VOLUME – IA
Part I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED

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VOLUME - IA PART – I CHAPTER – I

1.1 PROJECT INFORMATION

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

APPROACH TO SITE

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

Nearest Airport – Chennai

Nearest Airstrip – Chennai

Nearest Seaport – Ennore

A. Project Information & Location

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

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

Type of Project: Green field

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

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

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

13o 17’ N to 13o 18’ N Latitude

Nearest Village: Vayalur

Nearest Town & City: Chennai (35 Km)

State Capital: Chennai (35 Km)

Nearest Railway Station: Athipattu Pudunagar (~5 Km)

Nearest Airport: Chennai (~60 Km)

Nearest Seaport: Ennore (~5 Km)

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

B. Meteorological Condition

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

Owner Consultant: DESEIN, DELHI,

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

Ambient Temperature: a. Maximum 32.0 Deg. C

b. Minimum 24 Deg. C

c. Design ambient temperature 35 Deg. C

Relative Humidity: a. Maximum 100%

b. Minimum 36%

c. Design 75%

Annual Rainfall: a. Maximum 2540 mm

b. Average 1600 mm

c. Minimum 1175 mm

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

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

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

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

VOLUME-IA PART-I CHAPTER – II

1.2 SCOPE OF WORKS

1.2.1 The scope of works covers mainly Civil works in entire network of roads, drains & murram blanketing (Inside plant boundary) of Ennore SEZ (2 x 660 MW) TPP Unit-1 & 2, as mentioned below, including supply of all materials (excluding MS round for earthing, Reinforcement steel & Structural Steel), labour, tools and plants, including all architectural works and hand over to TANGEDCO in all respect as per BOQ, Specifications and drawings.

1.2.2 The scope of work is indicative but not limited to the given below.

1.2.3 Area of work

1.2.3.1 Roads inside plant boundary including peripheral road

1.2.3.2 Drains inside plant boundary including peripheral drain

1.2.3.3 Murram/ gravel blanketing inside plant boundary

1.2.3.4 Other related miscellaneous works inside plant boundary

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

1.2.5 Reinforcement steel, MS round for earthing, structural steel for civil & structural works (applicable, if any) 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.

1.2.6 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, etc. are included in the rates of items of work.

1.2.7 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.

1.2.8 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.

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

1.2.10 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.

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

1.2.12 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.

1.2.13 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 coated binding wire. Payment for this work shall be made against relevant item of BOQ.

1.2.14 Bidder shall visit site for better clarification against present status of civil works in various area for proper assessment of pending works. Bidder to note that a minor portion of the work (i.e. road network, drain network & murram blanketing) has already been completed and the work covered under this tendered scope shall be taken up on AS IS WHERE IS basis, as applicable in site as per the instructions of BHEL Engineer in charge.

1.2.15 Special arrangements to be made for tackling COVID-19 pandemic – Contractor shall make arrangements for stay of workers within their premises as far as possible and/ or adjacent building and for implementation of STANDARD OPERATING

PROTOCOL (SOP) as per government order. The transportation of workers to work place shall be arranged by the contractor in dedicated transport by ensuring social distance. Any person violating the COVID -19 measures published vide government order time to time will be liable to be proceeded for legal action as per the government order. Following shall be observed in work place:

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

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

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

1.2.15.4 Contractor shall sanitize their work place between shifts.

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

1.2.15.6 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.

1.2.15.7 **Indicative Standard operating procedure for social distancing for workplace and offices (Govt issued SOP, time to time for Covid-19, shall be followed)**

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

1. All areas in the work premises including the following shall be disinfected completely using user friