bound, and bitumen/tar bound;</li> <li>v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;</li> <li>vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and</li> <li>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.</li> </ul> <p>c) <b>Soft and Decomposed Rock</b></p> <p>This shall include :</p> <ul style="list-style-type: none"> <li>i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;</li> <li>ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;</li> <li>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</li> </ul>	


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	<p>in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and</p> <p>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.</p> <p><b>d) Hard Rock (requiring blasting)</b></p> <p>This shall include :</p> <p>i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;</p> <p>ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and</p> <p>iii) boulders requiring blasting.</p> <p><b>e) Hard Rock (blasting prohibited)</b></p> <p>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.</p> <p>In case of any dispute regarding classification, the decision of the Engineer shall be final.</p> <p><b>3.5.0 Excavation for Foundations and Trenches</b></p> <p><b>3.5.1 General</b></p> <p>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.</p> <p>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</p>	





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	<p>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.</p> <p>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.</p> <p>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.</p> <p><b>Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.</b></p> <p><b>3.5.2 Excavation in All Type of Soil and in Soft Rock</b></p> <p>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</p>	

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	<p>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.</p> <p><b>3.5.3 Excavation in Hard Rock</b></p> <p>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.</p> <p><b>3.5.4 Blasting</b></p> <p>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).</p> <p>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.</p> <p>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.</p>	


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	<p><b>3.5.4.1 Materials</b></p> <p>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.</p> <p><b>3.5.4.2 Storage of Explosives</b></p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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</p>	

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<p>provided at the magazine for this purpose and should be careful</p> <ul style="list-style-type: none"> <li>* not to put their feet on the clean floor unless the magazine shoes on.</li> <li>* not to touch the magazine shoes on ground outside the clean floor.</li> <li>* not to allow any dirt or grit to fall on the clean floor.</li> </ul> <p>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.</p> <p>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.</p> <p><b>3.5.4.3 Carriage of Explosives</b></p> <p>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.</p> <p>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.</p> <p><b>3.5.4.4 Use of Explosives</b></p> <p>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</p>		


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	<p>responsibilities.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>	


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	<p>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.</p> <p><b>3.5.4.5 Restrictions in Blasting</b></p> <p>a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.</p> <p>b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.</p> <p>c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.</p> <p>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.</p> <p>e) The last blast shall not be more than 0.50 m in depth.</p> <p>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.</p> <p><b>3.5.5 Disposal</b></p> <p>The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.</p> <p>a) By using it straightway for backfilling.</p> <p>b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.</p> <p>c) i) By either spreading or ii) By spreading and compacting at designated disposal areas.</p> <p>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.</p> <p><b>3.5.6 Disposal of Surplus Materials</b></p> <p>All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer.</p>	





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	<p>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.</p> <p><b>3.5.7 Protection</b></p> <p>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.</p> <p><b>3.5.8 Dealing with Surface Water</b></p> <p>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.</p> <p>No works shall commence until surface water streams have been properly intercepted , redirected or otherwise dealt with.</p> <p>Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.</p> <p><b>3.5.9 Dewatering</b></p> <p>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.</p> <p>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</p>	



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	<p>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.</p> <p><b>3.5.10 Timber Shoring</b></p> <p>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.</p> <p><b>3.5.10.1 Close Timbering</b></p> <p>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.</p> <p>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.</p> <p>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.</p> <p><b>3.5.10.2 Open Timbering</b></p> <p>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.</p>	

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<b>3.6.0</b>	<b>Treatment of Slips</b>  <p>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.</p>	
<b>3.7.0</b>	<b>Backfilling</b>	
<b>3.7.1</b>	<b>General</b>	
	<p>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.</p> <p>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.</p>	
<b>3.7.2</b>	<b>Filling and Compaction in Pits and Trenches all Around the Structures</b>	
	<p>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.</p>	
<b>3.7.3</b>	<b>Plinth Filling</b>	
	<p>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.</p>	

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	<p><b>3.7.4 Filling in Trenches for Water Pipes and Drains</b></p> <p>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.</p> <p>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.</p> <p><b>3.7.5 Filling in Disposal Area</b></p> <p>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.</p> <p><b>3.8.0 Approaches and Fencing</b></p> <p>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.</p> <p><b>3.9.0 Lighting</b></p> <p>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.</p>	

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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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	<p>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.</p> <p><b>5.2.0 Measurements</b></p> <p>Method of measurements are specified as below:</p> <p>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.</p> <p>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.</p> <p>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 &amp; 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).</p> <p>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 &amp; 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).</p> <p><b>e) IN TRENCHES FOR BURIED PIPES &amp; CABLES</b></p> <p><b>Width of Trench</b></p> <p>i) Upto one metre depth the authorized width of trench for excavation</p>	

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	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>h) The authorized quantity (calculated on the basis of authorized width/ working space under clause no. 5.2.0 c, 5.2.0 d &amp; 5.2.0 e) or those actually excavated, whichever, are less, shall be measured for payment.</p>	



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	<p>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.</p> <p>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.</p> <p><b>6.0.0 INFORMATION TO BE SUBMITTED BY THE BIDDER</b></p> <p><b>6.1.0 With Tender</b></p> <p>Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.</p> <p><b>6.2.0 After Award</b></p> <p>After award of the contract the successful bidder shall submit the following for approval.</p> <p>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.</p> <p>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.</p>	



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**TECHNICAL SPECIFICATION FOR  
CEMENT CONCRETE (PLAIN &  
REINFORCED)**

SPECIFICATION NO. PE-TS-635-600-C001

VOLUME -

SECTION - D SUB SECTION - D2

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**CIVIL, STRUCTURAL & ARCHITECTURAL WORKS**

**SPECIFICATION NO. PE-TS-635-600-C001**

**SECTION – D**


**SUB SECTION – D2**


***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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<p style="text-align: center;"><b>SUB-SECTION – D2</b></p> <p style="text-align: center;"><b>CEMENT CONCRETE (PLAIN &amp; REINFORCED)</b></p> <p><b>1.00.00        SCOPE</b></p> <p><b>1.01.00        General</b></p> <p>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.</p> <p><b>1.02.00</b>        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.</p> <p><b>2.00.00        General</b></p> <p><b>2.01.00        Work to be provided for by the Contractor</b></p> <p>The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following</p> <ol style="list-style-type: none"> <li>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.</li> <li>b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.</li> <li>c) Prepare working drawings of formworks, scaffolds, supports, etc.</li> <li>d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.</li> <li>e) Prepare detailed drawings of supports, templates, hangers, etc. required for</li> </ol>		


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	<p>installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.</p> <p>As decided by the Engineer some or all of the drawings &amp; schedules prepared under item (b) to (e) above will have to be submitted for approval.</p> <p>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.</p> <p>g) Design and submit for approval concrete mix designs required to be adopted on the job.</p> <p>Furnish samples and submit for approval results of tests of various properties of the following:</p> <ul style="list-style-type: none"> <li>i) The various ingredients of concrete</li> <li>ii) Concrete</li> <li>iii) Embedments</li> <li>iv) Joint seals</li> </ul> <p>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.</p> <p>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.</p> <p><b>2.02.00 Work by others</b></p> <p>No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.</p> <p><b>2.03.00 Information to be submitted by the Tenderer</b></p> <p><b>2.03.01 With Tender</b></p> <p>The following technical information's are required with the tender:</p> <p>a) Source and arrangement of processing of aggregates proposed to be adopted.</p>	


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<b>2.03.02</b>	<p>b) Type of plant and equipment proposed to be used.</p> <p>c) Names of firms with which association is sought for to execute the special items of work in the contract.</p> <p>d) Types of formwork proposed to be used.</p> <p><b>After Award</b></p> <p>The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.</p> <p>a) Programme of Execution</p> <p>Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.</p> <p>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.</p> <p>Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.</p> <p>b) Samples</p> <p>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:</p> <p>i) Coarse and fine aggregates.</p> <p>ii) Admixtures.</p> <p>iii) Plywood for Formwork.</p> <p>iv) Embedded and anchorage materials as may be desired by the Engineer.</p> <p>v) Joint sealing strips and other*waterproofing materials.</p> <p>vi) Joint filling compounds.</p> <p>vii) Foundation quality Rubber Pads.</p>	


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	<p>c) Design Mix</p> <p>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.</p> <p>d) Bar Bending Schedules</p> <p>Bar Sending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.</p> <p>e) Detailed Drawings and Designs of Formworks to be used</p> <p>Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).</p> <p>f) Detailed Drawings for Templates &amp; Temporary Supports for embedment As per Clause 2.01.00 (e).</p> <p>g) Mill Test Reports for Cement &amp; Reinforcing Steel.</p> <p>h) Inspection Reports</p> <p>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.</p> <p>i) Test Reports</p> <p>Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING &amp; TESTING of this specification or as directed by the Engineer.</p> <p>j) Any other data, which may be required as per this specification or as directed by the Engineer.</p> <p><b>2.04.00 Conformity with Design</b></p> <p>The Contractor will prepare checklists in approved Performa, 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</p>	





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	<p>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.</p> <p><b>2.05.00 Materials to be used</b></p> <p><b>2.05.01 General Requirement</b></p> <p>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.</p> <p><b>2.05.02 Cement</b></p> <p>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.</p> <ul style="list-style-type: none"> <li>a) TG foundation top deck and sub structures including raft.</li> <li>b) Spring Supporting decks of all machine foundations.</li> <li>c) Structures requiring grade of concrete of M30 and above.</li> </ul> <p>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.</p> <p>For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.</p> <p><b>2.05.03 Coarse Aggregate</b></p> <p>Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as</p>	


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	<p>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.</p> <p><b>2.05.04 Fine Aggregate</b></p> <p>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.</p> <p><b>2.05.05 Water</b></p> <p>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.</p> <p><b>2.05.06 Admixture</b></p> <p>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:</p> <ul style="list-style-type: none"> <li>a) Accelerating admixture</li> <li>b) Retarding admixture</li> <li>c) Water reducing admixture</li> <li>d) Air entraining admixture</li> <li>e) Water proofing admixture</li> </ul> <p>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</p>	

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	<p>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.</p> <p><b>2.05.07 Reinforcement</b></p> <p>Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.</p> <p><b>2.06.00 Storage of Materials</b></p> <p><b>2.06.01 General</b></p> <p>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.</p> <p><b>2.06.02 Cement</b></p> <p>Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.</p> <p>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.</p> <p>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.</p> <p><b>2.06.03 Aggregates</b></p> <p>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</p>	


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	<p>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.</p> <p><b>2.06.04 Reinforcement</b></p> <p>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.</p> <p>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.</p> <p><b>2.07.00 Quality Control</b></p> <p>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:</p> <p>a) Admixture: Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete.</p> <p>For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.</p> <p>b) Aggregate: Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.</p> <p>c) Water: Impurities tests.</p> <p>d) Cement: Tests to satisfy relevant IS Specifications.</p> <p>e) Formwork: Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.</p> <p>f) Reinforcement: Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.</p>	


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	<p>Material tests or Certificates to satisfy relevant IS Specification.</p> <p>g) Grades of Concrete: Usage and mix design, testing of all properties.</p> <p>h) Batching &amp; Mixing: Types and capacity of plant, concrete mixers and transportation equipment.</p> <p>i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.</p> <p>j) Embedded and Anchorage Items: Material, shape, location, setting.</p> <p>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.</p> <p>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.</p> <p>m) Setting of base &amp; Bearing plates: Lines, elevations, and bedding mortar.</p> <p>n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.</p> <p>o) Curing: Methods and length of time.</p> <p>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.</p>	
<b>3.00.00</b>	<b>INSTALLATION</b> <p>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</p>	


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	<p>cover all the aspects to the full satisfaction of the Engineer.</p> <p><b>3.01.00 Washing and Screening of Aggregates</b></p> <p>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.</p> <p><b>3.02.00 Admixture</b></p> <p>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.</p> <p><b>3.03.00 Grades of Concrete</b></p> <p>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.</p> <p><b>3.04.00 Proportioning and Works Control</b></p> <p><b>3.04.01 General</b></p> <p>“Design Mix Concrete” and “Nominal Mix Design” is defined as follows for use in this specification:</p> <p>a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".</p> <p>b) Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".</p> <p>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</p>	


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<b>3.04.02</b>	<p>adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.</p> <p><b>Mix Design Criteria</b></p> <p>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</p> <ol style="list-style-type: none"> <li>Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.</li> <li>The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.</li> <li>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.</li> <li>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.</li> <li>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.</li> </ol> <p>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.</p> <p><b>3.05.00</b></p> <p><b>Strength Requirements</b></p> <p>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.</p> <p><b>3.06.00</b></p> <p><b>Minimum Cement Content</b></p> <p>The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at</p>	





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	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p><b>3.07.00 Water-Cement Ratio</b></p> <p>The choice of water-cement ratio in designing a concrete mix will depend on:-</p> <p>a) The requirement of strength.</p> <p>b) The requirement of durability.</p> <p><b>3.07.01 Strength Requirement</b></p> <p>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.</p> <p>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.</p> <p><b>3.07.02 Durability Requirement</b></p>	


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<p>Tables 4 &amp; 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.</p> <p>Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.</p> <p>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.</p> <p><b>3.08.00 Workability</b></p> <p>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:</p> <p style="text-align: center;"><b><u>TABLE-V</u></b></p> <p style="text-align: center;"><b>LIMITS OF CONSISTENCY</b></p> <table border="1"> <tr> <td>Degree of</td><td>Slump in mm with Standard Cone as</td><td>Use for which concrete is suitable</td></tr> </table>			Degree of	Slump in mm with Standard Cone as	Use for which concrete is suitable
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.			
<p>Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.</p> <p>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.</p> <p>The workability of concrete shall be checked at frequent intervals by slump tests.</p>					
3.09.00		Size of coarse Aggregates			
<p>The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer</p>					
		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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	<p style="text-align: center;">Lean concrete</p> <p style="text-align: right;">- 40 mm</p> <p>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.</p> <p>Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles</p> <p>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.</p> <p>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.</p> <p><b>3.09.01</b> 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:</p> <p>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.</p> <p><b>3.09.02</b> Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.</p> <p><b>3.10.00</b> <b>Mixing of Concrete</b></p> <p>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.</p>	


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	<p>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 &amp; 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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p><b>3.11.00 Conveying Concrete</b></p> <p>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.</p> <p><b>3.12.00 Placing and Compacting Concrete</b></p> <p>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</p>	


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	<p>adopted. Concrete may have to be placed against the following types of surfaces:</p> <ul style="list-style-type: none"> <li>a) Earth foundation</li> <li>b) Rock foundation</li> <li>c) Formwork</li> <li>d) Construction joint in concrete or masonry</li> </ul> <p>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.</p> <p>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.</p> <p>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.</p> <p>Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.</p> <p>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.</p> <p>After concrete has been placed, it shall be spread, if necessary &amp; 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</p>	


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	<p>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 &amp; consolidation of concrete.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.</p> <p><b>3.13.00 Construction Joints and Cold Joints</b></p> <p><b>3.13.01 Construction Joints</b></p>	





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	<p>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.</p> <p>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.</p> <p>Where the location of the joints are not specified, it will be in accordance with the following:</p> <ol style="list-style-type: none"> <li>In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.</li> <li>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.</li> <li>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.</li> <li>Feather-edges in concrete shall be avoided while forming a joint.</li> <li>A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.</li> <li>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.</li> </ol> <p><b>3.13.02 Cold Joint</b></p> <p>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.</p> <p>If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:</p> <ol style="list-style-type: none"> <li>If the concrete is so green that it can be removed manually and if vibrators</li> </ol>	

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	<p>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.</p> <p>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.</p> <p>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.</p> <p><b>3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces</b></p> <p><b>3.14.01</b> 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.</p> <p>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 &amp; 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:</p> <p>a) Sack rubbing with mortar and stoning with carborundum stone.</p> <p>b) Cutting away the defective concrete to the required depth shape.</p> <p>c) Cleaning of reinforcement &amp; embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.</p> <p>d) Roughening by sand blasting or chipping.</p>	


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	<p>e) Installing additional reinforcement/welded mesh fabric.</p> <p>f) Dry packing with stiff mortar.</p> <p>g) Plastering, guniting, shotcreting etc.</p> <p>h) Placing and compacting concrete in the void left by cutting out defective concrete.</p> <p>i) Grouting with cement sand slurry of 1:1 mix.</p> <p>j) Repairing with a suitable mortar either cement or resin modified mortars.</p> <p>k) Polymer modified patching and adhesive repair&amp; mortar for beams &amp; columns.</p> <p><b>3.14.02 Finishing unformed Surface</b></p> <p>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</p> <p>a) Floor</p> <p>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.</p> <p>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.</p> <p>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.</p>	

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	<p>To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.</p> <p>b) Beans, Columns &amp; Walls</p> <p>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.</p> <p><b>3.15.00 Protection and Curing of concrete</b></p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>	


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	<p>The contractor shall arrange for the manufacturer's supervision at no extra cost.</p> <p>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.</p> <p><b>3.16.00 Reinforcement</b></p> <p>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.</p> <p><b>3.16.01 Bar Bending Schedules</b></p> <p>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 &amp; schedules with one reproducible print.</p> <p><b>3.16.02 Cleaning</b></p> <p>All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.</p> <p><b>3.16.03 Bending</b></p> <p>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</p>	


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	<p>final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.</p> <p>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.</p> <p><b>3.16.04 Placing in Position</b></p> <p>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.</p> <p><b>3.16.05 Welding / Coupler for Splicing</b></p> <p>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.</p> <p>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</p>	




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	<p>severe environmental conditions to rule out any risk of galvanic corrosion will be done by the contractor at no extra cost. Proper fitting &amp; 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.</p> <p><b>3.16.06 Control</b></p> <p>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.</p> <p><b>3.17.00 Cold Weather Concreting</b></p> <p>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.</p> <p><b>3.18.00 Hot Weather Concreting</b></p> <p>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.</p> <p><b>3.19.00 Concreting under water</b></p> <p>When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.</p>	



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<b>3.20.00</b>  <b>3.20.01</b>	<p><b>Form Work</b></p> <p><b>General</b></p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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</p>	

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	<p>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.</p> <p>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.</p> <p><b>3.20.02 Cleaning and Treatment of Forms</b></p> <p>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.</p> <p><b>3.20.03 Design</b></p> <p>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.</p> <p>Removing any props or reproping 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.</p> <p><b>3.20.04 Inspection of Forms</b></p> <p>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.</p>	

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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


3.20.07

Re-use of Forms


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<b>3.20.08</b>	<p>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.</p> <p><b>Classification</b></p> <p>Generally, the "ordinary" class formwork shall be used unless otherwise specified.</p> <p>a) <b>Ordinary:</b> 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.</p> <p>b) <b>Plywood:</b> 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.</p> <p>c) <b>Ornamental:</b> 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.</p> <p><b>3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.</b></p> <p>The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.</p> <p><b>3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures</b></p> <p>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.</p> <p>Necessary templates, jigs, fixtures, supports etc. shall be used as may be</p>	


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	<p>required or directed by the Engineer.</p> <p>Items to be embedded</p> <ol style="list-style-type: none"> <li>Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.</li> <li>Anchor bolts and plates for machinery, equipment and for structural steel work.</li> <li>Steel structurals to be left embedded for future extension, special connection etc.</li> <li>Dowel bars, etc. for concrete work falling under the scope of other contractors.</li> <li>Lugs or plugs for door and window frames occurring in concrete work.</li> <li>Flashing and jointing in concrete work.</li> <li>Any misc. embedments and fixture as may be required.</li> </ol> <p>Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.</p>	
<b>3.23.00</b>	<b>Expansion and Isolation Joints</b>	
<b>3.23.01</b>	<b>General</b>	
	<p>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.</p>	
<b>3.23.02</b>	<b>Bitumen Board/ Expanded Polystyrene Board</b>	
	<ol style="list-style-type: none"> <li>Bitumen Board</li> </ol>	


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	<p>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.</p> <p>b) Expanded Polystyrene Boards</p> <p>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.</p> <p><b>3.23.03 Joint sealing strips</b></p> <p>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.</p> <p>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.</p> <p>a) Metal Sealing Strips</p> <p>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</p>	


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	<p>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.</p> <p>i) G.I. Strips</p> <p>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.</p> <p>ii) Aluminium Strips</p> <p>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.</p> <p>iii) Copper Strips</p> <p>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.</p> <p>b) Non-metallic Sealing Strips</p> <p>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:</p> <p>i) Plain</p> <p>ii) Central bulb</p> <p>iii) Dumb-bell or flattened ends</p> <p>iv) Ribbed and Corrugated Wings</p> <p>v) V shaped</p> <p>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</p>	





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<p>central bulbs &amp; the edges accurately.</p> <p>c) Rubber Sealing Strips</p> <p>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:</p> <table> <tr> <td>Specific Gravity</td><td>:</td><td>1.1 to 1.15</td></tr> <tr> <td>Shore Hardness</td><td>:</td><td>65A to 75A</td></tr> <tr> <td>Tensile Strength</td><td>:</td><td>25 - 30 N/Sq.mm</td></tr> <tr> <td>Maximum Safe Continuous Temperature</td><td>:</td><td>75°C</td></tr> <tr> <td>Ultimate Elongation</td><td>:</td><td>Not less than 350%</td></tr> </table> <p>b) P.V.C., Sealing Strips</p> <p>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</p> <table> <tr> <td>Specific Gravity</td><td>:</td><td>1.3 to 1.35</td></tr> <tr> <td>Shore Hardness</td><td>:</td><td>60A to SOA</td></tr> <tr> <td>Tensile Strength</td><td>:</td><td>10 - 15 N/Sq.mm</td></tr> <tr> <td>Maximum Safe Continuous Temperature</td><td>:</td><td>70 Deg.C</td></tr> <tr> <td>Ultimate Elongation</td><td>:</td><td>Not less than 275%</td></tr> </table> <p><b>3.23.04 Bitumen Compound</b></p> <p>When shown in drawing or directed, the gap in expansion joints shall be</p>			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%	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%
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	<p>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.</p> <p><b>3.23.05 Isolation Joints</b></p> <p>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.</p> <p><b>3.23.06 Pad</b></p> <p>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.</p> <p><b>3.24.00 Grouting under Machinery or Structural Steel Bases</b></p> <p>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.</p> <p><b>3.25.00 Precast Concrete</b></p> <p>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,</p>	


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	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p><b>3.26.00      Waterproofing of Concrete Structure</b></p> <p><b>3.26.01      General</b></p> <p>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.</p> <p><b>3.26.02      Water Bar/Seal/Special Treatment of Construction Joint</b></p> <p>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</p>	

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	<p>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.</p> <p><b>Method 1:</b> 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</p> <table> <tr> <td>Compressive strength</td><td>-</td><td>55 to 60 N/Sq.mm</td></tr> <tr> <td>Flexural strength</td><td>-</td><td>5 to 30 N/sq.mm</td></tr> <tr> <td>Tensile strength</td><td>-</td><td>15 N/Sq.mm (approx.)</td></tr> <tr> <td>Bonding strength to concrete</td><td>-</td><td>3 N/Sq.mm (approx.)</td></tr> <tr> <td>Bonding strength to steel</td><td>-</td><td>20 N/Sq.m (approx.)</td></tr> </table> <p>The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.</p> <p><b>Method 2:</b> 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.</p>	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.)	
Compressive strength	-	55 to 60 N/Sq.mm															
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Bonding strength to steel	-	20 N/Sq.m (approx.)															


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<b>3.26.03</b>	<b>Waterproofing Admixtures</b>  <p>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.</p> <p>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.</p> <p>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.</p>	
<b>3.26.04</b>	<b>Structural waterproofing</b>  <p>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.</p> <p>b) External Treatment</p> <p>Two layers of (1:4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer</p>	


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<p style="text-align: center;">surface of concrete underground structures.</p> <p><b>3.26.05      Protective coating on Inside Surface.</b></p> <p>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.</p> <p><b>3.26.06      Bitumen Felt: Application for Tanking</b></p> <p>This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.</p> <p>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.</p> <p>The Contractor shall execute this work in direct collaboration with one of the well-known specialized firm approved by the Engineer.</p> <p>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.</p> <p><b>3.26.07      Polyethylene Films: Application in Walls or base of structures</b></p> <p>Waterproof treatment shall be applied as outlined and as per sequence given hereunder</p> <ol style="list-style-type: none"> <li>i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.</li> <li>ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum</li> <li>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.</li> </ol> <p style="text-align: center;">Alternatively, the overlaps shall be heat sealed by an electric iron having</p>		




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	<p>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.</p> <p>iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,</p> <p>v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.</p> <p>vi) Lay 250-micron polyethylene film as second layer similar to (iii)above.</p> <p>viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.</p> <p>ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.</p> <p>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.</p> <p><b>3.27.00 Protective Coating on Concrete Surface</b></p> <p><b>3.27.01 On Foundation</b></p> <p>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.</p> <p><b>4.00.00 SAMPLING AND TESTING</b></p> <p><b>4.01.00 General</b></p> <p>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.</p>	



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<b>4.02.00</b>	<b>Cement</b>  <p>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.</p>	
<b>4.03.00</b>	<b>Aggregates</b>	
	<p>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.</p>	
<b>4.04.00</b>	<b>Water</b>	
	<p>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.</p>	
<b>4.05.00</b>	<b>Admixture</b>	
<b>4.05.01</b>	<b>Air Entraining Agents</b>	
	<p>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.</p>	
<b>4.05.02</b>	<b>Other Admixtures</b>	
	<p>Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.</p>	
<b>4.06.00</b>	<b>Concrete</b>	

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	<p>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.</p> <p><b>5.00.00 ACCEPTANCE CRITERIA</b></p> <p><b>5.01.00 Standard Deviation</b></p> <p>Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.</p> <p><b>5.02.00 Acceptance Criteria</b></p> <p>The strength requirements and acceptance criteria shall conform to IS: 456.</p> <p><b>5.03.00 Inspection and Core Tests</b></p> <p>Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.</p> <p><b>5.04.00 Load Test</b></p> <p>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.</p> <p>If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.</p> <p>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.</p> <p>If, in the course of dismantling, any damage is done to the embedded items</p>	

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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**


- 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.
- 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.
- 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.
- The unit rates shall include all arrangement for maintaining stability of structure during execution.
- Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.
- 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.


- The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.
- 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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	<p>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.</p> <p>b) No deductions shall be made for the following:</p> <p>i) Ends of dissimilar materials embedded inside for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm in cross section;</p> <p>ii) Opening upto 0.1 sq.m.</p> <p>iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.</p> <p>iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.</p> <p>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.</p> <p>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 23°C.</p> <p><b>6.02.00 Reinforcement</b></p> <p><b>6.02.01 Rates</b></p> <p>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.</p> <p>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.</p> <p>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</p>	


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	<p>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.</p> <p>d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).</p> <p>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.</p> <p><b>6.02.02 Measurements</b></p> <p>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.</p> <p>b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.</p> <p><b>6.03.00 Formwork and Staging</b></p> <p><b>6.03.01 Rates</b></p> <p>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.</p> <p>b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.</p> <p>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.</p> <p>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.</p>	


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	<p>e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.</p> <p>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.</p> <p><b>6.03.02      Measurements</b></p> <p>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.</p> <p>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.</p> <p>For suspended floor, no deduction shall be made for flange area of secondary steel beams.</p> <p>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.</p> <p>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.</p> <p>e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.</p> <p><b>6.04.00      Embedded Parts</b></p> <p><b>6.04.01      Rates</b></p> <p>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 &amp; installation including setting material in concrete, etc. complete.</p> <p>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.</p> <p>c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.</p>	


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<b>6.04.02</b>	<b>Measurements</b> <p>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.</p> <p>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.</p> <p>c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.</p> <p>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.</p> <p>e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.</p> <p>f) The expansion fasteners shall be measured in number according to tension capacity.</p> <p>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.</p>	
<b>6.05.00</b>	<b>Groutings</b>	
<b>6.05.01</b>	<b>Rates</b>	
	Rate shall include the cost of surface preparation, admixtures, and curing.	
<b>6.05.02</b>	<b>Measurements:</b>	
	<p>a) Measurement shall be in cubic decimeters.</p> <p>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.</p> <p>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.</p>	





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	<p>d) No deduction shall be made for shims, bolts, shear keys and such other embedments.</p> <p>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.</p> <p><b>6.06.00 Joints</b></p> <p><b>6.06.01 Rates</b></p> <p>The unit rate shall include all the activities described in the schedule of items.</p> <p><b>6.06.02 Measurements</b></p> <p>a) Bitumen Board/Expanded polystyrene.</p> <p>The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.</p> <p>b) Water Stops</p> <p>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.</p> <p>c) Metal Cover Strips</p> <p>The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.</p> <p>d) Vibration Damping Resilient Pads</p> <p>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.</p>	
	<p><b>6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete</b></p>	


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<b>6.07.01</b>	<b>Rates</b>  <p>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.</p> <p>In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.</p> <p>In the case of chipping work, the cutting of reinforcement shall be paid separately.</p> <p>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.</p>	
<b>6.07.02</b>	<b>Measurements</b>  <p>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.</p> <p>b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).</p> <p>c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.</p>	
<b>6.08.00</b>	<b>Precast Concrete</b>  <p>This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.</p>	
<b>6.08.01</b>	<b>Rates</b>  <p>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.</p>	
<b>6.08.02</b>	<b>Measurements</b>  <p>The measurement of pre-cast concrete members shall be on the basis of</p>	

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<p>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.</p> <p><b>7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE</b></p> <p>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:-</p> <p>IS: 73 - Indian Standard Specification for Paving Bitumen</p> <p>IS: 216 - Indian Standard Specification for Coal Tar Pitch</p> <p>IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete</p> <p>IS: 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement</p> <p>IS: 455 - Indian Standard Specification for Slag Cement</p> <p>IS: 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete</p> <p>IS: 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures</p> <p>IS: 516 - Indian Standard Specification for Methods of Test for Strength</p>		


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	<p style="text-align: center;">of Concrete</p> <p>IS: 702 -      Indian Standard specification for industrial bitumen.</p> <p>IS: 1199 -      Indian Standard Specification for Methods of Sampling and Analysis of Concrete</p> <p>IS: 1322 -      Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing</p> <p>IS: 1489 -      Indian Standard Specification for Portland Pozzolona Cement</p> <p>IS: 1566 -      Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.</p> <p>IS: 1609 -      Code of Practice for Laying Damp-proof Treatment using Bitumen Felts</p> <p>IS: 1786 -      Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.</p> <p>IS: 1791 -      Indian Standard Specification for Batch Type Concrete Mixers.</p> <p>IS: 1838 -      Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).</p> <p>IS: 2185 -      Indian Standard Specification for Hollow Cement Concrete Blocks</p> <p>IS: 2210 -      Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates</p> <p>IS: 2386 -      Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII</p> <p>IS: 2502 -      Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement</p> <p>IS: 2505 -      Indian Standard Specification for Concrete Vibrators, Immersion Type</p> <p>IS: 2506 -      Indian Standard Specification for Screed Board Concrete Vibrators</p> <p>IS: 2514 -      Indian Standard Specification for Concrete Vibrating Tables</p>	

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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 Batches 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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	<p style="text-align: center;">Stacking and Storage of Construction Materials at site</p> <p>IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches</p> <p>IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes</p> <p>IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete</p> <p>IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant</p> <p>IS: 4926 - Indian Standard Specification for Ready Mixed Concrete</p> <p>IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work</p> <p>IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground</p> <p>IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I &amp; II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials</p> <p>IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.</p> <p>IS: 5256 - Code of practice for sealing joints in concrete lining on canals.</p> <p>IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials</p> <p>IS: 5513 - Indian Standard Specification for vacate Apparatus.</p> <p>IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.</p> <p>IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.</p> <p>IS: 5624 - Indian Standard Specification for foundation bolts.</p> <p>IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks.</p> <p>IS: 5816 - Indian Standard Specification for Method of Test for Splitting</p>	

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	<p style="text-align: center;">Tensile strength of Concrete Cylinders.</p> <p>IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.</p> <p>IS: 5892 - Indian Standard Specification for transit mixer and agitators.</p> <p>IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use</p> <p>IS: 6909 - Indian Standard Specification for Super sulphated Cement</p> <p>IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.</p> <p>IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.</p> <p>IS: 7242 - Indian Standard Specification for Concrete Spreaders.</p> <p>IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.</p> <p>IS: 7251 - Indian Standard Specification for Concrete Finishers.</p> <p>IS: 7293 - Safety code for working with construction machinery.</p> <p>IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.</p> <p>IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&amp;II for Extreme Weather Concreting.</p> <p>IS: 7969 - Safety Code for Storage and Handling of Building Materials.</p> <p>IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.</p> <p>IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.</p> <p>IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.</p> <p>IS: 8989 - Safety Code for Erection of Concrete Framed Structures.</p>	



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	<p>IS: 9012 -    Recommended method for shortcreting.</p> <p>IS: 9013 -    Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.</p> <p>IS: 9077 -    Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.</p> <p>IS: 9103 -    Indian Standard Specification for Admixtures for Concrete.</p> <p>IS: 10262 -    Recommended Guidelines for Concrete Mix Design.</p> <p>IS: 13311 -    Non-destructive testing of concrete.</p> <p>SP: 34 -    Handbook of concrete, reinforcement and detailing.</p>	

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## SECTION - D


### SUB-SECTION – D5

## METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

**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**

 <b>BHEL</b> Maharatna Company	TITLE: <b>TECHNICAL SPECIFICATION          FOR METAL DOORS, WINDOWS,          VENTILATORS, LOUVERS ETC.</b>	SPECIFICATION NO. PE-TS-635-600-C001 VOLUME - SECTION - D   SUB-SECTION – D5 REV.NO. 00 DATE 13/02/2018 SHEET 2 OF 15
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## **METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.**

### **1.00.00 SCOPE**

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The scope of work shall also include the assembly and erection of all doors, windows, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

### **2.00.00 INSTALLATION**

#### **2.01.00 Materials**


Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified.


Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.


Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:733 or IS:1285 or as manufactured by Indian Aluminium Company Limited or approved equivalent. Aluminium door, windows and ventilator shall be fabricated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified and the best quality from approved manufacturers shall only be used. The tenderer shall specifically state the particular manufacturer's materials he proposes to use. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility.


All hardware and fixtures shall be able to withstand repeated use. Door closures shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or shall be replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance Requirements and endurance test stated in IS: 3564 - Appendix-A. The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In general, mastic for fixing of metals frames shall be as per IS: 1081 or as approved by the Engineer.


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<b>2.02.00</b>	<b>Fabrication</b>	
<b>2.02.01</b>	<b>Steel Doors, Windows, Ventilators, louvers etc.</b>	
	a) Door Frames	
	<p>Frames shall be fabricated from 16 gage(G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered Corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose “T” masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be installed. Frames shall be brought to site with floor ties/weather bars installed in, place.</p>	
	b) Double Plate Flush Door Shutters	
	<p>Door shutters shall be 45 mm thick, completely flush design and shall comprise of the outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.</p>	
	<p>Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. Where shown on drawing, or called for in the schedule of items, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.</p>	
	<p>Doors shall be mortised, reinforced, drilled, and tapped in shop for hinges, locks, and bolts. They shall also be reinforced for closers, push-plates, and other surface hardware's where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.</p>	


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	<p>c) Single Sheet Door Shutters</p> <p>Single sheet doors shall be made from best quality 18 G mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail, which shall convey the lock and other fixture. The frames shall be made from best quality, 16 G mild steel sheets.</p> <p>Wherever required, provisions for fixing glass panes, louvers etc. shall be made.</p> <p>The manufacturing shall be done as specified in 2.02.01 (b) “Double Plate Flush Door Shutters.”</p> <p>d) Sliding Door</p> <p>Sliding doors shall be either double plate or single plate Construction made out of 18-gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.</p> <p>e) Door Threshold</p> <p>Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.</p> <p>f) Steel Windows, Sashes, and Ventilators etc.</p> <p>These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Jindal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.</p>	


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<b>2.02.02</b>	<p><b>Aluminium Door, Windows, and Frames</b></p> <p>Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15-micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.</p> <p>All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.</p>	
<b>2.03.00</b>	<p><b>Shop Coat or Paint</b></p> <p>The shop Paint for steel doors, windows etc. shall be best lead or zinc chromate primer paint from, approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.</p> <p>Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1½ - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.</p> <p>Portions of aluminium frame, which come in contact with masonry construction shall be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.</p>	
<b>2.04.00</b>	<p><b>Handling &amp; Storage of Fabricated Material</b></p> <p>All metal doors, windows, etc. shall be packed and crated properly before dispatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.</p>	





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	<p>When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.</p> <p>All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.</p> <p><b>2.05.00 Assembly &amp; Erection at Site</b></p> <p>In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper “Lines and levels”, and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take all precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation, without any extra charge.</p> <p>After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.</p> <p>All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the cement in original sealed containers of manufacturer and shall apply it as per the instruction. For all frames supplied by either the owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.</p> <p>Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.</p> <p>Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one meters from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.</p>	


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<b>2.06.0</b>	<b>Fire proof Door</b>  <p>Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from external fire. The construction details of door shall conform to the requirements stipulated in IS:3614 (Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be approved by Tariff Advisory Committee and shall have minimum 2 hrs. fire rating.</p> <p>Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open outside.</p> <p>All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting.</p>	
	<b>3.00.00 ACCEPTANCE CRITERIA</b>	
	<b>3.01.00 For fabricated Items</b>	
	<ul style="list-style-type: none"> <li>a) Overall dimensions shall be within <math>\pm 1.5</math> mm of the size shown on drawings.</li> <li>b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to <math>\pm 1.5</math> mm from the axis of the member.</li> <li>c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm for double leaf doors; the gap at the meeting stiles shall not be more than 1.5 mm.</li> <li>d) Door leaves shall be undercut where shown on drawings.</li> <li>e) Doors, windows, frames, etc. shall be on a true plane, free from warp or buckle.</li> <li>f) All welds shall be dressed flush on exposed and contact surfaces.</li> <li>g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures</li> <li>h) Provision for hardware and fixtures to be installed at site.</li> <li>i) Glazing beads shall be cut with mitered corners.</li> <li>j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.</li> </ul>	

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	<p>k) Shop coats shall be properly applied.</p> <p>l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.</p> <p><b>3.02.00 For installed Items</b></p> <p>a) Installations shall be at correct location, elevation and in general, on a true vertical plane.</p> <p>b) Fixing details shall be strictly as shown on drawings.</p> <p>c) Assembly of composite units shall be strictly, as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.</p> <p>d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.</p> <p>e) All openable section shall operate smoothly without jamming.</p> <p>f) Locks, fasteners etc. shall be engage positively. Key shall, be non-interchangeable.</p> <p>g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.</p> <p>h) Aluminium doors, windows, etc. shall be free from scratches stain or discoloration.</p> <p><b>4.00.00 INFORMATION TO BE SUBMITTED</b></p> <p><b>4.01.00 With Tender</b></p> <p>a) Names of manufacturers for Doors, windows etc.</p> <p>b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.</p> <p><b>4.02.00 After Award</b></p> <p>a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.</p>	


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<b>5.00.00</b>	<p>b) He shall submit a programme of work to be done for the approval of the Engineer.</p> <p>c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.</p> <p><b>IS CODES</b></p> <p>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.</p> <table border="0"> <tr> <td>Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)</td> <td>-</td> <td>IS: 733</td> </tr> <tr> <td>Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)</td> <td>-</td> <td>IS: 1285</td> </tr> <tr> <td>Steel doors, windows, and ventilators</td> <td>-</td> <td>IS: 1038</td> </tr> <tr> <td>Steel windows for industrial, building</td> <td>-</td> <td>IS: 1361</td> </tr> <tr> <td>Aluminium doors windows, and ventilators</td> <td>-</td> <td>IS: 1948</td> </tr> <tr> <td>Aluminium windows for industrial buildings</td> <td>-</td> <td>IS: 1949</td> </tr> <tr> <td>Steel doorframes</td> <td>-</td> <td>IS: 4351</td> </tr> <tr> <td>Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.</td> <td>-</td> <td>IS: 1081</td> </tr> <tr> <td>Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type</td> <td>-</td> <td>IS: 3614</td> </tr> <tr> <td>Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification</td> <td>-</td> <td>IS: 7452</td> </tr> </table>	Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733	Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)	-	IS: 1285	Steel doors, windows, and ventilators	-	IS: 1038	Steel windows for industrial, building	-	IS: 1361	Aluminium doors windows, and ventilators	-	IS: 1948	Aluminium windows for industrial buildings	-	IS: 1949	Steel doorframes	-	IS: 4351	Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081	Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614	Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452	
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 BHEL Bharat Heavy Electricals Limited	TITLE: <b>TECHNICAL SPECIFICATION          FOR METAL DOORS, WINDOWS,          VENTILATORS, LOUVERS ETC.</b>	SPECIFICATION NO. PE-TS-635-600-C001 VOLUME - SECTION - D   SUB-SECTION – D5 REV.NO. 00 DATE 13/02/2018 SHEET 11 OF 15
<b>6.00.00</b>	<b>RATES AND MEASUREMENT</b>	
<b>6.01.00</b>	<b>Rates</b>	
	<p>Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per “Schedule of Items”.</p> <p>Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.</p> <p>Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.</p>	
<b>6.02.00</b>	<b>Measurement</b>	
	<p>Supply and installation of doors, windows, and ventilators shall be measured in Sqm or Kg as per BOQ item. If measured in sqm, it shall be for net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in “Schedule of Items”. Frame for steel or aluminum shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminum partition frames shall be in Kg. Paneling and glazing shall be paid separately if not covered in BOQ item description.</p> <p>Measurement for fire proof door shall be in Sqm in net area outer to outer of the door.</p>	

 <b>BHEL</b> Maharatna Company	TITLE: <b>TECHNICAL SPECIFICATION          FOR METAL DOORS, WINDOWS,          VENTILATORS, LOUVERS ETC.</b>	SPECIFICATION NO. PE-TS-635-600-C001 VOLUME - SECTION - D   SUB-SECTION – D5 REV.NO. 00   DATE 13/02/2018 SHEET 12 OF 15
<div style="text-align: right;">ANNEXURE-A</div> <div style="text-align: center;"> <b>SCHEDULE OF FIXTURES</b> </div>		
<b>A. TIMBER DOORS</b>		
1. For single leaf panel/flush doors		
i) 100 mm brass butt hinges with screws - 3 Nos.		
ii) 150 mm brass tower bolts with screws - 1 No.		
iii) 100 mm x 225 mm clear plastic push Plate with counter sunk brass screws - 1 No.		
iv) 30 mm brass ring pull handle with Plates and screws - 1 No.		
v) 150 mm brass coat hook with screws - 1 No.		
vi) Heavy duty, cylinder looks on active leaf - for flush door. For door- closure, see "Door Schedule".		
<b>B. ALUMINIUM DOORS</b>		
1. For double leaf door		
i) Concealed hanging arrangement for door leaves.		
ii) Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.		
iii) Heavy duty, cylinder look on active leaf.		
iv) Pull handle of approved design on both leaves.		
v) Doors stops for both leaves.		
vi) Overhead door closure for both leaves.		

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ANNEXURE-A					
<b>C. STEEL DOORS AND WINDOWS</b>					
<b>1. Doors</b>					
a) Double leaf doors					
i) 100 mm butt hinges - 3 Nos. on each leaf.					
ii) 300 mm aluminum tower bolt - 2 Nos. (top and bottom) On inside of inactive Leaf. 1. No. (Top only) On inside active leaf.					
iii) 200 mm anodized aluminum pull handle - 1 No. of each leaf.					
iv) Door stop of approved design - 1 No. of each leaf.					
NOTE: For locks, door closure and threshold, see "Door Schedule".					
b) Single leaf doors					
i) 100 mm butt hinges - 3 Nos.					
ii) 300 mm aluminum tower bolt - 2 Nos. top & bottom of Inside face					
iii) 200mm anodised aluminum Pull handle - 1 No.					
iv) Door stop of approved design - 1 No.					
NOTE: For locks, door closures and threshold, see “Door Schedule”.					
<b>2. Windows, Ventilators, etc.</b>					
a) Side Hung Windows					
i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.					
ii) 12" peg stays - 1 No. per leaf					



	TITLE: <b>TECHNICAL SPECIFICATION FOR METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.</b>	SPECIFICATION NO. PE-TS-635-600-C001 VOLUME - SECTION - D   SUB-SECTION – D5 REV.NO. 00   DATE 13/02/2018 SHEET 14 OF 15
<p style="text-align: right;">ANNEXURE-A</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>iii) 2 point handles</p> <p>b) Top Hung Ventilators (Projecting Out)</p> <p>    i) Hinges</p> <p>        ii) Adjustable sliding fabrication             assembles</p> <p>        iii) 2 point handles</p> <p>c) Bottom Hung Ventilators (Projecting in)</p> <p>    i) Hinges</p> <p>        ii) Concealed side arms for             opening adjustment.</p> <p>        iii) Spring Catch</p> </div> <div style="width: 45%;"> <p>- 1 No. per leaf</p> <p>- As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.</p> <p>- 2 Nos. per leaf.</p> <p>- 1 No. per leaf.</p> <p>- As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.</p> <p>- 2 Nos. per leaf.</p> <p>- 1 No. per leaf.</p> </div> </div>		

	TITLE: <b>TECHNICAL SPECIFICATION FOR METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.</b>	SPECIFICATION NO. PE-TS-635-600-C001 VOLUME - SECTION - D   SUB-SECTION – D5 REV.NO. 00   DATE 13/02/2018 SHEET 15 OF 15
<div style="text-align: right;">ANNEXURE-A</div> <p><b>D. ALUMINIUM WINDOW, VENTILATORS, ETC.</b> (As per IS-1948 latest editions)</p> <p>a) Side Hung Windows</p> <p>i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.</p> <p>ii) 300 mm peg stays - 1 No per leaf</p> <p>iii) 2 point handles - 1 No per leaf</p> <p>b) Top Hung Ventilators (Projecting out)</p> <p>i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.</p> <p>ii) Adjustable sliding fabrication assemblies - 2 Nos. per leaf</p> <p>iii) 2 Point handles - 1 No. per leaf</p> <p>c) Bottom Hung Ventilation &amp; (Projecting In)</p> <p>i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.</p> <p>ii) Concealed side arms for opening adjustment - 2 Nos. per leaf</p> <p>iii) Spring Catch - 1 No. per leaf</p>		

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	TITLE:		SPECIFICATION NO. PE-TS-635-600-C001	
	<b>TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS AND GRILLS</b>		VOLUME -	
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## SECTION - D

### SUB-SECTION – D7

### ROLLING STEEL SHUTTERS AND GRILLS

**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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	TITLE:		SPECIFICATION NO. PE-TS-635-600-C001	
	<b>TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS AND GRILLS</b>		VOLUME -	
			SECTION - D SUB-SECTION – D7	
			REV.NO. 00 DATE 13/02/2018	
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## C O N T E N T

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1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA & GUARANTEE	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	5

	TITLE:		SPECIFICATION NO. PE-TS-635-600-C001	
	<b>TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS AND GRILLS</b>		VOLUME -	
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## **ROLLING STEEL SHUTTERS AND GRILLS**


### **1.00.00 SCOPE**


This Section covers the design and supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

### **2.00.00 INSTALLATION**

#### **2.01.00 Components**

- a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
- b) Rolling grills shall be constructed out of 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia. rods.
- c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.
- d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.
- e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.
- f) Shafts shall be of steel pipe of sufficient size to carry the tensional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.
- g) Hoods shall be formed of not less than 20-gauge steel, suitable reinforced to prevent sag.
- h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as prescribed by the Engineer.

	<b>TITLE:</b> <b>TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS AND GRILLS</b>	<b>SPECIFICATION NO.</b> PE-TS-635-600-C001 <b>VOLUME -</b> <b>SECTION - D</b> <b>SUB-SECTION - D7</b> <b>REV.NO.</b> 00 <b>DATE</b> 13/02/2018 <b>SHEET</b> 4 <b>OF</b> 5
	<p>i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and be either floor or wall mounted unit. The motor shall be of sufficient capacity, to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing.</p> <p>It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.</p> <p>j) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection.</p> <p>k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.</p> <p><b>2.02.00      Manually Operated Shutters/Grills</b></p> <p>Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for opening up to 9 Sq. metre in area. Larger shutters shall, be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.</p> <p><b>2.03.00      Power operated Shutters/Grills</b></p> <p>These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.</p> <p><b>2.04.00      Shop Coat</b></p> <p>Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.</p> <p><b>2.05.00      Erection</b></p> <p>Door shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters</p>	

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	and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.		
3.00.00	ACCEPTANCE CRITERIA AND GUARANTEE		
3.01.00	Shop Inspection		
	After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.		
3.02.00	Field Inspection		
	After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.		
3.03.00	Guarantee		
	The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.		
4.00.00	I.S. CODE		
	IS: 6248 - Metal rolling shutters and rolling grills.		
5.00.00	RATES AND MEASUREMENT		
5.01.00	Rates		
	Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.		
5.02.00	Measurement		
	Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in “Schedule of Items”.		



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	<b>TITLE:</b> <b>TECHNICAL SPECIFICATION FOR</b> <b>MISCELLANEOUS METAL SIDING</b>		SPECIFICATION NO. PE-TS-635-600-C001	
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## SECTION - D

### SUB-SECTION – D8

### MISCELLANEOUS METAL

**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**

1394217/2023/PS-SR-PM

	<b>TITLE:</b> <b>TECHNICAL SPECIFICATION FOR</b> <b>MISCELLANEOUS METAL SIDING</b>		SPECIFICATION NO. PE-TS-635-600-C001	
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## C O N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	7
4.00.00	IS CODES	8
5.00.00	RATES AND MEASUREMENTS	8

 Maharatna Company	<b>TITLE:</b> <b>TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL SIDING</b>	SPECIFICATION NO. PE-TS-635-600-C001			
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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 be 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.

	<b>TITLE:</b> <b>TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL SIDING</b>	SPECIFICATION NO. PE-TS-635-600-C001 VOLUME - SECTION - D      SUB-SECTION - D8 REV.NO.      00      DATE      13/02/2018 SHEET      4      OF      9
<b>2.02.00</b>	<b>Erection</b>	
<b>2.02.01</b>	<b>Bracing</b>	
	<p>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.</p>	
<b>2.02.02</b>	<b>Temporary Bolting-Up</b>	
	<p>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.</p>	
<b>2.02.03</b>	<b>Turned Bolt</b>	
	<p>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.</p>	
<b>2.02.04</b>	<b>Welding</b>	
	<p>Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium &amp; Alloys.</p>	
<b>2.02.05</b>	<b>Cutting and Fitting</b>	
	<p>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.</p>	
<b>2.02.06</b>	<b>Drifting</b>	
	<p>Correction minor misfits and a reasonable amount of reading 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.</p>	

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	<p>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.</p> <p><b>2.02.07 Spot Painting</b></p> <p>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.</p> <p><b>2.02.08 Good</b></p> <p>All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.</p> <p><b>2.02.09 Grouting</b></p> <p>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.</p> <p><b>2.02.10 Anchor Fasteners</b></p> <p>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.</p> <p><b>Heavy Duty Anchor Fasteners</b></p> <p>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.</p> <ol style="list-style-type: none"> <li>Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.</li> <li>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.</li> </ol>	

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	<p>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.</p> <p>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.</p> <p>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.</p> <p><b>Light Duty Anchors</b></p> <p>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.</p> <p><b>2.02.11 Pipe Joints</b></p> <p>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.</p> <p><b>2.03.0 FENCING</b></p> <p><b>2.03.01 Chain Link Fencing</b></p> <p>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 <math>\pm 0.05</math>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</p>	



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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  $75 \pm 12$ 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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	<p>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.</p> <p><b>3.00.00 ACCEPTANCE CRITERIA</b></p> <p>a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.</p> <p>b) For installed items, the tolerances shall be as follows</p> <p>i) Permissible deviation from, straightness – 1 in 1000.</p> <p>ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.</p> <p>c) All castings shall be free from blowholes, cracks, and other blemishes.</p> <p>d) All MS wire fencing shall be in true vertical plain, and shall not bulge.</p> <p><b>4.00.00 IS CODES</b></p> <p>IS:278 Specification for Galvanized Steel Barbed wire for fencing.</p> <p>IS:816 Code of practice for use of Metal Arc welding for general construction in mild steel.</p> <p>IS:1367 Industrial Fasteners – Threaded steel fasteners - Technical supply condition.</p> <p>IS:2721 Specification for Galvanized Steel Chain Link fence fabric.</p> <p>IS:2812 Arc welding of Aluminum and Alloy</p>	

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<b>5.00.00</b>	<b>RATES AND MEASUREMENTS</b>	
<b>5.01.0</b>	<b>Rates</b>	
	<p>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.</p> <p>Rate for fencing shall also include excavation, concreting and supply, erection &amp; fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.</p>	
<b>5.02.0</b>	<b>Measurements</b>	
	<p>Measurement for MS gates shall be in MT.</p>	
	<p>Measurement for galvanised MS wire fencing shall be in Sqm.</p>	
	<p>Measurement for Anchors shall be in nos. for the type as specified in schedule of items.</p>	
	<p>Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.</p>	



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**PAINTING, WHITEWASHING,**  
**POLISHING**

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**PAINTING, WHITEWASHING, POLISHING**


**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**

1394217/2023/PS-SR-PM


 Maharatna Company	TITLE: TECHNICAL SPECIFICATION FOR PAINTING, WHITEWASHING, POLISHING	SPECIFICATION NO. PE-TS-635-600-C001																					
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<p style="text-align: center;"><b><u>PAINTING, WHITE WASHING, POLISHING, ETC.</u></b></p> <p><b>1.00.00      SCOPE</b></p> <p>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.</p> <p>Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.</p> <p>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.</p> <p><b>2.00.00      INSTALLATION</b></p> <p><b>2.00.01      Materials</b></p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>		

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	<p>a) White Wash/Colour Wash</p> <p>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.</p> <p>b) Dry distemper</p> <p>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.</p> <p>c) Oil Bound Washable Distemper</p> <p>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.</p> <p>d) Waterproof Cement Paint</p> <p>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.</p> <p>e) Acrylic Emulsion Paint</p> <p>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.</p>	

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	<p>f) Synthetic Enamel Paint</p> <p>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.</p> <p>g) Aluminium Paint</p> <p>Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.</p> <p>h) Varnishing</p> <p>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.</p> <p>i) French Polish</p> <p>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.</p> <p>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.</p> <p>j) Bitumen paint (black bituminous anti-corrosive paint)</p> <p>Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.</p> <p><b>2.00.02      Storage</b></p> <p>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, &amp; 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.</p> <p><b>2.01.00      Preparation of surface</b></p> <p>Before starting the work, the Contractor shall obtain the approval of the Engineer regarding the soundness &amp; readiness of the surface to be painted on.</p>	



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<b>2.01.02</b>	<p><b>Wood</b></p> <p>All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails &amp; 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 &amp; 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.</p> <p><b>2.01.02 Masonry, Concrete, and Plastered Surface</b></p> <p>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.</p> <p>Surface with <b>Mildew or Efflorescence</b> shall be treated as below:</p> <p>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.</p> <p><b>2.01.03 Metal</b></p> <p>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.</p>	

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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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<b>2.02.02</b>	<b>White Washing</b>  <p>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.</p> <p>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.</p>	
<b>2.02.03</b>	<b>Dry Distemper</b>  <p>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.</p> <p>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.</p>	
<b>2.02.04</b>	<b>Oil bound washable distemper</b>  <p>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.</p>	
<b>2.02.05</b>	<b>Waterproof Cement Paint</b>  <p>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.</p>	


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<b>2.02.06</b>	<b>Acrylic Emulsion Paint</b>  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.	
<b>2.02.07</b>	<b>Synthetic Enamel Paint</b>	
	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.	
<b>2.02.08</b>	<b>Aluminium Paint</b>	
	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.	
<b>2.02.09</b>	<b>Clear Synthetic Varnish</b>	
	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 flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a	

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	<p>hard dry surface before next coat is applied. All work shall be as per relevant IS Code.</p> <p><b>2.02.10      French polish</b></p> <p>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.</p> <p>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.</p> <p><b>2.02.11      Chemical Resistant Paint</b></p> <p>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 &amp; fumes, shall be followed.</p> <p><b>2.03.00      Protection</b></p> <p>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.</p> <p><b>2.04.00      Cleaning up</b></p> <p>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.</p>	



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<b>3.00.00</b>	<b>ACCEPTANCE CRITERIA AND TESTING</b>  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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<p><b>Testing</b></p> <p>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.</p> <p>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.</p> <p>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.</p> <p><b>4.00.00      I.S. CODE</b></p> <p>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.</p> <p>IS: 348      Specification for French polish</p> <p>IS: 427      Specification for Distemper, dry colour as required.</p> <p>IS: 428      Specification for Distemper oil emulsion, colour as required.</p> <p>IS: 1477 (I &amp; II)      Code of Practice for painting of ferrous metal in buildings.</p>		





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	<p>IS: 2338 (I &amp; II) Code of Practice for finishing of wood and wood based materials.</p> <p>IS: 2339 Specification for Aluminium, Paints for general purposes in dual containers.</p> <p>IS: 2395 Code of Practice for painting concrete, masonry, and Plaster surface.</p> <p>IS: 2932 Specification for enamel, exterior type-1.</p> <p>IS: 5410 Specification for cement paint, colour as required.</p> <p><b>5.00.00 RATES AND MEASUREMENT</b></p> <p><b>5.01.00 Rates</b></p> <p>Rates shall be unit rates for complete items described in the “Schedule of Items”.</p> <p>Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.</p> <p><b>5.02.00 Measurements</b></p> <p>Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.</p> <p>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.</p>	


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<p style="text-align: center;"> <b>SECTION - D</b>   <b>SUB-SECTION – D12</b>   <b>FLOOR FINISH AND ALLIED WORKS</b>   <b>SPECIFICATION NO. PE-TS-635-600-C001</b> </p> <p style="text-align: center;">   <b>Bharat Heavy Electricals Limited</b>  <b>Project Engineering Management</b>  <b>PPEI Building, Power Sector,</b>  <b>Plot No. 25, Sector 16A,</b>  <b>Noida (U.P.)-201301</b> </p>		

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<b>C O N T E N T</b>				
<b>CLAUSE NO.</b>	<b>DESCRIPTION</b>	<b>SHEET NO.</b>		
1.00.00	SCOPE	3		
2.00.00	INSTALLATION	4		
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<p style="text-align: center;"><b><u>FLOOR FINISH AND ALLIED WORKS</u></b></p> <p>1.00.0      SCOPE</p> <p>This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below</p> <p>a) In Situ Finishes</p> <ul style="list-style-type: none"> <li>i) Integral finish to concrete base</li> <li>ii) Terrazzo finish</li> <li>iii) Granolithic finishes</li> <li>iv) Patent Stone</li> <li>v) Metallic Hardener like “Ironte”/Hardonate Finish</li> <li>vi) Mastic Asphalt finishes</li> <li>vii) Chemical Resistant finish</li> </ul> <p>b) Tiled Finishes</p> <ul style="list-style-type: none"> <li>i) Terrazzo tile</li> <li>ii) Chequered tile</li> <li>iii) Glazed tile</li> <li>iv) Tesse rae (Mosaic etc.)</li> <li>v) Chemical Resistant</li> <li>vi) Rubber, Vinyl etc.</li> <li>vii) Stone Slab including Kota Stone.</li> </ul>		


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<b>1.01.00</b>	<b>Base</b>  The base to receive the finish is covered under other relevant specifications.  <b>1.01.01</b> <b>Sequence</b>  Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.  <b>2.00.00</b> <b>INSTALLATION</b>  <b>2.00.01</b> <b>Special Materials</b>  Basic materials are covered elsewhere under the Specification. In general, all such materials shall be as per relevant Codes where available. In all cases these materials shall be of the best quality available indigenously unless specified otherwise.  The materials for finishing items must be procured from well-reputed specialized manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.  <b>2.00.02</b> <b>Workmanship</b>  Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.  <b>2.00.03</b> <b>Preparation of the Base Surface</b>  The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.  For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water and hard brush and	


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	<p>detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification.</p> <p>To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up. The surface shall be bone dry where adhesives are used for fixing the finishes.</p> <p>Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as per the acceptability of the surface.</p> <p><b>2.01.00 In Situ Finishes</b></p> <p><b>2.01.01 Integral Finish to Concrete Base</b></p> <p>While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still 'green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.</p> <p>The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.</p> <p>As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.</p> <p><b>2.01.02 Terrazzo Finish in Situ</b></p> <p>It shall consist of an underbed and a topping laid over an already laid and matured concrete base.</p> <p>a) Thickness</p> <p>Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to achieve the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.</p>	


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	<p>b) Mix</p> <p>i) Underbed</p> <p>The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1-part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.</p> <p>ii) Topping</p> <p>The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1-part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.</p> <p>The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Sieve No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.</p> <p>c) Laying</p> <p>The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.</p> <p>Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.</p> <p>After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but firm enough to receive the</p>	





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	<p>topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in an even pattern of distribution.</p> <p>d) Curing</p> <p>The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.</p> <p>e) Grinding and Polish</p> <p>When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine cannot be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.</p> <p><b>2.01.03      Granolithic Finish</b></p> <p>Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.</p>	


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	<p>a) Thickness</p> <p>The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.</p> <p>b) Mix</p> <p>The mix shall consist of 1-part cement, 1-part coarse sand, 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.</p> <p>c) Laying of Monolithic Topping</p> <p>The concrete base shall be laid as per specification “Cement Concrete” and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.</p> <p>Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary, the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.</p> <p>The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.</p> <p>For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.</p> <p>d) Laying of Topping Separately on Hardened Base</p> <p>The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.</p> <p>Curing</p> <p>Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or ponding of water on the surface. The floor shall not be exposed to heavy traffic during this period.</p>	

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	<p>f) Grinding</p> <p>If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.</p> <p>g) Finishing</p> <p>Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.</p> <p><b>2.01.04 Patent Stone</b></p> <p>It shall consist of an underbed and a topping laid on an already laid and matured concrete base.</p> <p>a) Thickness</p> <p>The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.</p> <p>b) Mix</p> <p>i) Underbed</p> <p>The mix shall be as stipulated under clause 2.01.02 (b).</p> <p>ii) Topping</p> <p>The mix for the topping shall consist of 1-part cement and 2-part stone aggregate 6mm nominal size by volume.</p> <p>c) Laying</p> <p>The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.</p> <p>The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.</p> <p>A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with</p>	


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	<p>a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.</p> <p>After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.</p> <p><b>2.01.05 Metallic Hardener Like ‘Ironite’/ ‘Hardonate’ Finish</b></p> <p>This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is ‘green’.</p> <p>a) Thickness</p> <p>Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.</p> <p>b) Material</p> <p>The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.</p> <p>c) Mix</p> <p>Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1-part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.</p> <p>d) Laying</p> <p>The concrete floor shall be laid as per specification ‘Cement Concrete’ and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brash as soon as possible.</p>	

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<p>The finish shall be laid while the concrete underbed is still very 'green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigoursly and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.</p> <p>The finished floor shall be cured for 7 days by keeping it wet.</p> <p><b>2.01.06      Mastic Asphalt Finish</b></p> <p>This is a one-layer treatment on concrete or brick base.</p> <p>a) Thickness</p> <p>The thickness shall be as specified in the drawing.</p> <p>b) Materials</p> <p>Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.</p> <p>Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.</p> <p>Fine aggregate shall be crushed and graded natural limestone or other hard work.</p> <p>Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick &amp; 10 mm chips for thicker finish.</p> <p>c) Composition</p> <p>Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.</p> <p>d) Laying</p> <p>The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small</p>		

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	<p>quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.</p> <p>The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.</p> <p><b>2.01.07 Chemical Resistant in Situ Finish</b></p> <p>Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.</p> <p><b>2.02.00 Tiled Finish</b></p> <p>These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.</p> <p><b>2.02.01 Terrazzo Tile Finish</b></p> <p>The finish will consist of manufacture terrazzo and an underbed.</p> <p>a) Thickness</p> <p>The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.</p> <p>The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.</p> <p>b) Tiles: Terrazzo</p> <p>The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.</p> <p>Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be <math>\pm 1</math> mm and the</p>	

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	<p>thickness <math>\pm 3</math> mm. Face of the tile shall be plane, free from pinholes and other blemishes.</p> <p>The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.</p> <p>The total thickness including the topping shall be as specified but not less than 20 mm in any case.</p> <p>The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.</p> <p>The topping shall be as specified under clause 2.01.02 (b).</p> <p>The tile shall be cured at the shop for at last 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.</p> <p>Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.</p> <p>The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.</p> <p>c) Mix: Underbed</p> <p>The underbed for floor and similar horizontal surfaces shall be 1-part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1-part cement and 3 parts coarse sand by weight.</p> <p>d) Laying</p> <p>The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The</p>	



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joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

**2.02.02 Chequered Tile Finish**

The finish shall consist of manufactured gray or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).


b) Tiles: Chequered


The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.


The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.


c) Under-bed


As per clause 2.02.01 (c).


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	<p>d) Laying As per clause 2.02.01 (d).</p> <p>e) Grinding and Polishing  As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.</p> <p><b>2.02.03      Glazed Tiles Finish</b></p> <p>This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.</p> <p>a) Thickness  The total thickness shall be between 20mm and 25mm including the underbed.</p> <p>The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.</p> <p>b) Tiles: Glazed  The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be <math>\pm 1.5</math> mm for length and breadth and <math>\pm 0.5</math> mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawling, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.</p> <p>The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.</p>	

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	<p>c) Mix: Underbed</p> <p>The mix for the underbed shall consist of 1-part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.</p> <p>c) Laying</p> <p>Same as clause 2.02.01 (d).</p> <p>e) Finishing</p> <p>The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.</p> <p><b>2.02.04 Tesserae Finish (Mosaic etc.)</b></p> <p>This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.</p> <p>a) Thickness</p> <p>The total thickness including the underbed shall be between 16 mm &amp; 25 mm.</p> <p>b) Tesserae Finish</p> <p>These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.</p> <p>The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.</p> <p>c) Mix: Underbed</p> <p>Same as clause 2.02.03 (c)</p> <p>d) Laying</p> <p>The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-</p>	


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	<p>mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.</p> <p><b>2.02.05 Chemical Resistant Tiled Finish</b></p> <p>This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.</p> <p>a) Tiles</p> <p>The chemical resistant tiles shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.</p> <p>Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm<sup>2</sup>. The surface shall be abrasion resistant and durable.</p> <p>b) Laying</p> <p>The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.</p> <p><b>2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish</b></p> <p>This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.</p> <p>a) Thickness</p> <p>The thickness of the tiles shall be as incorporated in drawing.</p> <p>b) Tiles</p> <p>Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be <math>\pm 1.5</math> mm.</p>	


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	<p>The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.</p> <p>Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number, and date of manufacturer.</p> <p>Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.</p> <p>Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.</p> <p>c) Mix: Underbed</p> <p>The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1-part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.</p> <p>d) Laying</p> <p>The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.</p> <p>The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.</p> <p>The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.</p> <p>The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The</p>	

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<b>2.02.07</b>	<p>joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.</p> <p>e) Finishing</p> <p>If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried, and polished with an approved type of polish just before handing over.</p> <p><b>Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone</b></p> <p>a) Thickness</p> <p>The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.</p> <p>b) Stone Slab</p> <p>The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of <math>\pm 5</math> mm in dimensions and <math>\pm 2</math> mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.</p> <p>The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.</p> <p>The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.</p> <p>c) Mix: Underbed Same as clause 2.02.01 (c).</p> <p>d) Laying</p> <p>The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.</p> <p>The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to</p>	


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	<p>stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall</p> <p>be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.</p> <p>e) Polishing, Finishing</p> <p>Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.</p> <p><b>2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish</b></p> <p>Generally, clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.</p> <p>The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto <math>\pm 6</math> mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to <math>\pm 2</math> mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.</p> <p>The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form an inverted 'Y'.</p> <p><b>3.00.00 ACCEPTANCE CRITERIA</b></p> <p>The finish shall be checked specially for:</p> <ol style="list-style-type: none"> <li>Level, Slope, Plumb as the case may be</li> <li>Pattern and Symmetry</li> <li>Alignment of joints, dividing strip etc.</li> <li>Colour, texture</li> </ol>	



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<p>e) Surface finish</p> <p>f) Thickness of joints</p> <p>g) Details at edges, junctions etc.</p> <p>h) Performance</p> <p>i) Precautions specified for durability</p> <p><b>4.00.00 I.S. CODES</b></p> <p>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.</p> <p>IS: 777 : Glazed earthenware tiles</p> <p>IS: 1196 : Code of practice for laying bitumen mastic flooring.</p> <p>IS: 1197 : Code of practice for laying of rubber floors</p> <p>IS: 1237 : Cement concrete flooring tiles</p> <p>IS: 1443 : Code of practice for laying and finishing of cement concrete flooring tiles.</p> <p>IS: 2114 : Code of practice for laying in situ terrazzo floor.</p> <p>IS: 3461 : PVC asbestos floor tiles</p> <p>IS: 4860 : Specification for acid resistant bricks</p> <p>IS: 5518 : Code of practice for laying of flexible PVC Sheet and tile flooring.</p> <p>IS: 5491 : Code of practice for laying in situ granolithic floor topping.</p>		

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<b>5.00.00</b>	<b>RATES AND MEASUREMENT</b>  <b>5.01.00 Rates</b>  Rates shall be for the complete work (including dividing strips, Ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.  Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.  <b>5.02.00 Measurement</b>  The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.	

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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**

1394217/2023/PS-SR-PM

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<p style="text-align: center;"><b>C O N T E N T</b></p> <table> <tr> <th>CLAUSE NO.</th><th>DESCRIPTION</th><th>SHEET NO.</th></tr> <tr> <td>1.00.00</td><td>SCOPE</td><td>3</td></tr> <tr> <td>2.00.00</td><td>GENERAL</td><td>3</td></tr> <tr> <td>3.00.00</td><td>WORKMANSHIP</td><td>19</td></tr> <tr> <td>4.00.00</td><td>INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY</td><td>29</td></tr> <tr> <td>5.00.00</td><td>INFORMATION TO BE SUBMITTED</td><td>33</td></tr> <tr> <td>6.00.00</td><td>RATES AND MEASUREMENTS</td><td>34</td></tr> </table>			CLAUSE NO.	DESCRIPTION	SHEET NO.	1.00.00	SCOPE	3	2.00.00	GENERAL	3	3.00.00	WORKMANSHIP	19	4.00.00	INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY	29	5.00.00	INFORMATION TO BE SUBMITTED	33	6.00.00	RATES AND MEASUREMENTS	34
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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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<p>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.</p>			
2.02.00	Work by others		
<p>No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.</p>			
2.03.00	Codes and standards		
<p>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:</p>			
<p>IS: 226 - Structural steel (Standard Quality)</p>			
<p>IS: 800 - Code of Practice for general construction in steel.</p>			
<p>IS: 806 - Code of practice for use of steel tubes in general building construction.</p>			
<p>IS: 808 - Rolled steel beams, channels, and angle sections</p>			
<p>IS: 813 - Scheme of symbols for welding</p>			
<p>IS: 814 - Covered electrodes for metal arc welding of structural steel</p>			
<p>IS: 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.</p>			
<p>IS: 816 - Code of practice for use of metal arc welding for general construction in mild steel</p>			
<p>IS: 817 - Code of practice for training and testing metal arc welders</p>			
<p>IS: 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations</p>			
<p>IS: 822 - Code of practice for inspection of welds</p>			
<p>IS: 919 - Recommendations for limits and fits for Engineering</p>			


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<p>IS: 961 - Structural Steel (High Tensile)</p> <p>IS: 1148 - Rivet bars for structural purposes</p> <p>IS: 1149 - High tensile rivet bars for structural purposes</p> <p>IS: 1161 - Steel Tubes for structural purposes</p> <p>IS: 1200 - Method of measurement of steelwork and ironwork (Part 8)</p> <p>IS: 1239 - Mild Steel Tubes</p> <p>IS: 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (Dia 6 to 24 mm)</p> <p>IS: 1364 - Precision and semi-precision hexagon bolts, screws, nuts and locknuts (Dia, range 6 to 39 mm)</p> <p>IS: 1367 - Technical supply conditions for threaded fasteners</p> <p>IS: 1442 - Covered electrodes for the metal arc welding of high tensile structural steel</p> <p>IS: 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube</p> <p>IS: 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.</p> <p>IS: 1731 - Dimensions for steel flats for structural and general engineering purposes</p> <p>IS: 1852 - Rolling and cutting tolerances for hot-rolled steel products</p> <p>IS: 1977 - Structural steel (ordinary quality) St-42-0</p> <p>IS: 2062 - Steel for General Structural Purposes</p> <p>IS: 2074 - Ready mixed paint, red oxide Zinc chromate priming</p> <p>IS: 2595 - Code of Practice for Radiographic Testing</p> <p>IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel</p> <p>IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles</p>					




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<div>IS: 3757 - High strength structural bolts</div> <div>IS: 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products</div> <div>IS: 7205 - Safety Code for Erection of Structural Steelwork</div> <div>IS: 7215 - Tolerances for fabrication of steel structures</div> <div>IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels.</div> <div>IS: 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.</div>			
<b>2.04.00</b>		<b>Conformity with Designs</b>	
<p>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.</p>			
<b>2.05.00</b>		<b>Materials to be used</b>	
<b>2.05.01</b>		<b>General</b>	
<p>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.</p>			
<p>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</p>			


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<b>2.05.02</b>	<b>Steel</b>  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.	amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.
<b>2.05.03</b>	<b>Rivet Steel</b>  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.	
<b>2.05.04</b>	<b>Electrodes</b>  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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	<p>d) IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels</p> <p><b>2.05.05 Bolts and Nuts</b></p> <p>All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.</p> <p>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.</p> <p>a) Mild Steel</p> <p>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/mm<sup>2</sup> 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</p> <p>i) IS: 1367: Technical supply conditions for threaded fasteners</p> <p>ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube</p> <p>b) High Tensile Steel</p> <p>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.</p> <p><b>2.05.06 Washers</b></p> <p>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:</p> <p>a) IS: 2062 - Steel for general structural purposes</p> <p>b) IS: 961 - Structural Steel (High Tensile Quality)</p> <p>c) IS: 1977 - Structural steel (Ordinary Quality) St-42-0</p> <p>d) IS: 6649 - Hardened washers</p>	


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<b>2.05.07</b>	<b>Paints</b>  <p>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.</p>	
<b>2.06.00</b>	<b>Coal Bin</b>	
<b>2.06.01</b>	<p>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.</p>	
<b>2.06.02</b>	<p>For general requirements, fabrication and construction details IS: 9178 (Pt. I &amp; II) shall be followed as general guidance. The bins shall be fabricated and erected in segments.</p>	
<b>2.06.03</b>	<p>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.</p>	
<b>2.06.04</b>	<p>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.</p>	
<b>2.06.05</b>	<p>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.</p>	
<b>2.07.00</b>	<b>New Erection Marks</b>	
<b>2.07.01</b>	<p>Additional structures involving new erection marks may be required to be added at any stage of work.</p>	
<b>2.07.02</b>	<p>All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.</p>	
<b>2.07.03</b>	<p>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.</p>	


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<b>2.08.00</b>	<b>ELECTRO FORGED STEEL GRATINGS</b>	
<b>2.08.01</b>	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.	
<b>2.08.02</b>	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.	
<b>2.08.03</b>	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.	
<b>2.08.04</b>	The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.	
<b>2.08.05</b>	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.	
<b>2.08.06</b>	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.	
<b>2.08.07</b>	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.	
<b>2.08.08</b>	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.	
<b>2.08.09</b>	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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	<p>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.</p> <p><b>2.09.05</b>      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.</p> <p><b>2.09.06</b>      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.</p> <p><b>2.09.07</b>      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.</p> <p><b>2.09.08</b>      All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.</p> <p><b>2.09.09</b>      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.</p> <p><b>2.10.00</b>      <b>STAINLESS STEEL HOPPERS (As per BOQ item)</b></p> <p><b>2.10.01</b>      <b>Material</b></p> <p>In case SS Hopper is to be fabricated &amp; 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.</p> <table> <thead> <tr> <th>Material</th><th>%</th><th>Remarks</th></tr> </thead> <tbody> <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> </tbody> </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:				
Description		Value	Remarks	
Hardness Rock Well B Scale		90	Max.	
Tensile Strength		450 MPa	Min.	
Yield Strength		300 MPa	Min.	
Elongation		25%	Min.	
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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	<p>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.</p> <p>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.</p> <p><b>2.10.04      Cuffing</b></p> <p>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.</p> <p><b>2.10.05      Jointing</b></p> <p>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.</p> <p><b>2.10.06      Bending</b></p> <p>The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.</p> <p><b>2.10.07      Welding sequence</b></p> <p>The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.</p> <p><b>2.10.08      Acceptance Criteria of Fabricated Structures</b></p> <p>The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory</p>	

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	<p>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.</p> <p><b>2.11.00                      BEARINGS</b></p> <p><b>2.11.01                      PTFE (Poly tetra fluorethylene) slide bearing</b></p> <p><b>a) General</b></p> <p>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 <math>\pm 50</math> mm.</p> <p><b>b) Material</b></p> <p>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/cm<sup>2</sup>. 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.</p> <p>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/cm<sup>2</sup> and shear loads upto 40 kg/cm<sup>2</sup>.</p> <p><b>c) Installation</b></p> <p>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</p>	

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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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<b>2.14.00</b>	<b>Standard dimensions, forms and weights</b>  <p>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.</p>	
<b>2.15.00</b>	<b>Fabrication Drawings</b>  <p>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.</p> <p>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.</p> <p>The fabrication drawings shall include but not limited to the following:</p> <ol style="list-style-type: none"> <li>Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.</li> <li>Dimensional drawings of base plates, foundation bolts location etc.</li> <li>Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.</li> <li>Complete Bill of Materials and detailed drawings of all sections as also their billing weights.</li> <li>Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.</li> </ol> <p>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</p>	


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	<p>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.</p> <p>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.</p> <p><b>3.00.00 WORKMANSHIP</b></p> <p><b>3.01.00 Fabrication</b></p> <p><b>3.01.01 General</b></p> <p>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.</p> <p><b>3.01.02 Straightening Material</b></p> <p>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.</p> <p><b>3.01.03 Cutting</b></p> <p>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</p>	





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	<p>expert hand, subject to the approval of the Engineer.</p> <p>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.</p> <p><b>3.01.04                      Planning of edges</b></p> <p>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.</p> <p><b>3.01.05                      Clearances</b></p> <p>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.</p> <p><b>3.02.00                      Riveted and bolted construction</b></p> <p><b>3.02.01                      Holes</b></p> <p>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.</p> <p>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.</p> <p>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</p>	


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	<p>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.</p> <p>Holes for rivets or bolts shall not be formed by gas cutting process.</p> <p><b>3.02.02                      Assembly</b></p> <p>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 not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.</p> <p>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 he holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125°C they shall not be driven after their temperature has fallen below 540°C.</p> <p>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.</p> <p>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.</p> <p>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</p>	

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	<p>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.</p> <p>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.</p> <p>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.</p> <p><b>3.03.00                      Welded Construction</b></p> <p><b>3.03.01                      General</b></p> <p>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.</p> <p><b>3.03.02                      Preparation of material</b></p> <p>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.</p> <p><b>3.03.03                      Assembling</b></p> <p>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°).</p> <p>The work shall be positioned for flat welding whenever practicable.</p>	


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<b>3.03.04</b>	<b>Welding Sequence</b>  <p>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.</p> <p>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.</p> <p>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.</p>	
<b>3.03.05</b>	<b>Welding technique</b>  <p>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.</p> <p>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.</p> <p>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.</p>	
<b>3.03.12</b>	<b>Temperature</b>  <p>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</p>	

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	<p>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.</p> <p><b>3.03. 13      Peening</b></p> <p>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.</p> <p><b>3.03. 14      Equipment</b></p> <p>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.</p> <p><b>3.04.00      Finish</b></p> <p>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.</p> <p><b>3.05.00      Slab bases and caps</b></p> <p>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.</p> <p>To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.</p>	


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<b>3.12.00</b>	<b>Lacing bars</b>  The ends of lacing bars shall be neat and free from burns.  <b>3.13.00</b> <b>Separators</b>  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.  <b>3.14.00</b> <b>Bearing Plates</b>  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.  <b>3.15.00</b> <b>Floor Grating</b>  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.  <b>3.10.00</b> <b>Chequered Plates</b>  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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<b>3.11.00</b>	<b>Architectural Clearances</b>  Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.  <b>3.11.00 Shop connections</b>  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.  <b>3.13.00 Castings</b>  Steel castings shall be annealed.  <b>3.14.00 Shop erection</b>  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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3.15.00	Shop painting
3.15.01	General
	<p>Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.</p> <p>After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.</p>
3.15.02	Inaccessible parts
	<p>Surfaces not in contact, but inaccessible 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.</p>
3.15.03	Contact surfaces
	<p>Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.</p>
3.15.04	Finished surfaces
	<p>Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.</p>
3.15.05	Surfaces adjacent to field welds
	<p>Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.</p>


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<b>3.16.00      Galvanizing</b>					
<b>3.16.01      General</b>		<p>Structural steelwork for switchyard or other structures as may be specified in the contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.</p>			
<b>3.16.02      Surface Preparation</b>		<p>All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.</p> <p>The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.</p>			
<b>3.16.03      Procedure</b>		<p>Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested 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 &amp; other allied products.</p> <p>After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.</p> <p>The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.</p> <p>Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken</p>			


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	<p>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.</p> <p><b>4.00.00      INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY</b></p> <p><b>4.01.00      Inspection</b></p> <p>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.</p> <p>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.</p> <p><b>4.02.00      Testing and Acceptance Criteria</b></p> <p><b>4.02.01      General</b></p> <p>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.</p> <p><b>4.02.02      Steel</b></p> <p>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.</p> <p>All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.</p>	


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<b>4.02.02</b>	<b>Welding</b>
	<p>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.</p> <p>b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:</p> <p>    i) 10% at random on fillet-joints.</p> <p>    ii) 100% on all butt-joints.</p> <p>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.</p> <p>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.</p>
<b>4.02.04</b>	<b>Rivets, bolts, nuts and washers</b>
	<p>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.</p>
<b>4.02.05</b>	<b>Shop painting</b>
	<p>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.</p>


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<b>4.02. 12</b>	<b>Galvanizing</b>  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.  <b>4.03.00</b> <b>Tolerance</b>  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.  <b>4.04.00</b> <b>Acceptance</b>  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.  <b>4.05.00</b> <b>Delivery of materials</b>  <b>4.05.01</b> <b>General</b>  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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<b>4.05.02</b>	<b>Marking</b>  <p>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.</p>	
<b>4.05.03</b>	<b>Shipping</b>  <p>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.</p> <p>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:</p> <ol style="list-style-type: none"> <li>Name and address of the consignee</li> <li>Name and address of the consignor</li> <li>Gross weight of the package in tonnes and its dimensions</li> <li>Identification marks and/or number of the package</li> <li>Custom registration number, if required</li> </ol> <p>All markings shall be carried out with such materials as would ensure quick drying and indelibility.</p> <p>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.</p> <p>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 -</p> <ol style="list-style-type: none"> <li>Name of the Contractor</li> <li>Number and date of the Contract</li> <li>Name of the office placing the contract</li> <li>Nomenclature of stores</li> </ol>	


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<p>e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.</p> <p>The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.</p> <p>After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>Necessary advice regarding the shipment with relevant details shall reach the Engineer at least a week in advance.</p> <p><b>5.00.00 INFORMATION TO BE SUBMITTED</b></p> <p><b>5.01.00 With Tender</b></p> <p>The following information is required to be submitted with the Tender:</p> <p>a) Progress Schedule</p> <p>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.</p> <p>i) Preparation and approval of fabrication drawing</p> <p>ii) Procurement of Materials</p> <p>iii) Fabrication and shipping of all anchor bolts</p> <p>iv) Fabrication and shipping of main steelwork.</p>		




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<p>v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.</p> <p>vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.</p> <p>vii) Final date of completion of all shipments.</p> <p>b) Shop</p> <p>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.</p> <p><b>5.02.00 After Award</b></p> <p>After award of the Contract the successful Tenderer is to submit the following:</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>d) Results of any test as and when conducted and as require by the engineer.</p> <p>e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.</p>			


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<b>6.00.00</b>	<b>RATES AND MEASUREMENT</b>	
<b>6.01.00</b>	<b>Rates</b>	
<b>6.01.01</b>	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.	
<b>6.01.02</b>	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.	
<b>6.01.03</b>	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.	
<b>6.01.04</b>	No claims shall be entertained, if the details shown on the 'Released for Construction' drawings differ from those shown on the bid/tender drawings.	
<b>6.01.05</b>	Rates shall be inclusive of all leads and lifts/elevation.	
<b>6.01.06</b>	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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	<p><b>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.</b></p> <p><b>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.</b></p> <p><b>6.01.07</b>      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.</p> <p><b>6.01.08</b>      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.</p> <p><b>6.01.09</b>      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.</p> <p><b>6.01.10</b>      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.</p> <p><b>6.01.11</b>      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.</p> <p><b>6.01.12</b>      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.</p> <p><b>6.01.13</b>      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.</p>	

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<b>6.01.14</b>	<p>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.</p> <p><b>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.</b></p>	
<b>6.01.15</b>	<p>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.</p>	
<b>6.01.16</b>	<p>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.</p>	
<b>6.01.17</b>	<p>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.</p>	


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from assumed minimum circumscribing rectangular area for the purpose of payment.			
<b>6.02.07</b>	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.		
<b>6.02.08</b>	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.		
<b>6.02.09</b>	The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.		
<b>6.02.10</b>	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.		
<b>6.02.11</b>	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.		
<b>6.02.12</b>	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.		
<b>6.02.13</b>	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.		
<b>6.02.14</b>	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.		
<b>6.02.15</b>	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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6.02.16	The measurement for the item of permanent bolts with nuts and washers 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, and as per the approved bolts and nuts schedules.
6.02.17	The measurement for the item of High Strength Structural bolts with nuts and washers 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, and as per the approved bolts and nuts schedules.
6.02.18	The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below
6.02.19	For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.
6.02.20	For the work of addition to, alteration in and / or modification of 'erection marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.
6.02.21	For re-erection the weight of the modified erection mark shall only be measured.
6.02.22	The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.
6.02.23	The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.
6.02.24	The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.
6.02.25	The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.



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6.02.26	<p>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.</p>
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## SECTION - D (PART I)


### SUB-SECTION – D 18

### ERECTION OF STRUCTURAL STEELWORK




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

1394217/2023/PS-SR-PM

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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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	<p>g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:</p> <ul style="list-style-type: none"> <li>i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.</li> <li>ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.</li> <li>iii) Reaming of holes for use of higher size rivet or bolt if required.</li> <li>iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.</li> <li>v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.</li> <li>vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.</li> <li>vii) Carry out tests in accordance with this specification.</li> </ul> <p><b>2.02.00                      Work by Others</b></p> <p>No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.</p> <p><b>2.03.00                      Codes and Standards</b></p> <p>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:</p> <p>IS: 800 - Code of practice for general construction in steel.</p> <p>IS: 456 - Code of practice for main or reinforced concrete.</p> <p><b>2.04.00                      Conformity with Designs</b></p> <p>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.</p>	

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2.05.00	<b>Material</b>	
2.05.01	<b>General</b>	
	<p>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.</p>	
2.05.02	<b>Materials to conform to Indian standards</b>	
	<p>All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.</p>	
2.06.00	<b>Storage of Materials</b>	
2.06.01	<b>General</b>	
	<p>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.</p>	
2.06.02	<b>Yard</b>	
	<p>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.</p>	
	<p>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.</p>	

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<b>2.06.03</b>		<b>Covered Store</b>  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.			
<b>2.07.00</b>		<b>Quality Control</b>  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: <ul style="list-style-type: none"> <li>i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.</li> <li>ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.</li> <li>iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.</li> </ul>			
<b>2.08.00</b>		<b>Taking Delivery</b>  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.			
<b>3.00.00</b>		<b>WORKMANSHIP</b>			
<b>3.01.00</b>		<b>Erection</b>			
<b>3.01.01</b>		<b>Plant and Equipment</b>  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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	<p>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.</p> <p><b>3.01.06      Field Riveting</b></p> <p>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.</p> <p><b>3.01.07      Field Bolting</b></p> <p>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:</p> <p>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.</p> <p>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.</p> <p>a) Turn-of-nut Method</p> <p>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</p>	

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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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	<p>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.</p> <p>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.</p> <p>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.</p> <p><b>3.01.08      Field Welding</b></p> <p>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.</p> <p><b>3.01.09      Holes, Cutting and Fitting</b></p> <p>No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.</p> <p>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.</p> <p><b>3.02.00      Drifting</b></p> <p>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</p>	


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<b>3.03.00</b>	<p>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.</p> <p>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.</p> <p><b>Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)</b></p> <p>Grouting shall be carried out with Ordinary Cement grout as described below:</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p><b>3.04.00      Painting after Erection</b></p> <p>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</p>	


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	<p>with the requirements of the specification for fabrication of structural steelwork applicable for the project.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p><b>3.05.00      Final cleaning up</b></p> <p>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.</p> <p><b>4.00.00      TESTING AND ACCEPTANCE CRITERIA</b></p> <p><b>4.01.00      General</b></p> <p>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</p>	


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	<p>and appropriate time extensions will be allowed.</p> <p>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.</p> <p><b>4.01.01      Stiffness Test</b></p> <p>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.</p> <p><b>4.01.02      Strength Test</b></p> <p>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.</p> <p>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.</p> <p><b>4.01.03      Structure of same design</b></p> <p>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.</p>	



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	<p>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.</p> <p><b>4.01.04      Repair for subsequent test and use after strength tests</b></p> <p>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.</p> <p><b>4.02.00      Tolerances</b></p> <p>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.</p> <p>I.    For Buildings Containing Cranes</p> <table> <tr> <th>Component</th><th>Description</th><th>Variation Allowed</th></tr> <tr> <th>1.</th><th>2.</th><th>3.</th></tr> <tr> <td rowspan="4">Main columns</td><td>a) shifting of column axis at foundation level with respect to building line</td><td></td></tr> <tr> <td>i) In longitudinal direction</td><td>i) <math>\pm 3.0</math> mm</td></tr> <tr> <td>ii) In lateral direction</td><td>ii) <math>\pm 3.0</math> mm</td></tr> <tr> <td>b) Deviation of both major column axis from vertical between foundation and</td><td></td></tr> </table>		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) $\pm 3.0$ mm	ii) In lateral direction	ii) $\pm 3.0$ mm	b) Deviation of both major column axis from vertical between foundation and	
Component	Description	Variation Allowed															
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other member connection levels:			
	i) For a column upto and including 10M height	i) $\pm 3.5$ mm from true vertical	
	ii) For a column greater than 10M but less than 40M height	ii) $\pm 3.5$ mm from true vertical for any 10 M length measured between connection levels, but not more than $\pm 7$ mm per 30m length.	
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	$\pm 9.0$ mm on true span.	
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	$\pm 3.0$ 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	a) Deviation at centre of span of upper chord member from vertical plane running through least.	1/1500 of the span or greater than 10mm whichever is the	
	centre of bottom chord.		
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	$\pm 3.0$ mm	

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	<p>c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.      1.0 mm.</p> <p>d) Deviation of crane rail axis from centre line of web.      <math>\pm 3.5</math> mm</p> <p>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.</p> <p>iv) For Building without Cranes</p> <p>The maximum tolerances for line and level of the steel work shall be <math>\pm 3.0</math> 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.</p> <p>These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.</p> <p><b>4.03.00      Acceptance</b></p> <p>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.</p> <p><b>5.00.00      INFORMATION TO BE SUBMITTED</b></p> <p><b>5.01.00      Before Tender</b></p> <p><b>5.01.01      Tentative Programme</b></p> <p>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.</p>	

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<b>5.01.02</b>	<p>Constructional Plant and Equipment, Tools, Temporary works &amp; 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.</p>	
<b>5.01.03</b>	<p><b>Erection Yard</b></p> <p>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.</p>	
<b>5.02.00</b>	<p><b>After award of the Contract</b></p> <p>After award of the contract, the Contractor shall submit the following:</p>	
<b>5.02.01</b>	<p><b>Detailed Programme</b></p> <p>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.</p>	
<b>5.02.02</b>	<p><b>Fortnightly Progress Report</b></p> <p>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.</p>	

<div><div><div>बी एन डी एल</div><div><div>BHEL</div><div>Maharatna Company</div></div></div></div>		<div>TITLE:</div> <div>TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT</div>		<div>SPECIFICATION NO. PE-TS-635-600-C001</div>	
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## SECTION – D

### SUB SECTION – D23

### ANTI-TERMITE TREATMENT

**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**

1394217/2023/PS-SR-PM

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	<b>TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT</b>		VOLUME -	
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**TECHNICAL SPECIFICATION FOR  
ANTI-TERMITE TREATMENT**

**1.00.00**

**SCOPE**

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

**2.00.00**

**EXECUTION**

**2.01.00**

**General**

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

**2.02.00**

**Chemicals and Rate of Application**

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.


Chemicals	Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	: 1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	: 0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	: 1.0


**2.02.01**

**Treatment of Column Pits, Wall Trenches and Basement Excavations**

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column



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	<p>pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M<sup>2</sup> of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M<sup>2</sup> of the vertical surface.</p> <p>Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.</p> <p><b>2.02.02 Treatment of Top Surface of Plinth Filling</b></p> <p>Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M<sup>2</sup> of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.</p> <p><b>2.02.03 Treatment of Soil Surrounding Pipes, Wastes and Conduits</b></p> <p>Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.</p> <p><b>2.02.04 Treatment of Expansion Joints</b></p> <p>These shall receive special attention and shall be treated in a manner approved by the Engineer.</p> <p><b>2.02.05 Treatment at Junction of the Wall and the Floor</b></p> <p>Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.</p> <p>A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.</p> <p><b>3.00.00 ACCEPTANCE CRITERIA</b></p> <p>The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.</p>	

	<b>TITLE:</b>  <b>TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT</b>	<b>SPECIFICATION NO.</b> PE-TS-635-600-C001 <b>VOLUME -</b> <b>SECTION - D</b>   <b>SUB-SECTION – D23</b> <b>REV.NO.</b> 00 <b>DATE</b> 13/02/2018 <b>SHEET</b> 5 <b>OF</b> 5
<b>4.00.00</b>	<b>RATES</b>  Rates shall be of complete work per unit area as stated in the Schedule.	
<b>5.00.00</b>	<b>METHOD OF MEASUREMENT</b>  Complete work of anti-termite treatment shall be measured for plinth area treated.  This includes treatment, to foundations, walls, trenches, basements, plinth, buried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work.	
<b>6.00.00</b>	<b>I.S. CODE</b>  Relevant code applicable for this Specification.  IS: 6313 (Part-II) 1981 : Code of Practice of Anti-Termite Measures in Buildings Pre-constructional chemical treatment measures.	



TITLE:

**TECHNICAL SPECIFICATION FOR  
REINFORCED CONCRETE  
CHIMNEY**

**2x600 MW ENNORE TPS  
TECHNICAL SPECIFICATION FOR  
REINFORCED CONCRETE  
CHIMNEY**

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VOLUME - II  
SECTION-C  
SPECIFIC TECHNICAL REQUIREMENTS FOR ELECTRICAL WORKS  
SPECIFICATION NO. PE-TS-----

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Note : In case of any conflict between section-C & section-D of electrical portion, section-C of electrical prevail.

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



3.06.00 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.



b) The DC Emergency Lighting Distribution Boards will be fed from two power

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





## 6.02.00 GENERAL REQUIREMENTS

### 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



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- 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.

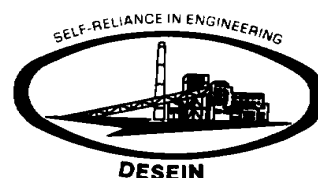


- d) Lighting Distribution Boards shall have provision of cable entry from bottom and, panels shall have provision of cable entry from top and bottom, as required, with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminium cable lugs are to be furnished.
- 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.

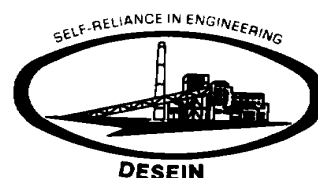
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**6.11.00 Conduits and Accessories**

- 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



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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.



## 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 mm<sup>2</sup> 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  $\pm 2$  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 mm<sup>2</sup> (3 core) & Cu – 2.5 mm<sup>2</sup> (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)	<b>For Conductor</b>	
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)	<b>For Armour Wires/ Formed Wires</b>	
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)	<b>For XLPE insulation &amp; PVC Sheath</b>	
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 :

- 1. 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.
- 2. Fire resistance test as per SS 4241475 (F3 category)
- 3. One length per size / lot for surface finish and length measurement
- 4. 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.



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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.
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Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor.
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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





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TITLE

LIGHTNING PROTECTION & EARTHING  
OF CHIMNEY  
(SUPPLY & INSTALLATION)

SPECIFICATION NO. PES-509-02A

VOLUME II B

SECTION D

REV NO. 0 DATE 08.02.2002

SHEET 3 OF 4

GENERAL TECHNICAL REQUIREMENTS  
OF  
LIGHTNING PROTECTION OF CHIMNEY

SPECIFICATION NO. PES-509-02A



## LIGHTNING PROTECTION & EARTHING OF CHIMNEY (SUPPLY & INSTALLATION)

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### 1.0 GENERAL

- 1.1 This section includes the design, fabrication, supply, installation and testing of Lightning Protection system for the Chimney(s). The requirements of this specification shall be complied with in relation to the requirements set out in Data Sheet-A & Section-C.
- 1.2 The contractor's scope, besides material supply shall include complete installation of Lightning Protection System, protective coating application, and testing of the system. All materials, consumables, erection equipment etc. as required for the completion of installation and testing facilities shall be supplied.

### 2.0 CODES & STANDARDS

- 2.1 The latest revisions of the following codes & standards shall be applicable:

IS:2309 Code of practice for protection of buildings & allied structures against lightning.

IS:3043 Code of Practice for earthing

IS:4759 Hot-dipped galvanised coating on structural steel

IS:2629 Recommended practice for Hot-dipped galvanising for Iron & Steel.

IS:2633 Methods of Testing Uniformity of Coating on zinc-coated Articles.

IS:1731 Dimensions for Steel flats for structural & General Engineering Purposes.

IS:1752 Electroplated Coatings of Cadmium on Iron & Steel

Indian Electricity Rules, 1956,

Indian Electricity Act, 1960.

IS:4990(Part-I) Criteria for Design of Reinforced concrete Chimney.

### 3.0 DESIGN REQUIREMENTS

- 3.1 Lightning Protection system for the chimney shall consist of air-termination network comprising requisite number of vertical copper rods, 20mm in dia, projecting at least 1000mm above the top of the chimney and the flues, spaced uniformly along the top periphery of the outer shell of the Chimney and that of the flues. A ring of 75x6mm GI strip shall be laid along the top periphery of the flues and the Chimney, forming the



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annular horizontal air terminations. The vertical air terminations shall be electrically connected (Brazed) to the horizontal air terminations, the vertical termination of the flues and those of the Chimney to the horizontal termination of the Chimney. The vertical terminations shall be spaced not more than 3m apart from each other.

- 3.2 The air terminations shall be secured to the top of Chimney top by an arrangement of substantially strong construction to withstand high wind pressure prevalent in the area commensurate with the height involved. All materials for the securing arrangement shall be of the same grade as the conductors and must be galvanised. The vertical air terminals at the top of the shell shall also be secured to the guard ring at the top of the shell.
- 3.3 A minimum of two numbers of equally spaced conductors, each consisting of 50x6mm GI strip, shall be brought down from their connecting points on the annular rings at the top of the Chimney/flues. The down-conductors originating at the top of the flues shall be brought down along the walls of the flues and electrically connected (welded) to the annular ring at the top of the outer shell of the Chimney. The down conductors (minimum two numbers) from the chimney top shall be brought down to the bottom of the Chimney all along the exterior Chimney wall.
- 3.4 A test link of copper black/phosphor bronze gunmetal bolted to the conductor for the purpose of isolation & testing shall be provided on each down conductor 1000mm above ground level.
- 3.5 Down conductors shall be cleated to the wall at an interval of 1500mm all along the length of the Chimney.
- 3.6 Down conductors near ground level shall be protected against mechanical injuries by means of wood-moulding or non-metallic cover. A removable cover of the same material shall be provided over the test-link for easy access.
- 3.7 The connection between the downconductor from the test link onwards upto an annular ring of galvanised steel running around the entire periphery of the chimney bottom shall be provided through risers which shall be of 40mm dia MS rods.
- 3.8 The risers shall be terminated on the annular ring of 40mm dia MS rod running around the periphery of the chimney buried 1 metre deep in the ground and clearing all foundation by at least 2 metres.
- 3.9 From the termination points of the downconductors on to this underground ring, mild steel rods shall terminate at test pits complete with test-links and electrodes.
- 3.10 The test pits at para 3.9 shall in turn be connected to the main earthmat of the power house through 40mm dia MS rod.
- 3.11 All joints, except for testing purposes, shall be welded type lap joints with an overlap of 100mm. The welding shall be complete around the joint and not tack welded. Electric arc welding shall be used for all joints.
- 3.12 After welding, two coats of anti-corrosive (red-oxide) paint followed by a coat of bituminous paint shall be applied to each joint.
- 3.13 The 40mm dia MS rods shall be protected against corrosion by applying a coat of barium chromate paint and two coats of bitumen below the test link.



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- 3.14 The complete lightning protection system arrangement including air-terminations, conductors, connections, fittings etc. and materials located on the exterior within 10m from the top of the chimney shall have lead coating of 2.0mm thickness.
- 3.15 All exposed metal structures such as hand rails, platforms, ladders/stairs shall be connected to the downconductors through earthing band rings, of 50x6mm GI strip located 2000mm above each platform. Ladders and platforms shall be bonded together for electrical continuity. A strip of 25x3mm GI shall be used for connection between equipment and earthing band rings. Similarly, all lighting fixtures shall be earthed.
- 3.16 Temporary lightning protection system shall have to be provided and maintained during the construction of chimney or till final lightning protection system is installed by the contractor free of cost and in line with IS:4998(Part-I).
- 3.17 For general reference and guidance, Below Ground Earthing Typical Details drg.no. PE-DG-XXX-509-0004 & drg.no. PE-DG-XXX-509-003 may be used.

#### 4.0 GALVANISING

- 4.1 All steel strips and materials requiring galvanisation shall be hot-dip galvanised according to the IS:2629 & IS:4759. Galvanising shall be done at a place where galvanising and testing facilities conforming to the relevant Indian Standards exist. The galvanising shall be smooth, clean, uniform, continuous & free from acid spots. The thickness of zinc deposit at any spot shall not be less than 75 microns. The purchaser reserves the right to measure the thickness of zinc deposit and reject any component which shows thickness of zinc at any location less than 75 microns. Should the galvanising of the sample be found defective, the entire batch of the steel will have to be re-galvanised at the seller's cost.
- 4.2 All nuts, bolts and washers, wherever used, shall be cadmium coated or zinc passivated, the thickness of plating conforming to the relevant Indian Standards.

#### 5.0 INSPECTION & TESTING

- 5.1 The following stages of manufacture/installation shall be stage inspected by purchaser or his duly authorised representative:
- 5.1.1 Inspection of all material such as vertical air terminals, steel strips, electrodes, test links including hardware items such as bolts, nuts etc.
- 5.1.2 Inspection of manufacturing processes such as shearing, punching, bending, welding, galvanising, painting etc.
- 5.1.3 Inspection of installation procedures
- The actual inspection will be carried out as per the agreed Quality Plan.

#### 5.2 TESTING

- 5.2.1 The supplier shall perform all tests necessary to ensure that the material and workmanship conform to relevant standards and that such tests are adequate to



TITLE

# **LIGHTNING PROTECTION & EARTHING OF CHIMNEY (SUPPLY & INSTALLATION)**

SPECIFICATION NO. PES-509-02A

VOLUME II B

SECTION D

REV NO. 0 DATE 08.02.2002

SHEET 3 OF 4

demonstrate that the equipment shall comply with the requirements of this specification.

5.2.2 The tolerance in dimensions shall be in accordance with appropriate Indian Standards.

5.2.3 Forged steel below 10mm thick is subject to Magnetic Particle Testing.

## **6.0 DRAWINGS, DATA & DOCUMENTS**

6.1 Data sheet-A of this specification gives the details of materials to be used for the Lightning Protection system for Chimney.

6.2 The tenderer shall submit his design(s) and drawings for Direct stroke Lightning Protection System of Chimneys for purchaser's evaluation/scrutiny and approval.

6.3 The contractor shall furnish his design(s) and installation drawings for approval.

6.4 The contractor shall furnish the requisite number of prints & RTF's of all drawings as specified elsewhere in this specification.

6.5 The site modifications/deviations shall be marked on the latest revision of the drawings & submitted as 'As Built' drawings to the purchaser after completion of installation.

6.6 Tenderer shall submit all filled up schedules as per Volume-III.

6.7 The tenderer shall submit reports on Type tests & Special tests conducted on lightning protection materials & accessories.

## **7.0 COMPLETENESS**

7.1 The offer for supply and erection shall be complete in all respects & shall include all materials, tools and appliances, whether specified or not, required for the completion of the job.

7.2 Supply/arrangements of all accessories and material etc. shall be the responsibility of the contractor.

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TITLE

# **LIGHTNING PROTECTION & EARTHING OF CHIMNEY (SUPPLY & INSTALLATION)**

SPECIFICATION NO. PES-509-02A

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## SPECIFIC TECHNICAL REQUIREMENTS

### MATERIALS & SIZES

The following are the minimum sizes of material to be used for lightning protection system:

S.No.	Material	Minimum Size
1.	COPPER RODS (Lead Coated)(for vertical air Terminations projecting 1000mm above the Chimney/ flues)	20mm dia
2.	GI STRIP (for annular horizontal band ring at the top of the Chimney/flues)	75x6mm
3.	GI STRIP (for downconductor)	50x6mm
4.	GI STRIP (for earthing band ring each platform)	50x6mm
5.	MS ROD (for risers)	40mm dia
6.	TEST LINK	compatible with size at Sl.No.3 & 5 above
7.	MS ROD (for annular ring buried 1 metre in the ground around the chimney)	40mm dia
8.	MS ROD (for electrodes) with Test Pits	40mm dia
9.	MS ROD (for connection between test pit and customer's earthmat)	40mm dia
10.	GI STRIP/WIRE (for connection between equipment and earthing band rings)	25x3mm/As required

### 1.0 GUARANTEED TECHNICAL PARTICULARS:

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TITLE

**LIGHTNING PROTECTION & EARTHING  
OF CHIMNEY  
(SUPPLY & INSTALLATION)**

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The tenderer shall fill up and submit the following technical particulars:

1.01 Name of Manufacturer :

1.02 Place and country of Manufacture :

1.03 Standards applicable :

i/ For materials & sizes :

ii/ For galvanisation/Electroplated coating :

iii/ For testing uniformity of Galvanization :

iv/ For code of practice :

v/ For hexagonal bolts, nuts washers :

vi/ For welding :

1.04 Thickness of galvanizing on steel :

1.05 Thickness of Electroplated coatings :

1.06 Thickness of Lend coating on copper :

1.07 Materials and sizes offered :

i/ Below ground conductor :

ii/ Electrodes :

iii/ Risers :

iv/ Down Conductors :

v/ Air terminations (Vertical) :

vi/ Air termination (Horizontal) :

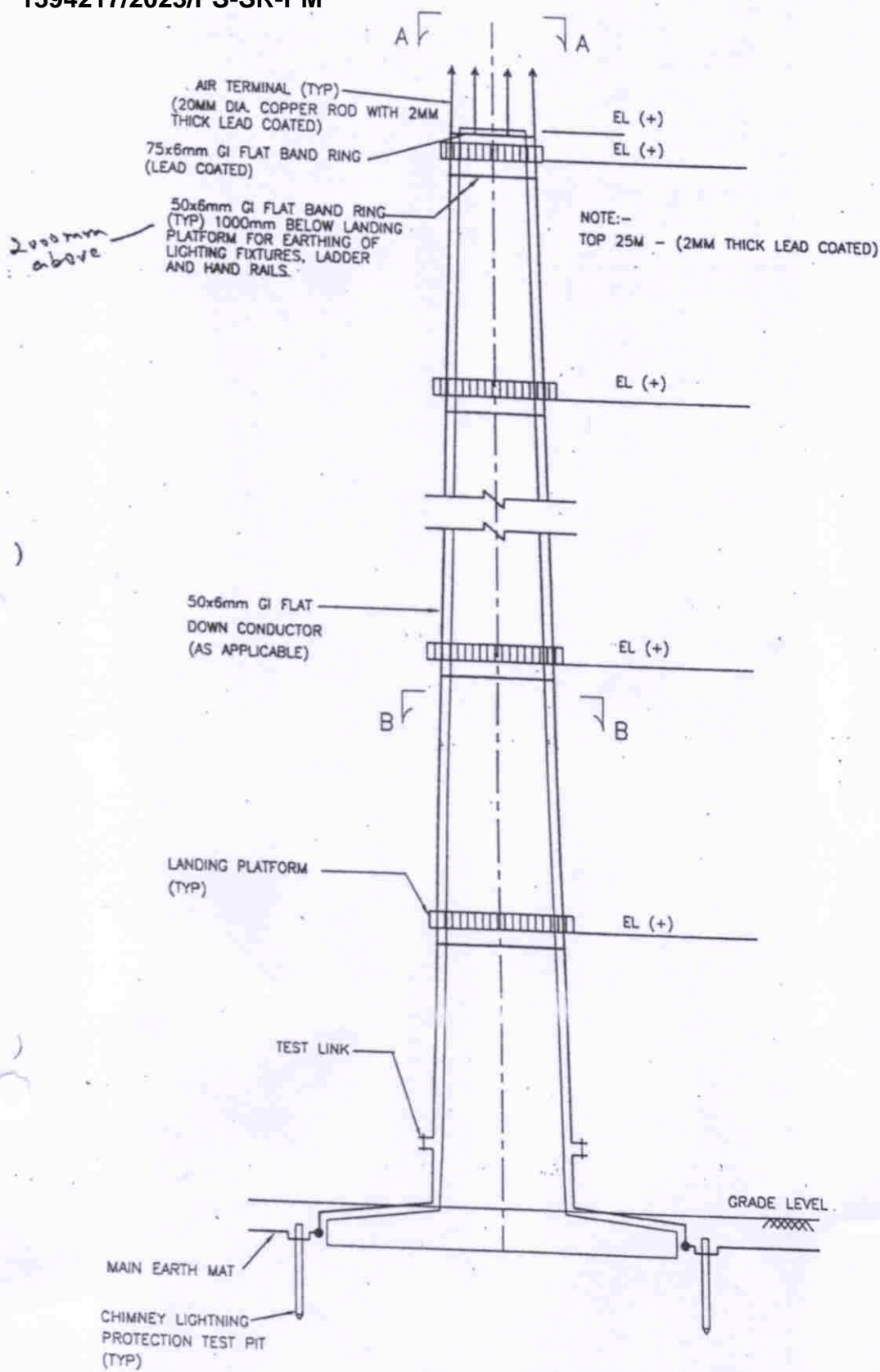
vii/ Test Pits :

viii/ Test Links :

1.08 Whether all type test certificates furnished

1.09 Whether all schedules of Vol.III filled up and submitted.

1394217/2023/PS-SR-PM



CHIMNEY (ELEVATION)



BHARAT HEAVY ELECTRICALS LIMITED  
PROJECT ENGINEERING MANAGEMENT  
NEW DELHI

LIGHTNING PROTN. OF CHIMNEY

DRG. No.

PE-DG-XXX-509-0003

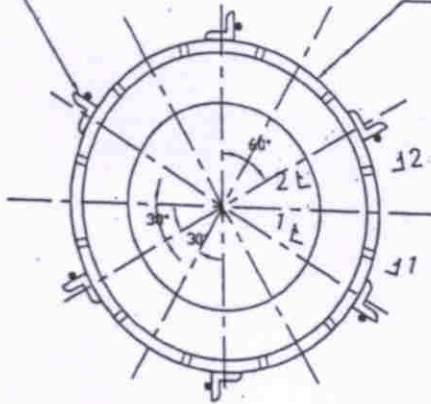
SHEET 1 OF 4

REV. 00



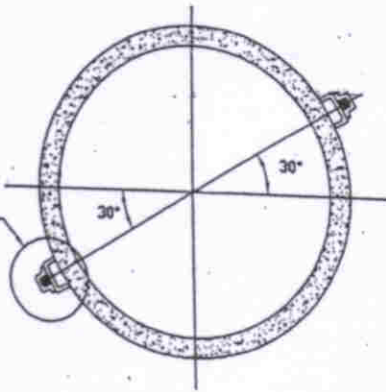
AIR TERMINAL (TYP)  
(20MM DIA. COPPER  
ROD WITH 2MM THICK  
LEAD COATING)

75X6 G.I. FLAT BAND  
RING-LEAD COATED  
(HORIZONTAL AIR  
TERMINATION)



SECTION A-A

SEE DETAIL-'Y'



SECTION B-B

NOTE:-  
TOP 25M OF CHIMNEY SHALL  
HAVE A LEAD COATING OF  
2MM THICKNESS.

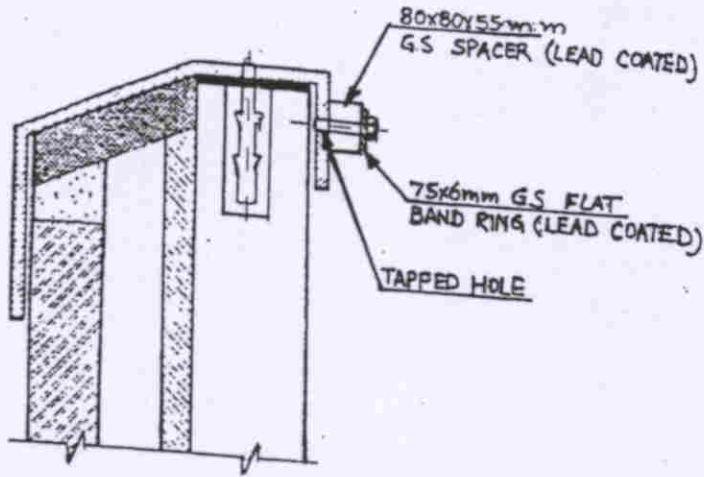


BHARAT HEAVY ELECTRICALS LIMITED  
PROJECT ENGINEERING MANAGEMENT  
NEW DELHI

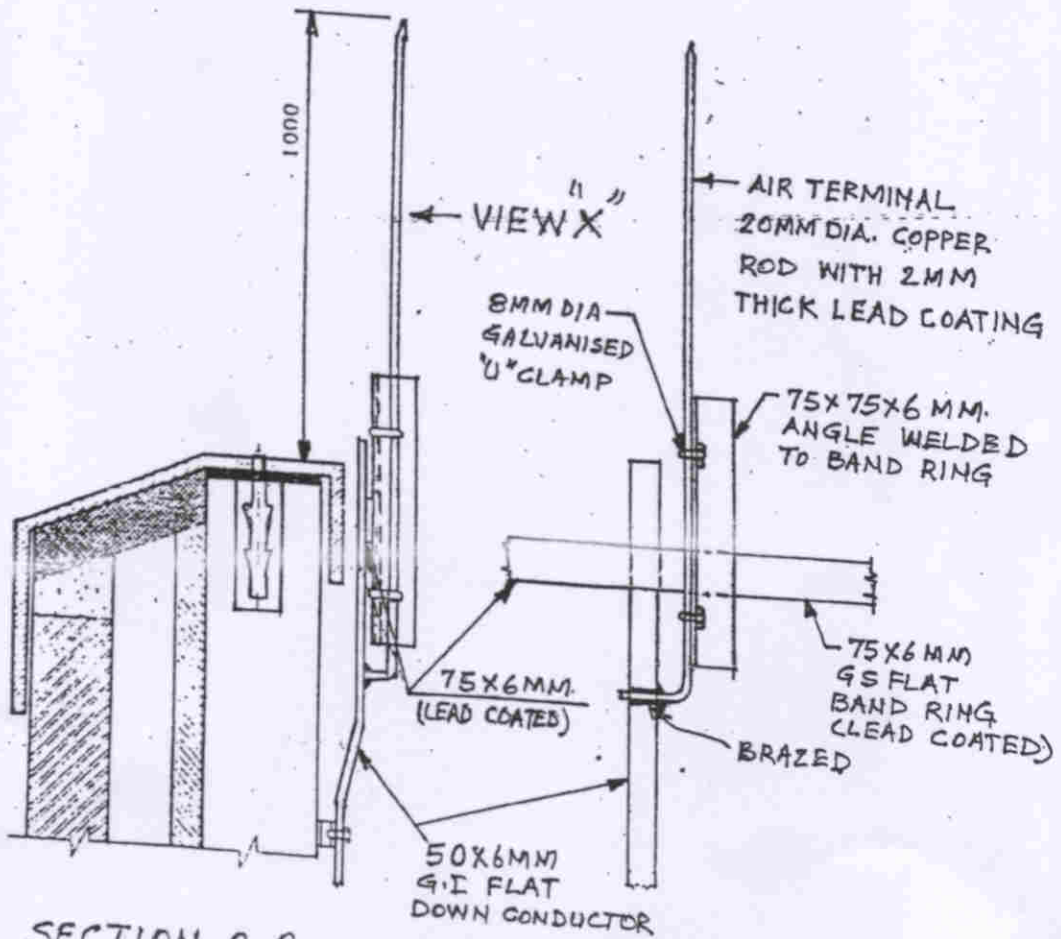
DRG. No.  
PE-DG-XXX-509-0003

SHEET 2 OF 4

REV. 00



SECTION 1-1



SECTION 2-2

BHARAT HEAVY ELECTRICALS LIMITED  
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NEW DELHI

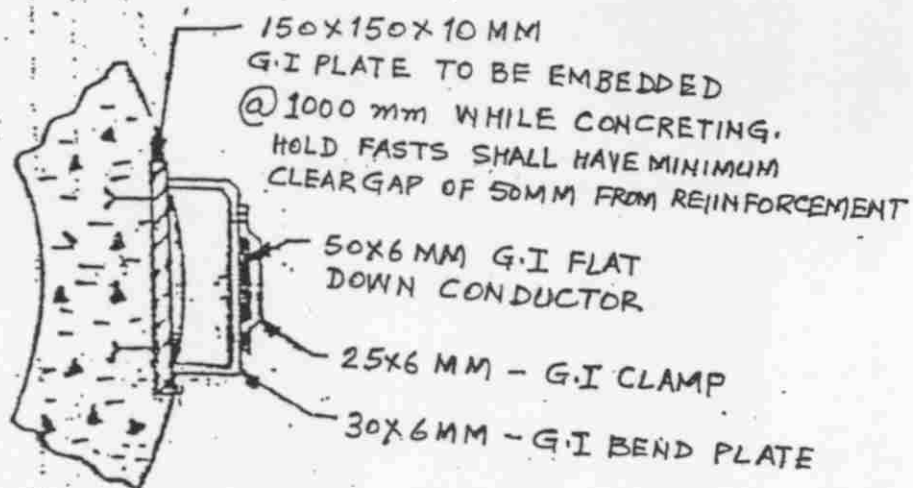
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PE-DG-XXX-509-0003

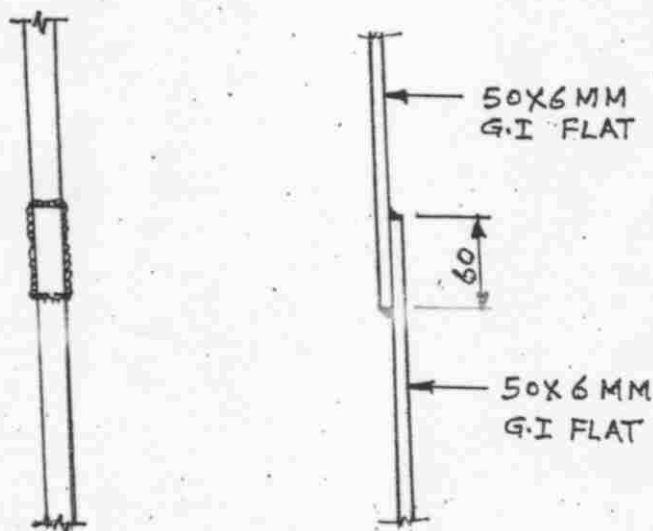
SHEET 3 OF 4

REV. 00





DETAIL- "Y"



TYPICAL WELDED JOINT



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NEW DELHI

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1394217/2023/PS-SR-PM

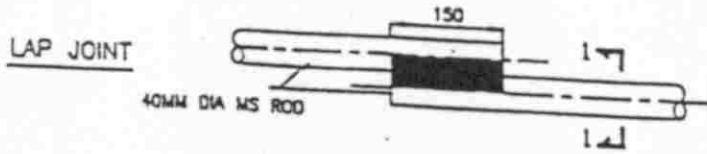
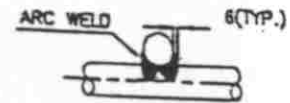
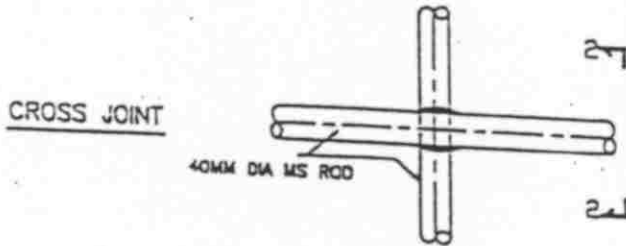
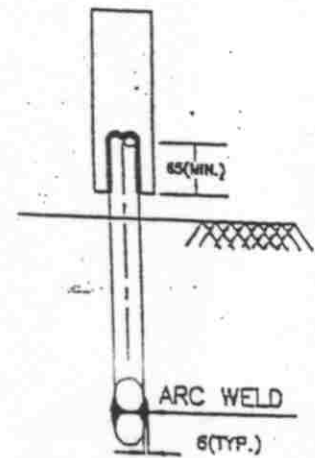
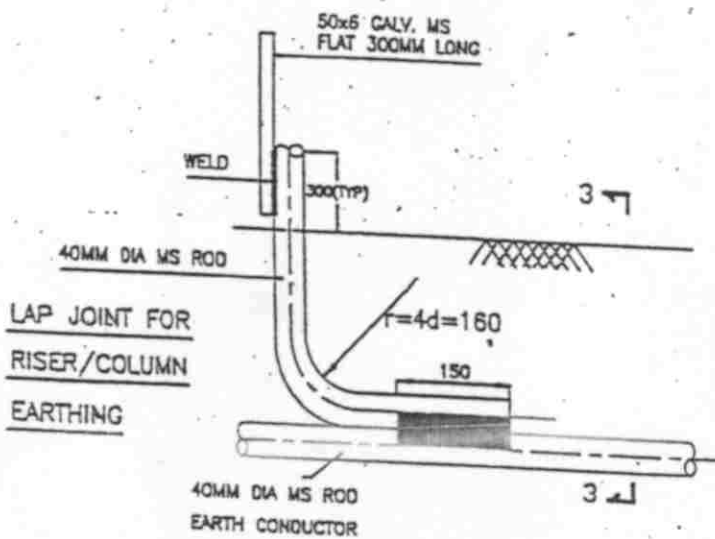
BELOW GROUND EARTHING  
TYPICAL DETAILS

DRG. NO. PE-DG-~~287~~509-0004



BHARAT HEAVY ELECTRICALS LIMITED  
PROJECT ENGINEERING MANAGEMENT  
NEW DELHI

SHEET 1 OF 8

SECTION 1-1SECTION 2-2SECTION 3-3WELDED JOINTSNOTES :-

ALL DIMENSIONS ARE IN MM.

SHEL DRAWING No.

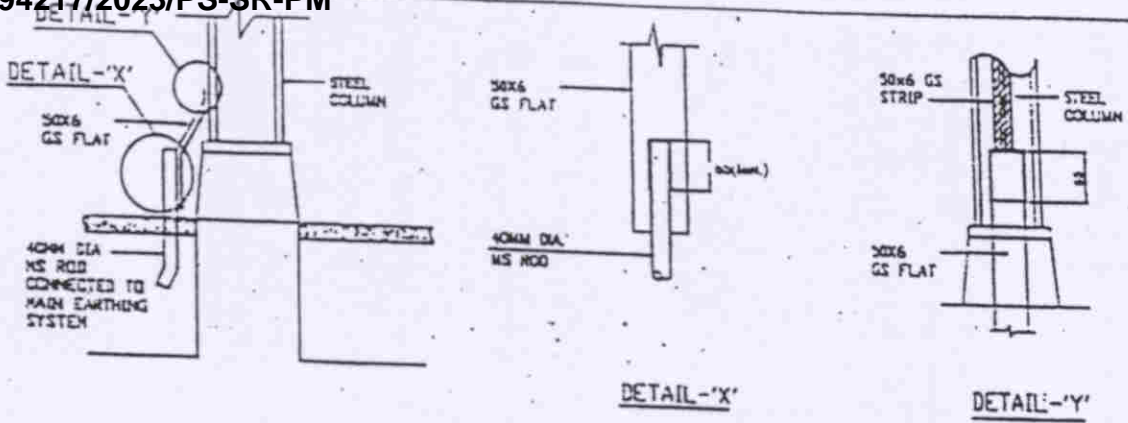
PE-DG-XXX-509-000-4

SHEET 2 OF 8

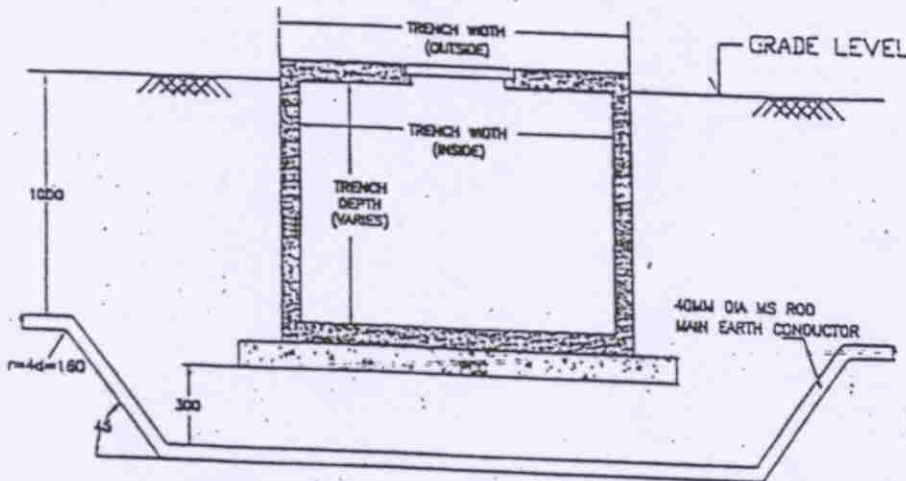


BELOW GROUND EARTHING  
TYPICAL DETAILS

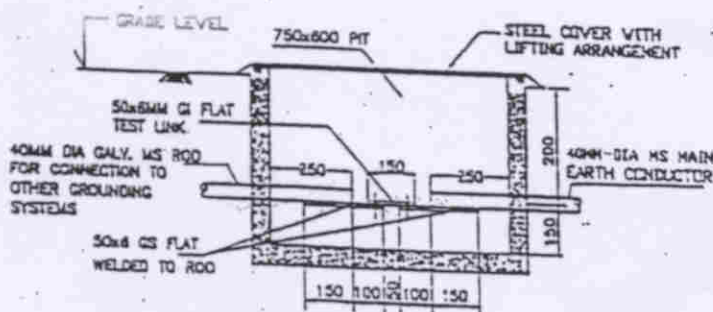
1394217/2023/PS-SR-PM



### COLUMN EARTHING



### TRENCH CROSSING



*Concrete cover*

### TEST-LINK

(PROVIDED FOR CONNECTION BETWEEN VARIOUS GROUNDING SYSTEMS)

### NOTES :-

ALL DIMENSIONS ARE IN MM.

BHEL DRAWING No.

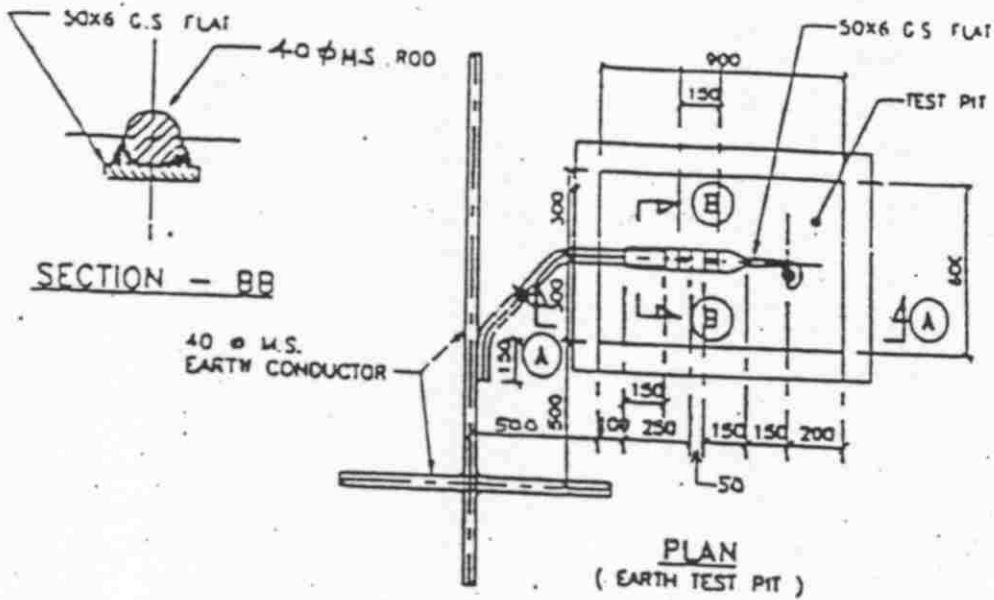
PE-DG-XXX-503-0004

SHEET 3 OF 8

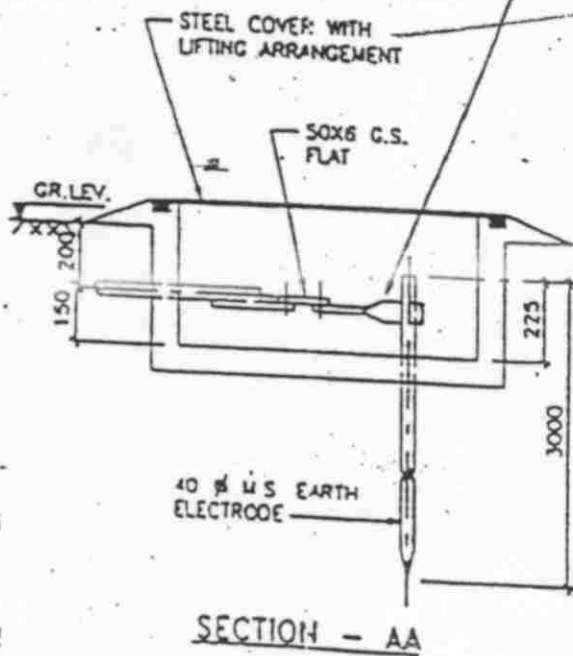


BELOW GROUND EARTHING  
TYPICAL DETAILS





50x6 GALVANISED FLAT TWISTED AT 90° BY GAS HEATING AND WELDED TO ELECTRODE ON TOP AND BOTTOM ALL AROUND BEFORE ELECTRODE IS DRIVEN INTO THE EARTH



NOTE: ALL DIMENSIONS ARE IN MM.



BELOW GROUND EARTHING  
TYPICAL DETAILS

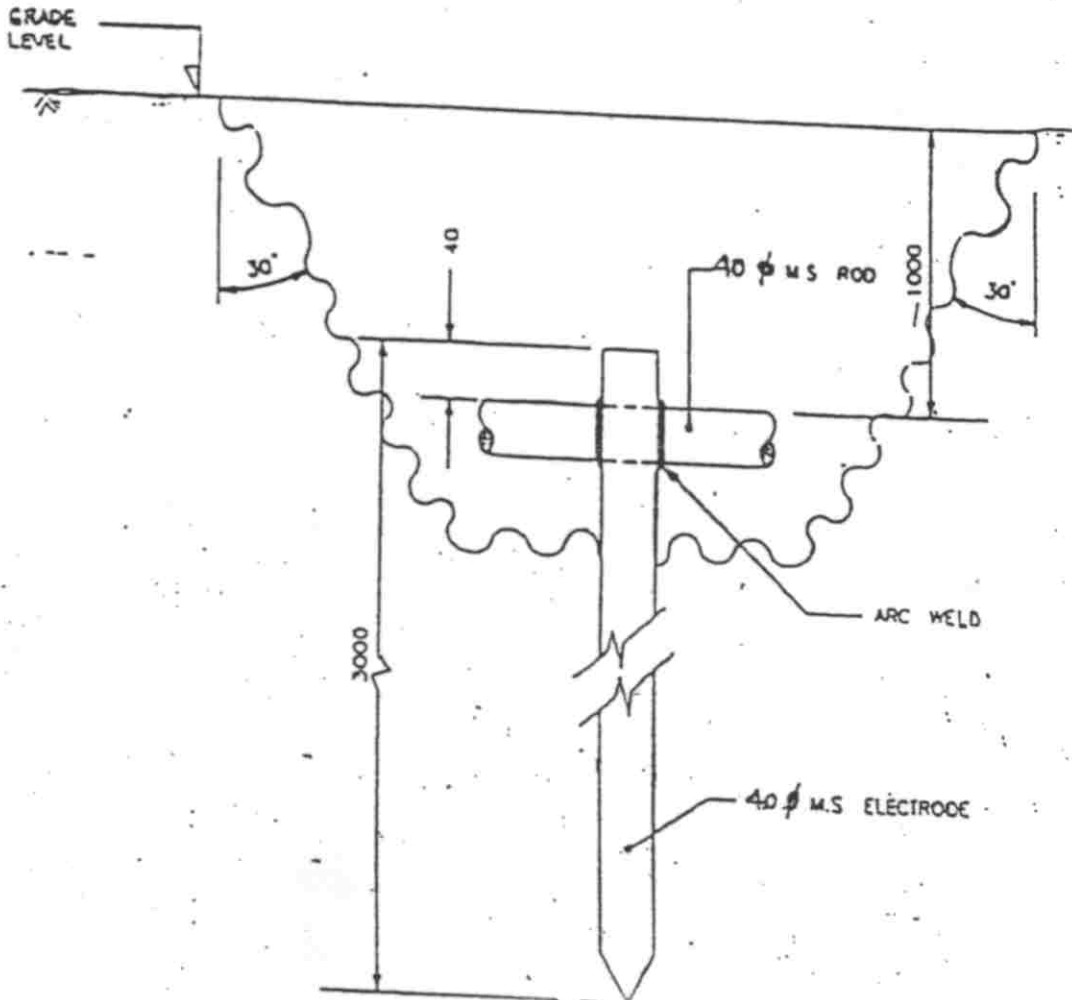
BHEL DRAWING No.

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CH-EE- 4 OF 8

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### GROUND ELECTRODE

NOTE:-

1. ALL DIMENSIONS ARE IN MM.

27



### BELOW GROUND EARTHING TYPICAL DETAILS

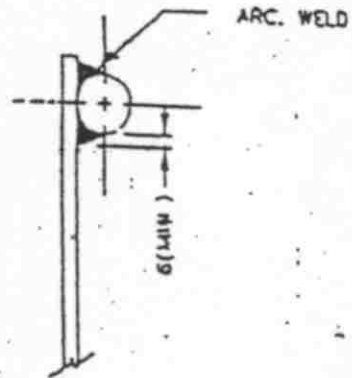
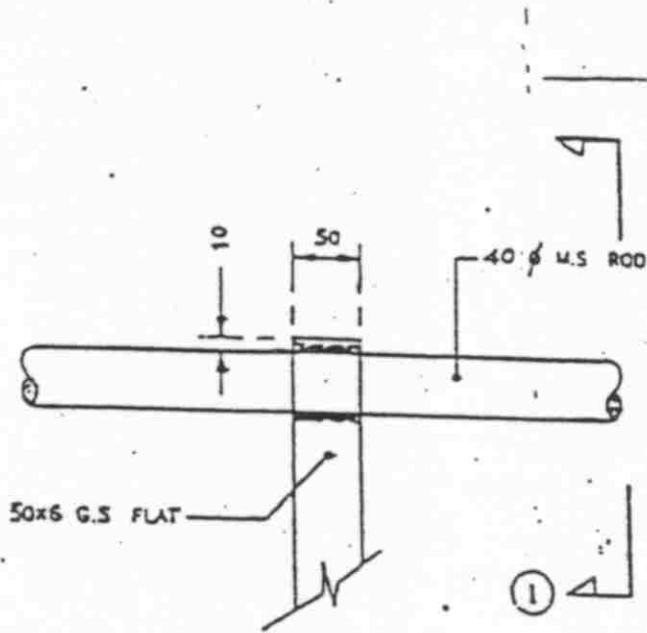
BHEL DRAWING No.

PE-DG-XXX509-0004

SHEET 5 OF 8



1394217/2023/PS-SR-PM



SECTION - ①

CROSS JOINT  
BETWEEN M.S. ROD & G.S. FLAT

NOTE:-

1. ALL DIMENSIONS ARE IN MM.

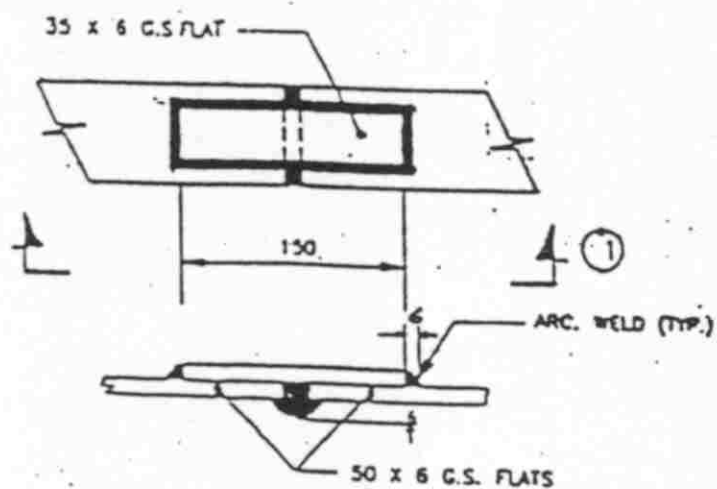


BELOW GROUND EARTHING  
TYPICAL DETAILS

BHEL DRAWING No.

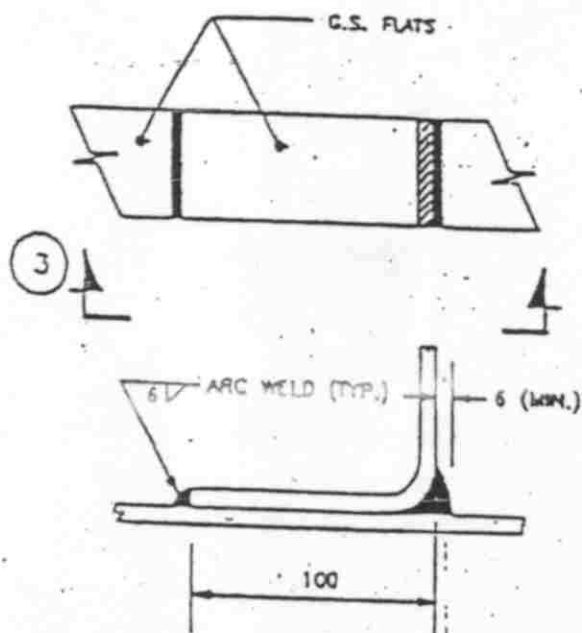
PE-DG-~~XXX~~509-0004

SHEET 6 OF 8



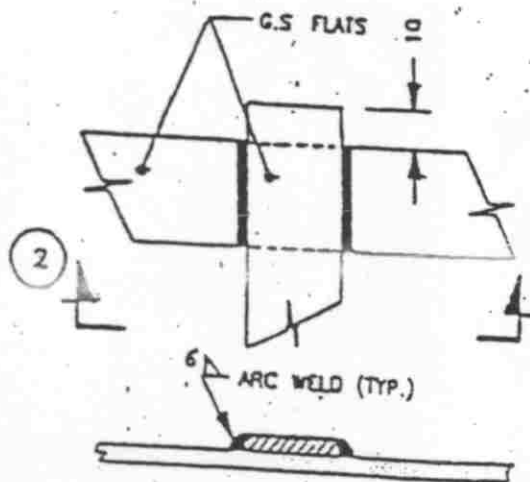
SECTION - ①

LAP JOINT  
BETWEEN G. S. FLATS



SECTION - ③

ANGULAR JOINT  
BETWEEN G. S. FLATS



SECTION - ②

CROSS JOINT  
BETWEEN G. S. FLATS



BELOW GROUND EARTHING  
TYPICAL DETAILS

SHEEL DRAWING No.

PE-DG-~~XXX~~-509-0004

SHEET 7 OF 8

NOTES:-

1. WELDING OF GALVANISED FLAT/MS RODS SHALL BE CARRIED OUT AS FOLLOWS:
  - a) CLEANING OF WELD AREA WITH WIRE BRUSH.
  - b) REMOVAL OF GALVANISATION COATING IN THE WELD AREA.
  - c) WELDING OF CONDUCTORS AS PER DETAILS SHOWN IN THIS DRAWING BY ELECTRIC ARC WELDING PROCESS USING LOW HYDROGEN CONTENT WELDING ELECTRODES.
  - d) NATURAL COOLING OF WELDED JOINT.
2. EARTH CONDUCTOR SHALL BE ROUTED BELOW ROADS/ TRENCHES WITH MINIMUM CLEARANCE OF 300MM.
3. CIVIL DETAILS OF EARTH PITS/ TEST PITS ARE INDICATIVE. ACTUAL DETAILS SHALL BE SHOWN IN CIVIL DRAWINGS.
4. MINIMUM DEPTH OF BURIAL OF EARTH CONDUCTOR SHALL BE 1000 MM.

NOTES :-

ALL DIMENSIONS ARE IN MM.



BELOW GROUND EARTHING  
TYPICAL DETAILS

BHEL DRAWING No.

PE-DG-XXX-509-0004

SHEET 8 OF 8

FORM No. PEM - 6686-0



TITLE CHIMNEY LIGHTING

SPECIFICATION NO. PES-558-03

VOLUME II B

SECTION D

REV. NO. 1 DATE 7.2.95

SHEET 1 OF 7

GENERAL TECHNICAL REQUIREMENTS  
OF  
CHIMNEY LIGHTING

SPECIFICATION NO. PES-558-03 REV-01



TITLE CHIMNEY LIGHTING

SPECIFICATION NO. PES-558-03

VOLUME II B

SECTION D

REV. NO. 1 DATE 7.2.95

SHEET 2 OF 7

## 1.0 GENERAL

1.1 This specification covers the following :

- Engineering of lighting system including the associated power distribution system for chimney.
- Design, manufacture, supply, storage at site, testing of all necessary equipment such as lighting luminaries, lamps, wires, conduits, wiring accessories and any other equipment and material as would be found necessary for the satisfactory execution/ completion of the job.
- Erection, testing and commissioning of the lighting system for chimney.
- Temporary warning lights shall be provided during the course of work for heights above 45m free of cost.

## 2.0 CODES &amp; STANDARDS

2.1 Unless otherwise specified, the following codes &amp; standards are applicable. In all cases latest revision of codes shall be referred to.

Indian StandardsTitle

IS 418	Tungsten filament general service electric lamps.
IS 732	Code of practice for electric wiring installation (system voltage not exceeding 650 V)
IS 5133 (Part-I)	Boxes for enclosure of electrical accessories steel & cast iron boxes.
IS 9537	Hot dip galvanised conduit.
IS 1913	General Safety requirements for electric lighting fitting.
IS 1947	Specification for flood lights.
IS 9900	High pressure mercury vapour Lamp.
IS 3043	Code of practice for earthing.
IS 9974	High pressure sodium vapour Lamps.



TITLE CHIMNEY LIGHTING

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SHEET 3 OF 7

IS 3528 Water proof electric lighting fitting.

IS 694 PVC insulated cables for working voltages up to &amp; including 1100 V.

Indian Electricity Rules -1956.  
International Civil Aviation Code.

## 3.0 DESIGN REQUIREMENTS

## 3.1 Lighting luminaries

3.1.1 Twin obstruction luminaire for aviation lighting shall be used having aluminium alloy casting body with separate galleries to take two specially designed red prismatic glass domes to give a symmetrical light distribution with maximum intensity 10 degrees above horizontal. Two porcelain Bayonet cap lamp holders for 100 watt incandescent lamps shall be provided. Approved weather proof paint shall be provided.

3.1.2 Alternatively Neon lamp type Luminaire shall also be quoted.

3.1.3 The obstruction lights shall be fixed lights, red in colour, having an intensity sufficient to ensure conspicuity considering the intensity of adjacent lights and general level of illumination against which they would normally be viewed. In no case, the intensity shall be less than 10 candles of red lights.

3.1.4 Flood light shall be outdoor type consisting of light weight die cast aluminium alloy housing, heat resistant and toughened glass cover with synthetic rubber gasket, reflector and mounting bracket. The luminaries shall be suitable for 1x250 W High pressure Mercury Vapour lamp (HPMV) with suitable lamp holder, ballast, power factor improvement capacitor, mounting box for accessories and connector block & fuses duly pre-wired.

3.1.5 Alternatively flood lights with 150 W High Pressure sodium vapour lamp (HPSV) HPSV lamp shall be provided with external igniters and rapid restart facility.

## 3.2 Arrangement of lights

3.2.1 The number and arrangement of lights at each platform to be provided shall be such that the obstruction is indicated from every angle in azimuth. Number of obstruction luminaire at each platform shall not be less than four.



TITLE CHIMNEY LIGHTING

SPECIFICATION NO. PE-8-558-13


VOLUME II B

SECTION D

REV. NO. 1 DATE 7.2.95

SHEET 4 OF 7

- 3.2.2 The lights shall be placed between 1.5 metres and 3 metres below the top of chimney.
- 3.2.3 When the top of the chimney is more than 45metres above the level of the surrounding ground, intermate lights shall be provided for each additional 45metres or fraction thereof.
- 3.2.4 Four (4) Nos. flood lights shall be provided at the lowest platform of chimney for illuminating the surrounding of chimney.
- 3.3 Power Distribution Scheme
- 3.3.1 Lighting system load shall be supplied from A.C. Emergency lighting board. From the outgoing of A.C. ELDB, PVC armoured cable of suitable size shall emanate for feeding supply to lighting panel for chimney.
- 3.3.2 The contractor shall install lighting panel to be supplied by the purchaser.
- 3.3.4 A.C. ELDB shall be supplied & erected by the purchaser. Inter-connecting power cable between A.C. ELDB and lighting panel shall be supplied and installed by the purchaser. However, necessary provision shall be made by the chimney vendor in his civil works near the chimney for installation of above cable.
- 3.4 Method of wiring
- 3.4.1 From A.C. ELDB to lighting panel for chimney 650/1100 V grade, PVC insulated, PVC sheathed, armoured cable of aluminium conductor shall be installed. From lighting panel further distribution to lighting luminaries shall be done with 650 V/1100V grade, Single core, stranded copper conductor, PVC insulated, unsheathed wires of minimum 4mm sq in conduits fixed on the chimney wall.
- 3.4.2 Each circuit from lighting panel shall be taken in a separate conduit.
- 3.4.3 The minimum acceptable copper conductor size for connecting lighting fixtures shall be 4 sq.mm. or more depending upon the voltage drop consideration.
- 3.4.4 Minimum conductor size shall be such that the voltage drop to the farthest lighting point shall not exceed 2.5% of 240 V.
- 3.4.5 The aviation obstruction lights/flood lights shall be balanced on all the three phases to the extent possible.

	TITLE CHIMNEY LIGHTING	SPECIFICATION NO. PES- 558-03	
		VOLUME II B	
		SECTION D	
		REV. NO. 1	DATE 7.2.95
		SHEET 5 OF 7	

## 3.5. Conduits

3.5.1 Conduits (Heavy gauge) & junction boxes, shall be hot dip galvanised type as per relevant IS. No conduit less than 20mm diameter shall be used. Junction boxes/pull boxes shall be made from 1.6mm thick galvanised sheet steel and shall incorporate terminal block for termination of incoming and outgoing cables. Junction boxes to be used outdoor shall be weather proof type with gasket conforming to degree of protection IP 55.

3.5.2 Conduit accessories/ fittings shall be as per relevant IS.

## 3.6 Earthing

A separate G.I. wire of 14 SWG shall be used for earthing the lighting fittings, lighting panels as per IE Rules & IS 3403. The contractor shall connect this earthing system to main earthing mat provided by the purchaser. Main earthing mat shall be located near the chimney.

3.7 For other general reqts. of Lighting design, refer to (w) enclosed "Lighting Notes & Details" (Dy No. PE-DG-XXX-558-0004).

## 4.0 TESTING &amp; INSPECTION

4.1 Standard quality plan (QP) for lighting system is enclosed in VOL III. Bidder to confirm compliance to this quality plan by signing every page of it.


4.2 All equipment shall comply with the type and routine tests as prescribed in the relevant standards. Certificates of type tests shall be furnished with the tender. The vendor shall furnish certified test reports for all routine tests before the equipment is dispatched.

4.3 Test at Site: The vendor, in the presence of the customer shall subject the installation to the following tests.

- Insulation resistance test.
- Testing of earth continuity path connections.
- Complete operational tests on the whole of the installation.

4.4 Field quality plan (FQP) for quality checks to be observed at site during erection, testing & commissioning shall also be furnished by vendor alongwith offer as per standard BHEL format.



	<b>TITLE</b> CHIMNEY LIGHTING	<b>SPECIFICATION NO.</b> PES-552-03	
		<b>VOLUME</b> IB	
		<b>SECTION</b> D	
		<b>REV. NO.</b> 1	<b>DATE</b> 7.2.95
		<b>SHEET</b> 6 OF 7	

5.0

**SPARE PARTS**

Recommended list of spares for commissioning and for operation and maintenance of the lighting system for a period specified in data sheet -A shall be furnished. The vendor shall furnish separate price and list of the same. Unit rates shall also be furnished in addition to total price.

6.0

**GUARANTEED PERFORMANCE REQUIREMENTS**

The vendor shall guarantee satisfactory performance of equipment supplied under all conditions & requirement as laid down by this specification.

7.0

**DRAWINGS & DATA**

7.1

Drawings & data to be furnished with the offer

- a) Filled in Data Sheet B.
- b) Technical leaflets of luminaires offered.

7.2

Drawings & data to be furnished after award of contract

- a) Design calculation for luminaries.
- b) Design calculation for selection of lighting wires.
- c) Lighting Layout plan showing lighting fixtures, conduit routing, conduit Size, cable size etc.
- d) Fixing and mounting details of luminaires, conduits, junction boxes etc.
- e) Test certificates for all equipment .
- f) General arrangement drawing of equipment supplied.
- g) Manufacturer catalogues/literature.
- h) Field quality plan
- i) As built drawings



TITLE CHIMNEY LIGHTING

SPECIFICATION NO. TES-558-03

VOLUME II B

SECTION D

REV. NO. 1 DATE 7.2.95

SHEET 7 OF 7

## 8.0 OPERATION AND MAINTENANCE MANUAL

Operation and maintenance manual shall contain the followings :

- a) Technical Data Sheet.
- b) Instruction for maintenance for various lighting equipment.



TITLE

# DATA SHEET A CHIMNEY LIGHTING

SPECIFICATION NO. PE

VOLUME II BSECTION AREV. NO. 0

DATE

SHEET 1OF 1

## 1.0 Details of Supply System

- a) Rated voltage :  $415\text{ V} \pm 10\%$
- b) Rated frequency :  $50\text{ Hz} \pm 5\%$
- c) Combined voltage and frequency variation :  $10\%$  (Absolute)
- d) System fault level at rated voltage :  $50\text{ kA for } 0.25\text{ sec.}$
- e) LV System grounding : Solidly
- f) Design ambient temp. :  $50^\circ\text{C}$

2.0 Type of conduit mounting :

Surface Mounting

3.0 Type of obstruction light :

- i) GEC ZA 750 (L) NEON
- ii) High intensity flashing white light having intensity  $> 2000$  candles & flashing freq.  $40-60/\text{min.}$

4.0 Type of Flood light :

→ 250W HPSV lamps

5.0 Source for power :

Normal AC & Emergency AC

6.0 Junction boxes :

Weather-proof, Galvanised steel

7.0 Main earthing mat details :

MS Rod 40 mm dia

8.0 No. of years for which O&M spares required :


3 years

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FORM No. PEM - 6019 B-0

INSTRUCTIONS FOR BHEL

1. In the DE b. e issue for an enquiry. The standard specification number shall be entered by the bidder. The specification number for the project shall be entered by the bidder.

	TITLE  DATA SHEET - B  CHIMNEY LIGHTING	SPECIFICATION NO.
		VOLUME III
		SHEET 1 OF 2

## 1.0 CONDUIT

- a) Make :
- b) Size :
- c) Material :
- d) Applicable Standard :

## 2.0 Applicable Standard for Conduit accessories and fittings :

3.0 JUNCTION BOX  
(for each type & size)



- a) Make :
- b) Type :
- c) Material :
- d) Degree of protection of enclosure :
- e) Applicable Standard :



## 4.0 LIGHTING WIRES

- a) Make :
- b) Type :
- c) Conductor material :
- d) Size :
- e) Voltage grade :
- f) Applicable Standard :

Name of Bidder / Vendor				Project	
Revision Number	0	1	2	3	
Signature of Bidder / Vendor / Authorised Representative					
Date					

1. In the DE Bids, the specification number for it shall be entered by FORM No. PEM-6019 B-0. The standard specification number shall not be entered.

	TITLE		DATA SHEET - B		SPECIFICATION NO.	
			CHIMNEY LIGHTING		VOLUME III	
					SHEET 2 OF 2	
<div>5.0 LUMINARIES</div> <div><div>a) Make :</div><div>b) Type :</div><div>c) Type of lamp holder :</div><div>d) Applicable Standard :</div></div> <div>6.0 LAMPS</div> <div><div>a) Make :</div><div>b) Type :</div><div>c) Wattage :</div><div>d) Nominal lamp voltage :</div><div>e) Light output :</div><div>f) Applicable Standard :</div></div>						
Name of Bidder / Vendor					Project	
Revision Number		0	1	2	3	
Signature of Bidder / Vendor / Authorised Representative						
Date						

	TITLE				DATA SHEET - C				SPECIFICATION NO.			
	CHIMNEY LIGHTING				VOLUME II B				PART D			
					SHEET 1				OF 3			
<div>1.0 CONDUIT</div> <div>(for each type &amp; size)</div> <div>a) Make :</div> <div>b) Type :</div> <div>c) Size :</div> <div>d) Applicable Standard :</div> <div>2.0 JUNCTION BOX</div> <div>(for each type &amp; size)</div> <div>a) Make :</div> <div>b) Material :</div> <div>c) Size :</div> <div>d) Degree of protection of enclosure :</div> <div>e) Applicable Standard :</div> <div>3.0 LIGHTING WIRES</div> <div>a) Make :</div> <div>b) Type :</div> <div>c) Voltage grade :</div> <div>d) Applicable Standard :</div> <div>e) Continuous current rating at design ambient :</div> <div>f) Conductor</div> <div>i. Material :</div>												
Name of Bidder / Vendor								Project				
Revision Number		0		1		2		3				
Signature of Bidder / Vendor / Authorised Representative												
Date												

Form No. PEM - 60188-0



TITLE

DATA SHEET - C

SPECIFICATION NO.

CHIMNEY LIGHTING

VOLUME II B PART D

SHEET 2 OF 3

ii. Nominal cross :  
sectional area

iii. No. & Diameter:  
of wires

g) Insulation

i. Composition of :  
insulation

ii. Thickness of :  
insulation

iii. Tolerance on :  
thickness of  
insulation

h) Colour scheme for :  
identification of  
wires

4.0 LUMINARIES  
(for each type)

a) Make :

b) Type :

c) Type of lamp holder :

d) Capacitor rating :

e) Weight of luminaires :

f) Applicable Standards :

5.0 LAMPS :

a) Make :

b) Type :

c) Wattage :

Name of Bidder / Vendor

Project

Revision Number

0

1

2

3

Signature of Bidder / Vendor /  
Authorised Representative

Date

BIDDER'S SEAL

Instructions for use of the specification number for  
issue for an enquiry. The standard specification number  
shall be entered by  
if not be entered.

INSTRUCTIONS  
FOR SHEET

Form No. PEM - 60188-0



TITLE

DATA SHEET - C

SPECIFICATION NO.

CHIMNEY LIGHTING

VOLUME II B PART D

SHEET 3 OF 3

- d) Nominal lamp voltage :
- e) Light output (lumen) :
- f) Life of lamp :
- g) Applicable Standard :

 INSTRUCTIONS FOR BHEL  
 In the column "SPECIFICATION NO." the specification number for the standard specification number shall be entered by the bidder.

Name of Bidder / Vendor

Project

Revision Number

0

1

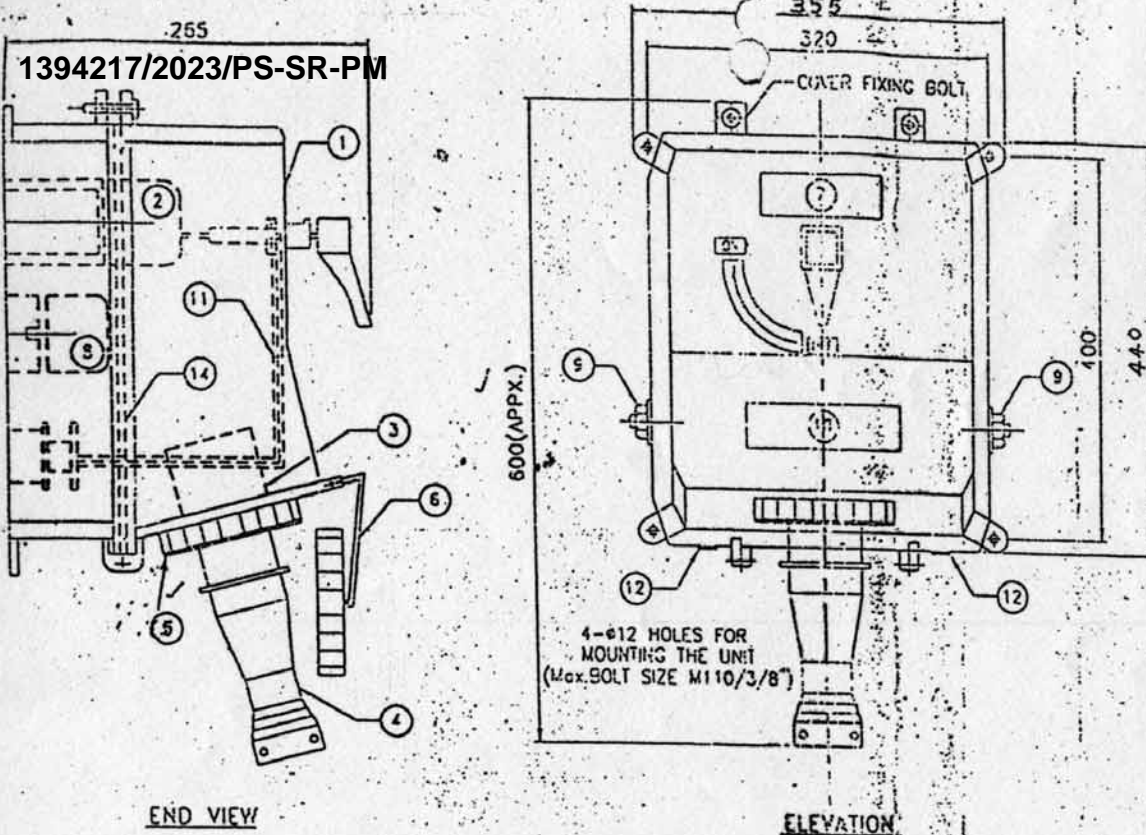
2

3

Signature of Bidder / Vendor /  
Authorised Representative



1394217/2023/PS-SR-PM

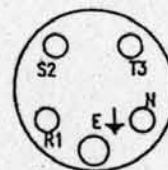
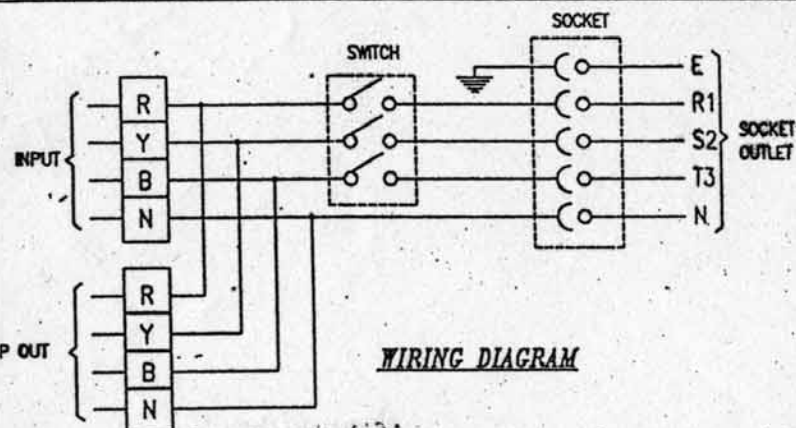


### SPECIFICATION

- 1] ALUMINIUM ALLOY HOUSING (MIN THICKNESS 3mm)
- 2] GE POWER CONTROL TP ON/OFF SWITCH DOUBLE BREAK TYPE SP02, AC23 CATEGORY CONFORMING TO IS-13947-3
- 3] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH SOCKET
- 4] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH PLUG
- 5] PLUG RING
- 6] SPRING LOADED COVER FOR SOCKET OUTLET
- 7] NAME PLATE
- 8] 4 WAY STUD TYPE TERMINAL BLOCK 2 Nos. FOR LOOP IN LOOP OUT, ARRANGEMENT TO TERMINATE 3.5C/50 sq.mm STUD TYPE BEST & CROMPTON MAKE
- 9] ELECTROPLATED EARTHING TERMINAL 2 Nos. COMPLETE WITH 6mm BOLT, NUT & WASHER SUITABLE FOR 14 SWG. GI. EARTHING CONDUCTOR
- 10] CAUTION STACKER
- 11] MECHANICAL INTERLOCKING ARRANGEMENT
- 12] DETACHABLE GLAND PLATE 0 TAKE 2 Nos. GLAND SUITABLE FOR 3.5x70 sq.mm. CABLES.

### NOTES

- 1] ALL DIMENSION ARE IN MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE  $\pm 5\text{mm}$
- 2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE  $16^{25}$  sq.mm. CABLE
- 3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 - POWER COATING
- 4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
- 5] SWITCH CAN NOT BE MADE 'ON' UNLESS PLUG IS INSERTED  
PLUG CAN NOT BE WITHDRAWN UNLESS SWITCH IS IN OFF POSITION
- 6] UNIT IS MANUFACTURE BY "BEST & CROMPTON"
- 7] SUITABLE CABLE GRIP SHALL BE PROVIDED



### SHOWING TERMINAL POSITION

COLOR CODED SLEEVE WILL BE PROVIDED ON BOTH ENDS ON COPPER FLEIBLE  
 R PHASE - RED COLOUR  
 Y PHASE - YELLOW COLOUR  
 B PHASE - BLUE COLOUR  
 NEUTRAL - BLACK COLOUR

### CHIMNEY LIGHTING SPECIFICATION

REV	DATE	DESCRIPTION
01		
02		

NATIONAL THERMAL POWER CORPORATION LTD.  
 RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II



**BHARAT HEAVY ELECTRICALS LIMITED**  
 POWER SECTOR, PROJECT ENGINEERING MANAGEMENT  
 NEW DELHI



**bajaj electricals limited**

MUMBAI

Engineering & Projects Division

DRN	CHKD	APPD	DATE	BHEL DWG. No
KBM	JS	AP	30.06.03	PE-V0-200-558-E073

TITLE GENERAL ARRANGEMENT DWG FOR 63 A  
 FULLY INTERLOCKED SWITCHED PLUG  
 63 AMPS 415 VOLTS [TYPE RC]

DWG. NO. **EPBU-03-PS005-04-073**

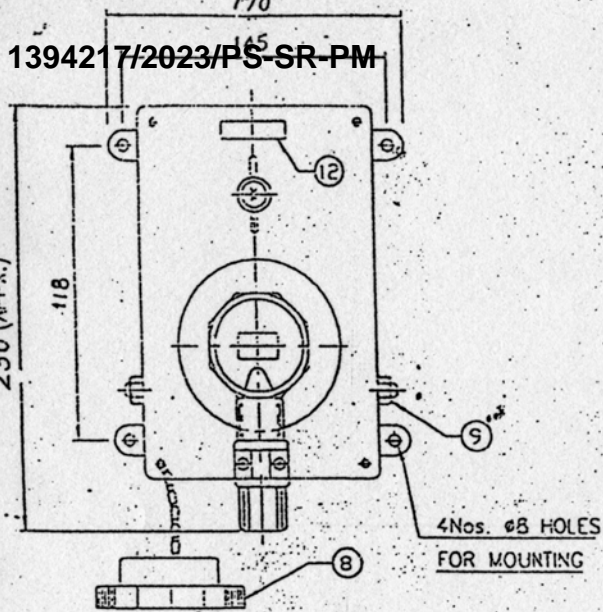
REV.

0

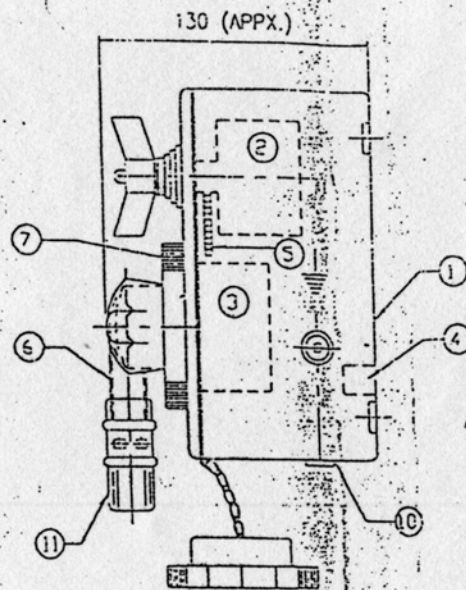
SHT. 1 OF 1

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230 (APPX.)



ELEVATION



END VIEW

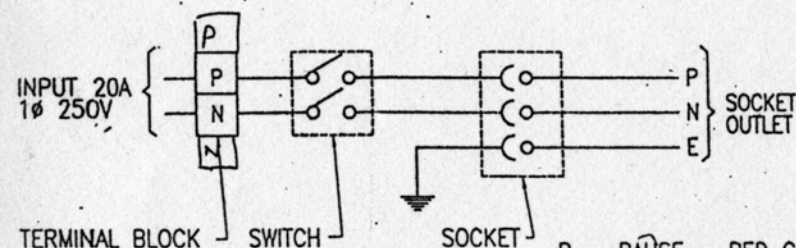
SPECIFICATION

- 1] ALUMINIUM ALLOY ENCLOSURE 3mm THICK
- 2] 25A, 250V, DOUBLE POLE/ OFF ROTARY SWITCH AC 23 CATEGORY IS-4064 - RECOM MAKE
- 3] ALUMINIUM ALLOY METAL CLAD SOCKET UNIT "BEST & CROMPTON" MAKE
- 4] BAKELITE STUD TYPE 2 WAY TERMINAL BLOCK TO TERMINATE 2Cx4 sq.mm CABLE
- 5] MECHANICAL INTERLOCKING SYSTEM
- 6] DIE CAST ALUMINIUM ALLOY METAL CLAD PLUG AND SOCKET OF 20A, 240V, 3 PIN (P+N+E), 3rd PIN GROUNDED
- 7] THREADED PLUG LOCKING RING
- 8] SOCKET COVER WITH CHAIN FOR SOCKET OUTLET
- 9] EARTHING TERMINAL 2 Nos. - M6 SIZE
- 10] CABLE ENTRY 25mm DIA - 2Nos.
- 11] PVC CABLE GRIP
- 12] NAME PLATE

NOTES

- 1] ALL DIMENSION ARE IN MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE OF  $\pm 5$ mm
- 2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE 4 sq.mm. COPPER CABLE
- 3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 - POWER COATING
- 4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
- 5] SWITCH CAN ~~NOT~~ BE MADE 'ON' ONLY WHEN PLUG IS FULLY ENGAGED WITH SOCKET. PLUG CAN NOT BE WITH DRAWN WHEN SWITCH IS ON
- 6] 2 Nos. CABLE ENTRY AT BOTTOM

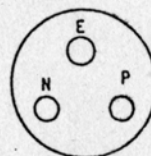
CHIMNEY LIGHTING SPECIFICATION.

WIRING DIAGRAM

(FOR SINGLE PHASE UNIT)

P - PHASE - RED COLOUR  
 N - NEUTRAL - BLACK COLOUR  
 E - GREEN COLOUR.

VIEW ON SOCKET  
PLUG REMOVED



1230-061-29PE-PVG-B-070

NATIONAL THERMAL POWER CORPORATION LTD.  
 RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II

BHARAT HEAVY ELECTRICALS LIMITED  
 PROJECT ENGINEERING MANAGEMENT


bajaj		bajaj electricals limited		MUMBAI
Engineering & Projects Division				
DRN	CHKD	APPD	DATE	BHEL DWG. No
10/11	IS	AP	10.05.03	PE-V0-200-558-E070


REV	DATE	DESCRIPTION
01		
02		

TITLE	GENERAL ARRANGEMENT DWG FOR FULLY INTERLOCKED SWITCHED PLUG 20 AMPS, 250 VOLTS [TYPE RA]
DWG. NO.	EPBU-03-PS005-04-070
REV	0

SHT. 1 OF 1

	TITLE:  <b>LIGHTING NOTES AND DETAILS</b>	SPECIFICATION NO. PES-558-0004	
		VOLUME - II	
		SECTION - C	Sub Sec -II
		REV.NO. 0	DATE
		SHEET 1	OF
<div>LIGHTING NOTES AND DETAILS</div> <div>SPECIFICATION NO. PES-558-0004</div>			

	<b>TITLE:</b>  <b>LIGHTING NOTES AND DETAILS</b>	SPECIFICATION NO. PES-558-0004 VOLUME - II SECTION - C      Sub Sec -II REV.NO.      0      DATE SHEET   1      OF
<p style="text-align: center;"><b>LIGHTING NOTES</b></p> <p>1.0 These lighting notes and details shall be read and construed in conjunction with the lighting specifications and drawings</p> <p>2.0 Contractor shall develop final conduit/cable routings based on fixture location and other site conditions.</p> <p>3.0 Unless otherwise shown, the mounting heights of lighting fixtures and accessories shall generally be as follows.</p> <p>3.a. Lighting fixture in general areas of powerhouse, miscl. Pump house etc.</p> <p>3.a.i. Low bay type : 3000 mm to bottom.</p> <p>3.a.ii. Medium bay type : bet 3500 mm to 8000 mm to bottom.</p> <p>3.a.iii. High bay type : above 8000mm to bottom.</p> <p>3.b. Bracket lights over door opening : 300 mm bot of fixture above opening.</p> <p>3.c. Receptacles</p> <p>3.c.i. In control room office : 450 mm floor to center.</p> <p>3.c.ii. Elsewhere : 900 mm floor to center.</p> <p>3.d. Local switches : 1500 mm floor to center</p> <p>3.e. Lighting panels : 1800 mm floor to top</p> <p>4.0 All outdoor illumination fixtures unless it fed from photocell/tank-switch controlled lighting panel shall be provided with outdoor type local switches.</p> <p>5.0 Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in the form of switch or fuse.</p>		

5. SEPARATE NEUTRAL WIRE SHALL BE PROVIDED FOR EACH CIRCUIT. WIRING THROUGHOUT THE INSTALLATION SHALL BE SUCH THAT THERE IS NO BREAK IN THE NEUTRAL WIRE IN THE FORM OF SWITCH OR FUSE.

6. ALL EXPOSED CONDUIT RUNS IN BATTERY ROOM, CHEMICAL FEED STATION AREA, WATER TREATMENT BUILDING ETC. SHALL BE SUITABLY PAINTED WITH ACID/ALKALI PROOF PAINTS.

7. THE ENTIRE METALLIC CONDUIT SYSTEM SHALL BE ELECTRICALLY CONTINUOUS AND THOROUGHLY GROUNDED.

8. LIGHTING FIXTURES SHALL NOT BE SUSPENDED DIRECTLY FROM JUNCTION BOX IN THE MAIN CONDUIT RUN.

9. AC AND DC CIRCUITS SHALL NOT BE RUN IN THE SAME CONDUIT.

10. RECEPTACLE SUB-CIRCUITS SHALL BE KEPT SEPARATE AND DISTINCT FROM LIGHTING AND FAN SUB-CIRCUITS.

11. WIRES/CABLES SHALL BE SPLICED ONLY AT JUNCTION BOXES WITH RING-TONGUE LUGS OR APPROVED EQUAL.

12. FOR CABLE/WIRE NUMBERING, PVC SLEEVE WITH CABLE/WIRE TAP NUMBER OF DIFFERENT COLOUR CODE SHALL BE USED.

13. IN OUTDOOR AREAS, MAIN RUNS FROM LIGHTING PANELS SHALL BE BY MEANS OF ATW CABLES, LAID IN TRENCHES OR DIRECTLY BURIED IN GROUND WITH PROPER PROTECTION AS PER DETAILS SHOWN.

14. WHEN BURIED CABLES CROSS ROAD/RAILWAY TRACK, ADDITIONAL PROTECTION TO BE PROVIDED IN FORM OF RUPC/G.I. PIPE.

15. FLAME PROOF INSTALLATIONS SHALL BE CARRIED OUT WITH FLAME-PROOF G.I. CONDUITS AND FLAME-PROOF ACCESSORIES AND STATION BOXES.

16. UNLESS OTHERWISE NOTED, THE SIZE OF CABLES, WIRES, CONDUITS, JUNCTION BOXES SHALL BE AS BELOW :-



## LIGHTING NOTES & DETAILS

DRG. No.  
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PAGE : THREE

1) CABLESFROM STATION AUXILIARY SYSTEM TO MAIN  
LIGHTING DISTRIBUTION BOARDS: AL ~~HPVC~~ FRLS \*1) FROM MAIN LIGHTING DISTRIBUTION  
BOARDS TO 415 V NORMAL A.C. LIGH-  
TING PANELS: AL ~~HPVC~~ FRLS \*11) FROM EMERGENCY MAIN LIGHTING DIST.  
BOARDS (EMLDB) TO 415 V EMERGENCY  
A.C. LIGHTING PANELS: AL ~~HPVC~~ FRLS \*111) FROM MAIN LIGHTING DIST. BOARDS  
(MLDB) TO 415 V AC/220 V DC  
EMERGENCY LIGHTING DISTRIBUTION  
BOARDS (DCMLDB): AL ~~HPVC~~ FRLS \*1v) FROM 220 V MAIN DC DISTRIBUTION  
BOARDS TO 415 V AC/220 V DC  
EMERGENCY LIGHTING DISTRIBUTION  
BOARD (DC MLDB): AL ~~HPVC~~ FRLS \*v) FROM MCC/PMCC/DB TO RC, RD  
RECEPTACLES

: AL HRFVCFRLS \*

vi) FROM 415 V NORMAL AC STREET AREA  
LIGHTING PANEL TO STREET LIGHTING  
POLE JUNCTION BOX

: AIWY \*

\* SIZE OF CABLES TO BE DECIDED BY THE BIDDING.

LIGHTING NOTES & DETAILSDRG. No.  
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OF 15

B) W I R E S

- 1) FROM LIGHTING PANELS TO JUNCTION BOXES : 1C, 14 mm<sup>2</sup> Cu
- II) FROM JUNCTION BOXES TO LIGHTING FIXTURES : 1C, 2.5 mm<sup>2</sup> Cu.
- III) FROM JUNCTION BOXES TO FLOOD LIGHT FIXTURES : 2 x 2.5 mm<sup>2</sup>, 1C, Cu
- IV) FROM LIGHTING PANELS TO 240 V AC 5/15A, 1 PHASE RECEPTACLES & 24 V AC SUPPLY MODULES TYPE M4 : 1C, 14 mm<sup>2</sup> Cu
- V) FROM 24 V AC SUPPLY MODULES TO 24 V AC, 5A RECEPTACLES : 1C, 14 mm<sup>2</sup> Cu

C) C O N D U I T S

CABLE SIZE	CONDUIT SIZE					MAXIMUM NO. OF CONDUCTORS ADMISSTIBLE FOR CONDUIT
	20 MM	25 MM	32MM	40MM	50 MM	
1) 10 mm <sup>2</sup> AL	-	2	5	7	8	}
II) 2.5 mm <sup>2</sup> CU	3	5	9	-	-	

D) JUNCTION BOXES

CONDUIT SIZE (MM)	JUNCTION BOX SIZE (MM)			
	4-WAY	3-WAY	STRAIGHT THROUGH	90°
1) 20 / 25	150x150x100	150x100x100	88 Ø	88 Ø
II) 32 / 40	254x200x127	254x200x127	150x150x100	-
III) 50	254x200x127	254x200x127	254x200x127	-



LIGHTING NOTES & DETAILS

DRG. No.	PE-DG- <del>XXX</del> -558-0004
REV. No.	0
SHEET 4	OF 15

PAGE : FIVE

17. ALL LIGHTING PANELS/DISTRIBUTION BOARDS, JUNCTION BOXES, RECEPTACLES, PICTURES, CONDUITS, ETC. SHALL BE GROUNDED IN COMPLIANCE WITH THE PROVISION OF I.E. RULE AND AS DETAILED BELOW :-


- |   |                        |
|---|------------------------|
| i) LIGHTING PANELS  | : 35 x 6 MM G.S. PLATS |
| ii) DISTRIBUTION BOARDS   | : 50 x 6 MM G.S. PLATS |
| iii) PICTURES, RECEPTACLES, SWITCHES, CONDUITS, JUNCTION BOXES ETC. | : 16 SWG G.I. WIRE     |
| iv) STREET LIGHT POLES & TOWERS FOR FLOOD LIGHTING                  | : 50 x 6 MM G.S. PLATS |

18. A CONTINUOUS GROUND CONDUCTOR OF 12 SWG G.I. WIRE SHALL RUN ALONG EACH CONDUIT RUN AND BONDED TO IT EVERY 600 MM.

19. THE ELECTRICAL INSTALLATION WORK SHALL MEET THE REQUIREMENTS OF INDIAN ELECTRICITY RULES, RELEVANT IS CODES OF PRACTICE & SAFETY CODES, ALL AS ATTENDED UPTO DATE. IN ADDITION, OTHER RULES OR REGULATIONS, AS APPLICABLE TO THE WORK SHALL BE FOLLOWED. IN CASE OF ANY DISCREPANCY, THE MORE RESTRICTIVE RULE SHALL BE BINDING.

20. TYPICAL DETAILS OF LIGHTING PICTURES, OTHER LIGHTING SYSTEM COMPONENTS AND THEIR MOUNTING ARRANGEMENT AS SHOWN IN DRAWING NO.

SHEET 6 TO ARE FOR GENERAL GUIDANCE ONLY. THE CONTRACTOR HAS TO DESIGN THE SAME FULFILLING THE REQUIREMENT OF THE SPECIFICATION.

 LIGHTING NOTES & DETAILS

DRG. No.  
PE-DG-~~XXXX~~-558-0004

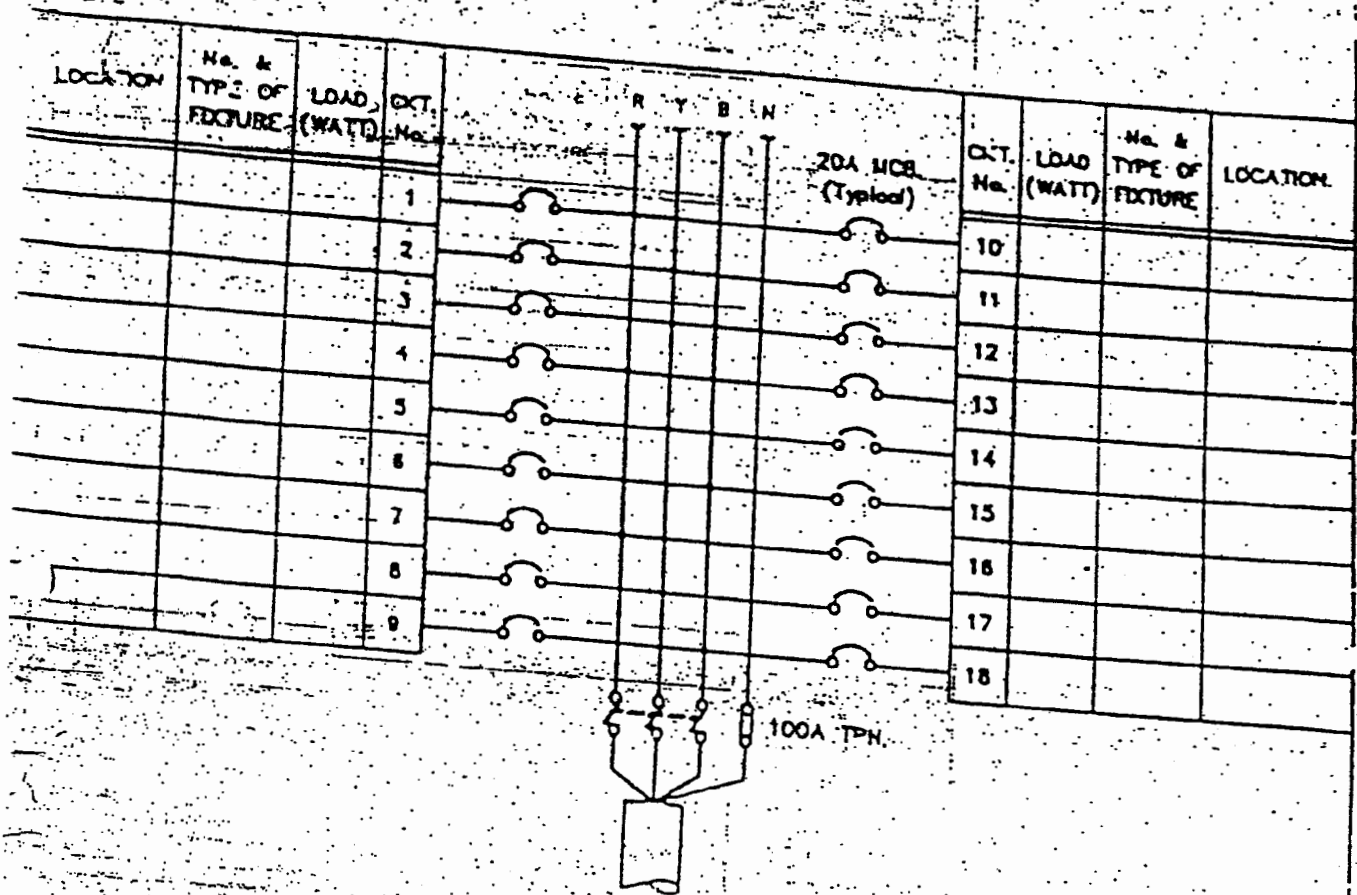
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SHEET 5 OF 5



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LIGHTING NOTES & DETAILS  
SLD OF 415V LTG. PANEL

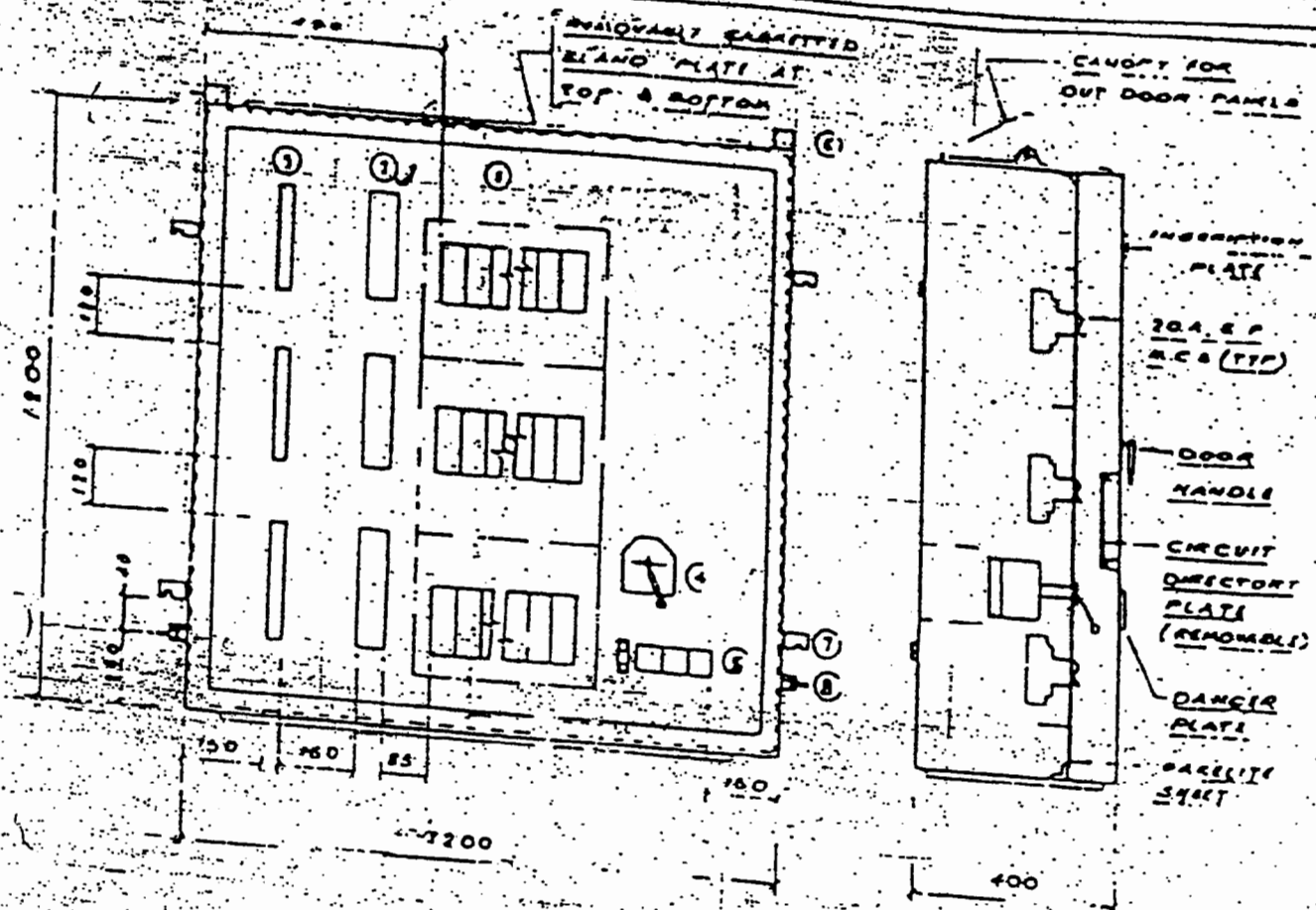
DRG. No.  
PE-DG-~~558~~-558-0004

REV. No.

0

SHEET 7

OF 15

**LEGEND**

- MINIATURE CRT BRK
- ① PHASE TERMINALS STOP
- ① NEUTRAL BUS WITH NUT, BOLT & WASHER
- ④ ISOLATOR
- ⑤ TERMINAL BLOCK
- ⑥ LIFTING LUG
- ⑦ FIRING LUG
- ⑧ EARTHING STUD WITH NUT



**LIGHTING NOTES & DETAILS**  
G.A. OF LIGHTING PANEL

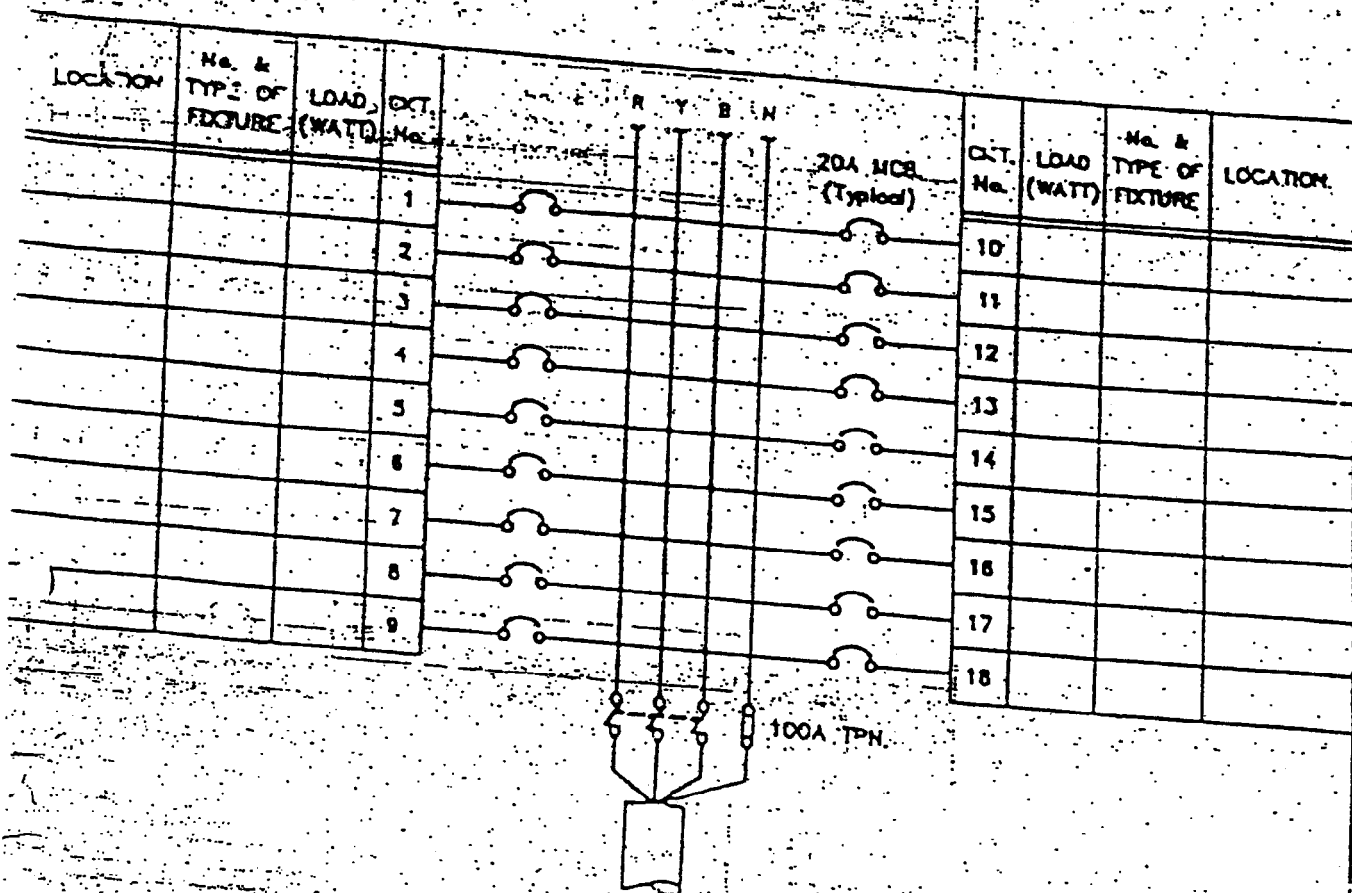
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REV. No.

0

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LIGHTING NOTES & DETAILS  
SLD OF 415V LTG. PANEL

DRG. No.  
PE-DG-~~558~~-558-0004

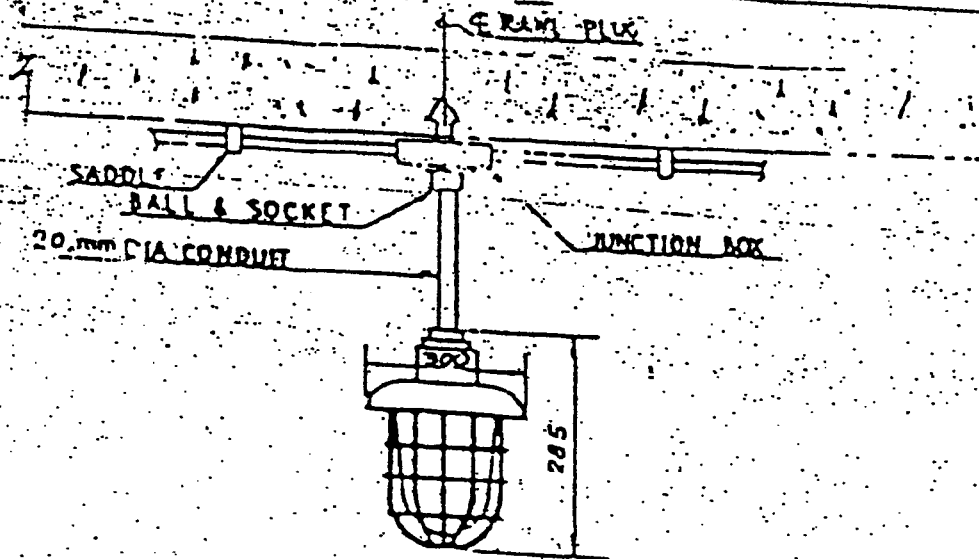
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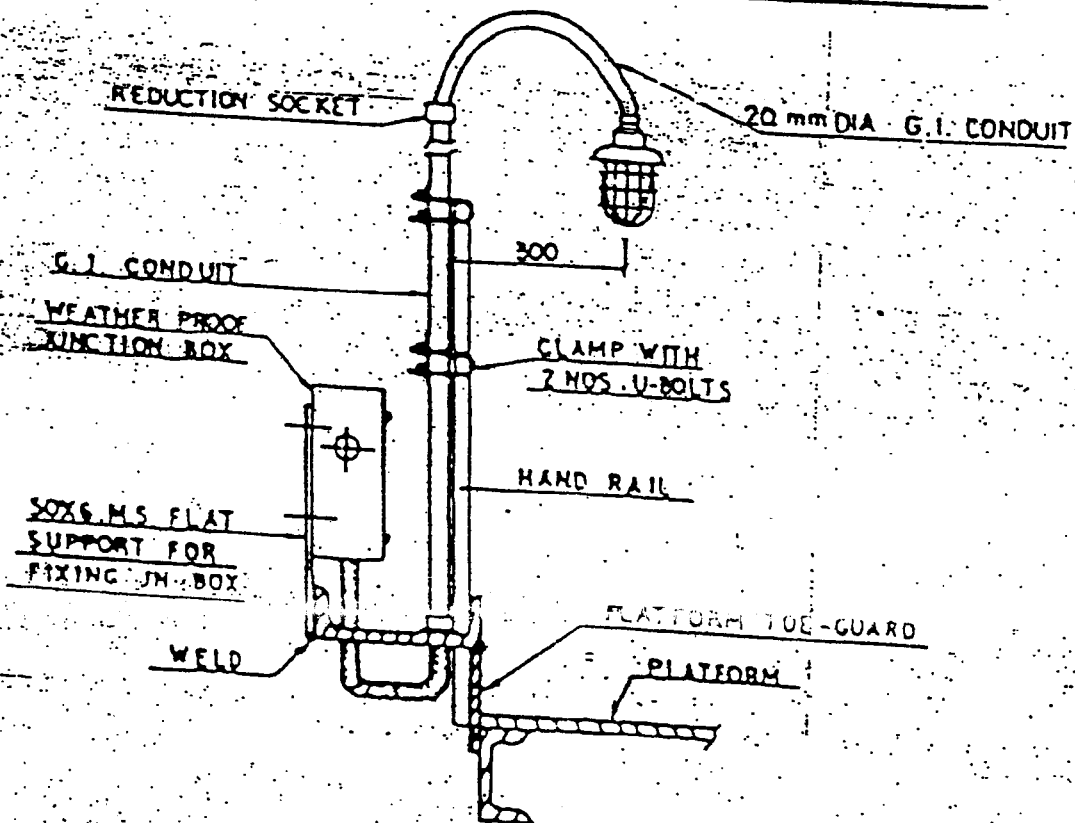
SHEET 7

OF 15

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PENDANT/CEILING MOUNTING : TYPE-CA



PLATFORM MOUNTING : TYPE-CB



LIGHTING NOTES & DETAILS  
FIXTURE MOUNTING ON DECK/  
STAIRS

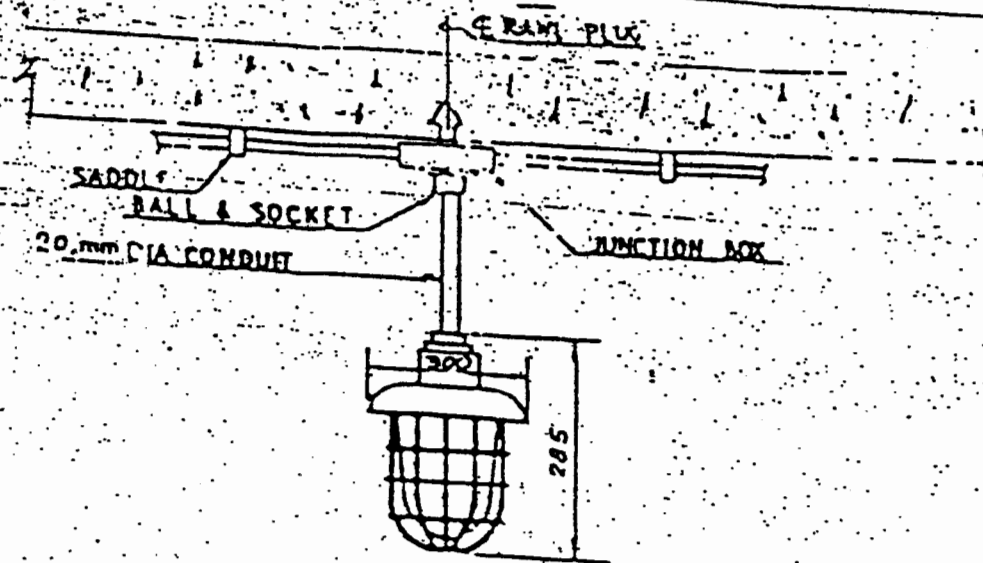
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REV. No.  
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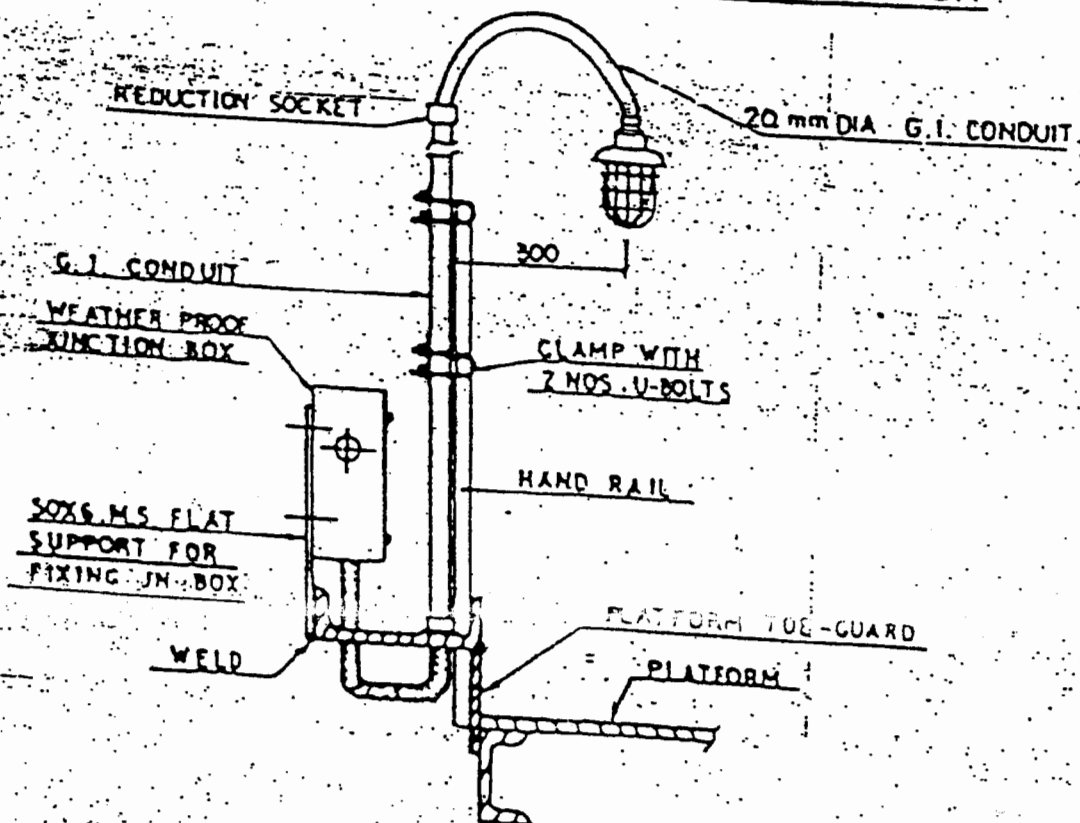
SHEET 8 OF 15

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PENDANT/CEILING MOUNTING : TYPE-CA



PLATFORM MOUNTING : TYPE-CB



LIGHTING NOTES & DETAILS  
FIXTURE MOUNTING ON DECK  
STAIRS

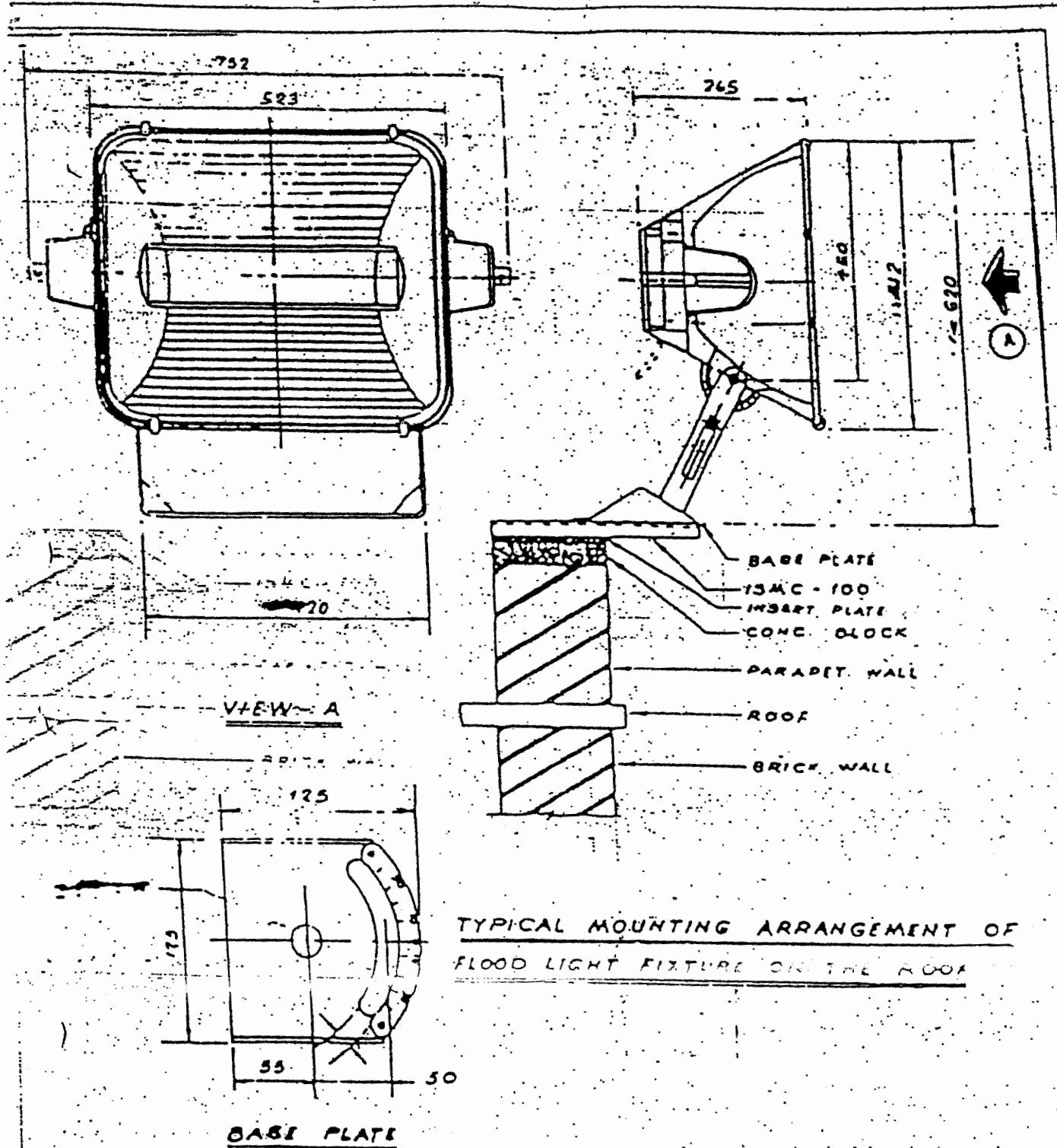
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 PE-DG-~~558~~558-0004

REV. No.

0

SHEET 8 OF 15

56



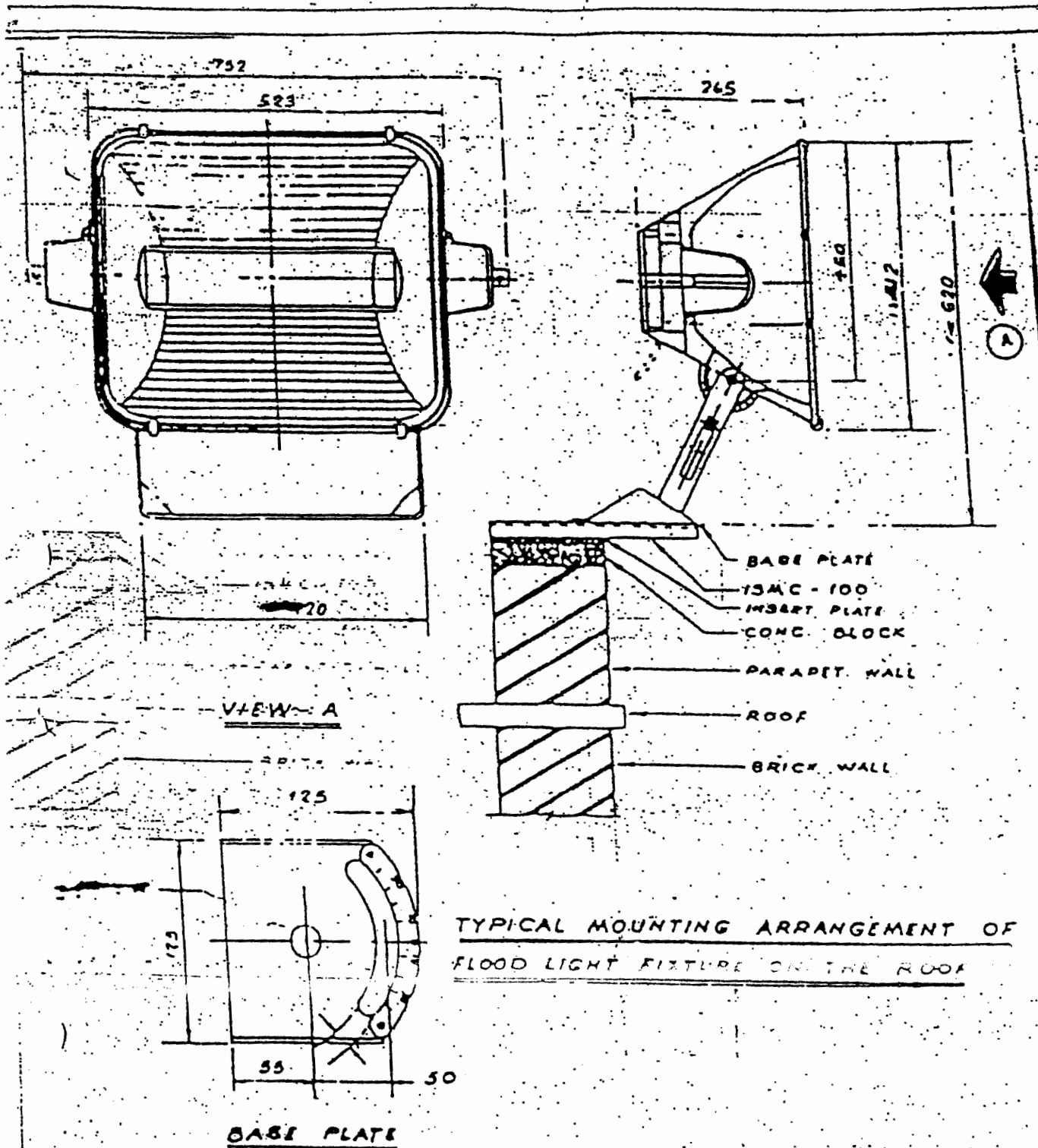
# LIGHTING NOTES & DETAILS

MOUNTING OF FLOOD LIGHT  
FIXTURE

DRG. No.  
PE-DG-~~XXX~~-558-0004

REV. No. 0

SHEET 9 OF 15

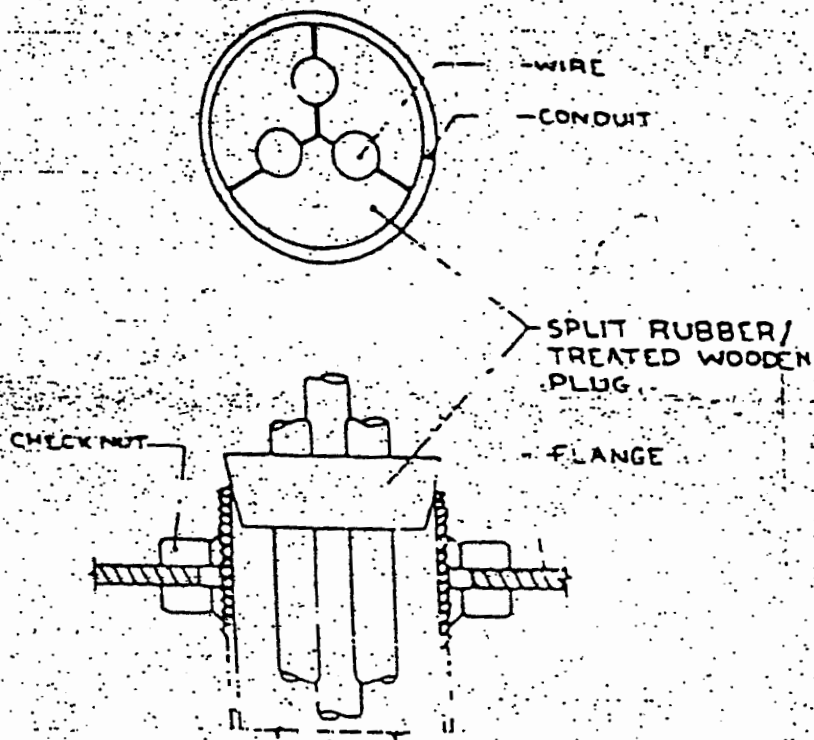


LIGHTING NOTES & DETAILS  
MOUNTING OF FLOOD LIGHT  
FIXTURE

DRG. No.  
PE-DG-~~XXX~~-558-0004

REV. No. 0

SHEET 9 OF 15



CLAMPING OF WIRES  
IN CONDUIT VERTICAL RUN



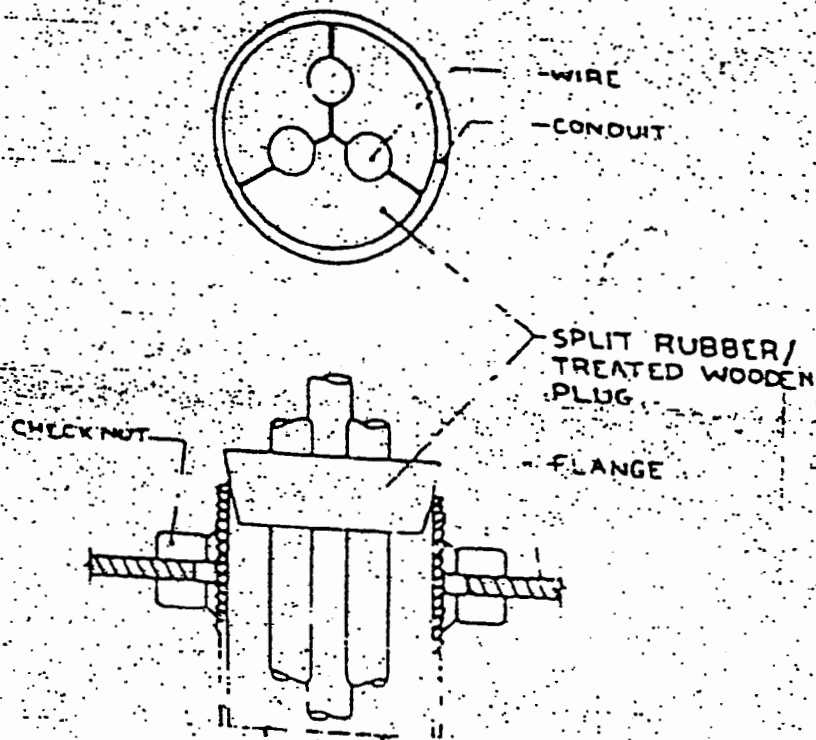
LIGHTING NOTES & DETAILS

DRG. No.  
PE-DG-~~XXX~~-558-0004

REV. No. 0

SHEET 10 OF 15





CLAMPING OF WIRES  
IN CONDUIT VERTICAL RUN

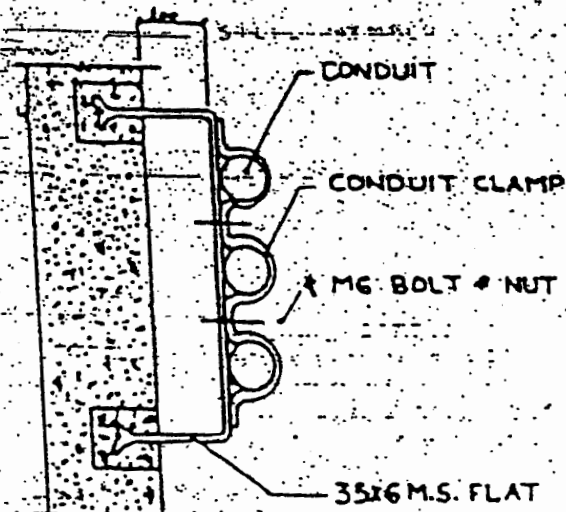


LIGHTING NOTES & DETAILS

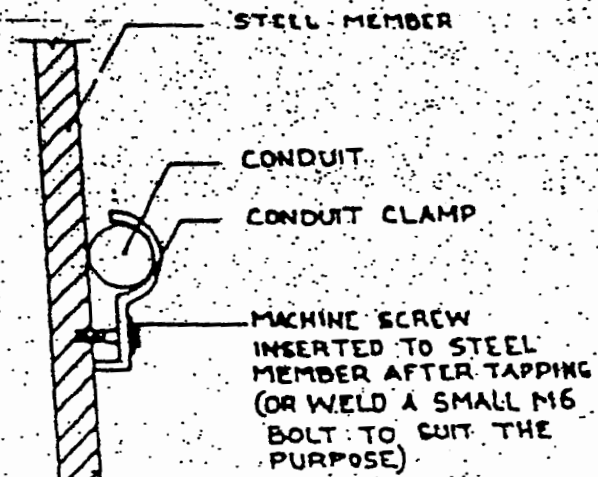
DRG. No.  
PE-DG-~~XXX~~-558-0004

REV. No.  
0

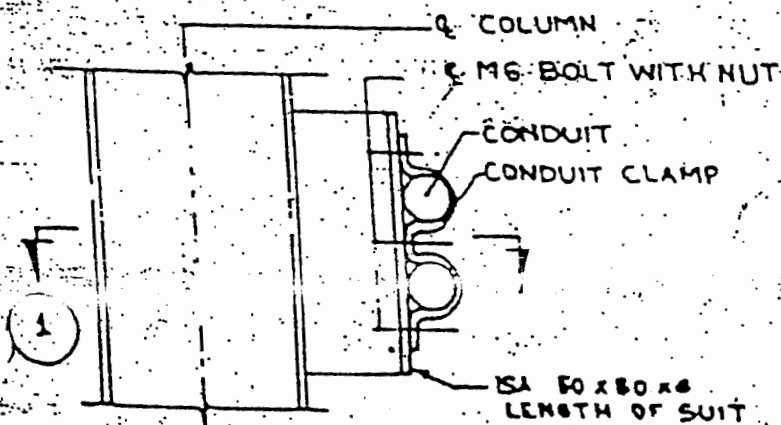
SHEET 10 OF 15



GROUP OF CONDUITS RUN ON CONCRETE SURFACE

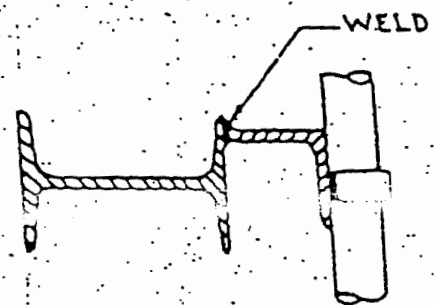


SINGLE CONDUIT RUN ON STEEL MEMBER



ELEVATION

GROUP OF CONDUIT RUN ON STEEL MEMBER ARRANGEMENT-A



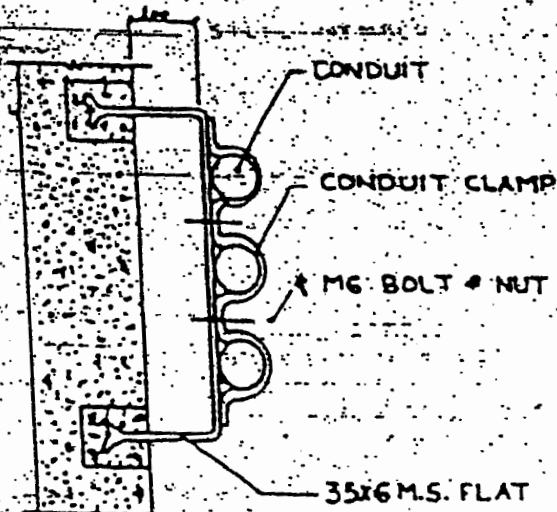
SECTION — 1



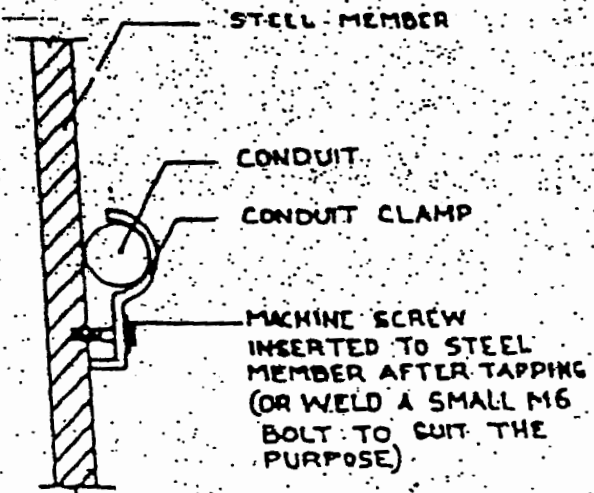
LIGHTING NOTES & DETAILS

DRG. No.  
PE-DG-~~XXX~~558-0004

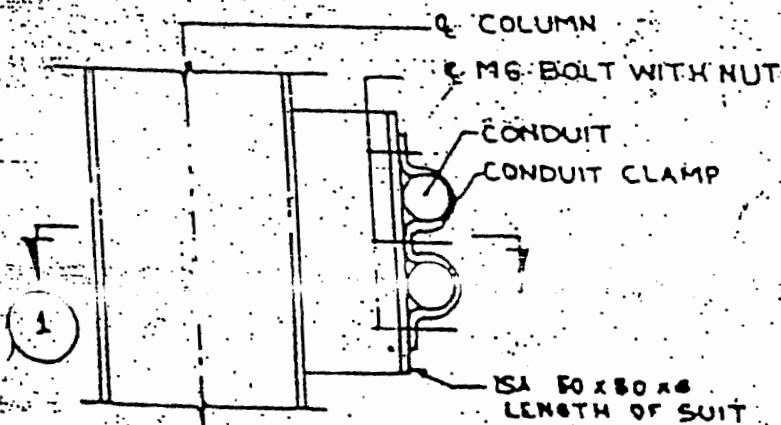
REV. No.  
11 OF 15



GROUP OF CONDUITS RUN ON CONCRETE SURFACE

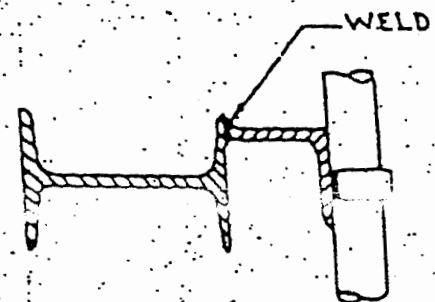


SINGLE CONDUIT RUN ON STEEL MEMBER



ELEVATION

GROUP OF CONDUIT RUN ON STEEL MEMBER ARRANGEMENT-A



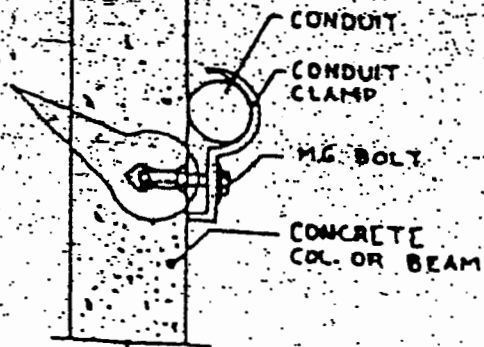
SECTION —



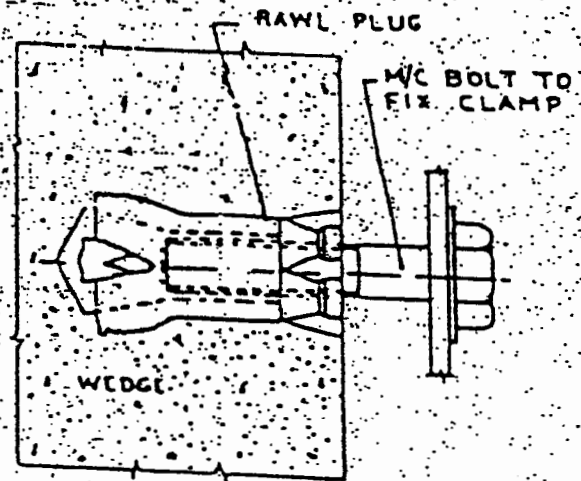
LIGHTING NOTES & DETAILS

DRG. No.  
PE-DG-~~XXX~~558-0004

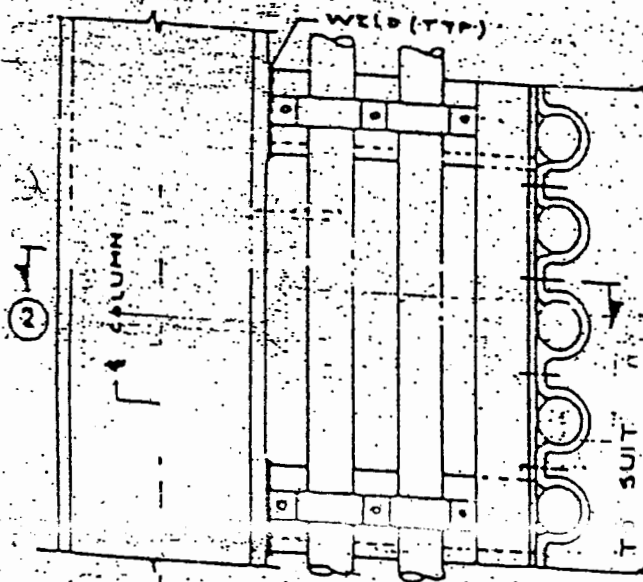
REV. No.  
11 OF 15

SEE  
DETAIL-A

SINGLE CONDUIT RUN  
ON CONCRETE SURFACE

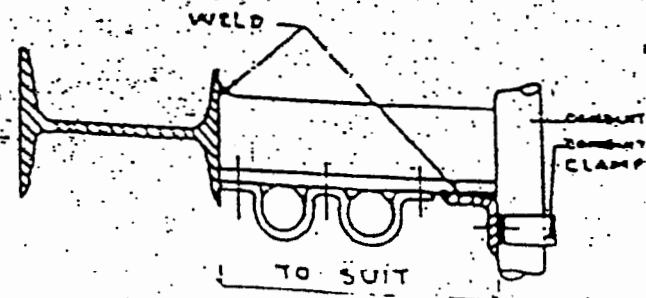


DETAIL-A



ELEVATION

GROUP OF CONDUIT RUN ON  
STEEL MEMBER ARRANGEMENT-B



SECTION-②

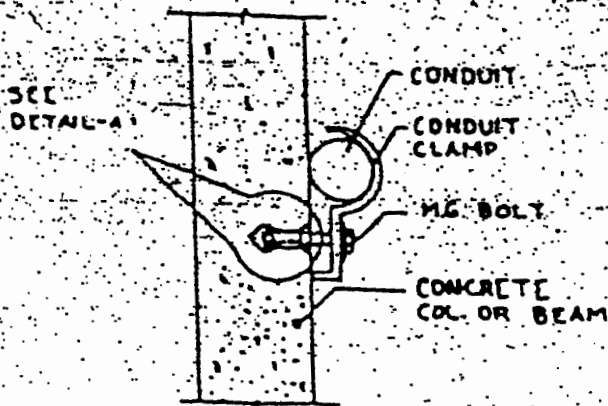


LIGHTING NOTES & DETAILS

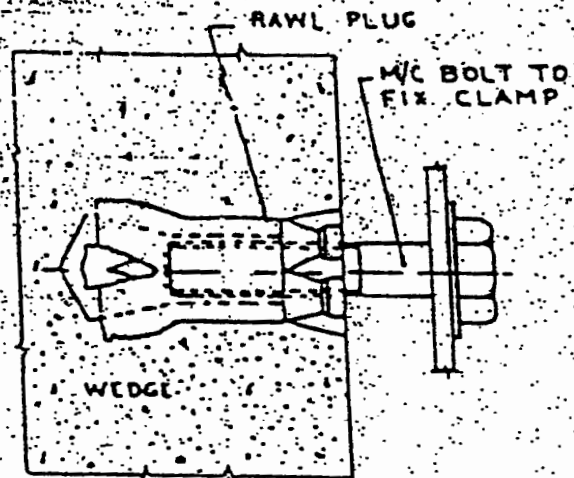
DRG. No.  
PE-DG-~~XXX~~558-0004

REV. No.  
0

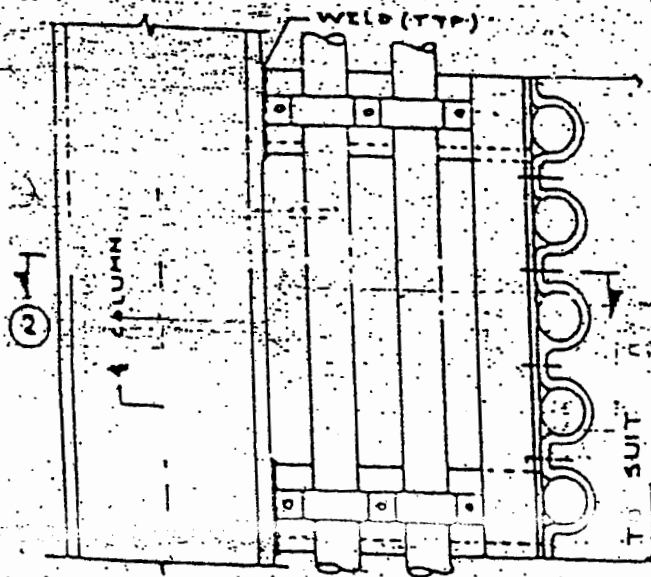
SHEET 12 OF 15



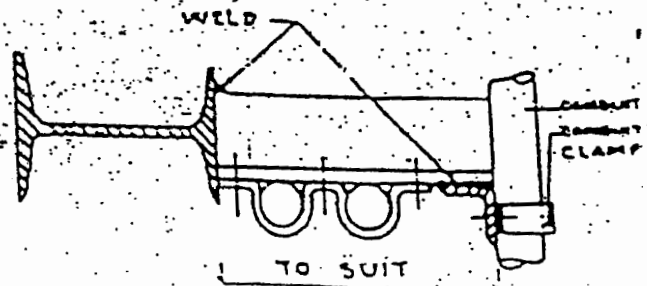
SINGLE CONDUIT RUN ON CONCRETE SURFACE



DETAIL - A



ELEVATION



SECTION-②

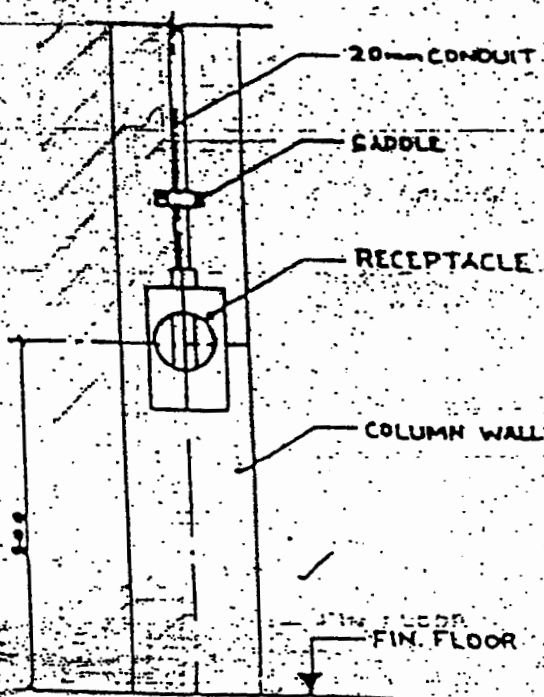


LIGHTING NOTES & DETAILS

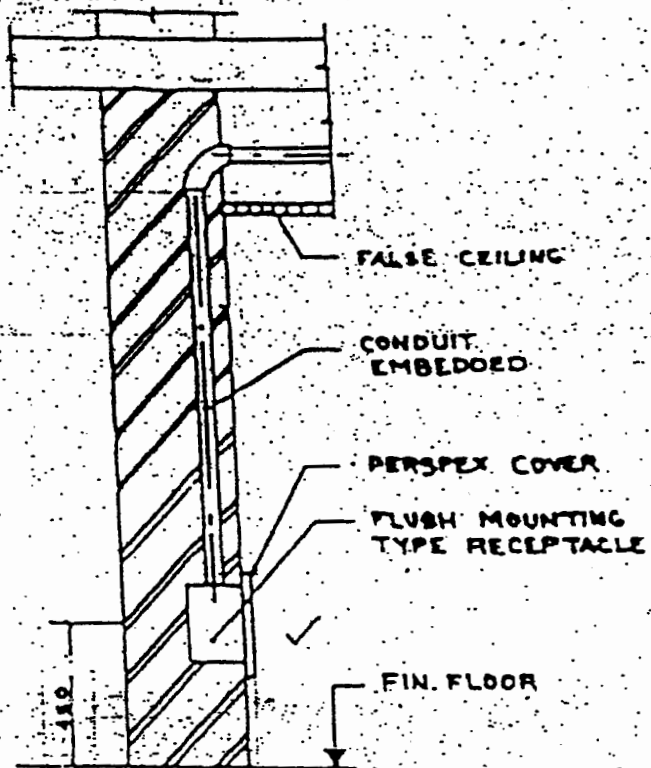
DRG. No.  
PE-DG-~~XXX~~558-0004

REV. No.  
0

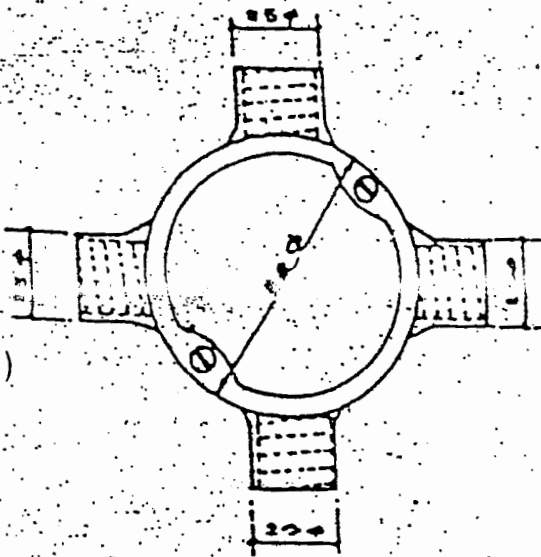
SHEET 12 OF 15



RECEPTACLE - TYPE 'R<sub>B</sub>'  
(STRUCTURE MOUNTING)



RECEPTACLE - TYPE 'R<sub>A</sub>'  
(WALL MOUNTING)



JUNCTION BOX ROUND (TYP.)



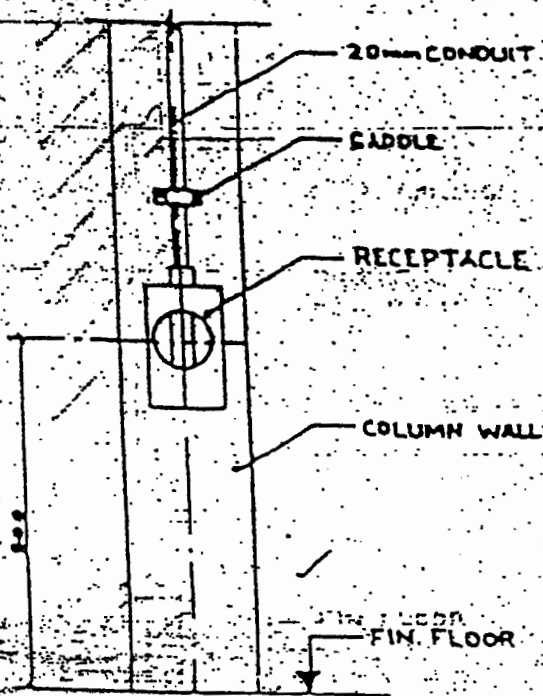
# LIGHTING NOTES & DETAILS

DRG. No.  
PE-DG-~~XXX~~558-0004

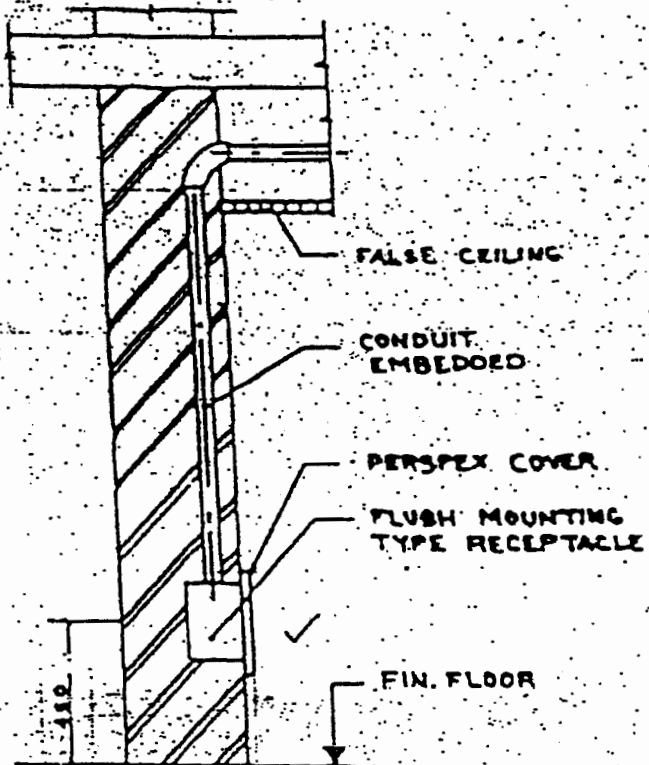
REV. No. 0

SHEET 13 OF 15

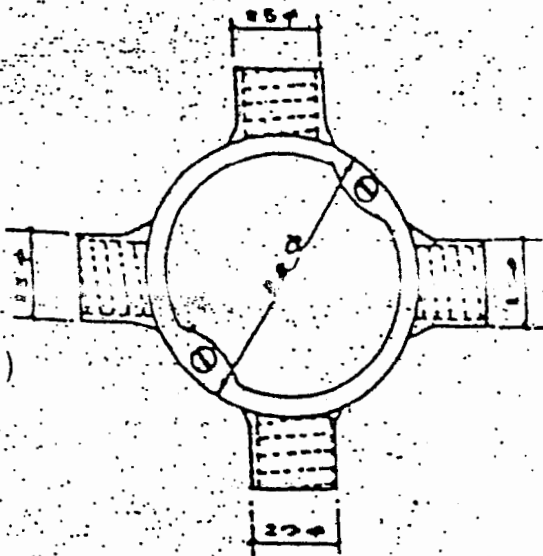
1394217/2023/PS-SR-PM



RECEPTACLE - TYPE 'R<sub>B</sub>'  
(STRUCTURE MOUNTING)



RECEPTACLE - TYPE 'R<sub>A</sub>'  
(WALL MOUNTING)



JUNCTION BOX ROUND (TYP.)



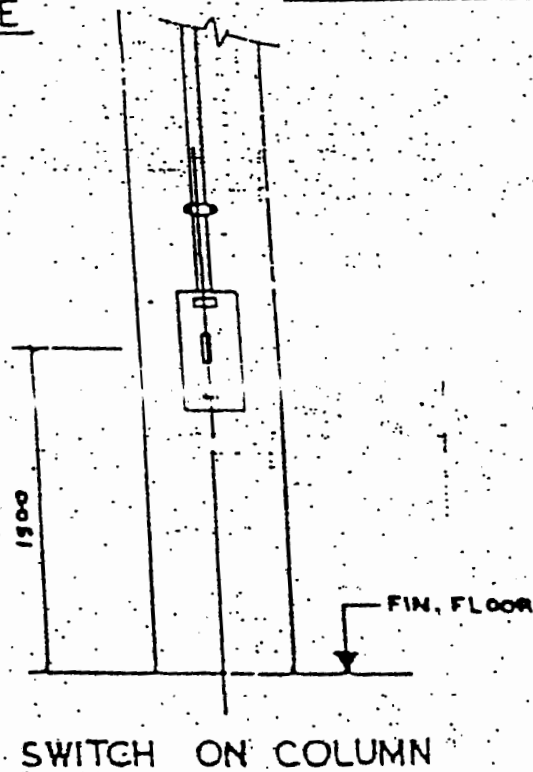
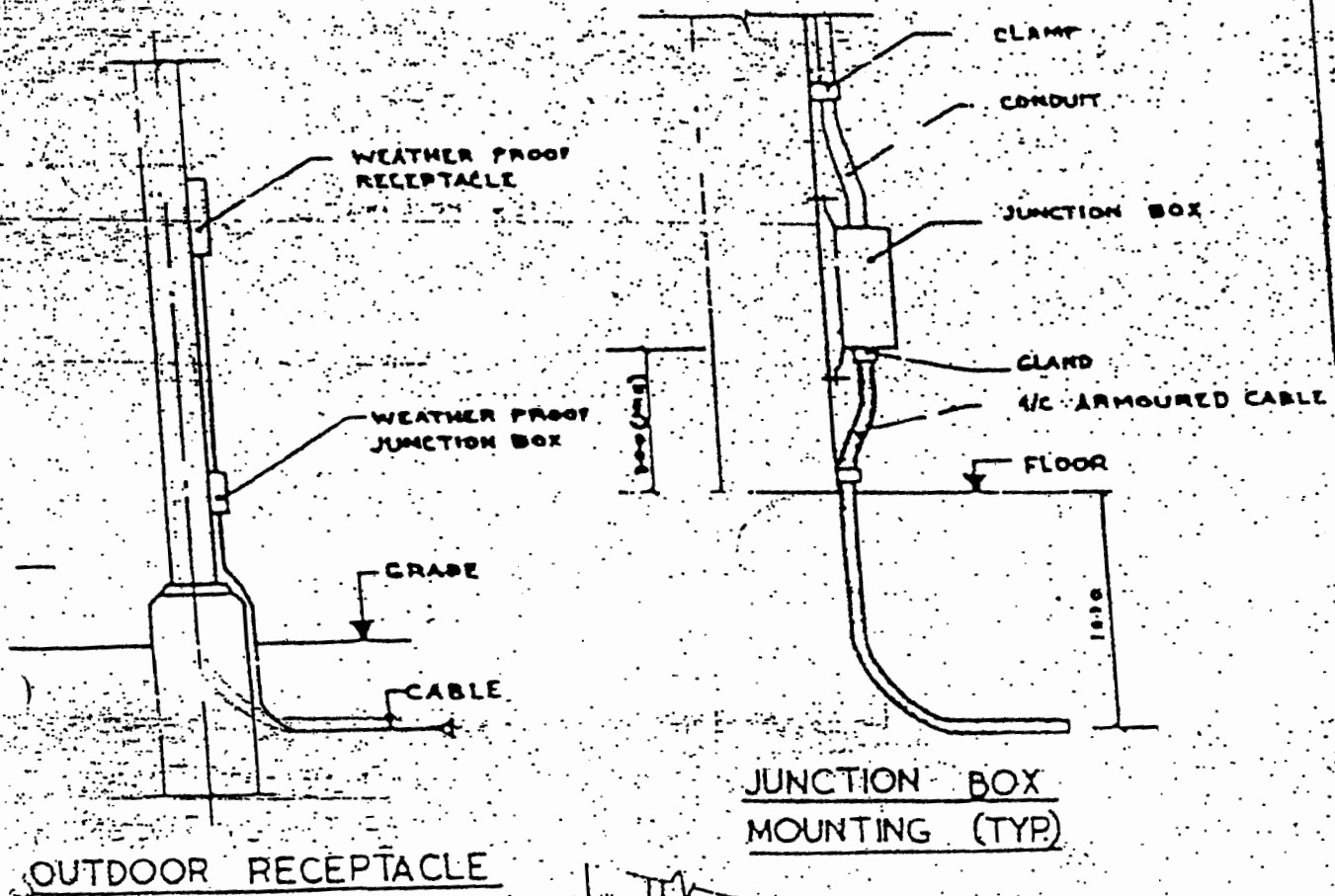
# LIGHTING NOTES & DETAILS

DRG. No.  
PE-DG-~~XXX~~558-0004

REV. No. 0

SHEET 13 OF 15





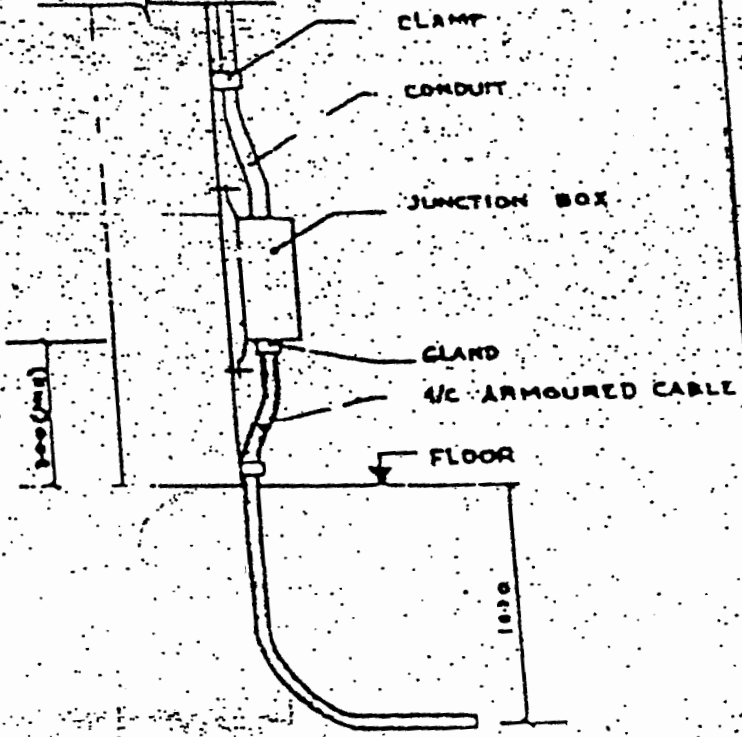
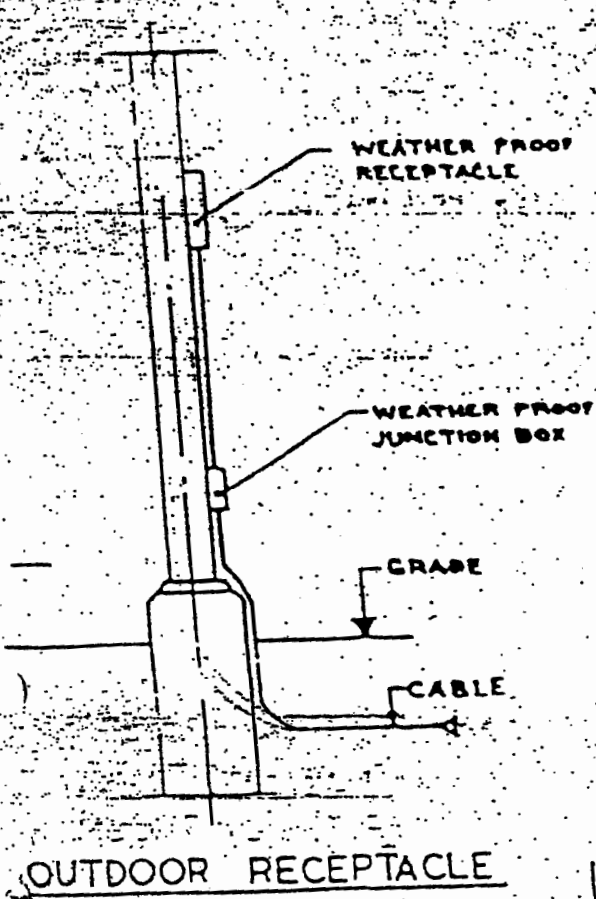
# LIGHTING NOTES & DETAILS

DRG. No.  
PE-DG-~~XXX~~558-0004

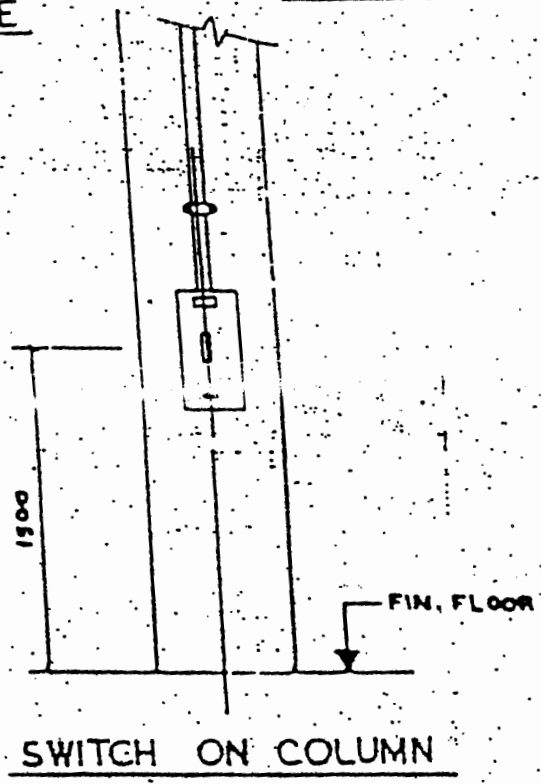
REV. No.  
0

SHEET 14 OF 15



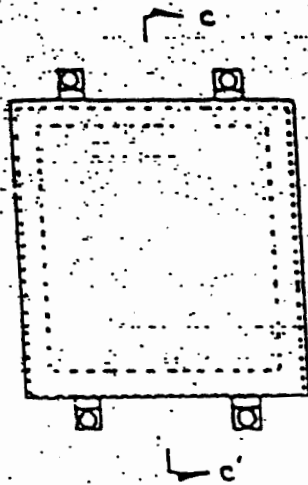


JUNCTION BOX MOUNTING (TYP)

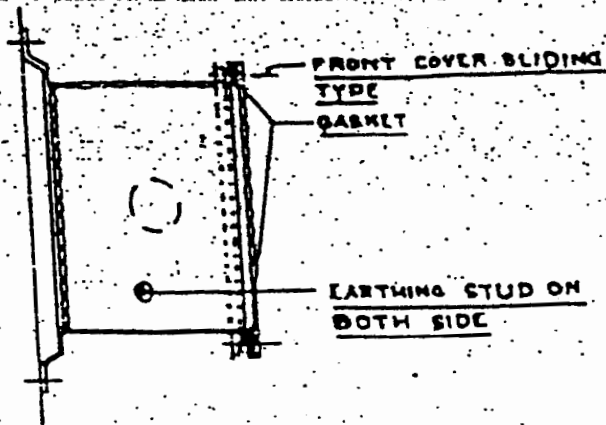


LIGHTING NOTES & DETAILS

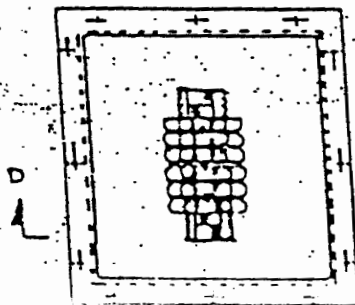
DRG. No.	PE-DG- <del>XXX</del> 558-0004
REV. No.	0
SHEET 14	OF 15



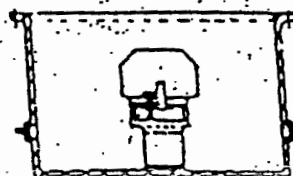
TYP. FIXING DETAIL  
OF JUNCTION BOX



SECTION: C-C'



JUNCTION BOX (TYP)  
FRONT VIEW



SECTION: D-D'



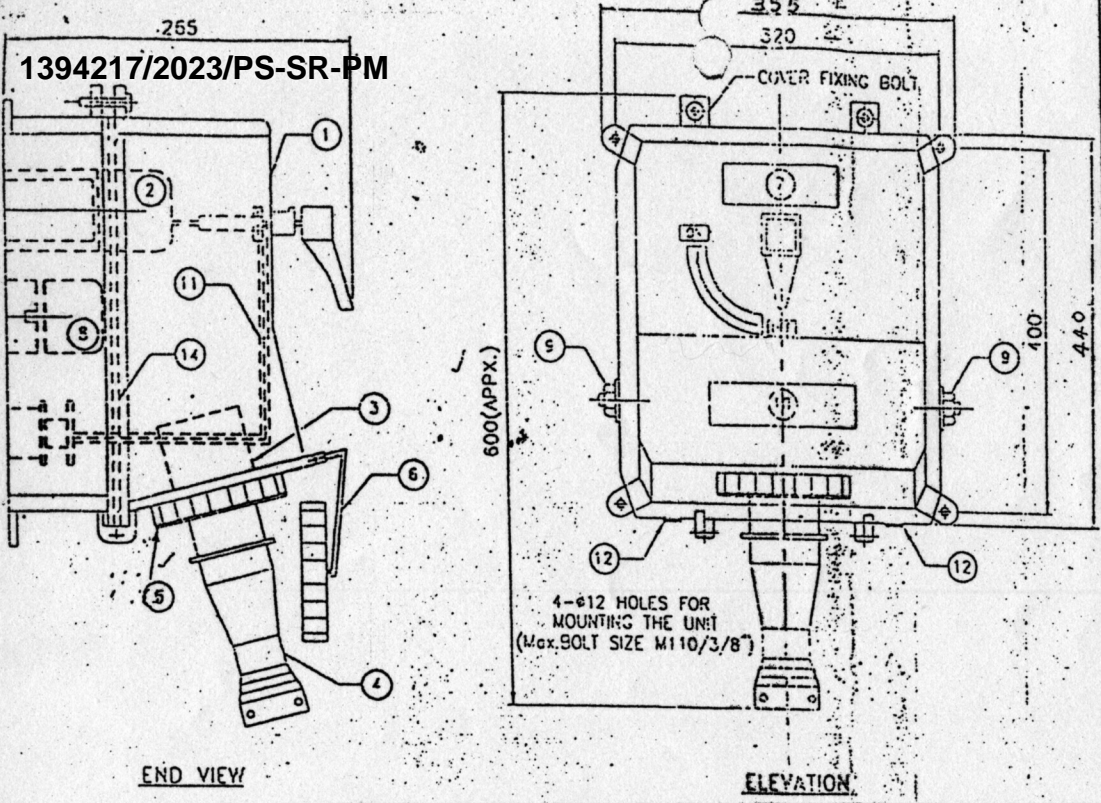
LIGHTING NOTES & DETAILS

DRG. No.  
PE-DG-~~XXX~~558-0004

REV. No. 0

SHEET 15 OF 15

1394217/2023/PS-SR-PM

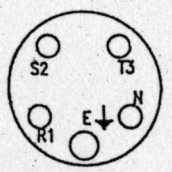
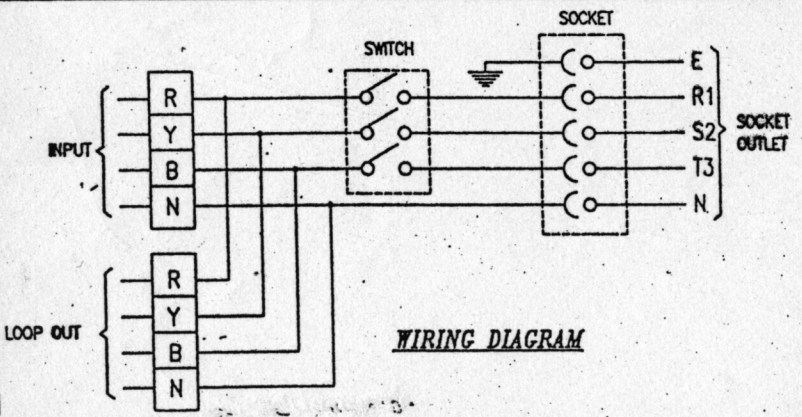


**SPECIFICATION**

- 1] ALUMINIUM ALLOY HOUSING (MIN THICKNESS 3mm)
- 2] GE POWER CONTROL TP ON/OFF SWITCH DOUBLE BREAK TYPE SP02, AC23 CATEGORY CONFORMING TO IS-13947-3
- 3] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH SOCKET
- 4] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH PLUG
- 5] PLUG RING
- 6] SPRING LOADED COVER FOR SOCKET OUTLET
- 7] NAME PLATE
- 8] 4 WAY STUD TYPE TERMINAL BLOCK 2 Nos. FOR LOOP IN LOOP OUT, ARRAGEMENT TO TERMINATE 3.5x50 sq.mm STUD TYPE BEST & CROMPTON MAKE
- 9] ELECTROPLATED EARTHING TERMINAL 2 Nos. COMPLETE WITH 6mm BOLT, NUT & WASHER SUITABLE FOR 14 SWG. GI. EARTHING CONDUCTOR
- 10] CAUTION STACKER
- 11] MECHANICAL INTERLOCKING ARRANGEMENT
- 12] DETACHABLE GLAND PLATE 0 TAKE 2 Nos. GLAND SUITABLE FOR 3.5x70 sq.mm. CABLES.

**NOTES**

- 1] ALL DIMENSION ARE IN MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE  $\pm 5\text{mm}$
- 2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE  $16 \frac{25}{10}$  sq.mm. CABLE
- 3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 - POWER COATING
- 4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
- 5] SWITCH CAN NOT BE MADE 'ON' UNLESS PLUG IS INSERTED  
PLUG CAN NOT BE WITHDRAWN UNLESS SWITCH IS IN OFF POSITION
- 6] UNIT IS MANUFACTURE BY "BEST & CROMPTON"
- 7] SUITABLE CABLE GRIP SHALL BE PROVIDED



**SHOWING TERMINAL POSITION**

COLOR CODED SLEEVE WILL BE PROVIDED ON BOTH ENDS ON COPPER FLEIBLE  
 R PHASE - RED COLOUR  
 Y PHASE - YELLOW COLOUR  
 B PHASE - BLUE COLOUR  
 NEATRAL - BLACK COLOUR

**CHIMNEY LIGHTING SPECIFICATION**

REV	DATE	DESCRIPTION
01		
02		

NATIONAL THERMAL POWER CORPORATION LTD.  
 RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II

**bajaj electricals limited** MUMBAI

Engineering & Projects Division

TITLE GENERAL ARRANGEMENT DWG FOR 63 A FULLY INTERLOCKED SWITCHED PLUG 63 AMPS 415 VOLTS [TYPE RC]



**BHARAT HEAVY ELECTRICALS LIMITED**  
 POWER SECTOR, PROJECT ENGINEERING MANAGEMENT  
 NEW DELHI

DRN	CHKD	APPD	DATE	BHEL DWG. No
KBM	JS	AP	30.06.03	PE-V0-200-558-E073

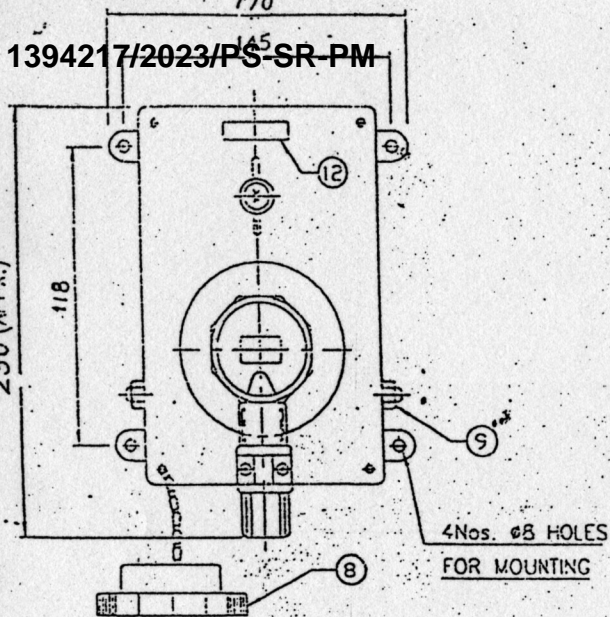
DWG. NO. **EPBU-03-PS005-04-073**

SHT. 1 OF 1

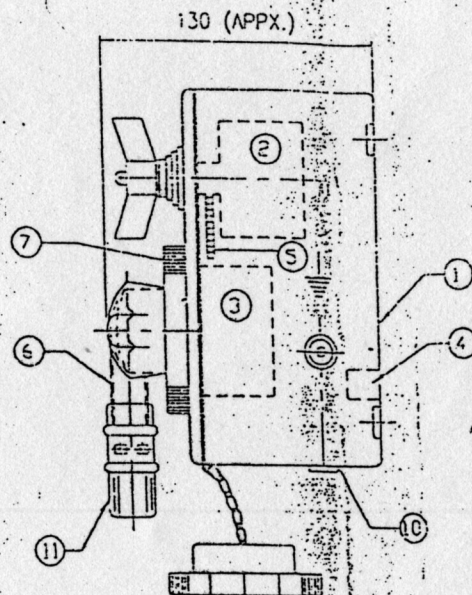


1394217/2023/PS-SR-PM

230 (APPX.)



ELEVATION



END VIEW

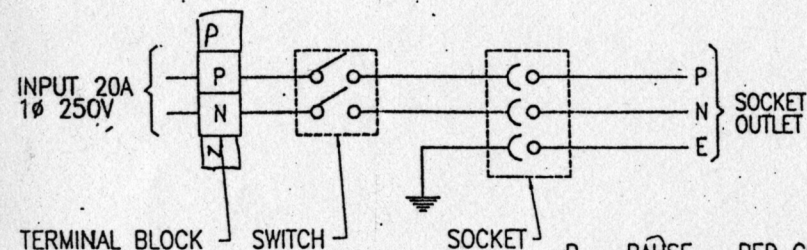
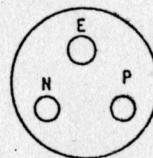
SPECIFICATION

- 1] ALUMINIUM ALLOY ENCLOSURE 3mm THICK
- 2] 25A, 250V, DOUBLE POLE/ OFF ROTARY SWITCH AC 23 CATEGORY IS-4064 - RECOM MAKE
- 3] ALUMINIUM ALLOY METAL CLAD SOCKET UNIT "BEST & CROMPTON" MAKE
- 4] BAKELITE STUD TYPE 4 WAY TERMINAL BLOCK TO TERMINATE 2Cx4 sq.mm CABLE
- 5] MECHANICAL INTERLOCKING SYSTEM
- 6] DIE CAST ALUMINIUM ALLOY METAL CLAD PLUG AND SOCKET OF 20A, 240V, 3 PIN (P+N+E), 3rd PIN GROUNDED
- 7] THREADED PLUG LOCKING RING
- 8] SOCKET COVER WITH CHAIN FOR SOCKET OUTLET
- 9] EARTHING TERMINAL 2 Nos. - M6 SIZE
- 10] CABLE ENTRY 25mm DIA - 2Nos.
- 11] PVC CABLE GRIP
- 12] NAME PLATE

NOTES

- 1] ALL DIMENSION ARE IN MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE OF  $\pm 5\text{mm}$
- 2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE 4 sq.mm. COPPER CABLE
- 3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 - POWER COATING
- 4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
- 5] SWITCH CAN ~~NOT~~ BE MADE 'ON' ONLY WHEN PLUG IS FULLY ENGAGED WITH SOCKET. PLUG CAN NOT BE WITH DRAWN WHEN SWITCH IS ON
- 6] 2 Nos. CABLE ENTRY AT BOTTOM

CHIMNEY LIGHTING SPECIALIZATION

WIRING DIAGRAM  
(FOR SINGLE PHASE UNIT)VIEW ON SOCKET  
PLUG REMOVED

1230-061-29PE-PVG-B-070

NATIONAL THERMAL POWER CORPORATION LTD.  
RIHAND 2X500MW THERMAL POWER PROJECT STAGE-IIBHARAT HEAVY ELECTRICALS LIMITED  
PROJECT ENGINEERING MANAGEMENT

bajaj electricals limited MUMBAI

Engineering &amp; Projects Division

DRN	CHKD	APPD	DATE	BHEL DWG. No
1011	IS	AP	30.05.03	PE-V0-200-558-E070


REV	DATE	DESCRIPTION
01		
02		

TITLE GENERAL ARRANGEMENT DWG FOR  
FULLY INTERLOCKED SWITCHED PLUG  
20 AMPS, 250 VOLTS [TYPE RA]

DWG. NO. EPBU-03-PS005-04-070


SHT. 1 OF 1

REV  
0

		QUALITY PLAN			CUSTOMER		PROJECT TITLE		SPECIFICATION NUMBER			
					BIDDER / VENDOR		QUALITY PLAN NUMBER PED-558-00-Q-001 / 01		SPECIFICATION TITLE			
		SHEET 1 OF 3			SYSTEM		ITEM ILLUMINATION		SECTION VOLUME III			
S. 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	CABLES & WIRES	1. SURFACE DEFECTS	MA	VISUAL	SAMPLE	BHEL SPEC., IS:694, IS:1554	BHEL SPEC., IS:694, IS:1554	INSPN. REPORT & TEST REPORT FROM MANUFACTURER	3/2	2	1	TO BE PROCURED FROM APPROVED SOURCE
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-DD-	-DD-	-DD-	3/2	2	1	
		3. TYPE TESTS	CR	ELEC. TESTS	ONE/TYPE & SIZE	BHEL SPEC., IS:694, IS:1554	BHEL SPEC., IS:694, IS:1554	TEST CERT.	3	2	1	
		4.ACCEP-TANCE TESTS	MA	-DD-	SAMPLING	-DD-	-DD-	-DD-	3	2	1	
		5. ROUTINE TESTS	MA	-DD-	100%	-DD-	-DD-	-DD-	3	-	2,1	
		6. FRLS PROPS.	CR	FRLS TESTS	SAMPLES	BHEL SPEC.	BHEL SPEC.	-DD-	3	2	1	
2.0	JUNCTION BOXES, LIGHTING PANELS AND DISTRIBUTION BOARDS											
2.1	JUNCTION BOXES	1.DIMENSIONS	MA	MEASUREMENTS	100%	BHEL DRG.	BHEL DRG.	INSP. REPORT	3	-	2	COMPONENTS TO BE OF APPROVED MAKE.
		2.PAINT SHADE/THICKNESS	MA	VISUAL / MEAS.	SAMPLE	BHEL SPEC./DRG.	BHEL SPEC./DRG.	-DD-	3	-	2	
		3.HV / IR / HV	MA	ELECT. TESTS	100%	2KV AC FOR 1 MINUTE IS:2147	2KV AC FOR 1 MINUTE IS:2147	-DD-	3	-	2	
		4.DEGREE OF PROTECTION	MA	TESTS	1/SIZE			TEST CERT.	-	-	2,1	
		5.SPECIAL TESTS IF ANY, EXPLOSION PROOF ETC.	MA	-DD-	-DD-	IS:2148	IS:2148	-DD-	-	-	2,1	
2.2	LIGHTING PANELS AND LIGHTING DISTRIBUTION BOARDS	1. DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DRG.	BHEL DRG.	INSPT. REPORT	3	2,1	-	COMPONENTS TO BE OF APPROVED MAKE.
BHEL			PARTICULARS			BIDDER / VENDOR						
			NAME									
			SIGNATURE									


1394217/2023/PS-SR-PM


FORM No. PEM 6041-0

		QUALITY PLAN			CUSTOMER		PROJECT TITLE		SPECIFICATION NUMBER			
					BIDDER / VENDOR		QUALITY PLAN NUMBER PED-558-00-Q-001 /01		SPECIFICATION TITLE			
		SHEET 2 OF 3			SYSTEM		ITEM ILLUMINATION		SECTION VOLUME III			
S. 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	TUNGSTEN FILAMENT LAMPS, TUBULAR FLUORESCENT LAMPS, H.P. MERCURY VAPOUR LAMPS, SODIUM VAPOUR LAMPS, BALLASTS, LUMINAIRES	2. PAINT SHADE / THICKNESS	MA	VISUAL / MEASUREMENT	-DD-	BHEL SPEC. / DRG.	BHEL SPEC. / DRG.	INSPT. REPORT	3	2,1	-	BHEL SHALL WITNESS ON RANDOM ONE SAMPLE, THOUGH EACH ITEM SHALL BE CHECKED BY THE MANUFACTURER.
		3. DEGREE OF PROTECTION (INCLUDING EXPLOSION PROOF IF ANY)	MA	TESTS	1 / SIZE	BHEL SPEC. / RELEVANT IS	BHEL SPEC. / RELEVANT IS	TEST CERTF.	-	-	2,1	
		4. PERFORMANCE TESTS	MA	ELEC.	100%	BHEL SPEC.	BHEL SPEC.	INSPT. REPORT	3	2,1	-	
		5. HV / IR / HV	MA	ELEC.	100%	2.5 KV AC FOR 1 MINUTE	2.5 KV AC FOR 1 MINUTE	-DD-	3	2,1	-	
		6. TEMP. RISE TEST (FOR COMPLETE ASSEMBLED LDB)	MA	ELEC.	1 / RATING	BHEL SPEC.	BHEL SPEC.	-DD-	3	2	1	
		1. - ACCEPTANCE TESTS	MA	TESTS	SAMPLE	BHEL SPEC. / RELEVANT IS	BHEL SPEC. / RELEVANT IS	TEST CERTF.	3,2	-	1	
BHEL			PARTICULARS		BIDDER / VENDOR							
			NAME									
			SIGNATURE									


1394217/2023/PS-SR-PM


FORM No. PEM 6041-0

		QUALITY PLAN			CUSTOMER		PROJECT TITLE		SPECIFICATION NUMBER			
					BIDDER / VENDOR		QUALITY PLAN NUMBER PED-558-00-Q-001 /01		SPECIFICATION TITLE			
		SHEET OF 3			SYSTEM		ITEM ILLUMINATION		SECTION VOLUME III			
S. 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
4.0	CONDUITS	1. MATERIAL	MA	VISUAL, MECH. AND CHEMICAL	AS PER SPEC./ IS: 9537	IS:9537	IS:9537	INSPT. REPORT	3	2	1	
		2. DIMENSIONS	MA	MEASUREMENT	AS PER SPEC./ IS: 9537	IS:9537	IS:9537	-DD-	3	2	1	
		3. OTHER TESTS	MA	TESTS	AS PER SPEC./ IS:9537,	AS PER SPEC./ IS:9537,	IS:9537,	-DD-	3	2	1	
5.0	ELECTRIC POLES											
5.1	MATERIAL	1. CHEMICAL COMP.	MA	CHEM. ANALYSIS	SAMPLE	IS:2713, IS:228 & IS:1894	IS:2713 IS:228 & IS:1894	-DD-	3/2	-	2,1	
		2. PHYSICAL PROP.	MA	PHYS. TESTS	-DD-	-DD-	-DD-	-DD-	3/2	-	2,1	
5.2	FINAL INSPECTION	1. WORK-MANSHIP & FINISH	MA	VISUAL & MEAS.	SAMPLES	BHEL DRG./IS:2713	BHEL DRG./IS:2713	-DD-	3/2	2,1	-	
		2. DIMENSIONS	MA	-DD-	-DD-	-DD-	-DD-	-DD-	3/2	2,1	-	
		3. WEIGHT	MA	-DD-	-DD-	-DD-	-DD-	-DD-	3/2	2,1	-	
		4. TESTS AS PER IS:2713	MA	-DD-	-DD-	IS:2713	IS:2713	-DD-	3/2	2,1	-	
NOTE : 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.												
BHEL			PARTICULARS			BIDDER / VENDOR						
			NAME									
			SIGNATURE									

	TITLE:		SPECIFICATION NO. PE-TS-Q11-600-C051	
	SPECIFIC TECHNICAL REQUIREMENT		VOLUME - IIB	
			SECTION "C"	Sub Sec-II
			REV. 00	DATE: 22 – 10 - 2003
			SHEET 1 of 3	
1.00.00	CODES AND STANDARDS	IS:1554, IS:7098, IEC:502, IS:6380, IS:9968		
2.00.00	TYPE	All cable shall be Flame retardent low smoke type		
3.00.00	RATING	As per requirement specified in General Electrical Requirements.		
4.00.00	OPERATIONAL REQUIREMENTS			
	All cables shall be suitable for high ambient, high humid tropical Indian climatic conditions. All cables shall be designed to withstand the mechanical, electrical and thermal stresses under the foreseen steady state and transient/fault conditions, and shall be suitable for the proposed method of installation.			
5.00.00	DESIGN AND CONSTRUCTIONAL FEATURES			
5.01.00	Parameters of the cables are as follows :			
	Particulars	Power cables	Control cables	Trailing cables
		XLPE      PVC		
	a) Conductor			
	i) Material	Stranded Aluminium	Stranded plain annealed copper	Tinned copper of class 5 of IS:8130
	ii) Size	As required, but Min. 6 sq.mm size.	As required, but min. 1.5 sq.mm. size.	As required, but min. 1.5 sq.mm. size.
	iii) Shape	Circular/ sector shaped. Circular only for HT cables	Circular/ sector shaped	
	b) Main Insulation			
	i) Material	XLPE    PVC	PVC	Heat resistant elastomeric compound based on Ethylene Propylene Rubber (EPR)




	TITLE:  SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION NO. PE-TS-Q11-600-C051																																																																														
		VOLUME - IIB																																																																														
		SECTION "C"		Sub Sec-II																																																																												
		REV. 00		DATE: 22 – 10 - 2003																																																																												
		SHEET 2 of 3																																																																														
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5.01.02	<b>HT cables</b>  For HT cables conductor screen and insulation screen shall be of extruded semi-conducting compound and shall be applied alongwith XLPE insulation in a single operation by triple extrusion process. Method of curing for 11kV/6.6kV cables shall be "Dry curing/gas curing/steam curing" whereas for 33KV cables it shall be "Dry/Gas curing". 11kV/6.6kV cables shall be provided with copper metallic screen suitable for carrying allowable earth fault current for 2 secs. All other voltage grade HT cables shall be provided with copper metallic screen suitable for carrying earth fault current as per E0. For single core armoured cables, the armouring shall constitute the metallic part of screening.																														
5.01.03	LT Cables of size 150 sq.mm. and above shall be with XLPE insulation.																														
5.01.04	<b>Core identification</b>  For cables having more than five (5) cores, each core shall be identified by number marking. However, for cables upto five (5) cores, the same shall be by colour as per IS.																														
5.01.05	<b>Armouring</b>  Cables buried direct in ground and cables in switchyard shall be armoured.																														


Clause No.	POWER AND CONTROL CABLES		
	..... (Bidder's Name)		
	<b>POWER AND CONTROL CABLES</b> (Use separate sheet for each type and size of cables)		
1.00.00	Make	.....	.....
1.02.00	Country of Manufacturer	.....	.....
1.03.00	Type & designation	.....	.....
1.04.00	Applicable standard	.....	.....
1.05.00	Cable size & no. of cores	.....	.....
1.06.00	Rated voltage	.....	.....
1.07.00	Catalogue attached as Annexure No.	.....	.....
1.08.00	Continuous current rating for max. conductor temperature	.....	.....
	a) When laid in air at an ambient temperature of 50 deg. C	.....	.....
	b) When buried in soil having thermal resistivity of 150 deg.C cm/n at a depth of 1000 mm at ground ambient temperature of 40 deg. C	.....	.....
1.09.00	Short circuit withstand capacity and duration for	.....	.....
	a) Conductor	.....	.....
	b) Screen	.....	.....
	c) Armour	.....	.....
1.10.00	Conductor	.....	.....
	a) Material	.....	.....
	b) Nominal cross section area in sq. mm	.....	.....
<b>TECHNICAL DATA REQUIREMENTS SHEETS FOR POWER PLANT TURNKEY PACKAGE</b>		<b>VOLUME - III</b>	<b>BOOK 2 SECTION - DE-3</b>
			<b>PAGE 1 OF 2</b>

Clause No.	POWER AND CONTROL CABLES		
		..... (Bidder's Name)	
	c) Shape of conductor	.....	.....
	d) DC resistance at 20°C	.....	.....
1.11.00	Insulation		
	a) Material	.....	.....
	b) Nominal thickness (in mm)	.....	.....
	c) Type of curing (for XLPE)	.....	.....
1.12.00	Metallic screen (wherever applicable)		
	a) Material	.....	.....
	b) Type	.....	.....
	c) Rating KA, Sec		
1.13.00	Material & Type of Inner sheath	.....	.....
1.14.00	Armour material & shape	.....	.....
1.15.00	Outer sheath material & type	.....	.....
1.16.00	Over all dia of cable (in mm)	.....	.....
1.17.00	Guaranteed value of minimum oxygen index of outer sheath	.....	.....
1.18.00	Maximum acid-gas generation by weight (%) of outer sheath	.....	.....
1.19.00	Smoke Density rating of outer sheath	.....	.....
TECHNICAL DATA REQUIREMENTS SHEETS FOR POWER PLANT TURNKEY PACKAGE		VOLUME - III	BOOK 2 SECTION - DE-3
			PAGE 2 OF 2

44		QUALITY PLAN				CUSTOMER		PROJECT TITLE		SPECIFICATION NUMBER		
						BIDDER / VENDOR		QUALITY PLAN NUMBER PED-507-00-Q-002 / 02		SPECIFICATION TITLE		
		SHEET 1 OF 6				SYSTEM		ITEM PVC POWER & CONTROL CABLE		SECTION VOLUME III		
S. NO.	COMPONENT / OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL											
1.1	PVC COMPOUND (FOR INSULATION- AND SHEATH)	1. PHYSICAL PROPERTIES	MA	PHYS TESTS	SAMPLE	IS:5831/ BHEL SPECIFICATION	IS:5831/ BHEL SPECIFICATION	LOG BOOK /TEST CERT	3/2	-	2	* SAMPLE FROM EACH BATCH / LOT
		2. ELEC. PROPERTIES	MA	ELEC TEST	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		3.MAKE & TYPE	MA	VISUAL	100 %	PLANT STD.	PLANT STD.	DO	2	-	-	
1.2	GALVANIZED STEEL WIRE / STRIP	1. PHY. AND ELEC PROPERTIES	MA	PHY. ELEC.TESTS	SAM-*	IS:3975, BHEL SPEC	IS:3975 BHEL SPEC	-DO-	3/2	-	2	
		2. DIMENSION	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		3. GALVANIZATION QUALITY	MA	GALV. TESTS	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
1.3	COPPER / ALUMINIUM RODS / WIRES	1. PHYSICAL PROPERTIES.	MA	PHY.TESTS	-DO-	IS:613 IS:5484 IS:8130 AND BHEL SPEC.	IS:613 IS:5484 IS:8130 AND BHEL SPEC.	-DO-	3/2	-	2	
		2.CHEM COMPOSITION & PURITY	MA	CHEM ANALYSIS	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		3. ELECTRICAL PROPERTIES	MA	ELECTRICAL TESTS	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		4. DIMENSION	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
BHEL			PARTICULARS			BIDDER / VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S / VENDOR'S COMPANY SEAL			


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FORM No. PEM 6041-0

		QUALITY PLAN			CUSTOMER		PROJECT TITLE		SPECIFICATION NUMBER			
					BIDDER / VENDOR		QUALITY PLAN NUMBER PED-507-00-Q-002 / 02		SPECIFICATION TITLE			
		SHEET 2 OF 6			SYSTEM		ITEM PVC POWER & CONTROL CABLE		SECTION VOLUME III			
S. NO.	COMPONENT / OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	WIRE DRAWING, TINNING AND ANNEALING	1. PHYSICAL, ELECT. FINISH & DIMEN.	CR	PHY. & ELECT-TESTS VISUAL, MEAS.	SAMPLE	BHEL SPEC., IS-8130	BHEL SPEC., IS-8130	LOG BOOK	2	-	1	
		2. CHEMICAL TEST FOR TINNING	CR	CHEMICAL TEST	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.2	STRANDING OF WIRES	1. NO. OF WIRES	MA	COUNTING	SAMPLE	VENDORS/ BHEL SPEC. & APPD. DATA SHEET & RELEVANT IS	VENDORS/ BHEL SPEC. & APPD. DATA SHEET & RELEVANT IS	LOG BOOK	2	-	-	
		2 SEQUENCE, LAY LENGTH AND DIRECTION	MA	VISUAL, MEAS	-DO-	-DO-	-DO-	-DO-	2	-	-	
		3. SURFACE FINISH	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	2	-	-	
		4. DIMENSION	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.3	CORE - INSULATION (NO REPAIR PERMITTED)	1 SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM BULGING, BURNT PARTICLES LUMPS, CUTS & SCRATCHES	-DO-	2	-	1	
		2. INSULATION THICKNESS	CR	MEASUREMENT	SAMPLE	APPD. DATA SHT. IS : 1554	APPD. DATA SHT. IS : 1554	-DO-	2	-	-	
BHEL			PARTICULARS		BIDDER / VENDOR							
			NAME									
			SIGNATURE									
			DATE						BIDDER'S / VENDOR'S COMPANY SEAL			


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		QUALITY PLAN			CUSTOMER		PROJECT TITLE		SPECIFICATION NUMBER			
					BIDDER / VENDOR		QUALITY PLAN NUMBER PED-507-00-Q-002 / 02		SPECIFICATION TITLE			
		SHEET 3 OF 6			SYSTEM		ITEM PVC POWER & CONTROL CABLE		SECTION VOLUME III			
S. NO.	COMPONENT / OPERATION	CHARACTERISTIC S 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
2.4	CORE - LAYING	3. CONCENTRICITY. #	CR	MEASUREMENT	SAMPLE	MFR. STD. / APPD. DATA SHEET. -DO-	MFR. STD. / APPD. DATA SHEET. -DO-	-DO-	2	-	1	# TO BE CHECKED AT STARTING & FINISH END OF EXTRUDED LENGTH
		4. DIA OVER INSULATION	MA	MEASUREMENT	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		5. SPARK TEST OR WATER IMMERSION TEST	CR	ELECTRICAL	100%	MFR. STD.	MFR. STD.	-DO-	2	-	1	
		6. CORE IDENTIFICATION.	MA	VISUAL	100%	IS:1554	IS:1554	-DO-	2	-	-	
		1.DIA OVER LAID UP CORE	MA	MEASUREMENT	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
2.5	INNER SHEATH EXTRUSION	2.SEQUENCE OF LAY, LAY LENGTH & DIRECTION UP CORE	MA	VISUAL & MEAS.	SAMPLE	MFR. STD/ RELEVANT IS	MFR. STD/ RELEVANT IS	LOG BOOK	2	-	-	
		1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM BULGING, BURNT PARTICLES, LUMPS CUTS & SCRATCHES	-DO-	2	-	-	
2.6	ARMOURING	2. SHEATH THICKNESS	MA	MEASUREMENT	SAMPLE	IS:5831 & DATA SHEET IS-1554 -DO-	IS:5831 & DATA SHEET IS-1554 -DO-	-DO-	2	-	-	
		3. DIA OVER INNER SHEATH	MA	-DO-	-DO-	-DO-	-DO-	-DO-	2	-	-	
		1. NO. OF WIRES/ STRIPS	MA	COUNTING	AT THE START OF THE PROCESS -DO-	BHEL SPEC./ APPD.DATA SH. IS:3975 & IS:1554 -DO-	BHEL SPEC./ APPD.DATA SH. IS:3975 & IS:1554 -DO-	-DO-	2	-	-	
		2. LAY DIRECTION	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	2	-	-	
BHEL			PARTICULARS		BIDDER / VENDOR							
			NAME									
			SIGNATURE									
			DATE									
BIDDER'S / VENDOR'S COMPANY SEAL												


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					BIDDER / VENDOR		QUALITY PLAN NUMBER PED-507-00-Q-002 / 02		SPECIFICATION TITLE			
		SHEET 4 OF 6			SYSTEM		ITEM PVC POWER & CONTROL CABLE		SECTION VOLUME III			
S. NO.	COMPONENT / OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.7	OUTER SHEATH EXTRUSION	3. LAY LENGTH	MA	VISUAL, MEAS.	-DO-	-DO-	-DO-	-DO-	2	-	-	
		4. COVERAGE	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	2	-	-	
		5. DIA OVER - ARMOURING	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	2	-	-	
		1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM BULGING, BURNT PARTICLES, LUMPS CUTS & SCRATCHES.	LOG BOOK	2	-	-	
		2. SHEATH THICKNESS	MA	MEASUREMENT	SAMPLE	IS:5831 & IS-1554 DATA SHEET	IS:5831 & IS-1554 DATA SHEET	-DO-	2	-	-	
		3. DIA OVER OUTER SHEATH	MA	-DO-	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.8	FINISHED CABLE	4. MARKING	MA	VISUAL	100%	IS:1554 & BHEL SPEC.	IS:1554 & BHEL SPEC.	TEST REPORT	2	-	-	SEQUENTIAL MARKING SHALL BE DONE BY PRINTING.
		1. ROUTINE TEST	CR	ELEC. & MEAS.	100%	IS:1554 & BHEL SPEC.	IS:1554 & BHEL SPEC.	TEST REPORT	2	-	1	
3.0	FINAL INSPECTION	2. TYPE AND FRLS TESTS	CR	ELEC. PHY & MEAS	SAMPLE *	-DO-/APPD. DATA SHEET.	-DO-/APPD. DATA SHEET.	-DO-	2	-	1	*ONE DRUM / SIZE / LOT
		1. FINISH & LENGTH	MA	VISUAL	(SEE REMARK)	BHEL SPEC. IS: 1554	FREE FROM BULGING, BURNT PARTICLES LUMPS CUTS & SCRATCHES.	-DO-	2	1	-	
BHEL			PARTICULARS		BIDDER / VENDOR							
			NAME									
			SIGNATURE									
			DATE									
BIDDER'S / VENDOR'S COMPANY SEAL												



		QUALITY PLAN			CUSTOMER		PROJECT TITLE		SPECIFICATION NUMBER			
					BIDDER / VENDOR		QUALITY PLAN NUMBER PED-507-00-Q-002 / 02		SPECIFICATION TITLE			
		SHEET 5 OF 6			SYSTEM		ITEM PVC POWER & CONTROL CABLE		SECTION VOLUME III			
S. NO.	COMPONENT / OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
		2. DIMENSION	MA	MEASUREMENT	AS PER IS	APPD.DATA SHEET. IS:1554 IS:10810	APPD.DATA SHEET. IS:1554 IS:10810	-DO-	2	1	-	TYPE TEST SHELL BE WITNESSED ON ONE SAMPLE PER TYPE (POWER / CONTROL) OF EVERY LOT.
		3. ARMOURING- COVERAGE NO.OF WIRES /STRIPS	MA	VISUAL & MEAS.	AS PER IS	-DO-	-DO-	-DO-	2	1	-	
		4.MARKING/COLOR CODING	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	2	1	-	
		5 ACCEPTANCE TESTS	CR	PHY. & ELECT. TESTS	-DO-	-DO-	-DO-	-DO-	2	1	-	
		6. TYPE & FRLS TESTS	CR	MEASUREMENT	(SEE REMARK)	BHEL SPEC. , APPD. DATA SHEET	BHEL SPEC. APPD. DATA SHEET	-DO-	2	1	-	
BHEL			PARTICULARS		BIDDER / VENDOR							
			NAME									
			SIGNATURE									
			DATE									
BIDDER'S / VENDOR'S COMPANY SEAL												

		QUALITY PLAN				CUSTOMER		PROJECT TITLE		SPECIFICATION NUMBER		
						BIDDER / VENDOR		QUALITY PLAN NUMBER PED-507-00-Q-002 / 02		SPECIFICATION TITLE		
		SHEET 6 OF 6				SYSTEM		ITEM PVC POWER & CONTROL CABLE		SECTION VOLUME III		
S. NO.	COMPONENT / OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
<div>NOTES:</div> <div>A) JOINTS IN WIRES SHALL BE AS PERMITTED BY IS/BHEL SPECIFICATION. VENDOR TO CERTIFY THE SAME</div> <div>B) NO REPAIR OF CORE INSULATION FERMITTED.</div> <div>C) CABLE ENDS SHALL BE SEALED AS PER BHEL SPECIFICATION.</div> <div>D) PURCHASER SHALL HAVE RIGHT TO WITNESS THE SPARK TEST AT CORE STAGE.</div> <div>E) RECORD OF RAW MATERIAL, PROCESS &amp; ALL STAGES SHALL BE CERTIFIED BY VENDOR'S Q.C. AND ARE LIABLE TO AUDIT CHECK BY PURCHASER.</div> <div>F) FILLERS / DUMMY CORES ETC. SHALL BE AS PER BHEL SPECIFICATION.</div> <div>G) WHEREVER EXTENT OF CHECK FOR STAGE IS MENTIONED AS SAMPLES, THE SAME SHALL BE AS PER VENDOR'S SAMPLING PLAN.</div> <div>H) VENDOR SHALL FURNISH COMPLIANCE CERTIFICATE TO THE INSPECTION AGENCY CONFIRMING THE PACKING AS PER BHEL SPECIFICATION.</div> <div>LEGEND :- P – PERFORMER : W–WITNESSER : V – VERIFYER:</div> <div>1–BHEL/BHEL'S CUSTOMER: 2– VENDOR: 3–SUB VENDOR</div>												
BHEL			PARTICULARS			BIDDER / VENDOR						
			NAME									
			SIGNATURE									
			DATE						BIDDER'S / VENDOR'S COMPANY SEAL			

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E2  
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GENERAL TECHNICAL REQUIREMENTS  
OF  
415 V AC DISTRIBUTION BOARD  
  
SPECIFICATION NO. PES-506-05  
(7 SHEETS)

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TITLE

## 415 V AC DISTRIBUTION BOARD

SPECIFICATION NO. PES-506-05

VOLUME II B

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## 1.0 SCOPE

This specification covers the design, manufacture, assembly, testing, packing & despatch of AC Distribution Boards complete in all respect with all components, fittings & accessories for efficient and trouble free operation.

## 2.0 STANDARDS

Major standards which shall be followed are listed below. Other applicable standards for any component, if not covered in the listed standards, shall also be followed.

- IS:375 Marking & arrangement for swgr. busbars, main connections & aux. Wiring
- IS:4064 Air-break switches, disconnectors switch-disconnectors & fuse combination units
- IS:2147 Degree of protection provided by enclosures
- IS:8623 Factory built assemblies of switchgear & controlgear

## 3.0 CONSTRUCTIONAL FEATURES

## 3.1 GENERAL REQUIREMENTS

ACDBs shall be of single front construction having a continuous line-up of vertical sections housing switch-fuse modules only. ACDBs shall have duplicate incomers and a bus-section. In-cubicle rating of incomer and bus-section switches shall be identical to the associated busbar rating. Outgoing feeders shall be such so as to ensure uniform loading on each section DB.

ACDBs shall be indoor, air insulated, metal-clad and fixed type suitable for floor mounting. It shall conform to the degree of protection IP:54. Panels shall be fabricated from minimum 2mm thick CRCA sheet steel.

DB shall be front wired and front connected. They shall be fully compartmentalised with metal insulating partitions between compartments. Working height shall be limited between 450mm and 1800mm from floor level.

All instruments, switches etc. mounted on the front face of the panels shall be of flush type.

Each panel shall be provided with internal illumination lamp operated by door switch, space heater and switchfuse unit and plug socket with switch for hand lamp.

DBs shall be supplied with base frame made out of structural steel sections along with all necessary mounting hardware required for bolting/welding the base frames to the foundation.

## 3.2 BUSBARS &amp; CONNECTIONS

Busbars shall be sized to carry continuously the total running load of the ACDB plus a 20% margin. The minimum clearance in air between phases and between phases and

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earth for entire run of horizontal and vertical busbars shall be 25mm. Horizontal and vertical busbars and bus connections shall be of high conductivity copper/ aluminium alloy. Maximum temperature shall be limited to 90 deg C.

## 3.3 PANEL WIRING

All panels shall be fully wired at the factory to ensure proper functioning of all control, protection and interlock schemes. All wiring for external connection shall be brought to terminal blocks and numbered.

Panel wiring shall be carried out with flexible heat resistant 650V grade, PVC insulated stranded copper wire of minimum 2.5sq.mm cross-section.

Solderless compression /clamp type connection shall be used for wire terminals. Wiring shall be continuous between terminals without splicing. Each wire shall be identified at both ends with permanent markers having wire numbers as per approved wiring drawings.

Terminal blocks shall be box clamp type with marking strip. Not more than two wires shall be connected to one terminal. Spare terminals equal in number to 20% of active terminals shall be furnished.

## 3.4 GROUNDING

A copper ground bus, sized to carry maximum short circuit current shall run along the entire length of panel structure and shall have terminal connection at each end for connection to station ground grid (50x6 mm GI flat).

## 3.5 NAME PLATE

Name plates of approved design shall be furnished on each panel and for each instrument or device mounted on panel.

The material shall be lanucoid or approved equal 3mm thick with white letters on black background.

Name plates shall be held by self tapping screws. Name plates size shall be minimum 20x75mm for instruments devices and 40x50mm for panels.

## 4.0 SWITCHGEAR COMPONENTS

## 4.1 SWITCHES

Switches shall be triple/double pole air break type.

The switch shall have a quick-make, quick-break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON & OFF position.

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The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing the interlock at any time.

Switches shall be capable of withstanding the through fault current of back up fuse.

Wherever two incoming switches and one bus-section switch are provided for an assembly, these shall be mechanically/key interlocked to ensure that only two out of three can be closed at a time.

## 4.2 FUSES

Fuses shall be HRC, preferably link type with a minimum interrupting capacity equal to short circuit current of the LV system.

Fuses shall be furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element. Visible indication shall be provided on blowing of the fuse.

The fuse on incoming feeder wherever provided shall be chosen to provide discrimination with outgoing feeder fuses.

## 4.3 METERS &amp; METER SELECTOR SWITCHES

All indicating instruments (96x96mm) shall be switchboard types with 250deg. Scale, antiglare glass and accuracy class of  $\pm 2\%$  full scale. Each meter shall have zero adjuster on the front.


Meter selector switches shall be maintained contact, stay-put type with knob handle. Voltmeter selector switches shall be four position type.

## 5.0 PAINTING

All metal surface shall be cleaned, phosphated and given two coats of rust-resistant primer followed by two coats of synthetic enamel paint in light grey shade (IS:5 shade 631).

## 6.0 TESTS

Each panel shall be completely assembled, wired, adjusted and tested at the factory prior to shipment. The test shall include wiring continuity tests, insulation tests and functional tests to ensure satisfactory operation and control of individual equipment.

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## 415 V AC DISTRIBUTION BOARD

(DATA SHEET - A)

## 1.0 GENERAL

- 1.1 Type : Fixed Type
- 1.2 Service : Indoor
- 1.3 Enclosure : IP-54

## 2.0 SYSTEM

- 2.1 Voltage : 415 V $\pm$ 10%
- 2.2 Phase : 3
- 2.3 Frequency : 50Hz $\pm$ 5%
- 2.4 System : Solidly grounded


## 3.0 RATED CURRENT AT 50 DEG.C

- 3.1 Busbar : to be decided by tenderer
- 3.2 Switches : to be decided by tenderer

## 4.0 SHORT CIRCUIT RATING

- 4.1 Interrupting : 50kA
- 4.2 Short time for 1sec. : 50kA

- 5.0 INSULATION LEVEL : 2.5kV for 1min

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1.0

EQUIPMENT

1.1

Make

:

1.2

Type

:

1.3

Reference Standard

:

1.4

Construction

a/ Degree of protection

:

b/ Sheet metal thickness (mm):

c/ Floor channel sills vibration

damping pads & kick

plate furnished

1.5

Whether all equipment are flush:

Mounted

1.6

Name plate

a/ Material

:

b/ Thickness

:

c/ Size for

-Equipment

:

-Panels

:

1.7

Internal illumination

a/ Volt

:

b/ Watt

:

c/ Door switch controlled

:

1.8

Space Heater

:

a/ Volt

:

b/ Watt

:

c/ Thermostat controlled

:

1.9

Plug Socket

:

a/ Type

:

b/ Rating

:



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## 415 V AC DISTRIBUTION BOARD

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1.10 Type & rating of isolating  
Switch-fuse units for incoming  
AC supply

1.11 Internal Wiring :

a/ Wire type :

b/ Voltage grade :

c/ Conductor material :

d/ Conductor size for :

-Current control circuit :

-Voltage circuit :

1.12 Terminal Block

a/ Make :

b/ Type :

c/ 20% spare terminals furnished

1.13 Ground Bus

a/ Material

b/ Size

1.14 Painting

a/ Type of finish

b/ Colour shade

## 2.0 SWITCHES

2.1 Make

2.2 Type

2.3 Reference standard

2.4 Breaking current at 415V AC

## 3.0 FUSE

3.1 Make

3.2 Type



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- 3.3 Reference standard
- 3.4 Rupturing capacity (kA rms)
- 3.5 Cont. current at 50deg.C ambient  
and within cubicle (Amp.)

- 3.6 Cut-off currents (kA peak)
- 3.7 Whether fuse characteristics


furnished

## 4.0 METER SELECTOR SWITCH


- 4.1 Make
- 4.2 Type
- 4.3 Reference standard
- 4.4 Contact rating
  - a/ Make & continuous (Amp.)
  - b/ Break inductive (Amp.)

## 5.0 INDICATING INSTRUMENT

- 5.1 Make
- 5.2 Type
- 5.3 Reference Standard
- 5.4 Type of movement
- 5.5 Accuracy class
- 5.6 Scale in degrees
- 5.7 VA barden

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<p>GENERAL TECHNICAL REQUIREMENTS</p> <p>OF</p> <p>LIGHTING DISTRIBUTION BOARD</p> <p>&amp;</p> <p>LIGHTING PANEL</p> <p>SPECIFICATION NO. PES-559-01A</p>			

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## 1.0 SCOPE

This specification covers the design, manufacture, assembly, testing, packing & despatch, installation & commissioning of AC Lighting Distribution Boards complete in all respect with all components, fittings & accessories for efficient and trouble free operation.

## 2.0 STANDARDS

Unless specified otherwise, the latest revisions of standards, codes and other applicable statutory rules and regulations specified in Annexure-I of Data Sheet A are applicable and shall be referred to.

## 3.0 Light Distribution Boards (LDBs)

### 3.1 General Requirements

3.1.1 LDBs shall be totally enclosed, modular in construction, indoor type and suitable for electrical system data as specified in Data Sheet A. The LDB shall be free standing type suitable for installation on cable trenches / floor.

3.1.2 LDBs shall be constructed from CRCA sheet and structural sections. Sheet thickness for load bearing members shall be 2.0 mm and that for non-load bearing members shall be 1.6 mm, unless specified otherwise in Data Sheet A. The design and construction of LDBs shall ensure adequate rigidity.

3.1.3 Vertical cable chambers / alleys of adequate width but not less than 250 mm shall be provided for incoming / outgoing cables of each panel.

3.1.4 LDBs shall have only one operational front. Door shall be provided at the front of each module to give full access to all the components.

3.1.5 LDBs shall consist of dust and vermin proof cubicles without the use of louvers (except the transformer compartment, where applicable).

3.1.6 Good quality synthetic rubber / neoprene gaskets shall be put around the door, cover edges and cutout edges for pushbutton, lamps etc. for protection against dust. The door when closed, shall compress the gasket uniformly.

3.1.7 Cutout edges for instruments, relays etc. shall have sufficient overlap surface to minimize the dust entry. The arrangement for the front mounting of switch handles shall render the LDB reasonably dust free such that the normal operations are not affected.

3.1.8 Degree of protection for completed LDBs (Distribution Board) shall be IP:52 unless mentioned otherwise in Data Sheet A.

3.1.9 The LDBs shall be designed to prevent contact with live parts both within the modules and in the cable alley.

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# LIGHTING DISTRIBUTION BOARD & LIGHTING PANEL

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- 3.1.10 The ratings of all components shown in the enclosed drawings are indicative only. The bidder shall be responsible to check and coordinate the MCB characteristic with back up fuses etc. provided. Any change in size / ratings of components required for final arrangement may be complied with and provided by the vendor at no extra cost.
- 3.1.11 All equipment shall be constructed of non-hygroscopic and non-inflammable materials.
- 3.1.12 All components mounted in the LDBs shall be accessible and shall not impede access to wiring or terminals. All faults except busbar fault which may occur within any individual unit shall be confined within that unit only and shall not cause shutdown of any section of the board other than the affected unit itself. Maintenance and inspection shall be possible in any individual unit without affecting other units.
- 3.1.13 Incoming unit shall comprise of either switch-fuse / composite fuse-switch unit or MCCB as per scheme / Data Sheet A. Outgoing units shall be a switch-fuse / composite fuse-switch unit / MCB.
- 3.1.14 The rated continuous current of the equipment and components shall be as given in the schemes. These ratings shall be obtained with the components mounted in their housing as in service without exceeding the permissible temperature rise.
- 3.1.15 Interlock between compartment door and modules shall be provided such that the door cannot be opened without switching off the power supply to the module.
- 3.1.16 Defeat interlock shall be provided for the units comprising of switch or moulded case circuit breaker as a means of isolation device, such that it is possible to open the door with device ON. It shall not be possible to close the door till the interlock has been reinstated.
- 3.1.17 Each LDB shall be fitted with base frame made of angle or channel.
- 3.1.18 All fixing nuts and bolts together with grounding bolts shall be provided.
- 3.1.19 Lifting lugs shall be provided for each shipping section of LDB. Removal of such lugs or hooks shall leave no opening in the LDB.
- 3.2 LDBs with transformers (Additional Features)
- 3.2.1 The lighting distribution board shall be arranged in two adjacent but separate compartments, one compartment for the lighting transformer and the other for the incoming & outgoing feeders etc.
- 3.2.2 The transformer shall be mounted on the base channel and it shall be possible to easily remove the transformer from the cubicle after opening the door. Necessary portable ramp made of mild steel shall be supplied along with each LDB.

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	<p>3.2.3 Independent gasketed hinged door with operating handle shall be provided for access to transformer &amp; its taps. Operating handle shall have built-in key locking arrangement.</p> <p>3.2.4 Suitable ventilation arrangement for the transformer compartment to dissipate the heat of the transformer shall be provided. The arrangement shall be in the form of louvers and the same shall be provided with galvanized wire mesh with dust catchers on the inside.</p> <p>3.2.5 The degree of protection for transformer compartment shall be IP:42 unless mentioned otherwise in Data Sheet A.</p> <p>3.2.6 Connections between transformer secondary terminals and the busbars shall be made by using PVC insulated flexible copper cables or busbars.</p> <p>3.2.7 Warning plate shall be provided on transformer enclosure. The inscription of warning plate shall be as given below:</p> <ul style="list-style-type: none"> <li>- DO NOT OPEN DOORS WHEN ENERGISED</li> <li>- KEEP TAPS AT SAME POSITION FOR ALL PHASES</li> </ul> <p>3.2.8 Transformer enclosure shall be provided with a danger plate.</p> <p>3.3 Lighting Transformer</p> <p>3.3.1 Lighting transformer, where specified shall form an integral part of lighting distribution board.</p> <p>3.3.2 Lighting transformer shall be dry type, natural air cooled and suitable for mounting inside the lighting distribution board. Transformer shall be non-encapsulated type, unless specified otherwise in Data Sheet A.</p> <p>3.3.3 Rating of transformer shall be 50 kVA as per type of LDB.</p> <p>3.3.4 Voltage rating shall be given in Data Sheet A.</p> <p>3.3.5 Percentage impedance shall be 3% for 50kVA and 4% for 100 kVA transformers, unless specified otherwise in Data Sheet A.</p> <p>3.3.6 Off circuit tap changers/links shall be provided for <math>\pm 5\%</math> in steps of 2.5%.</p> <p>3.3.7 Transformer winding insulation shall be class "F" or better.</p> <p>3.3.8 Transformer shall be of vector group Dyn1.</p>	

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	<p>3.3.9 Winding shall be of copper material maximum winding temperature at full load and under site conditions shall not exceed 120 Deg. C.</p> <p>3.3.10 Transformer shall be suitable for cable connections on the primary side and flexible cable or busbar connectin on the secondary side.</p> <p>3.3.11 The secondary neutral of the transformer shall be brought out for getting a grounded 4 wire supply system.</p> <p>3.3.12 The transformer neutral shall be brought outside the LDB for earthing. The neutral busbar shall be insulated from the LDB enclosure.</p> <p>3.3.13 Transformer shall be provided with the rollers, pulling holes, lifting lugs, jacking positions etc.</p> <p>3.4 Busbars, Connections and Joints</p> <p>3.4.1 Busbars shall be made of aluminium grade E 91E or high conductivity copper (ETC), Busbar material shall generally be aluminium unless mentioned otherwise in Data Sheet A.</p> <p>3.4.2 Busbars shall be supported on non-hygroscopic and non-inflammable insulators of material such as glass reinforced moulded plastic material, epoxy cast resin etc. Separate supports shall be provided for each phase of the busbars, Insulation level of neutral busbar shall be same as that of phase busbars.</p> <p>3.4.3 Busbars shall be contained in a separate vermin-proof compartment within the LDB and shall have bolted sheet steel covers for providing suitable access.</p> <p>3.4.4 Busbar clearances in the air shall be as per applicable standard for 500V, 3 phase system.</p> <p>3.4.5 Temperature of busbars, droppers and connections shall not exceed 90 Deg. C for an ambient of 50 Deg. C while carrying maximum continuous current.</p> <p>3.4.6 The busbar, busbar connections and supports shall have sufficient strength to withstand thermal and electromechanical stresses produced by the specified short circuit level of the system.</p> <p>3.4.7 Busbars (including neutral busbar) shall be capable of carrying the short-time current specified in Data Sheet A. The duration of short-time current shall be 1 sec unless mentioned otherwise in Data Sheet A. For the specified current and duration, there shall be no damage to the equipment.</p> <p>3.4.8 The neutral bus shall be rated same as phase bus.</p>	

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3.4.9 Main busbars and connections shall be prominently marked and displaced for standard sequence counting from rear to front top to bottom, or left to right as viewed from the switching device operating mechanism side.

3.4.10 Busbars and connections shall be provided with colour coded PVD sleeves. All live parts shall be properly shrouded with insulating material.

3.4.11 Earth busbar shall be provided separately. Material of earth busbar shall be GI unless mentioned otherwise in Data Sheet A.

3.4.12 Busbar Joints

a) Busbar and tap off joints shall be bolted type.

b) Busbars shall be thoroughly cleaned before jointing. Suitable contact greae shall be applied to remove oxide film just before jointing.

c) For copper busbars, the connecting portion shall be tinned or silver plated.

3.5 Wiring and Terminals

3.5.1 All internal wiring for connections to remote equipment shall be brought to terminal boards. Spare contacts of devices shall also be wired upto terminal board as per schemes. Wires shall not be jointed or teed-off except at terminal points.

3.5.2 Wiring shall be made by 1000 volt grade three / seven strand PVC insulated copper wire having a cross-sectional area of not less that 1.5 sq.mm. All connections from CT leads upto instruments, terminals shall be made by copper wires of minimum 2.5 sq.mm. size.

3.5.3 All wiring shall be made with the Colour Codes specified below:

a) 3 phase AC Connections


Phase 1 ( R )	Red
Phase 2 ( Y )	Yellow
Phase 1 ( B )	Blue
Neutral	Black


b) 1 phase AC Connections


Phase Red/ Yellow / Blue	
(as per associated circuit)	
Neutral	Black


c) DC Connections





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	<p>Positive      While Negative      Grey</p> <p>d)      Earth Connection      Green</p> <p>3.5.4 Where wiring passes from one compartment to another, the aperture shall be 'Bushed' to prevent damage to wires against sheet metal edges. Bushes may comprise of good quality rubber/ PVC grommets.</p> <p>3.5.5 Every wire end shall be fitted with numbered ferrules of white or yellow colour having glossy finish with identification number engraved in black, Ferrules shall be made of moisture and oil resisting insulating material. Ferrules shall be of interlocked type or tight fitting type. Ferrules shall be so fitted that they will not get detached, when the wire is removed from the terminal.</p> <p>3.5.6 System of marking of wiring shall be as per applicable standard.</p> <p>3.5.7 All wires used internally shall have crimped on tinned copper lugs for terminations.</p> <p>3.5.8 Terminal boards shall be stud type with insulating barriers of adequate height.</p> <p>3.5.9 Terminal boards shall have separate terminals for incoming and outgoing wires with not more than two wires connected to any one terminal.</p> <p>3.5.10 Terminal boards shall be mounted vertically or in the horizontal rows and properly spaced to have clean wiring arrangement, adequate access for putting ferrules, making terminations etc. It shall be possible to read the ferrule numbers when the wiring is complete. Where terminals may be live when the equipment is isolated from the main supply, these shall be clearly marked near the terminal boards.</p> <p>3.6 Controls</p> <p>The controls shall be provided as per purchaser's requirements covered in the specification and control schemes.</p> <p>3.7 Switch Fuse Units</p> <p>3.7.1 These units shall preferably comprise of switches having integral fuses, called composite units. Alternatively, combination units of separate switch and fuse may also be acceptable.</p> <p>3.7.2 These units shall be provided for general purpose i.e. incoming or outgoing units.</p> <p>3.7.3 The units shall be of the air break air insulated type and designed to ensure safety to operating personnel.</p>	

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	<p>3.7.4 Composite units shall have integral fuses i.e. fuse carrier with fuse link (fuse link forming the moving contact). The design shall ensure that the moving contact is not live when switch is open i.e. in OFF position, so as to facilitate removal of fuse.</p> <p>3.7.5 The switch shall be capable making and carrying the system prospective fault current, but limited in magnitude and duration by the cut off characteristics of the largest HRC fuse link that may be fitted to that unit.</p> <p>3.7.6 The fixed contact shall be so shrouded that maintenance of the unit can be carried out in safety with the busbars live.</p> <p>3.7.7 Where one isolating switch is used as the incoming device, the incoming side fixed contacts shall be shrouded to ensure that maintenance can be carried out with the remote fuse and switch closed.</p> <p>3.7.8 Composite switch-fuse or the combination of switch and fuse shall meet the requirements of its components as follows:</p> <p>3.7.9 Isolating Switch</p> <ul style="list-style-type: none"> <li>a) Switches shall be air-break, quick make, quick break heavy duty type conforming to applicable standard.</li> <li>b) All switches shall have visible ON / OFF position indication and shall be padlockable in any (ON /OFF) position.</li> <li>c) Switches shall be door interlocked such that it shall not be possible to gain access to inside the unit unless the isolating switch is in OFF position.</li> <li>d) The switches shall be suitable for independent manual operation.</li> <li>e) The switch contacts shall be of silver alloy or silver plated copper and springs of non corrosive material.</li> <li>f) Inter-phase barriers shall be provided to prevent possibilities of phase to phase fault in the switch. The switch shall also be shrouded from all sides to prevent access to live parts on the switch after opening the unit door. The barriers and shrouding shall extend upto the height of switch to fully enclose both side terminals of the device. The arrangement shall permit easy maintenance.</li> </ul> <p>3.7.10 High Rupturing Capacity (HRC) Fuses</p> <ul style="list-style-type: none"> <li>a) The fuse serving as the short-circuit protective device in isolating fuse-switch units shall be of HRC cartridge, current limiting and plug-in non-deteriorating type.</li> </ul>	


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	<p>b) The fuse carriers shall be easily withdrawable for replacement of fuse, Insulated fuse pullers shall be provided where fuses are not mounted in insulating carriers to remove and replace fuses in live conditions.</p> <p>c) Fuses shall preferably be fitted with a device to indicate operation (i.e. when the fuse has blown).</p> <p>d) Live terminals of fuse bases shall be shrouded to prevent contact with personnel where fuse links are not mounted in carriers and are directly plugged into the fuse base. Inter-phase barriers extending throughout the length of the fuse base shall be provided to prevent inter-phase short circuit. They shall be shrouded from all sides to prevent accidental contact.</p> <p>e) Fuse carriers and bases shall be of good quality moulded insulating material. Porcelain fuse bases and carriers will not be accepted.</p> <p><b>3.8 Cable Terminations</b></p> <p>3.8.1 All cable, either incoming or outgoing to the LDB, shall be terminated in a cable chamber. For each panel, there shall be a cable chamber on the side. The door of cable chamber should open or be locked with the help of a tool. Unless stated otherwise in Data Sheet A, all cables shall enter from the bottom.</p> <p>3.8.2 Removable undrilled gland plates of sheet steel shall be provided in the cable chamber for entry of cables. Minimum thickness of gland plate shall be 3mm. The gland plate shall be of adequate size for connecting requisite number of cable glands for power and control cables.</p> <p>3.8.3 Heavy duty bolt-on termination tinned copper lugs of compression type shall be used in for power cable termination.</p> <p>3.8.4 For supporting and clamping of cable cores at regular interval in cable alleys, suitable slotted angle upto the respective terminal blocks shall be provided.</p> <p>3.8.5 The supply of tinned copper cable lugs for power cables from part the supply of equipment.</p> <p><b>3.9 Earthing</b></p> <p>3.9.1 An earth busbar of adequate size of galvanized MS shall be provided at the bottom for the entire length of the LDB.</p>	

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	<p>3.9.2 Every metal part other than those forming parts of an electrical circuit shall connected to the earth bus by means of high conductivity copper wire of size not less than 2.5 sq. mm cross-sectional area.</p> <p>3.9.3 Doors shall have a flexible copper wire for earth connection to fixed unit.</p> <p>3.9.4 Each LDB shall be fitted with two earthing studs located in accessible position on sides for connection of internal earth busbar to the external earthing connection.</p> <p>3.9.5 Earth busbar shall be brought outside LDB for making external connections.</p> <p>3.10 Type of LDBs</p> <p>The LDBs shall be of following type:</p> <ul style="list-style-type: none"> <li>a) LDB-H (n) - AC LDB with 100 kVA transformer</li> <li>b) LDB-F (n) - AC LDB with 50 kVA transformer</li> <li>c) LDB-N (n) - AC LDB with no transformer</li> <li>d) LDB-D (n) - DC LDB</li> </ul> <p>NOTE: (n) indicates number of outgoing feeders.</p> <p>3.10.1 AC LDBs (LDB-H, LDB-F, LDB-N)</p> <p>Each LDB shall comprise of the following and comply with the enclosed single line diagrams:</p> <ul style="list-style-type: none"> <li>a) One lighting transformer (LDB-H &amp; LDB-F) LIGHTING SYSTEM</li> <li>b) One incomer of TP / TPN switch-fuse unit or MCCB / MCCB with neutral link as per Data Sheet A. It shall be provided on the primary side of transformer for LDB type LDB-H &amp; LDB-F.</li> <li>c) Set of busbars with 3 phase and neutral.</li> <li>d) TPN switchfuse units for each outgoing circuit.</li> <li>e) Three indicating lamps with fuses for indicating bus supply ON.</li> <li>f) CT operated ammeter with selector switch.</li> <li>g) VT operated voltmeter with selector switch.</li> </ul>	


	<b>TITLE:</b>  <b>LIGHTING DISTRIBUTION BOARD &amp; LIGHTING PANEL</b>	SPECIFICATION NO. PES-558-01A VOLUME - II B SECTION - D REV.NO. 0      DATE SHEET 1      OF
<p>h) Power &amp; control terminals, earth-stud, earth busbar, designation labels, internal wiring, power cable lugs, glands etc. shall be provided to complete the LDB in all respects.</p> <p><b>3.10.2 DC LDBs (LDB-D)</b></p> <p>Each LDB shall comprise of the following and comply with the enclosed single line diagrams::</p> <ul style="list-style-type: none"> <li>a) One incomer of two pole switch-fuse unit.</li> <li>b) Two pole DC contactor on the incoming circuit for changeover to DC in case of AC normal supply failure.</li> <li>c) One under voltage relay of suitable range, if specified in Data Sheet A.</li> <li>d) One ON delay timer.</li> <li>e) One test push button.</li> <li>f) Set of busbars for positive and negative.</li> <li>g) Two pole switch-fuse units / MCB for outgoing feeders.</li> <li>h) Two indicating lamps with fuses for indicating but supply ON.</li> <li>i) Power &amp; control terminals, earth busbar, designation labels, internal wiring, power cable lugs, glands etc. shall be provided to complete the LDB in all respects.</li> </ul> <p><b>4.0 LIGHTING PANELS (LPs)</b></p> <p><b>4.1 General Requirements of Lighting Panels</b></p> <p>4.1.1. LPs shall be totally enclosed, suitable for electrical system data as specified ind Data Sheet A.</p> <p>4.1.2 Panels shall be suitable for indoor / outdoor application as per Data Sheet A and BOQ. Outdoor panels shall have a sloping canopy.</p> <p>4.1.3 LPs shall be constructed from CRCA sheet. Sheet thickness shall be 2.0mm, unless mentioned otherwise in Data Sheet A. The construction of LPs shall ensure adequate rigidity.</p>		

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	<p>4.1.4 All components of the LP shall be fully mounted inside the panel, LPs shall have only one operational front. Door shall be provided to give full access to all the components. Door shall have padlocking arrangement.</p> <p>4.1.5 LPs shall consist of dust and vermin proof cubicles without the use of louvers.</p> <p>4.1.6 Good quality synthetic rubber / neoprene gaskets shall be put around the door. The door when closed, shall compress the gasket uniformity.</p> <p>4.1.7 Unless mentioned otherwise in Data Sheet A, degree of protection for completed LPs shall be IP:52 for indoor LPs and IP:55 (with weather-proof protection &amp; canopy) for outdoor LPs.</p> <p>4.1.8 The LPs shall be designed to prevent contact with live parts when the front door is open.</p> <p>4.1.9 All busbars (phase, neutral, positive, negative as applicable) within a panel shall be of the same size.</p> <p>4.1.10 All control wiring inside the panels shall be carried out with 1100 V grade, PVC insulated flexible copper wire of 2.5 sq.mm size.</p> <p>4.1.11 The rated continuous current of the equipment and components</p> <p>4.1.12 Each LP shall be fitted with MS. Mounting brackets.</p> <p>4.1.13 Panel shall be suitable for top / bottom cable / conduit entires. However, outdoor LPs shall have bottom cable / conduit entry. Removable undrilled undrilled gland plate of sheet steel shall be provided for entry of cables. Minimum thickness of gland plate shall be 3 mm. The gland plate shall be of adequate size having knock-outs for requisite number cable connections. Gland plate shall be provided with gasket.</p> <p>4.1.14 The lighting panel shall be complete with copper busbars, and shall incorporate switch fuse or MCB on the incoming side, single pole miniature circuit breakers (MCBs) for AC outgoing circuits and double pole MCBs for DC outgoing circuits. Number of outgoing circuits shall be as per BOQ.</p> <p>4.1.15 Each lighting panel shall be fitting with two GI earth studs located in accessible position on the outside of the panel on opposite sides.</p> <p>4.1.16 All metal parts of the panel except current carrying parts shall be bonded together electrically to the earthing stud.</p> <p>4.1.17 Each panel shall be fitted with phase barriers of fireproof insulating material in such a manner that it is not readily possible for personnel to touch the phase busbars.</p>	

	TITLE:	SPECIFICATION NO. PES-558-01A																				
	LIGHTING DISTRIBUTION BOARD & LIGHTING PANEL	VOLUME - II B																				
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<p>Insulating sheet shall be fitted around the MCBs such that only the surface and toggle of the MCBs are available on the front.</p> <p>4.1.18 The supply of cable lugs for power and control cable connections forms part the supply of equipment.</p> <p>4.1.19 Each panel shall be provided with a circuit directory plate with inscriptions neatly typed and laminated fitted on the inside of door.</p> <p>4.2      Type of Lighting Panels</p> <table><tr><td>a)</td><td>LP-A (n)</td><td>-</td><td>AC</td><td>Lighting Panel</td></tr><tr><td>b)</td><td>LP-D (n)</td><td>-</td><td>DC</td><td>Lighting Panel</td></tr><tr><td>c)</td><td>LP-F (n)</td><td>-</td><td>Fancy</td><td>Lighting Panel (Decorative)</td></tr><tr><td>d)</td><td>LP-V (n)</td><td>-</td><td>Aviation</td><td>Lighting Panel</td></tr></table> <p>NOTE: (n) indicates number of outgoing circuits.</p> <p>4.3      AC Lighting Panel (LP-A)</p> <p>4.3.1 LPs shall be provided with TPN switch as incomer.</p> <p>4.3.2 Requisite number of single pole MCBs shall be provided for outgoing circuits.</p> <p>4.3.3 Separate neutral shall be available at terminal block for each outgoing circuit.</p> <p>4.3.4 Construction of AC Normal and AC Emergency panels shall be same.</p> <p>4.4      DC Lighting Panels (LP-D)</p> <p>4.4.1 LPs shall be provided with double pole switch as incomer.</p> <p>4.4.2 Requisite number of double pole MCBs shall be provided for outgoing circuits.</p> <p>4.5      Decorative Type Lighting Panels (LP-F)</p> <p>4.5.1 Decorative lighting panels shall be designed for use in areas like administrative building, service building, canteen, residential premises etc.</p> <p>4.5.2 Thickness of sheet steel shall be as per manufacturer's practice.</p> <p>4.5.3 LPs shall be of tone colour with elegant finish.</p>			a)	LP-A (n)	-	AC	Lighting Panel	b)	LP-D (n)	-	DC	Lighting Panel	c)	LP-F (n)	-	Fancy	Lighting Panel (Decorative)	d)	LP-V (n)	-	Aviation	Lighting Panel
a)	LP-A (n)	-	AC	Lighting Panel																		
b)	LP-D (n)	-	DC	Lighting Panel																		
c)	LP-F (n)	-	Fancy	Lighting Panel (Decorative)																		
d)	LP-V (n)	-	Aviation	Lighting Panel																		

	<b>TITLE:</b>  <b>LIGHTING DISTRIBUTION BOARD &amp; LIGHTING PANEL</b>	SPECIFICATION NO. PES-558-01A VOLUME - II B SECTION - D REV.NO. 0      DATE SHEET 1      OF
	<p>4.5.4 LPs shall be provided with TPN switch as incomer and requisite number of MCBs shall be provided for outgoing circuits.</p> <p>4.5.5 LPs shall be suitable for either surface or flush mounting as per Data Sheet A and BOQ. Flush mounted panels shall have the collared door suitable for matching with the wall.</p> <p>4.5.6 Lighting Panels may be provided with transparent acrylic cover for operation of MCBs, if asked for in Data Sheet A.</p> <p>4.5.7 LPs shall be provided with knockouts on the top, bottom and sides.</p> <p>4.6 Aviation Lighting Panel (LP_V)</p> <p>4.6.1 Aviation Lighting Panels shall be provided for feeding power supply to Aviation obstruction luminaries.</p> <p>4.6.2 Each Aviation Lighting Panel shall comprise of the following:</p> <ul style="list-style-type: none"> <li>a) One TPN door interlocked switch-use unit. Interlock defeat feature shall also be provided.</li> <li>b) Three pole AC Contactor</li> <li>c) 00-24 hrs timer and a photo-electric switch for automatic switching of contactor</li> <li>d) Three phase &amp; neutral busbars</li> <li>e) Single pole or three pole MCBs for each outgoing circuit as per Data Sheet A</li> <li>f) Two lamps for bus supply ON &amp; OFF indications</li> <li>g) Complete wiring arrangement as per control scheme.</li> <li>h) Auto-Manual selector switch</li> <li>i) ON push button</li> <li>j) OFF push button</li> <li>k) Photo switch</li> </ul> <p>4.6.3 Switching ON and switching OFF shall be through both 00-24 hrs timer and light sensor in automatic mode.</p> <p>4.6.4 One number light sensor in weather proof enclosure having IP:55 degree of protection shall be supplied loose along with each SLP.</p>	



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4.6.5

Internal power wiring shall be done with PVC insulated Cu wire of suitable size. All control wiring inside the panel shall be carried out with 1100 V grade, PVC insulated flexible copper wires.

5.0

Guaranteed Performance Requirements

5.1

The vendor shall guarantee satisfactory performance of the equipment under all conditions and requirement as laid down by this specification.

5.2

For the general requirements of performance guarantees refer to other parts of the specification.

6.0


PAINTING


(All metal surface shall be cleaned, phosphated and given two coats of rust-resistant primer followed by two coats of synthetic enamel paint in light grey shade (IS:5 shade 631).


7.0

TESTS

Each panel shall be completely assembled, wired, adjusted and tested at the factory prior to shipment. The test shall include wiring continuity tests, insulation tests and functional tests to ensure satisfactory operation and control of individual equipment.

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	<b>LIGHTING DISTRIBUTION BOARD &amp; LIGHTING PANEL</b>		VOLUME - II B			
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			SHEET	1	OF	
1.0 SYSTEM DESIGN DATA						
1.1	Design Ambient	:	50 Deg.C			
1.2	Relative humidity	:				
	a) Average	:	As per project synopsis			
	b) Maximum	:	-do-			
1.3	Details of Operating parameters					
	a) AC Supply					
	i. Rated voltage	:	415 V			
	ii. Rated frequency	:	50 Hz			
	iii. Voltage variation (Permissible)	:	± 10 %			
	iv. Frequency variation (Permissible)	:	± 5 %			
	v. Combined voltage & Frequency variation (sum of absolutes permissible)	:	10%			
	vi. System fault level At rated voltage	:	50 kA for 0.25 sec.			
	vii. System grounding	:	Solidly			
	b) DC Supply	Not applicable				
	i. Rated voltage	:	V			
	ii. Voltage variation (Permissible)	:	%			
	iii. System fault level at rated voltage	:				
	c) AC Emergency luminaries as per percentage of total luminaries	:	Not applicable %			
2.0	APPLICABLE STANDARDS	:	As per Annexure I			

	<b>TITLE:</b>  <b>LIGHTING DISTRIBUTION BOARD &amp; LIGHTING PANEL</b>	SPECIFICATION NO. PES-558-01A VOLUME - II B SECTION - D REV.NO. 0      DATE SHEET 1      OF
3.0	LIGHTING DISTRIBUTION BOARDS	
3.1	Sheet thickness	: 2.0 mm
3.2	Degree of protection	:
	a) Main panel	: IP 54
	b) Transformer cubicle	: IP 33
3.3	Type of Incomer	: Switch-Fuse
3.4	Type of Outgoing Feeders	: Switch-Fuse
3.5	Voltage rating of transformer	: 415 V
3.6	Whether transformer is encapsulated:	No
3.7	Transformer impedance	
	a) 100 kVA	: - %
	b) 50 kVA	: 4.0 %
3.8	Bus bar material	: Aluminium
3.9	Earth busbar material	: GI (50X6 mm)
3.10	Cable entry	: Bottom
3.11	Whether under voltage relay required in DC LDB	: Not applicable
4.0	LIGHTING PANEL	
4.1	Application	: Both Indoor & outdoor
4.2	Sheet thickness	: 2.0 mm
4.3	Degree of protection	
	a) Indoor	: IP : 54
	b) Outdoor	: IP : 55 (weather-proof protection with canopy)
4.4	Type of Incomer	: Switch-Fuse
4.5	No. of poles for Aviation lighting panel MCBs	: 1 / 3

	<b>TITLE:</b> <b>LIGHTING DISTRIBUTION BOARD &amp; LIGHTING PANEL</b>	SPECIFICATION NO. PES-558-01A
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4.6	Type of mounting of decorative lighting panel	: Not applicable
4.7	Whether decorative lighting panel required with acrylic panel	: Not applicable
5.0	LABELING	: As per specification
6.0	PAINTING	:
6.1	Shade (as per IS:5)	<div>Interior      Exterior</div>
	a) LDBs	: Glossy white      631 of IS:5
	b) LPs	: -do-      -do-
6.2	FINISH	
	a) Interior	: Semi-glossy
	b) Exterior	: Semi-glossy
6.3	Paint thickness (min.)	: 50      microns
7.0	MAKE OF COMPONENTS	: Shall be subject to BHEL approval



TITLE

LIGHTING DISTRIBUTION BOARD  
&  
LIGHTING PANEL  
(DATA SHEET – B)

SPECIFICATION NO.

VOLUME II B

SECTION D

REV NO. DATE

SHEET 1 OF 4

1.0 SYSTEM DESIGN DATA

1.1 Design Ambient : °C

1.2 Details of Operating parameters

a) AC Supply

i. Rated voltage : V

ii. Rated frequency : Hz

iii. Voltage variation : %  
(Permissible)

iv. Frequency variation : %  
(Permissible)

v. Combined voltage & : %  
frequency variation  
(sum of absolutes  
permissible)

vi. System fault level :  
at rated voltage

b) DC Supply

i. Rated voltage : V

ii. Voltage variation : %  
(Permissible)

iii. System fault level :  
at rated voltage

2.0 APPLICABLE STANDARDS : As per Annexure I

3.0 Lighting Distribution Boards

3.1 Sheet thickness : mm

3.2 Degree of protection

a) Main panel :

b) Transformer cubicle :

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**LIGHTING DISTRIBUTION BOARD  
&  
LIGHTING PANEL  
(DATA SHEET – B)**

SPECIFICATION NO.

VOLUME II B

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REV NO. DATE

SHEET 2 OF 4

- 3.3 Type of Incomer : ☐ MCCB  
☐ Switch-Fuse
- 3.4 Type of Outgoing Feeders : ☐ Switch-Fuse  
☐ MCB
- 3.5 Bus bar material : ☐ Aluminium ☐ Copper
- 3.6 Cable entry : ☐ Bottom ☐ Top
- 3.7 Whether under voltage relay required in DC LDB : ☐ Yes ☐ No
- 3.8 Range of time delay relay :
- 3.9 Whether hinged door with locking facility provided : ☐ Yes ☐ No
- 3.10 Whether earth busbar provided : ☐ Yes ☐ No
- 3.11 Earth busbar material : ☐ GI ☐ Copper
- 3.12 Fault current and duration : kA
- 3.13 Lighting Transformer
- a) kVA Rating(s) : 50 100
- b) Type of cooling :
- c) Rated current
- i. Primary : Amp.
- ii. Secondary : Amp.
- d) Rated voltage
- i. Primary : Volts
- ii. Secondary : Volts
- e) Rated frequency : Hz
- f) No. of phases :
- g) Temperature rise above ambient in winding by resistance : °C

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**LIGHTING DISTRIBUTION BOARD  
&  
LIGHTING PANEL  
(DATA SHEET – B)**

SPECIFICATION NO.

VOLUME II B

SECTION D

REV NO. DATE

SHEET 3 OF 4

h) Vector Group :

i) Tap changer

i. Type :

ii. Range :

iii. No. of taps :

iv. Voltage of each tap :

j) Type of ventilation arrangement provided for transformer enclosure :

k) Iron loss at 50 Hz and 100% rated voltage : kW

l) Regulation at full load and at 75 °C and 0.8 p.f. lagging :

m) Copper loss at rated load and 75 °C : kW

n) Impedance at rated current, frequency and at 75 °C :

o) Winding conductor material :

p) Whether transformer is encapsulated : ☐ Yes ☐ No

q) Insulation class :

r) Weight : kg

4.0 Lighting Panel

4.1 Application : ☐ Indoor ☐ Outdoor ☐ Both

4.2 Sheet thickness : mm

4.3 Degree of protection

a) Indoor : IP :

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TITLE

**LIGHTING DISTRIBUTION BOARD  
&  
LIGHTING PANEL  
(DATA SHEET – B)**

SPECIFICATION NO.

VOLUME II B

SECTION D

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SHEET 4 OF 4

- b) Outdoor : IP :
- 4.4 Type of Incomer : ☐ Switch-Fuse  
☐ MCB
- 4.5 MCB type for street lighting panel. : ☐ 1 pole ☐ 3 pole
- 4.6 Busbar material :
- 4.7 Whether hinged door with with locking facility provided : ☐ Yes ☐ No
- 4.8 Whether earthing studs provided : ☐ Yes ☐ No
- 5.0 LABELING
- Requirement of specification complied with : ☐ Yes ☐ No
- 6.0 PAINTING
- 6.1 Shade (as per IS:5)
- |           | Interior | Exterior |
|-----------|----------|----------|
| a) LDBs : |          |          |
| b) LPs :  |          |          |
- 6.2 Finish
- a) Interior : ☐ Matt ☐ Semi-glossy
- b) Exterior : ☐ Semi-glossy ☐ Full-glossy
- 6.3 Paint thickness (min.) : microns
- 7.0 O&M SPARES
- 7.1 Duration for which O&M spares considered : years



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TITLE

**LIGHTING DISTRIBUTION BOARD  
&  
LIGHTING PANEL  
(DATA SHEET – C)**

SPECIFICATION NO.

VOLUME II B

SECTION D

REV NO. DATE

SHEET 1 OF 5

## 1.0 SYSTEM DESIGN DATA

1.1 Design Ambient : °C

## 1.2 Details of Operating parameters

## a) AC Supply

- i. Rated voltage : V
- ii. Rated frequency : Hz
- iii. Voltage variation : %  
(Permissible)
- iv. Frequency variation : %  
(Permissible)
- v. Combined voltage & : %  
frequency variation  
(sum of absolutes  
permissible)
- vi. System fault level :  
at rated voltage

## b) DC Supply

- i. Rated voltage : V
- ii. Voltage variation : %  
(Permissible)
- iii. System fault level :  
at rated voltage

2.0 APPLICABLE STANDARDS : As per Annexure I

## 3.0 LIGHTING DISTRIBUTION BOARDS

3.1 Sheet thickness : mm

## 3.2 Degree of protection

a) Main panel :

b) Transformer cubicle :

3.3 Type of Incomer : [ ] MCCB

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**LIGHTING DISTRIBUTION BOARD  
&  
LIGHTING PANEL  
(DATA SHEET - C)**

SPECIFICATION NO.

VOLUME II B

SECTION D

REV NO. DATE

SHEET 2 OF 5

- [ ] Switch-Fuse
- 3.4 Type of Outgoing Feeders : [ ] Switch-Fuse  
[ ] MCB
- 3.5 Bus bar material : [ ] Aluminium [ ] Copper
- 3.6 Cable entry : [ ] Bottom [ ] Top
- 3.7 Whether under voltage relay required in DC LDB : [ ] Yes [ ] No
- 3.8 Range of time delay relay :
- 3.9 Whether hinged door with locking facility provided : [ ] Yes [ ] No
- 3.10 Whether earth busbar provided : [ ] Yes [ ] No
- 3.11 Earth busbar material : [ ] GI [ ] Copper
- 3.12 Fault current and duration : kA
- 3.13 Lighting Transformer
- a) kVA Rating(s) : 50 100
- b) Type of cooling :
- c) Rated current
- i. Primary : Amp.
- ii. Secondary : Amp.
- d) Rated voltage
- i. Primary : Volts
- ii. Secondary : Volts
- e) Rated frequency : Hz
- f) No. of phases :
- g) Temperature rise above ambient in winding by resistance : °C
- h) Vector Group :



TITLE

LIGHTING DISTRIBUTION BOARD  
&  
LIGHTING PANEL  
(DATA SHEET - C)

SPECIFICATION NO.

VOLUME II B

SECTION D

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SHEET 3 OF 5


- i) Tap changer
- i. Type :
- ii. Range :
- iii. No. of taps :
- iv. Voltage of each tap :
- j) Type of ventilation arrangement provided for transformer enclosure :
- k) Iron loss at 50 Hz and 100% rated voltage : kW
- l) Regulation at full load and at 75 °C and 0.8 p.f. lagging :
- m) Copper loss at rated load and 75 °C : kW
- n) Impedance at rated current, frequency and at 75 °C :
- o) Winding conductor material :
- p) Whether transformer is encapsulated : ☐ Yes ☐ No
- q) Insulation class :
- r) Weight : kg

4.0 LIGHTING PANEL

- 4.1 Application : ☐ Indoor ☐ Outdoor ☐ Both
- 4.2 Sheet thickness : mm
- 4.3 Degree of protection
- a) Indoor : IP :
- b) Outdoor : IP :

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	<b>TITLE</b> <b>LIGHTING DISTRIBUTION BOARD</b> <b>&amp;</b> <b>LIGHTING PANEL</b> <b>(DATA SHEET - C)</b>		<b>SPECIFICATION NO.</b>																						
			<b>VOLUME</b> II B																						
			<b>SECTION</b> D																						
			<b>REV NO.</b>	<b>DATE</b>																					
			<b>SHEET</b> 4 OF 5																						
<p>4.4 Type of Incomer : <input type="checkbox"/> Switch-Fuse <input type="checkbox"/> MCB</p> <p>4.5 MCB type for street lighting panel. : <input type="checkbox"/> 1 pole <input type="checkbox"/> 3 pole</p> <p>4.6 Busbar material :</p> <p>4.7 Whether hinged door with locking facility provided : <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>4.8 Whether earthing studs provided : <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>5.0 LABELING</p> <p>Requirement of specification complied with : <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>6.0 PAINTING</p> <p>6.1 Shade (as per IS:5)</p> <table border="0"> <tr> <td></td> <td>Interior</td> <td>Exterior</td> </tr> <tr> <td>a) LDBs :</td> <td></td> <td></td> </tr> <tr> <td>b) LPs :</td> <td></td> <td></td> </tr> </table> <p>6.2 FINISH</p> <p>a) Interior : <input type="checkbox"/> Matt <input type="checkbox"/> Semi-glossy</p> <p>b) Exterior : <input type="checkbox"/> Semi-glossy <input type="checkbox"/> Full-glossy</p> <p>6.3 Paint thickness (min.) : microns</p> <p>7.0 MAKE</p> <table border="0"> <tr> <td>EQUIPMENT</td> <td>MAKE</td> <td>TYPE DESIGNATION OF MANUFACTURER</td> </tr> <tr> <td>7.1 LDBs</td> <td></td> <td></td> </tr> <tr> <td>a) AC</td> <td></td> <td></td> </tr> <tr> <td>b) DC</td> <td></td> <td></td> </tr> </table>						Interior	Exterior	a) LDBs :			b) LPs :			EQUIPMENT	MAKE	TYPE DESIGNATION OF MANUFACTURER	7.1 LDBs			a) AC			b) DC		
	Interior	Exterior																							
a) LDBs :																									
b) LPs :																									
EQUIPMENT	MAKE	TYPE DESIGNATION OF MANUFACTURER																							
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a) AC																									
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	<b>TITLE</b> <b>LIGHTING DISTRIBUTION BOARD</b> <b>&amp;</b> <b>LIGHTING PANEL</b> <b>(DATA SHEET - C)</b>	<b>SPECIFICATION NO.</b>	
		<b>VOLUME</b>	<b>II B</b>
		<b>SECTION</b>	<b>D</b>
		<b>REV NO.</b>	<b>DATE</b>
		<b>SHEET</b>	<b>5 OF 5</b>

## 7.2 LPs

- a) AC
- b) DC
- c) Decorative
- d) Street Lighting

## 8.0 QUANTITY VARIATION (Limited to the value of the contract)

- a) Till the "Engineering" : %  
is complete
- b) Till the "Erection" is : %  
complete

## 9.0 O&M SPARES


- 9.1 Duration for which O&M : years  
spares considered

## 10.0 DOCUMENTATION

Whether following enclosed :

- a) General Arrangement : ☐ Yes ☐ No  
drawings of all types  
of LDBs
- b) General Arrangement : ☐ Yes ☐ No  
drawing of Lighting  
Transformer
- c) Bar chart of activities : ☐ Yes ☐ No  
of manufacture, testing,  
inspection and dispatch

The above documents shall be submitted in the form of Annexure- A to Annexure - C in the exact order listed above along with this Data Sheet C duly filled up.

	TITLE	SPECIFICATION NO.	
	<b>LIGHTNING PROTECTION OF CHIMNEY</b> (SUPPLY & INSTALLATION)  <b>DATA SHEET – C</b> (TO BE SUBMITTED BY SUCCESSFUL BIDDER)	VOLUME	II B
		SECTION	D
		REV NO.	DATE
		SHEET	1 OF 1

1.0	Name of manufacturer	:
2.0	Place & country of manufacture	:
3.0	Standards applicable	:
i/	For materials & sizes	:
ii/	For galvanisation/Electroplated coating	:
iii/	For testing uniformity of Galvanization	:
iv/	For code of practice	:
v/	For temporary lightning protection during construction	:
4.0	Thickness of galvanizing on steel (microns)	:
5.0	Thickness of Electroplated coatings (microns)	:
6.0	Thickness of Lead coating on copper (mm)	:
7.0	Materials and sizes offered	:
i/	Below ground annular ring conductor	:
ii/	Electrodes	:
iii/	Below ground interconnection conductor	:
iv/	Down Conductors	:
v/	Vertical air terminations	:
vi/	Horizontal air termination	:
vii/	Test Pit	:
viii/	Earthing band ring (above landing platform)	:
ix/	Test Link	:
x/	Conductor for equipment earthing	:

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P E M

## LIGHTING SYSTEM

## SPECIFIC TECHNICAL REQUIREMENTS

SPECIFICATION No. PES-558-01

VOLUME IIB

SECTION D

REV. No. 01

DATE 31.03.93

SHEET

1

OF 4

## ANNEXURE-I

## LIST OF APPLICABLE STANDARDS

## Illumination

1.	Code of practice for interior illumination	[ ]	IS 3646
2.	Code of practice for industrial lighting	[ ]	IS 6665
3.	Code of practice for design of electrical street lighting installations	[ ]	IS 1944

## Luminaires

4.	General and safety requirement for electric lighting fittings	[ ]	IS 1913
5.	Luminaires	[ ]	IS 10322
6.	Industrial lighting fittings with metal reflector	[ ]	IS 1777
7.	Industrial lighting fittings with plastic reflectors	[ ]	IS 3287
8.	Decorative lighting outfits	[ ]	IS 5077
9.	Water proof electric lighting fittings	[ ]	IS 3528
10.	Water tight electric lighting fittings	[ ]	IS 3553
11.	Dust proof electric lighting fittings	[ ]	IS 4012
12.	Dust tight electric lighting fittings	[ ]	IS 4013
13.	Flameproof electric lgtg. fittings well glass & bulk head types	[ ]	IS 2206
14.	Electric lighting fittings for division 2 areas	[ ]	IS 8224

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P E M

## DATA SHEET - A

 LIGHTING SYSTEM  
 SPECIFIC TECHNICAL REQUIREMENTS

SPECIFICATION No. PES-558-01	
VOLUME IIB	SECTION D
REV. No. 01	DATE 31.03.93
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## Lamps

15.	Electric lamps, tungsten filament general service	[ ] IS 418 [ ]
16.	Tubular fluorescent lamps for general lighting service	[ ] IS 2418 [ ]
17.	High pressure mercury vapour lamps	[ ] IS 9900 [ ]
18.	High pressure sodium vapour lamps	[ ] IS 9974 [ ]

## Luminaire Components

19.	Ballast for fluorescent lamps for switch start circuits	[ ] IS 1534 [ ]
20.	Ballast for high pressure mercury vapour lamps	[ ] IS 6616 [ ]
21.	Capacitors for electric discharge lamps (fluorescent and MV)	[ ] IS 1569 [ ]
22.	Bi-pin lamp holders for tubular fluorescent lamps	[ ] IS 3223 [ ]
23.	Methods of measurement of lamp cap temp. rise	[ ] IS 8913 [ ]
24.	Starters for fluorescent lamps	[ ] IS 2215 [ ]
25.	Holders for starters for tubular fluorescent lamps	[ ] IS 3324 [ ]
26.	Cast acrylic sheets for use in luminaires	[ ] IS 7569 [ ]

## Assembled Equipment and Components

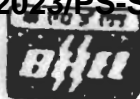
27.	General requirements for swgr. and control gear for voltage not exceeding 1000 V AC or 1200 V DC	[ ] IS 4237 [ ]
28.	Code of practice for selection, installation & maintenance of switchgear & control gear	[ ] IS 10118 [ ]
29.	Flame proof enclosures for electrical apparatus	[ ] IS 2148 [ ]



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DATA SHEET - A

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P E M

# LIGHTING SYSTEM SPECIFIC TECHNICAL REQUIREMENTS

SPECIFICATION No. PE S-558-01	
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30.	Classification of hazardous areas for electrical installations	[ ] IS 5572 [ ]
31.	Degree of protection provided by enclosures for LV switchgear & control gear	[ ] IS 2147 [ ]
32.	Dry type transformers	[ ] IS 11171 [ ]
33.	Air break switches, disconnectors etc. and fuse combinations units	[ ] IS 4064 [ ]
34.	Miniature air break circuit breaker for voltages not exceeding 1000 V	[ ] IS 8828 [ ]
35.	Low voltage Fuses	[ ] IS 9224 [ ]
36.	Contactors for voltages not exceeding 1000 V AC or 1200V DC	[ ] IS 2959 [ ]
37.	Indicator lamps (visual)	[ ] IS 1901 [ ]
Poles, Sockets and Other Miscellaneous		
38.	Tubular steel poles for over head power lines	[ ] IS 2713 [ ]
39.	Three pin plugs and sockets	[ ] IS 1293 [ ]
40.	Switch socket outlets (non-interlocking)	[ ] IS 4615 [ ]
41.	Interlocking switch socket outlet	[ ] IS 4160 [ ]
42.	Structural steel (Standard quality)	[ ] IS 226 [ ]
43.	Danger notice plates	[ ] IS 2551 [ ]
44.	Boxes for enclosure of electric accessories steel & cast iron boxes	[ ] IS 5133 [ ]
45.	Code of practice for general construction in steel	[ ] IS 800 [ ]

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SPECIFICATION No. PES-558-01

VOLUME IIB

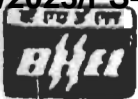
SECTION D

REV. No. 01

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P E M

## LIGHTING SYSTEM

## SPECIFIC TECHNICAL REQUIREMENTS

- |     |  |                    |
|-----|--|--------------------|
| 46. | Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes | [ ] IS 5082<br>[ ] |
| 47. | Code of practice for phosphating of iron and steel   | [ ] IS 6005<br>[ ] |
| 48. | Colour for ready mixed paints & enamels  | [ ] IS 5<br>[ ]    |
| 49. | Recommended practice for hot dip galvanising of iron & steel                                 | [ ] IS 2629<br>[ ] |
| 50. | Method of testing uniformity of coating on zinc coated articles                              | [ ] IS 2603<br>[ ] |

2X660 MW Ennore SEZ SUPERCRITICAL TPS Approved vendor list :			
Sl. No.	Package Name	Vendor Name	Remarks
<b>ELECTRICAL PACKAGES</b>			
1	ABOVE GROUND EARTHING MATERIALS	INDIA ELECTRICALS SYNDICATE	Submit cedentials
		PREMIER POWER PRODUCTS (CAL) PVT. LTD.	Approved
		RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	Approved
		Associated Power Structures Pvt. Ltd.	Submit cedentials
		PASSIVE INFRA PROJECTS PVT. LTD.	Submit cedentials
		INDUSTRIAL PERFORATION (I) PVT.LTD.	Approved
		PATNY SYSTEMS (P) LTD	Submit cedentials
		RUKMANI ELECTRICAL & COMPONENTS PVT LTD	Approved
		UNITECH FABRICATORS and ENGINEERS PVT LTD	Approved
		RABI ENGINEERING WORKS PVT. LTD.	Approved
		JAMNA METAL COMPANY	Approved
2	CABLE TERM.& JOINT KITS	HARI CONSOLIDATED PVT.LTD.,NEW DELHI	Submit cedentials

		3M Electro and Communication India P.Ltd	Approved
		RAYCHEM RPG PRIVATE LIMITED	Approved
		YAMUNA POWER and INFRASTRUCTURE LTD	Approved
3	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	PREMIER POWER PRODUCTS (CAL) PVT. LTD.	Approved
		STEELITE ENGINEERING LTD.	Submit cedentials
		INDUSTRIAL PERFORATION (I) PVT.LTD.	Approved
		RATANS PROJECTS AND ENGINEERING CO. PVT. LTD.	Submit cedentials
		AM-TECH ENGG.SERVICES	Approved
4	CABLE TRAYS & ACC.	RUKMANI ELECTRICAL & COMPONENTS PVT LTD	Approved
		EROS METAL WORKS PVT. LTD	Submit cedentials
		RABI ENGINEERING WORKS PVT. LTD.	Approved
		PATNY SYSTEMS (P) LTD	Submit cedentials
		PREMIER POWER PRODUCTS (CAL) PVT. LTD.	Approved
		UNITECH FABRICATORS and ENGINEERS PVT LTD	Approved
		PASSIVE INFRA PROJECTS PVT. LTD.	Submit cedentials

		RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	Submit cedentials
		INDIANA GRATINGS PVT. LTD.	Submit cedentials
		Maheshwari Electrical Mfrs. Pvt. Ltd.,	Submit cedentials
		INDUSTRIAL PERFORATION (I) PVT.LTD.	Approved
		INDIA ELECTRICALS SYNDICATE	Submit cedentials
		JAMNA METAL COMPANY	Approved
		PENTAX FERRO INCORPORATE	Submit cedentials
		PARMAR METALS PVT.LTD.	Submit cedentials
5	DC BATTERY CHARGER	DUBAS ENGG PVT LTD	Approved
		HBL POWER SYSTEMS LTD	Approved
		STATCON POWER CONTROLS LTD	Approved
		CHLORIDE POWER SYSTEMS & SOLUTIONS LIMITED	Approved
		JEMA ENERGY	Submit cedentials
		MASS-TECH CONTROLS PVT.LTD.	Submit cedentials
		CHHABI ELECTRICALS PVT.LTD.	Approved

		AMARA RAJA POWER SYSTEMS LIMITED	Approved
6	DC Ni Cd BATTERIES	AMCO SAFT INDIA LTD	Approved
		HOPPECKE BATTERIEN GMBH & CO.KG,	Approved
		AMARA RAJA POWER SYSTEMS LIMITED	Approved
		EXIDE INDUSTRIES LTD	Approved
		HBL POWER SYSTEMS LTD	Approved
7	ELECTRIC LAB EQUIPMENT	PCI LIMITED	Approved
		SCIENTIFIC MES-TECHNIK PVT.LTD.	Approved
		THE MOTWANE MANUFACTURING CO.PVT.LTD.	Approved
		Applied Techno Products Pvt. Ltd.,	Approved
		TECHNOLOGY PRODUCTS	Approved
		TTL Technologies Pvt. Ltd.	Approved
		THE TINSLEY GROUP LTD.	Approved
		HIOKI E.E. CORPORATION	Approved
		Pinkcity Electronics Pvt. Ltd.	Submit cedentials

		JOST's ENGG. CO. LTD.	Approved
8	FIRE SEALING SYSTEM	LLOYD INSULATIONS (INDIA) LIMITED	Approved
		MULTI KILFIRE PVT LTD	Approved
		VIJAY SYSTEMS ENGINEERS PVT LTD	Approved
		SIGNUM FIRE PROTECTION (INDIA) PVT LTD	Submit cedentials
		HILTI INDIA PRIVATE LIMITED	Approved
9	GENERATOR CIRCUIT BREAKER	ALSTOM GRID SAS	Approved
		ABB SWITZERLAND LTD.,	Approved
10	HT XPLE CABLES	POLYCAB WIRES PVT. LTD.	Approved
		RAVIN CABLES LIMITED	Approved
		TORRENT CABLES LTD.	Approved
		PARAMOUNT COMMUNICATIONS LTD.	Approved
		KEC INTERNATIONAL LIMITED	Approved
		KEI INDUSTRIES LTD.	Approved
		GEMSCAB INDUSTRIES LTD.	Submit cedentials

		SRIRAM CABLES PVT. LTD.	Submit cedentials
		CRYSTAL CABLE INDUSTRIES LTD.	Submit cedentials
		UNIVERSAL CABLES LTD.	Approved
		Havells India Limited	Approved
		Diamond Power Infrastructure Ltd	Not approved
		NICCO CORPORATION LTD.	Submit cedentials
		KRISHNA ELECTRICAL INDUSTRIES LTD.	Not approved
		APAR INDUSTRIES LIMITED,	Approved
		CABLE CORPORATION OF INDIA LTD.	Approved
11	LT PVC CONTROL CABLE	PARAMOUNT COMMUNICATIONS LTD.	Approved
		UNIVERSAL CABLES LTD.	Approved
		CRYSTAL CABLE INDUSTRIES LTD.	Submit cedentials
		KEC INTERNATIONAL LIMITED	Approved
		TORRENT CABLES LTD.	Approved
		Incom Cables (P) Ltd.,	Submit cedentials



Advance Cable Technologies (P) Ltd.	Submit cedentials
GOVIND CABLE INDUSTRIES	Not approved
KEI INDUSTRIES LTD.	Approved
Scot Innovation Wires and Cables Pvt. Ltd.	Submit cedentials
RAVIN CABLES LIMITED	Approved
ELKAY TELELINKS LTD.	Approved
Sam Cables & Conductors (P) Ltd.,	Submit cedentials
DELTON CABLES LTD.	Approved
GEMSCAB INDUSTRIES LTD.	Submit cedentials
SPECIAL CABLES PVT. LTD.	Submit cedentials
NICCO CORPORATION LTD.	Submit cedentials
POLYCAB WIRES PVT. LTD.	Approved
Havells India Limited	Approved
CMI LTD.	Submit cedentials
APAR INDUSTRIES LIMITED,	Approved

		KRISHNA ELECTRICAL INDUSTRIES LTD.	Not approved
		Diamond Power Infrastructure Ltd	Not approved
		CORDS CABLE INDUSTRIES LTD.	Approved
		SPM POWER & TELECOM PVT. LTD,	Submit cedentials
		GUPTA POWER INFRASTRUCTURE LIMITED,	Approved
		THERMO CABLES LTD.	Approved
		SUYOG ELECTRICALS LTD.	Approved
		MANSFIELD CABLES COMPANY LTD.	Approved
12	LT XLPE FIRE SURVIVAL CABLES	CORDS CABLE INDUSTRIES LTD.	Approved
		APAR INDUSTRIES LIMITED,	Approved
		KEI INDUSTRIES LTD.	Approved
		POLYCAB WIRES PVT. LTD.	Approved
13	LT XLPE POWER CABLE	KEI INDUSTRIES LTD.	Approved
		POLYCAB WIRES PVT. LTD.	Approved
		HAVELLS INDIA LTD.	Approved

KRISHNA ELECTRICAL INDUSTRIES LTD.	Not approved
KEC INTERNATIONAL LIMITED	Approved
Scot Innovation Wires and Cables Pvt. Ltd.	Submit cedentials
PARAMOUNT COMMUNICATIONS LTD.	Approved
SPECIAL CABLES PVT. LTD.	Submit cedentials
RAVIN CABLES LIMITED	Approved
APAR INDUSTRIES LIMITED,	Approved
MANSFIELD CABLES COMPANY LTD.	Approved
CORDS CABLE INDUSTRIES LTD.	Approved
TORRENT CABLES LTD.	Approved
Diamond Power Infrastructure Ltd	Not approved
SRIRAM CABLES PVT. LTD.	Submit cedentials
SUYOG ELECTRICALS LTD.	Approved
THERMO CABLES LTD.	Approved
GEMSCAB INDUSTRIES LTD.	Submit cedentials

		GUPTA POWER INFRASTRUCTURE LIMITED,	Approved
		Govind Cable Industries,	Submit cedentials
		CRYSTAL CABLE INDUSTRIES LTD.	Submit cedentials
14	MS ROD FOR BELOW GROUND EARTHING	STEEL AUTHORITY OF INDIA LTD.	Approved
		RASHTRIYA ISPAT NIGAM LIMITED	Approved
15	NEUTRAL GROUNDING RESISTOR	S.R.NARKHEDE ENGG.PVT.LTD.	Submit cedentials
		RSI SWITCHGEAR PVT. LTD.	Approved
		LACHHMAN ELECTRONICS	Approved
		RESITECH ELECTRICALS PVT.LTD.	Approved
		AMP CONTROL EQUIPMENTS PVT. LTD.	Approved
16	OIL FILLED SERVICE TRANSFORMER	ESENNAR TRANSFORMERS (P) LTD.	Submit cedentials
		DANISH PRIVATE LIMITED	Submit cedentials
		SOUTHERN POWER EQUIPMENT COMPANY PVT. LTD.	Submit cedentials
		Tesla Transformers Ltd.,	Approved
		KANO HAR ELECTRICALS LTD.	Submit cedentials

		EMCO LIMITED	Approved
		MARSONS LIMITED	Submit cedentials
		UNIVERSAL POWER TRANSFORMERS PVT. LTD.,	Submit cedentials
		SCHNEIDER ELECTRIC INFRASTRUCTURE LIMITED	Approved
		TECHNICAL ASSOCIATES LTD.,	Submit cedentials
		KRYFS Power Components Ltd. ,	Submit cedentials
		VOLTAMP TRANSFORMERS LTD.	Approved
		TRANSFORMERS and RECTIFIERS (INDIA) LTD.	Approved
17	PA SYSTEM	Hi-Tech audio Systems Pvt. Ltd	Approved
		KARTHIK ENGRS. and CONSULTANTS PVT. LTD.	Approved
		CHASHMITA ENGINEERS PVT. LTD.	Approved
		BYTE COMMUNICATIONS PVT.LTD.	Submit cedentials
		INDUSTRONIC INDUSTRIE-ELECTRONIC GmbH & CO KG	Submit cedentials
		POWER SYSTEMS	Approved
18	SCREENED CONTROL CABLES	THERMO CABLES LTD.	Approved

	CABLES	PARAMOUNT COMMUNICATIONS LTD.	Approved
		KEI INDUSTRIES LTD.	Approved
		ELKAY TELELINKS LTD.	Approved
		POLYCAB WIRES PVT. LTD.	Approved
		MANSFIELD CABLES COMPANY LTD.	Approved
		NICCO CORPORATION LTD.	Approved
		SUYOG ELECTRICALS LTD.	Approved
		DELTON CABLES LTD.	Approved
		CMI LTD.	Submit cedentials
		SPECIAL CABLES PVT. LTD.	Submit cedentials
		TC COMMUNICATION PVT. LTD.	Submit cedentials
		CORDS CABLE INDUSTRIES LTD.	Approved
19	STATION LIGHTING SYSTEM	BAJAJ ELECTRICALS LTD.	Approved
		M/s.Crompton	Approved
			Approved
			Approved

		SPACEAGE SWITCHGEARS LTD.	Submit cedentials
		TECHNO ELECTRIC and ENGG. CO. LTD.	Submit cedentials
		MIKA ENGINEERS,	Not approved
		AVAIDS TECHNOVATORS PVT. LTD.	Approved
20	TREFOIL CLAMPS	SUMIP COMPOSITES PVT.LTD.	Submit cedentials
		ELECTROMAC INDUSTRIES	Submit cedentials
		AJMERA INDUSTRIAL & ENGINEERING WORKS	Approved
		MOULDED FIBREGLASS PRODUCTS	Approved

1394217/2023/PS-SR-PM

**SPECIFIC TECHNICAL REQUIREMENT****STACK ELEVATORS**

SPECIFICATION NO. PE-TS-Q11-503-A-001

VOLUME II B

SECTION C

SUB-SECTION A6

REV. 0

SHEET 1 of 5


**SECTION - C**  
**SUB SECTION – A6**

**STACK ELEVATORS**



<div>PE-TS-Q11-503-A-001</div> <div><div>बीएचईल</div><div>BHEL</div></div>	SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION NO. PE-TS-Q11-503-A-001	
		VOLUME II B	
		SECTION C	SUB-SECTION A6
		REV. 0	
		SHEET 2 of 5	
1.	SYSTEM DESCRIPTION		
1.1	The Rack and pinion type stack elevator is required for installation inside multi-flue or outside single flue chimney. The stack Elevator is normally used for the movement of the maintenance personnel and for materials such as refractory bricks, etc. for maintenance of chimney.		
2.	SCOPE OF SUPPLY AND SERVICES		
2.1	The scope of supply and services covered under the specification are broadly described below:		
2.1.1	One No. Rack and Pinion type stack elevator complete with all other accessories and associated steel work.		
2.1.2	Drive motor and control panel for Stack elevator		
2.1.3	Control Panel		
2.1.4	Equipment earthing		
2.1.5	All power and control cables, trailing cables		
2.1.6	Limit switches		
2.1.7	Over speed governor		
2.1.8	Alarm push button in the cage connected to battery operated alarm at elevator base.		
2.1.9	Reverse phase relay connected to prevent operation of the cab with improper phase rotation or failure in any phase of power supply.		
2.1.10	Continuous duty electrical torque motor recoil cable reels or cable trolley or any equivalent arrangement to maintain electrical power service to all electrical components of the elevator for complete travel of stack elevator.		
2.1.11	One auxiliary panel shall be provided and mounted on the graded level enclosure equipped with a main ON-OFF selector switch, main contactor, breaker, relays, control transformer and fuses, tone frequency transmitter or equivalent arrangement, , terminal blocks and all other accessories required for normal operation of the elevator.		
2.1.12	One main control panel shall be furnished and mounted on top of the cab. Panel shall be in enclosure equipped with necessary equipment like rectifier, battery charger, tone frequency receiver, contactors, breakers, control transformer and fuses, thermal overload relays, and all other equipment and accessories required for normal operation of the elevator.		
2.1.13	Cab shall be controlled by semi-automatic floor selection control system. Cab shall be furnished with 240 V grounding receptacle, emergency alarm push button with normally open contact, indicating light, limit switches, and all other necessary control devices required to ensure safe and continuous cab operation. One trailing cable shall connect the main control panel to aux. Panel at ground level. Cable shall supply the cab necessary power supply requirements. Cable guides shall be installed at every 6 m intervals to avoid entanglement of this cable. Control signal between the aux. Panel at ground level, the main control panel on the cab and the landings shall be provided with tone frequency receiver or any other equivalent arrangement by trailing control cable.		

<div>PE-TS-Q11-503-A-001</div> <div><div>बीएचईएल</div><div>BHEL</div></div>	SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION NO. PE-TS-Q11-503-A-001	
		VOLUME II B	
		SECTION C	SUB-SECTION A6
		REV. 0	
		SHEET 3 of 5	
2.1.14	Each landing assembly shall include a limit switch and push button control station installed and wired to a landing junction box.		
2.1.15	All power cable and race way shall be provided and installed by the bidder for interconnection of the main control panel, auxiliary panel and landing junction boxes. Trailing cables shall be as per relevant IS/IEC standard.		
2.1.16	Bidder shall provide, install and connect a system equipment ground to owner's chimney grounding system. Equipment grounding system shall electrically connect panels and junction boxes which contain electrical devices, motors and elevator platform and structures. Raceway system shall not be considered as an equipment ground.		
2.1.17	All enclosures containing electrical devices shall be provided with 240 V, single phase heaters with adjustable thermostat control.		
2.1.18	Cab shall be equipped with a 240 V AC interior light and duplex outlet.		
2.1.19	Cable accessories as required to install the cables in bidder's scope shall be provided by the bidders.		
2.1.20	Complete erection, testing and commissioning including all erection materials, consumables and other tools and tackles required for erection along with commissioning spares.		
2.1.21	All inserts, anchor bolts, sleeves, anchoring steel and any other items required to complete the job satisfactorily shall be in bidder's scope.		
2.1.22	First fill of lubricant and consumables shall be in bidder's scope.		
2.1.23	Satisfactory running and maintenance of elevator for a continuous period of 30 days including training of owner's operators.		
2.1.24	Supply of One complete set of special maintenance tools and tackles shall be in bidder's scope.		
2.1.25	Any other equipment or accessories not specified, but required for the satisfactory operation of chimney elevator shall be in bidder's scope.		
2.1.26	Recommended spares including instrumentation for 3 years of normal operation of stack elevator. ( List to be furnished by the bidder and for which order shall be placed separately by owner as per their requirements)		

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<b>3.</b>	<b>SPECIFIC REQUIREMENTS</b>
3.1	The equipment supplied, erected and commissioned shall meet the technical requirements of respective Section –D and Data Sheet-A.
3.2	Bidder shall note that all QP and Field quality plans shall be subject to purchaser’s approval.
3.3	All equipment offered shall have suitable provision of termination and connection of power and control cables inclusive of cable boxes, lugs and glands, etc.
3.4	All the equipment shall be suitable for the power supply fault level and other climatic conditions as indicated in project information.
3.5	The bidder shall guarantee the rating and performance parameters of the system/equipment offered in accordance with specification requirements.
3.6	It is the responsibility of bidder to arrange license for operation of chimney elevator from statutory body of that area before handing over.
3.7	Bidder shall furnish deviation (clause wise) in the deviation schedule. In absence of dully filled deviation list, it will be presumed that offer is exactly in line with the technical specification.
3.8	Bidder shall furnish duly filled data sheet –B along with the offer. In absence of same, offer shall be treated as incomplete.
3.9	Bidder shall offer the stack elevator considering prevailing statutory and regulatory requirements of project location.
3.10	Bidder shall indicate degree of protection of various electrical equipment in the offer.
3.11	Makes of all bought out items shall subject to purchaser’s approval after award of contract.
3.12	All drawings/documents shall subject to purchaser’s approval after award of contract.
3.13	Please refer/ comply customer/ specification ( <i>rack &amp; pinion type elevator</i> CHAPTER: 20 Page no. Vol-III-713 TO Vol-VI-98)



## SPECIFIC TECHNICAL REQUIREMENT

## STACK ELEVATORS

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## DATA SHEET

1	Designation Elevator	:	Rack and Pinion type Stack
2	Type of loading	:	Passenger/goods
3	Quantity	:	As per project requirement
4	Carrying Capacity	:	400 Kg
5	Operating Speed	:	0.7 m/min (Approx)
6	Dimension of lift and lift well/cut out	:	As per IS:3534
7	No. of landings	:	Eight (8) nos. including ground. (0.0 m, 35m, 70m, 105m, 145m, 185m, 225m, and 265m)
8	Total vertical travel	:	265m.
9	Electrical power supply system	:	415 V, 3 ph, 3 wire, 50 Hz
10	Other accessories	:	As required

## CHAPTER 20

**20.0 ELEVATORS****20.1 Scope**

20.1.1 Scope covers design, engineering, fabrication, installation, commissioning and testing of elevators listed below.

20.1.2 The required equipment and services shall be as described below:

20.1.2.1 One (1) no. rack & pinion type stack elevator of <sup>400</sup>~~500~~ kg capacity complete with all other accessories and associated steel works for 275 m high **chimney**.

20.1.2.12 Electrical equipment such as motors, starters, switches, switch gears, control panels, interlocks, control & power cabling and earthing of electrical equipment.

20.1.2.13 Any other equipment or accessories not specified here in but required for the satisfactory and safe operation of the Elevator shall also be included in scope of work.

**20.2 Rack & Pinion Elevators****20.2.1 Design Criteria for Rack & Pinion Elevators**

20.2.1.1 Elevator shall be located outside the RCC stack, ~~Crusher house CRH-1, TT-5 & JTB-5 and~~ shall be capable of operating from the ground floor to the top interior platform with intermediate stops at all interior platforms.



- 20.2.1.2 All mechanical and electrical operating devices and trailing cable shall be designed for operation indoors with dusting and high humidity conditions and shall operate equally well in any ambient temperature from 75°C to 10°C. Additionally, all mechanical and electrical components of the elevator shall be designed to withstand without damage a temperature of 100°C when the elevator is not operating.
- 20.2.1.3 Elevator shall be attached to the chimney shell using anchor bolts supplied and installed into the chimney shell by the contractor.
- 20.2.1.4 Design and Operational Requirements
- 20.2.1.4.1 Design and operation of the stack elevator shall comply with the following requirements:
- |       |  |   |   |
|-------|--|---|---|
| i.    | Carrying capacity (kg)                         | : | 400 (minimum)   |
| ii.   | Operating speed (m/min)                        | : | 40  |
| iii.  | Cab floor size (inside) (mm)<br>width x length | : | 1100x1100 (minimum)   |
| iv.   | Landing levels (Nos.)                          | : | Minimum 22 (at all internal<br>platform levels) (landing platform<br>shall be provided) |
| v.    | Landing elevations                             | : | As per requirement  |
| vi.   | Total vertical travel (m)                      | : | 275.0   |
| vii.  | Electrical power supply<br>system              | : | 415 Volts, 3 phase, 50 Hertz  |
| viii. | Type of loading                                | : | Passenger cum goods   |



**20.2.2 Equipment Specifications for Rack & Pinion Elevators****20.2.2.1 Enclosures**

A three-sided enclosure with one access door shall be provided for ground landing. At each platform landing above ground level, a one-sided enclosure with access door shall be provided. Enclosures shall be fabricated from tubular steel and expanded metal or wire mesh of suitable height and primer coated with coats of the manufacturer's standard primer and finish paint. The ground landing shall be provided at a suitable height above the foundation slab to ensure a safety space underneath the cage. The space under the landing shall be surrounded by foundation enclosure. The staircase, bolted to the door front, shall be provided for access to the cage. Enclosure access doors shall be electrically and mechanically interlocked so that they remain closed and locked except when the cab is at a landing. Doors shall be bi-parting and swinging.

Base of the three sided enclosure shall be securely anchored to the ground level floor slab using expansion type anchors.

**20.2.2.2 Mast**

Mast shall be provided in flat sections of suitable length, consisting of tubular sections and/or structural shapes welded together to form a frame work to which the rack is bolted. Mast shall be securely anchored to the concrete chimney walls.

**20.2.2.3 Cab**

- a. Cab frame shall be fabricated from tubular steel and enclosed with expanded metal or wire mesh.
- b. Cab floor shall be of skid resistant chequered plate or fibreglass reinforced plywood or approved equivalent. Cab shall be attached to a framed structure and form an integral part with the drive mechanism located atop the cab.
- c. Framed structure shall include guide rollers and safety hooks to ensure positive engagement of the rack and pinions to prevent cab disengagement in case of roller failure.
- d. Cab roof shall be provided with an escape hatch electrically interlocked with the hoist control system. Tubular steel handrail shall enclose the cab roof for maintenance operations.
- e. Cab door and landing level enclosure doors shall be electrically and mechanically interlocked to prevent the cab from being operated unless the cab door and landing level enclosure doors are fully closed and to prevent the doors from being opened while the cab is in motion.

**20.2.2.4 Drive Units & Safety Device**

- a. Drive unit shall be located on top of the cab. It shall be a compact with pinion engaging into the rack of the mast. The pinion shall be mounted on a key joint & fitted to the secondary shaft of the worm gear which shall be driven by a AC squirrel cage induction motor.

Drive unit shall incorporate an Electro Hydraulic Thruster (EHT) type brake and an external manual brake release. The mechanical compression spring shall be held off by hydraulic pressure. This hydraulic pressure shall be



provided by EHT brakes. In the event of power failure, the brake shall be automatically applied & will stop the cab. The brake shall be of self adjusting type and released by means of a special handle provided in the cab.

- b. A safety device shall be provided in conjunction with the drive unit & shall have a separate flame hardened steel pinion engaging in the rack. The device shall be actuated by centrifugal weight & stops the hoist smoothly in case the normal travelling speed exceeds. The safety device shall remain locked on following this action & has to be manually reset before normal elevator operation can be resumed. For testing the safety device, the hoist shall be provided with a remote control facility. Bidder shall ensure that no person is in cab during the test.
- c. The hoist shall be provided with a centrifugal brake to prevent accidental tripping of the safety device when the cage shall be taken to the ground by gravity in case of power failure. The motor brake shall be released mechanically by a lever in the cage to allow the cage to move down. The centrifugal brake shall keep the preset speed lower than the tripping speed.

## 20.2.2.5

**Power and Control**

All electrical components furnished with the elevator shall be completely wired, energized and checked as part of the work.

All electrical control devices shall be in enclosures. Equipment furnished shall also include the following:

- a. Momentary contact push button for raise/lower control.
- b. Reversing combination motor starter with a three phase thermal overload relay for motor protection. However, the control circuit in the elevator will have miniature circuit breakers.
- c. Electric and mechanical interlocks on cab access door and landing level enclosure doors.
- d. An ultimate three phase over travel limit switch, which cuts off power and control supply in the event of over travel. The switch can also be manually turned to off position.
- e. Safety devices as described above.
- f. An alarm push button shall be provided in the cage. Alarm signal will be transferred to elevator base by means of alarm facility incorporated within the tone frequency equipment.

The auxiliary panel at the base will have battery and battery charger for the alarm horn. In case the bidder does not have tone frequency equipment the alarm push button shall be connected to a battery operated alarm at the elevator base.

- g. Reverse phase relay connected to prevent operation of the cab with improper phase rotation or failure in any phase in the power supply.
- h. The cable shall be supported by brackets on the cage and guide rails. A cable trolley will keep it in the tension and will be guided on the same rail as the cage. The traveling cable shall run through cable guides.





- i. One auxiliary panel shall be furnished and mounted on the ground level enclosure. Panel shall be in enclosure equipped with a main "ON-OFF" selector switch, main contactor, relays, control transformer and MCB's, tone frequency transmitter, terminal blocks, and all other accessories required for normal operation of the elevator.
- j. One main control panel shall be furnished and mounted on the top of the cab. Panel shall be in enclosure equipped with necessary equipment like rectifier, battery, battery charger, tone frequency receiver, contactors, breakers, control transformer and MCB's, thermal overload relays and all other equipment and accessories required for normal operation of the elevator.
- k. Cab shall be controlled by a semi-automatic control system with push buttons for 'UP', 'Down' and 'Stop next landing'. Cab shall be furnished with grounding type receptacle, emergency alarm push button with a normally open contact rated one ampere at 1 volts Dc, indicating light, limit switches, and all other necessary control devices required to ensure safe and continuous cab operation. One trailing cable shall connect the cab main control panel to the auxiliary panel at ground level. Cable shall supply the cab with all power requirements. Multicore cables shall be used and installed in accordance with latest applicable IS or equivalent international standards. Cable guides shall be installed every 6 metres to avoid entanglement of this cable. Control signals between the auxiliary panel at ground level, the main control panel on the cab, and the landings shall be provided with the tone frequency receiver. However, tone frequency receiver system is not available, system with trailing control cable is acceptable.
- l. Each landing assembly shall include a limit switch and push button control station installed and wired to a landing, junction box.
- m. Cab shall be equipped with a 220 volt AC interior light & duplex outlet



**20.3.5 Elevator Electrical****20.3.5.1 Electric Motor**

- The driving motors shall conform to IS 325 and suitable for variable voltage variable frequency (VVVF) application. All motors shall be squirrel cage induction type, suitable for operation at 415 V(+/- 10% variation), 3 phase, 3 wire 50 HZ (+3 % to -5% variation) supply. Motors shall be provided with class F Insulation.

**20.3.5.2 Controls**

The controls shall be variable voltage and variable frequency type and shall provide smooth and constant acceleration and retardation under all conditions of operation. Suitable control shall be provided in the machine room.

**20.3.5.3 Cables & Wiring**

All the cables except trailing cables shall be as per IS 1554-1 or IS 7098-1. The PVC outer sheath of these cables shall be flame retardant, low smoke (FRLS) type with the following FRLS properties.

1. Oxygen index of min 29 (as per IS:10810 Part 58).
2. Acid gas emission of max 20% (as per IEC 754-1)
3. Smoke density rating shall not be more than 60% (as per ASTM D-2843)

The circular trailing cables shall be either in accordance with IS 4289 Part-I (elastomer insulated) or IS 4289 Part II (PVC insulated). The flat type trailing cables if offered shall be in accordance with IEC 60227-6.

All wiring/ cabling between the equipments in the lift machine room and that between the machine room and equipments in the lift well and at the landings shall be wired in HDP conduits/ galvanized steel conduits to be supplied by the contractor. Alternatively armored cables may be used.

**20.3.5.4 Earthing**

The elevator structures and all equipment including metal conduits shall be effectively earthed with earth conductors provided in the machine room as per IS 3043.



**12.08.11****Lift**

Lift shall be provided for the chimney inside the wind shield. The lift shall be of open cage type and suitable for corrosive and dusty atmosphere that generally exists in thermal power stations/industrial complexes. It shall generally confirm to the provisions of IS:1860 and IS:4289 unless otherwise specified.

The lift shall have a minimum carrying capacity of 400 kg at a speed of 0.70 metre per second. The lift shall be of rack and pinion driven service type of approved make.

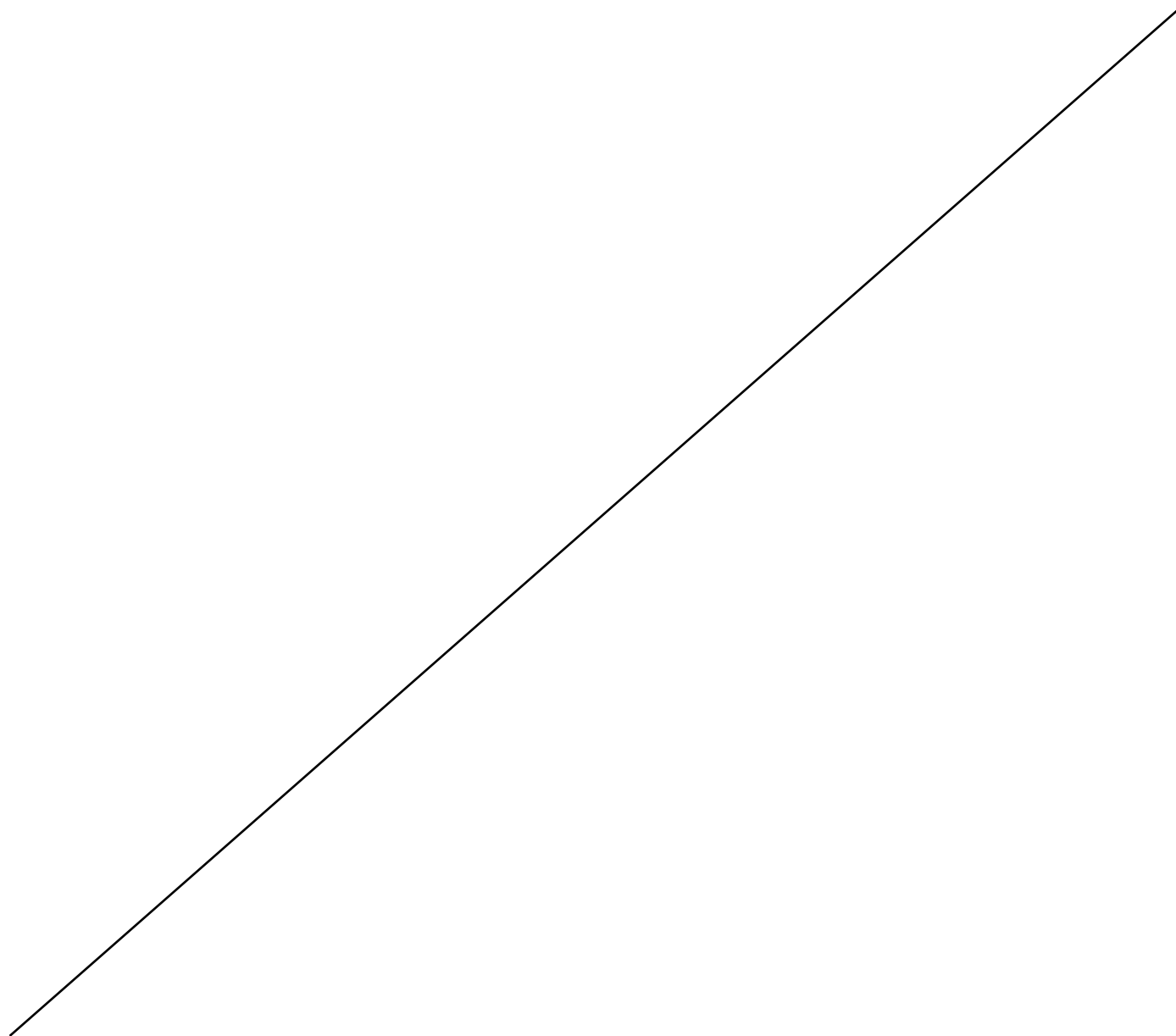


All the control devices inside the car shall be housed in a dust free and water proof enclosure. Only copper conductor FRLS insulated armoured cable of suitable size shall be included in BIDDER's scope.

Landing at all locations of platforms shall be provided unless otherwise specified in Data Sheet-A.


Construction of guard cage and supply of other accessories required for satisfactory and safe operation of lift shall be included in BIDDER's scope. BIDDER shall also supply and install safety devices such as automatic stop equipment, over speed governor etc. all complete as per Manufacturer's recommendation.


All the embedments for the lift structure, approach platforms at landing levels and the lift supporting structure including lift car shall be hot dip galvanized.



2 x 660 MW Ennore SEZ Supercritical Thermal  
Power Project at Ash Dyke of NCTPS  
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1.

DESIGN AND CONSTRUCTION

1.1

Stack Elevator - General

1.1.1

The stack elevator including mechanical and electrical components shall be installed outside/inside Single flue/ multi flue chimney. Since chimney is a free standing structure, deflection of chimney top is expected during the normal operation, so the design of the elevator shall be in such a way that the elevator operation will be safe even with the expected maximum deflection of the chimney structure. The stack elevator shall lift a pay load as indicated against rated load as mentioned in Data sheet-A or its nearest as per manufacturer’s present standard in addition to the weight of the car and its accessories and shall travel at a rated speed as indicated in the data sheet-A. Travel of the elevator car, number of landings and levels shall be as per Data sheet-A attached to this section.

1.1.2

Stack elevator mechanical and electrical operating devices and trailing cable shall be designed for operation indoors/out door with dusty and high humidity conditions and shall operate equally well in any ambient temperature encountered in the site conditions. Additionally, all mechanical and electrical components of the elevator shall be designed to withstand without damage a temperature of 100°C when the elevator is not operating.

1.1.3

Cage earthing shall be done through trailing cable.

1.1.4

Stack elevator shall be attached to the chimney shell using expansion type anchor bolts drilled in to chimney shell. Elevator shall be capable of operating from the ground floor to the top platform with intermediate stops at all platforms. Landing for elevator parking shall be one (1) metre above the stack ground floor. Suitable concrete/brick steps leading to the landing for entry to cabin shall also be provided,

1.1.5

The stack elevator shall be designed in line with recommendations contained in the latest editions of the applicable codes and standards.

1.2

Equipment Specification

1.2.1

Enclosures

i.

A three-sided enclosure with one access door shall be provided at graded level. At each platform landing above graded level, a one sided enclosure with access door shall be provided. Enclosures shall be fabricated from tubular steel and expanded metal or wire mesh, 2.1 m high and one coat of epoxy primer coated. Enclosure access doors shall be electrically and mechanically interlocked so that they remain closed and locked except when the Cab is at the landing. Doors shall be bi-parting and swinging type.

ii.

Base of three-sided enclosure shall be securely anchored to the grade level floor slab using expansion type anchors.

1.2.2


Mast

i.

Mast shall be provided in sections approximately 1.52 m in lengths considering of tubular sections and/or structural shapes welded together to form a frame work to which the rack is bolted. Mast shall be securely anchored to the concrete chimney walls.

1.2.3

Cab


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		<p>i. Cab frame shall be fabricated from tubular steel and enclosed with expanded metal or wire mesh.</p> <p>ii. Cab floor shall be of skid resistant glass fibre reinforced plywood or approved equal. Cab shall be attached to a framed structure and form integral part with the drive mechanism located atop the cab.</p> <p>Framed structure shall include guide rollers and safety hooks to ensure positive engagement of the rack and pinion to prevent cab disengagement in case of roller failure.</p> <p><b>1.2.4 Buffers</b></p> <p>i. Sufficient numbers of buffers of spring loaded/hydraulic type shall be fitted below the cab. The buffers shall be capable of stopping the cab without permanent damage or deformation to themselves or any other part of the equipment. The number of buffers shall be so fixed as to ensure proper sharing of impact loads by all of them.</p> <p><b>1.2.5 Drive unit and safety Device</b></p> <p>i. Drive unit located on the top of the cab shall be complete with Ac squirrel cage induction motor, reduction gear, drive pinion and an over speed governor. Drive unit shall incorporate an electric disc brake and an external manual brake release. The brake on the electric motor will be of the electromagnetic single disc self-adjusting type with the mechanical compression spring being held off by the electromagnet.</p> <p>ii. The hoist shall be provided with a centrifugal brake to prevent accidental tripping of safety device when the cage shall be taken to the ground by gravity in case of power failure.</p> <p><b>1.2.6 Power and Control</b></p> <p>i. All electrical components furnished with the elevator shall be completely wired, energised and checked. Necessary power distribution arrangement shall be provided by the contractor to feed the electrical power to the elevator.</p> <p>ii. All electrical control devices shall be in enclosures. Equipment furnished shall also include the following:</p> <ol style="list-style-type: none"> <li>Momentary contact push button for raise lower control.</li> <li>Reversing combination motor starter with a moulded case circuit breaker for the motor. Starter shall be equipped with three thermal overload relays for motor protection. Operating handle for the combination starter circuit breaker shall be accessible from inside the cab and shall also serve as an emergency stop switch.</li> <li>Electrical and mechanical interlocks on cab access door and landing level enclosure doors.</li> <li>Over travel protection, emergency stop push button, over speed governors.</li> <li>All electrical and mechanical interlocks on cab access door and landing level enclosure doors, phase reversal protection shall be provided.</li> <li>An alarm push button shall be provided in the cage connected to a battery-operated alarm at the elevator base. Simultaneous alarm shall also sound at the plant control room in the event of any fault in the stack</li> </ol>	

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<p>elevator for which one potential free contact shall be provided in each elevator for audiovisual alarm in PCR for “Stack Elevator fault” indication.</p> <p>g) Reverse phase relay connected to prevent operation of the cab with improper phase rotation or failure in any phase in the power supply.</p> <p>h) Continuous duty electric torque motor recoil cable reels as required to maintain electrical power service to all elevator electrical components throughout the limits of travel.</p> <p>i) One auxiliary panel shall be furnished and mounted on the grade level enclosure. Panel shall be equipped with a main ‘ON-OFF’ isolating switch, main contactor, relays, control transformer and fuses, tone frequency transfer, terminal blocks and all other accessories required for normal operation of the elevator.</p> <p>j) One main control panel shall be furnished and mounted on the top of the cab. Panel shall be equipped with necessary, equipped like rectifier, battery, charger, tone frequency receiver, contactors, MCBs, control transformer and fuses, thermal overload relays, and all other equipment and accessories required for normal operation of the elevator.</p> <p>k) Control cabinets shall be sheet steel enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be cold rolled and at least 2.0 mm thick and properly braced to prevent wobbling. Degree of protection of the control cabinets shall be IP-52 as per IS:2147. Control cabinets shall be provided with hinged door(s) with padlocking arrangement. All doors, removable covers and plates shall be gasket all around with neoprene gaskets, louvers, when provided, shall have screeners and filters. The screens shall be of fine wire mesh made of brass or GI wire. Suitable cable gland plate shall be supplied fitted on to this gland plate. All cable glands shall be screwed on type and made of brass.</p> <p>l) Each motor to be controlled from the control cabinet shall be provided with 3 pole isolating switch. HRC fuses, contactors of AC4 duty class with thermal overload relays with single phasing preventer and other equipment required for satisfactory control motor. The isolating switch and contractor shall be rated at least 20% more than the connected motor full load current. Motors of 0.2 KW and above shall be rated for 415 V 3 Phase and below 0.2 KW will be 240 V single phase supply.</p> <p>m) The controllers and resistors for motors shall conform to IS-8544 (latest edition) and IS-2959 (latest edition) and shall be continuously rated for 150% full load current of the motor. Switches shall be hand operated, air breaker heavy duty, quick make, quick break type conforming to IS-4064. The rating of switch shall be so chosen as to get complete protection by associated O/L relay or fuse under all normal / abnormal conditions such as full load, overload, locked rotor, short circuit. The incoming power supply isolating switch shall be inter-locked with the control cabinet door so as to prevent opening of the door when the switch is closed. Device for bypassing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.</p>			



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<div><div>n)</div><div>All fuses shall be of the HRC cartridge type mounted on plug in type of fuse base having a prospective current rating of not less than 80 KA. Fuses shall be provided with visible operation indicators to show that they have operated. All accessible live connections shall be adequately shrouded and it shall be possible to change fuses with the circuit alive without danger of contact with live metal.</div></div> <div><div>o)</div><div>Contractor shall provide dry type transformers with class B insulation for control power supply, lighting and space heating. Control supply will be 240 V AC. Transformer for control supply shall be provided with a control tap at 110 V, which will be earthed. Power and control supply to individual drives and users shall be distributed with separate isolating switches and primary and secondary fuses.</div></div> <div><div>p)</div><div>All push buttons shall be of push to actuate type having 2 “NO” and 2 “NC” self reset contacts. They shall be provided with integral escutcheon on plate engraved with their functions. Push button contacts shall be rated for 5 Amp at 415 V AC and 1 Amp. Inductive breaking at 250 V, DC. Mushroom type emergency push button to open the main contactor shall be provided in the operator’s cabin and two on the bridge platform within easy reach indicating lamps shall be of the filament type and low watt consumption lamps shall be provided with series resistors.</div></div> <div><div>q)</div><div>Strip type space heaters of adequate capacity shall be provided inside in each cabinet.</div></div> <div><div>r)</div><div>Control cabinets shall be supplied completely wired. All wiring shall be carried out with 650 V grade PVC insulated, stranded conductors. Power circuits shall be wired with stranded aluminum conductors of adequate sizes to suit the rated circuit shall be wired with stranded copper conductors of sizes not small than 1.5 Sq.mm. Control circuits shall be isolated from power circuits.</div></div> <div><div>s)</div><div>Cab shall be controlled by a semi-automatic floor selection control system. Cab shall be furnished with 240 Volt grounding type receptacle, emergency alarm push button with a normally open contact rated 0.5 ampere at 220 VDC volts, indicating light, limit switches, and all other necessary control devices required to ensure safe and continuous cab operation. One trailing cable shall connect the cab main control panel to the auxiliary panel at ground level. Cable shall supply the cab with all power requirements. Cable guides shall be installed at every 6 metres to avoid entanglement of this cable. Control signals between the auxiliary panel at ground level and the main control panel on the cab. Will be provided with the tone frequency receiver. However control and interlocks from the landings shall be connected to the auxiliary panels located at ground level through fixed armoured cables. The power and control cables and training power cables shall be FRLS type.</div></div> <div><div>t)</div><div>Each landing assembly shall include a limit switch for door interlock and push button control station installed and wired to a landing junction box.</div></div> <div><div>u)</div><div>Cable trolley with cable guides for recoil of cable on to cable reel to maintain electrical power service to all elevator components through out the limits of travel.</div></div>			

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	<b>TECHNICAL SECIFICATION</b>  <b>STACK ELEVATOR</b>	<b>SPECIFICATION NO. PE-SS-EPC-503-A-001</b>	
		<b>VOLUME II B</b>	
		<b>SECTION D</b>	<b>SUB-SECTION A6</b>
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shall be sealed and gasketted. Outdoor fittings shall be of heavy cast construction.

1.2.9 PVC Insulated FRLS Cable

i. Materials

a) Electrical part of this specification shall be referred for FRLS cable. Unless specified otherwise, Contractor shall submit to the Engineer-in-Charge four copies of the manufacturer's test report on each cable furnished. Conductor accessories including terminal materials like glands, lugs etc. makers, tying materials and cable support shall be furnished and installed. Wire termination materials for conductors 10 Sq. mm and larger shall be pressure or bolted type. Terminals for conductors smaller than 10 Sq. mm shall be an insulated pressure connection in the shape of a ring.

ii. Installation

a) Power and control cable shall be routed as required by the drawings. Cables pulled into the wrong conduit or cut too short shall be replaced. Cables removed from one conduit shall not be installed in another conduit.

1.2.10 Earthing

i. General

a) Earthing system furnished and installed and include a complete earthing system for the elevator. Earthing equipment and materials shall be furnished and installed in accordance with the reference codes and standards these specification and the contractor's shop drawings as reviewed and accepted by the Engineer-in-Charge.

ii. Materials

a) The earthing of all electrical items being supplied by the Bidder shall be in his scope. For earthing the various equipment, conductor sizes shall be as listed below:

- MCCs Motor above 90 KW : 50 x 6 Sq.mm G.I. flat
- Motors above 30 KW, upto 75 KW and lighting panel/ control panels/auxiliary panels : 25 x 6 Sq. mm G.I. flat
- Motor above 5 KW upto 30 KW : 25 x 3 mm G.I. flat
- Motors upto 5 KW and misc. : 8 SWG GI wire
- Small item like conduits,
- Junction boxes etc


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## SUB-SECTION - A6

## STACK ELEVATORS

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## 1.01.00 ELEVATOR PARTICULARS

- i) Load Carrying Capacity in Kg
- ii) Type of loading for which the stack elevator is designed
- iii) Type of stack elevator
- iv) Rated Load in Kg
- v) Speed in metre/minute
- vi) Chimney height in metre
- vii) Total travel height in metre
- viii) No. of floors to be served
- ix) Elevations of the floors to be served
- x) Method of control
- xi) Details of indicators and control
- xii) Weight of cab complete without load in Kg
- xiii) Weight of hoist cab in Kg
- xiv) Efficiency of Elevator

## 1.02.00 GROUND ENCLOSURE


- i) Size of the enclosure  
(Length x breadth x height)
- ii) Material of construction
- iii) Size of landing entrance
- iv) Method of door operation
- v) Electrical & mechanical interlocking  
Of the door provided.
- vi) Method of fixing enclosure to chimney
- vii) Any other details not covered above

## 1.03.00 LANDING ENCLOSURES

- viii) Size of the enclosure  
(Length x breadth x height)

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- ix) Material of construction
- x) Size of landing entrance
- xi) Method of door operation
- xii) Electrical & mechanical interlocking  
Of the door provided.
- xiii) Method of fixing enclosure
- xiv) Any other details not covered above

## 1.04.00 MAST

- i) Material of mast
- ii) Section of mast
- iii) Size of each piece of mast
- iv) Method of fixing of mast
- v) Type of mast

## 1.05.0 CAB


- i) Internal size  
(Length x breadth x height)
- ii) Material of construction
- iii) Type of floor
- iv) Size of the cab door
- v) Method of operation of cab door
- vi) Electrical & mechanical interlocking provided
- vii) Escape hatch, electrically interlocked
- viii) Guide roller and safety hooks provided
- ix) Arrangement of light/fan inside the cab.
- x) Indicators & controls inside the cab.

## 1.06.00 ELEVATOR DRIVE UNIT

- i) Location of drive unit
- ii) Name of components of drive unit

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## 1.07.00 DETAILS OF ELECTRIC MOTOR


- i) Manufacturer
- ii) Equipment driven by motor
- iii) Type
- iv) Frame size, type & designation
- v) Maximum load considered for  
Sizing of motor
- vi) Margin considered for sizing motor
- vii) Rated power in KW
- viii) Service factor
- ix) Speed in rpm
- x) Rated voltage in V
- xi) Current at rated voltage
  - Full load
  - Locked rotor
- xii) Insulation class
- xiii) Type of bearing and type of lubricant
- xiv) Space heater rating
- xv) Duration considered for specified  
Ambient temperature
- xvi) Applicable standard to which motor conforms
- xvii) Degree of protection
- xviii) Efficiency at rated output
- xix) Power factor
- xx) Type of mounting

## 1.08.00 DETAILS OF REDUCTION GEAR

- i) Make
- ii) Material of the gears and hardness in BHN
- iii) Type of gear
- iv) Gear ratio

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v) Gear power transmitted

vi) Input and output speed

## 1.09.0 DETAILS OF DRIVE AND PINION

i) Material

ii) Hardness

iii) Fixing arrangement

## 1.10.0 DETAILS OF RACK

i) Material

ii) Hardness

iii) Fixing arrangement

## 1.11.00 SAFETY DEVICE

i) Make

ii) Type of safety device

iii) Speed at which the safety device  
Come into action

iv) Method operation

v) Other details

vi) Remote control for testing  
The safety device

## 1.12.00 BRAKES

i) Manufacturer

ii) Types of brakes provided

iii) Method of operation

iv) Interlocking if any


v) Electromagnetic brake and external  
Manual brake release

vi) Degree of protection

Name of Bidder / Vendor						
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## 1.13.00 CENTRIFUGAL BRAKE

- i) Make
- ii) Details
- iii) Remote control for testing  
The safety device provided.
- iv) Any other details of drive unit  
Not covered above.

## 1.14.00 BUFFERS

- i) No. and location of the buffers provided
- ii) Type of buffers
- iii) If the buffers are spring type  
Furnish the following:
  - Diameter of the spring in mm
  - Max. Compression under extreme cond.
  - No. of spring coil
  - Sectional dimension
  - Material of spring
  - Compression /unit load

## 1.15.00 POWER CABLES


Fixed

Trailing

- i) Manufacturer
- ii) Type and material
- iii) Rated voltage
- iv) Rated current
- v) Type of insulation
- vi) No. of strands
- vii) No. of cores
- viii) Short circuit current rating
- ix) Resistance per 1000 metres

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x) Applicable standards

#### 1.16.00 CONTROL CABLES

- xi) Manufacturer
- xii) Type and material
- xiii) Rated voltage
- xiv) Rated current
- xv) Type of insulation
- xvi) No. of strands
- xvii) No. of cores
- xviii) Short circuit current rating
- xix) Resistance per 1000 metres
- xx) Applicable standards

#### 1.17.00 CONDUITS/ACCESSORIES AND FITTINGS


- i) Material
- ii) Manufacturer
- iii) Applicable standard

#### 1.18.00 CONTACTORS

- i) Make
- ii) Type
- iii) Applicable standards
- iv) No. of poles
- v) Rated voltage
- vi) Rated frequency
- vii) Rated current
- viii) Closing coil
  - Rated voltage
  - Current consumption

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- Power consumption in KW
- Insulation class for electromagnet

## ix) Rated duty

- Rated insulation category
- No. of operations per hour
- Rated breaking capacity
- Rated making capacity
- Short time rating in sec

## ix) Limits of operation

- Supply voltage variations (%)
- Supply frequency variations (%)
- Drop out voltage (%)
- Min. pick up voltage (%)

## x) Thermal overload relay setting range available

## xi) Auxiliary contacts

- Numbers
- Current rating (Make and break)

## xi) Rated utilization category as per IS 2459


## xii) Max. recommended back up HRC fuse size

## 1.19.00 FUSES

- i) Make
- ii) Type
- iii) Continuous current
- iv) Rated voltage
- v) Rated frequency
- vi) Rupturing capacity
- vii) Mounting details
- viii) Fixing and removing arrangement
- ix) Visual indication for fuses
- x) Applicable standards

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## 1.20.00 INDICATING LAMPS

- i) Make
- ii) Type
- iii) Rated voltage
- iv) Rated power consumption in Watt
- v) Permissible voltage variation
- vi) Series resistance provided

## 1.21.00 PUSH BUTTONS

- i) Make
- ii) Type
- iii) Rating
  - Voltage
  - Continuous current
- iv) No. of aux. Contacts
  - Normally open
  - Normally closed
- v) Contact rating
- vi) Colours
- vii) Mounting arrangement

## 1.22.00 OVER TRAVEL LIMIT SWITCH


- i) Make
- ii) Type
- iii) Material of contacts
- iv) Contact rating
- v) Numbers furnished

## 1.23.00 CONTROL TRANSFORMER

- i) Make
- ii) Type
- iii) Output rating (VA)
- iv) Ratio

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

1394217/2023/PS-SR-PM

	Title		Spec. No.: PE-SS-EPC-503-A-001			
	STACK ELEVATOR		Volume III		SUB SECTION A6	
	DATA SHEET 'B'		Sheet	10	of	11

- v) Class of insulation
- vi) Max. temp rise of winding over  
Specified ambient temperature.
- vii) One minute power frequency test voltage
- viii) Applicable standards

#### 1.24.00 CIRCUIT BREAKER AND ISOLATOR

- i) Make
- ii) Type
- iii) Current rating in amps
- iv) Interruption duty
- v) Max. breaking capacity
- vi) Operating voltage of tripping and closing coils
- vii) Max. permissible variation of operating voltage

#### 1.25.00 RACEWAY


- i) Raceway as per specification
- ii) Material of
  - Indoor fittings
  - Outdoor fittings
  - Raceway support
  - Junction boxes

#### 1.26.0 EARTHING

- i) Earthing conductor
  - Size
  - Material
- ii) Material of earthing cable
- iii) Clamps. Bolts, washers, nuts and another  
Hardware of iron steel are galvanized.

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						

1394217/2023/PS-SR-PM

	Title		Spec. No.: PE-SS-EPC-503-A-001	
	STACK ELEVATOR		Volume III	SUB SECTION A6
	DATA SHEET 'B'		Sheet 11	of 11

## 1.27.00 MOTOR STARTER

- i) Make & Size
- ii) Rating]
- iii) Mechanically latched type
- iv) Single phase prevention feature provided
- v) Degree of protection

## 1.28.00 DETAILS OF CONTROL PANELS

- i) No. of panels
- ii) Type of enclosures (Degree of protection)
- iii) Thickness of sheet metal
- iv) Painting
  - Colour
  - Finish
- v) Cable entry
- vi) Manufacturer

Name of Bidder / Vendor						
Project						
Revision No.	0	1	2	3	4	5
Signature of Bidder / Vendor / Authorised Representative						
Date						







**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)
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 version)	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- 248H 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- <del>UPGRADED</del>	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
<b>I.</b>	<b>LIFTING EQUIPMENTS</b>	
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	ELCTRIC WINCH 5T	1270
6	ELCTRIC 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
<b>II</b>	<b>WELDING &amp; HEAT TREATMENT EQUIPMENT</b>	
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
<b>III</b>	<b>SERVICE PLANTS &amp; ALLIED EQUIPT.</b>	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 <sup>3</sup> /Hr)	1160
22	Air Blower (Flow: 20000 m <sup>3</sup> /Hr)	940
IV	<b>METAL FORMING /CUTTING EQUIPMENT</b>	
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	<b>TESTING/INSPECTION EQUIPMENT</b>	
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 $\Omega$	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)	1260
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	4060
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
<b>I.</b>	<b>LIFTING EQUIPMENTS</b>	
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	ELCTRIC WINCH 5T	1410
6	ELCTRIC 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
<b>II</b>	<b>WELDING &amp; HEAT TREATMENT EQUIPMENT</b>	
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
<b>III</b>	<b>SERVICE PLANTS &amp; ALLIED EQUIPT.</b>	
1	500KVA DIESEL GENERATOR	4220
2	TRANSFORMER OIL FILTERATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	7070
3	-DO- , WITH STORAGE TANK	8080
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	1010
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON OIL)	1510
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	2020
7	OIL FILTERATION 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
<b>IV</b>	<b>METAL FORMING /CUTTING EQUIPMENT</b>	
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
<b>V</b>	<b>TESTING/INSPECTION EQUIPMENT</b>	
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**

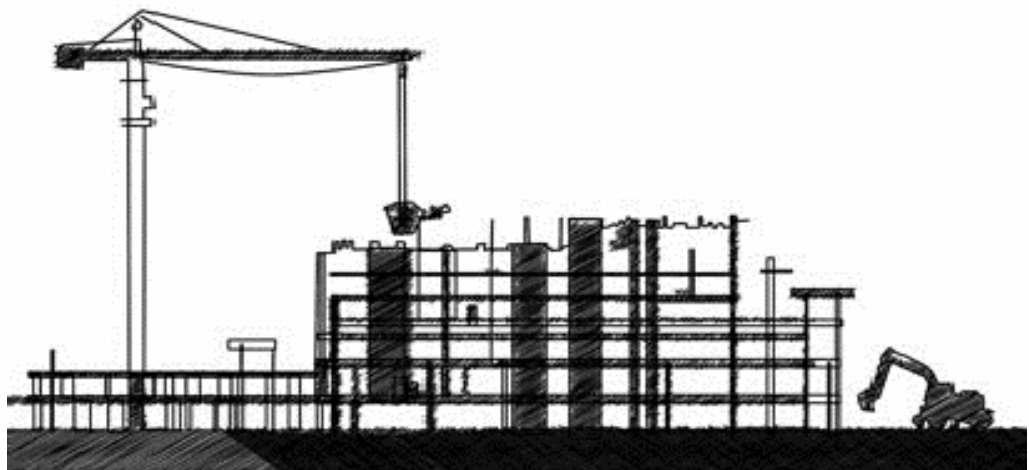
SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	130
37	ISKAMATIC 'A'	3550
38	CALIBRATOR '03'	1110
39	48 POLE EXTENDER CARD	220
40	MULTIJET NPM	440
41	OSCILLOMETER	11320
42	VOC EQUIPMENT	1550
43	BINARY SIGNAL GENERATOR	320
44	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 6-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 $\Omega$	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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# **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. Regular

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.

## 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

**Bharat Heavy Electricals Limited, Power Sector**

Regd. Office: BHEL House, Siri Fort, New Delhi-110049

- 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
<b>A. System Violations</b>			
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>B. Competency/ Training/ Induction Violations</b>			

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
<b>C. PPE Violations – Height Work</b>			
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
<b>D. PPE Violations – General</b>			
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
<b>E. Electrical Safety Violations</b>			
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
<b>F. Lifting &amp; Rigging Violations</b>			
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
<b>G. Housekeeping</b>			
1	Non-removal of scrap from platforms	5000	Per Event Per location per 7 days
2	Not conducting scheduled housekeeping drives	5000	Per drive
<b>H. Hot Work Safety Violations</b>			
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
<b>I. Vehicle Safety/ Operation</b>			
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
<b>J. Accidents/ Incidents/ Near Misses</b>			
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
<b>K. Miscellaneous</b>			
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.):

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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

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Name

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**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:

<b>First Offence:</b>	1 Punch on Gate Pass/ Induction Card/ ID Card etc. and 1-hour HSE Training. With one day off from duty
<b>Second Offence:</b>	2 Punches and 2-hours HSE Training with one day off from duty

<b>Third Offence:</b>	3 Punches and the worker will be dismissed. Gate pass to be confiscated
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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/ BHEL**

**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 action.

- 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	-	DLCBH	-	*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, DLFH: 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)
<b>A. Construction Site</b>		
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>B. Office</b>		
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.

<b>SAFETY INDUCTED</b>	
<b>Name :</b>	
<b>Date :</b>	
<b>Sign By Trainer :</b>	

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.

- 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

 <input type="checkbox"/> <b>OK</b>	<input type="checkbox"/> <b>NOT OK</b>
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.

- 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 for the



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

## 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 annemias arematations (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.
- xlii. 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.
- xlvii. 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

**A. Types of Displays****1. Based on Content**

SN	Type
1.	<b>HSE Hazards &amp; Precautions</b> 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.	<b>Other Displays, Signage etc.</b> 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	<b>Walls/ Foundations/ Cement Structures etc. belonging to the package area</b>	Safety Hazards Prevention and other HSE Awareness content	<b>[Type 3]</b>	As per BHEL assessment from time to time	
2	<b>Site Interior Roads belonging to the package area</b>	At least every 20 meters: 1. Speed Limit Indication, Safe Driving board 2. Boards for hazard awareness	1.As needed <b>[Type 2]</b> 2. A1 or equivalent each <b>[Type 2]</b>	As indicated	Sides of Roads; Height to ensure good visibility
3	<b>Specific Package Areas</b>	<b>A. Common</b> 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	<b>A0 [Type 2]</b>	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



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

## 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

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



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
<p>1. Latrines shall be provided in every establishment on the following scale, namely: -</p> <ol style="list-style-type: none"> <li>Where females are employed, there shall be at least one latrine for every 25 females;</li> <li>Where males are employed, there shall be at least one latrine for every 25 males:</li> </ol> <p>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</p> <p>2. Every latrine shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings.</p>	<p>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:</p> <p>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.</p> <p>2. The urinals shall be designed and located so as to ensure privacy.</p>

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

SN	Type of Fire Risk (Class of Fire)	Extinguishing Medium & Relevant INDIAN STANDARD	Scale of Equipment (Minimum recommended)
1.	<b>CLASS 'A'</b> 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.	<b>CLASS 'A'</b> (Extra hazard & high fire load)	-do	-do – (Also, consult local fire authority).
3.	<b>CLASS 'A'</b> (Special hazards)	-do	-do – Extra provision For every 100 square meter floor area or part, one 4.5 Kg. CO <sub>2</sub> ; minimum 2 numbers per room; should not be required to travel more than 10 meter to reach any extinguisher.
4.	<b>CLASS 'B'</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.	<b>CLASS 'B'</b> (Bulk storage other than in tank form))	-do -	-do- (but minimum 3 numbers per room)
6.	<b>CLASS 'C'</b> (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 <sub>2</sub> ; minimum 3 nos. per room; should not be required to travel more than 10 meter to reach any extinguisher.
7.	<b>CLASS 'D'</b> 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.	<b>MIXED OCCUPANCY</b> (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 <sub>2</sub> . 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

**Bharat Heavy Electricals Limited, Power Sector**

Regd. Office: BHEL House, Siri Fort, New Delhi-110049

- 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

Bill Ref no: \_\_\_\_\_ Date: \_\_\_\_\_

NAME OF THE AGENCY: \_\_\_\_\_ Work-Area/Package: \_\_\_\_\_

Sl. No.	Description	Remarks
1	<b><u>HOUSE KEEPING:</u></b>	
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	<b><u>GENERAL ILLUMINATION:</u></b>	
2.1	ALL the working areas at site & office of the agency including passages are having proper & sufficient illumination.	
3	<b><u>STATUTORY &amp; REGULATORY REQUIREMENT:</u></b>	
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	<b><u>SAFETY COMPLIANCE:</u></b>	
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.	

<b><u>VENDOR'S SIGNATURE</u></b>	
Erection Engineer	
HSE Officer	
Site-in-Charge	

<b><u>BHEL'S SIGNATURE</u></b>	
Erection Engineer	
HSE Officer	
Package-in-Charge	



## ANNEXURE I

Activity-Specific Safety Precautions/ Controls

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## General

The philosophy of hierarchy of controls as below shall be followed

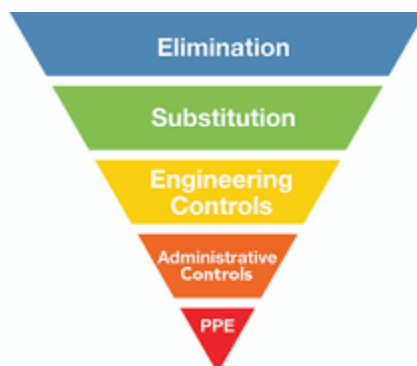


Fig. 1.1

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**

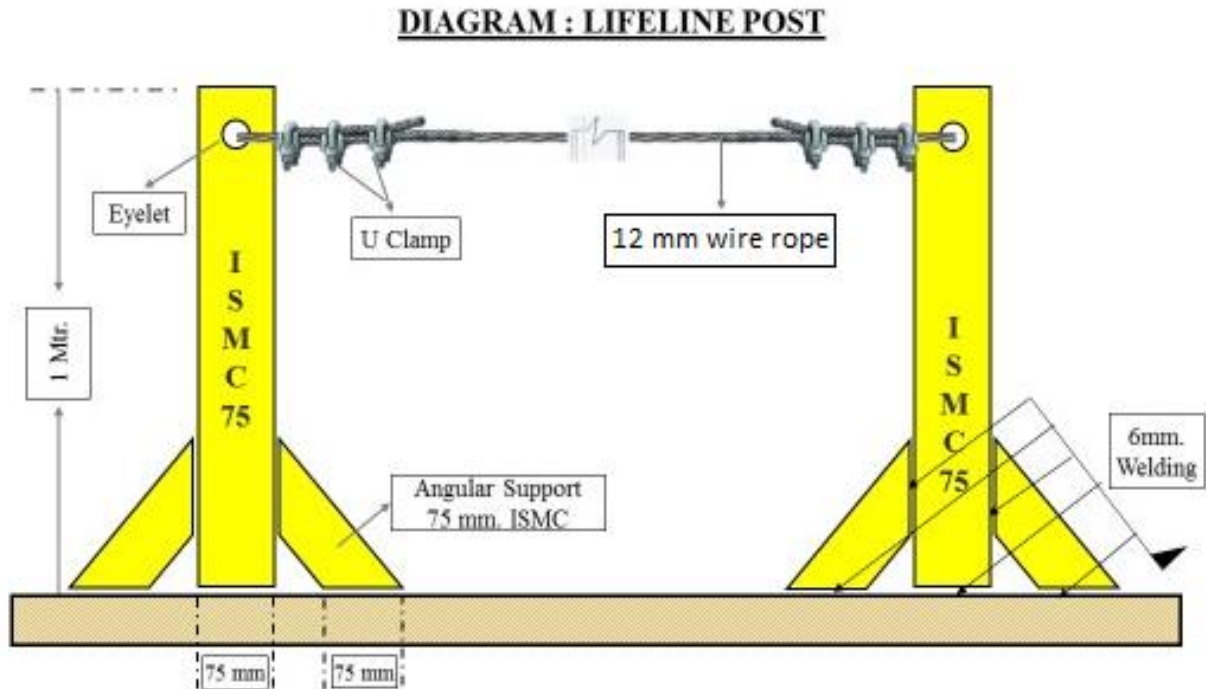
- i. The type of work and the environment conditions determine lanyard and lifeline selection. If welding, chemical cleaning that may damage lanyards, connectors or lifelines, sandblasting, etc., either protect the components or use more appropriate type of system.
- ii. Lanyards and lifelines must incorporate, 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

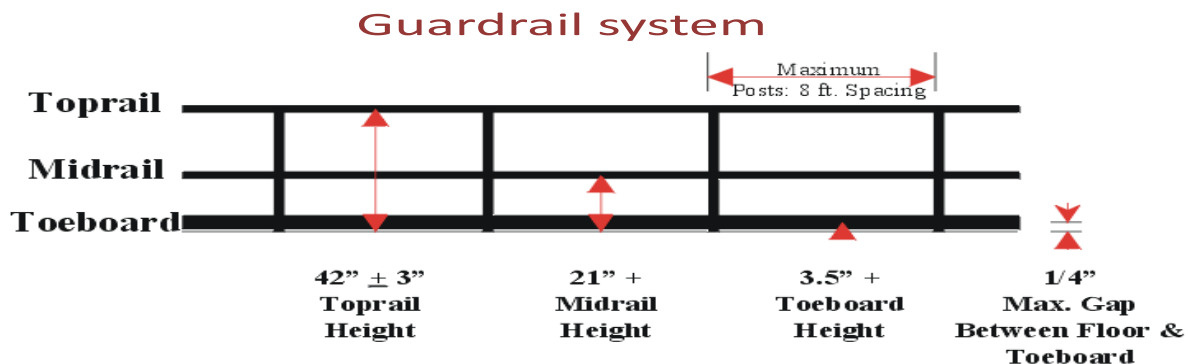
## 1.2 Working Platform

- 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.

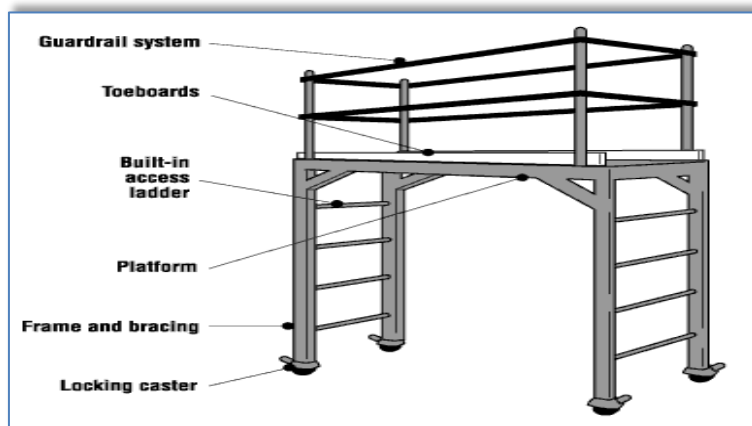
**x. Requirements for different types of Scaffolds:**

**A. Suspended Scaffold**

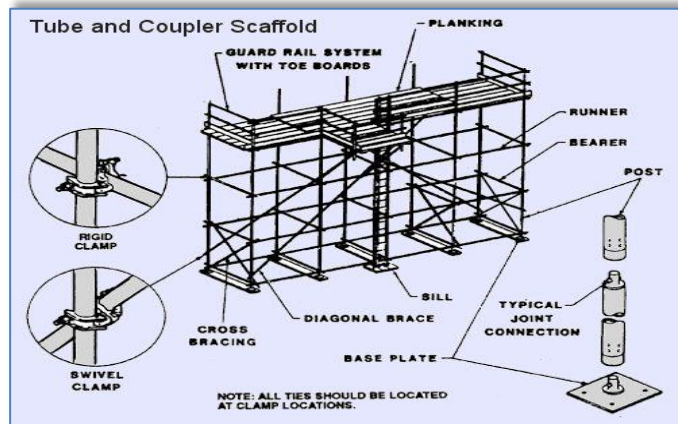
- i. Suspended scaffolds are platforms suspended by ropes, or other non-rigid means, from an overhead structure.
- ii. Requirements for use are to be preapproved by HSE Head, under a specific Permit to Work.

**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	$\frac{3}{4} : 1$	53 deg.
Type B	1 : 1	45 deg.
Type C	$1\frac{1}{2} : 1$	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 signaler /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

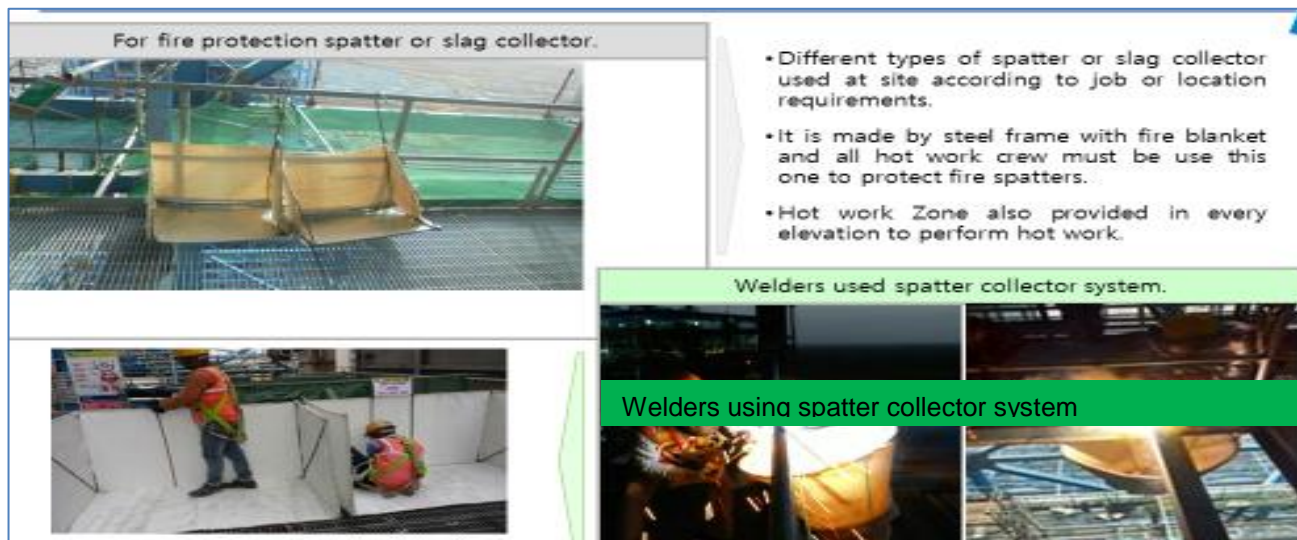
## **2.6 Concrete Mixers**

- 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):**

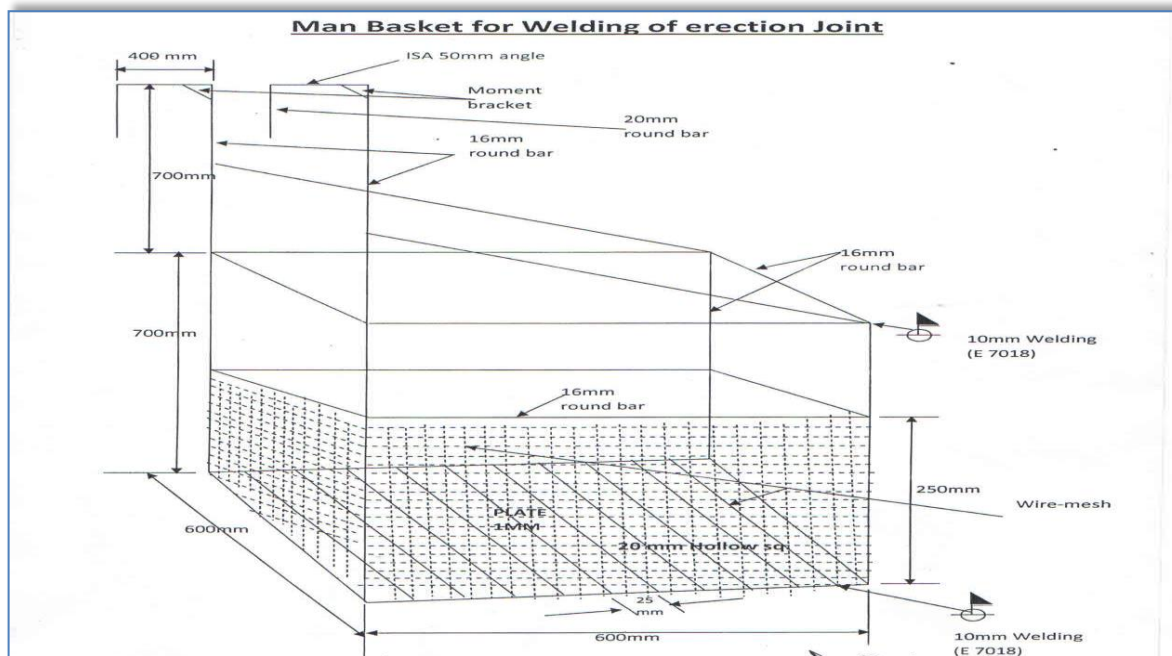
The design of personnel man basket shall be submitted to BHEL Engineer for approval before use. Relevant permit (Height work & others as applicable) shall be completed prior to lifting any people, along with a rigging plan.

- 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%.

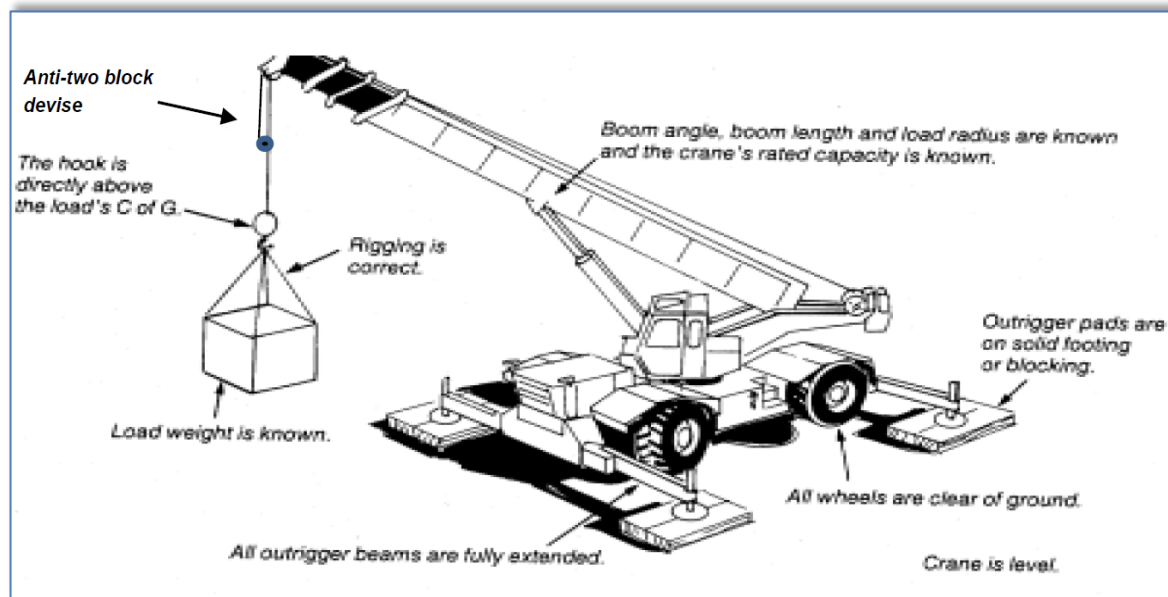
- v. It shall have a door with double latches and shall open inside. Anchor points shall be identified within the man-basket.
- vi. The man-basket shall be thoroughly inspected and load tested and a trial run performed without personnel before being put to job.
- vii. It shall be treated as a lifting 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**

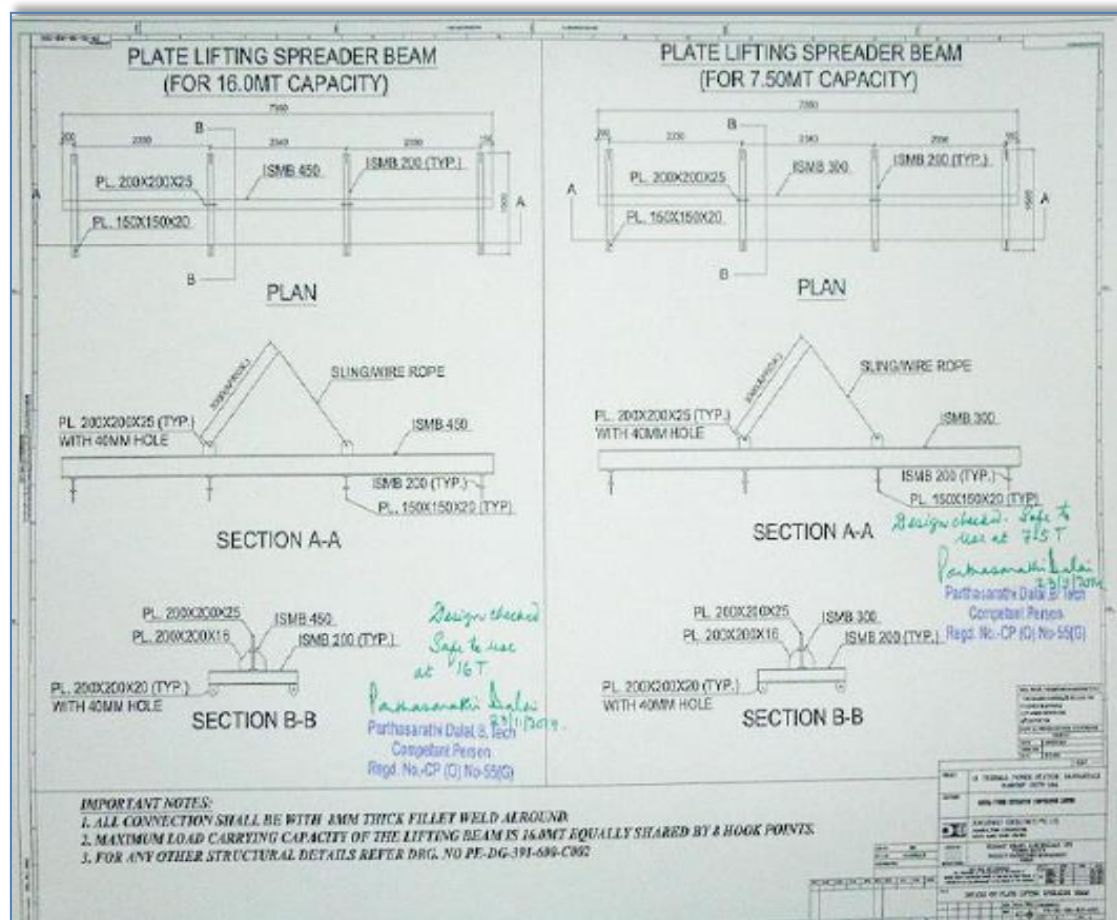
#### 4.1 Cranes & Hoisting Equipment:

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**

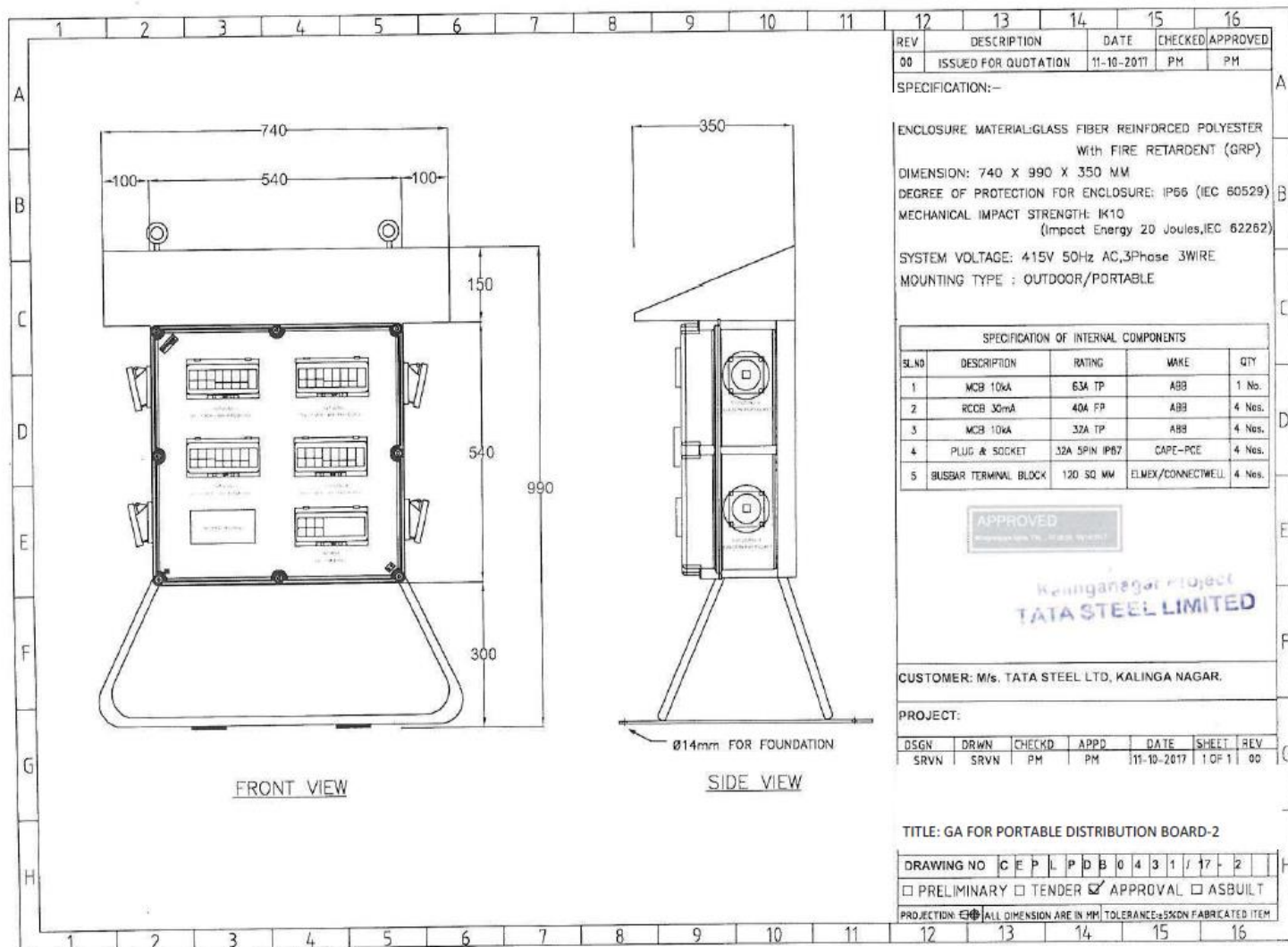
- i. Portable electric lights used in wet or potentially wet locations must be either low voltage type (24 volts or less) or protected by a GFI (ground fault interrupter).
- ii. They must be visually checked before each use and periodically while in use to assure their original integrity is maintained.
- 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/cm<sup>2</sup> 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/cm<sup>2</sup> 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/cm<sup>2</sup> and that too with effective chip guarding. The 2 kg/cm<sup>2</sup> 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 Charge is 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 &amp; Personal Locks and Multi Lock Hasp:



## #3. Lockout / Tagout Request Permit

		<b>LOCKOUT / TAGOUT REQUEST PERMIT</b>			LOTO Request Permit No.: Work Permit No.:		
Equip. Out of Service:	LOTO Date Required by: ____/____/____	Estimated Duration:		<b>LOTO Requested</b> Date:			
Scope of Work:				<b>LOTO Authorization</b> Signed by: Date:			
				<b>LOTO Removal Authorization</b> 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: <b>Attachment 3.Lockout / Tag out Request Permit:</b>							

## #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

**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

**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.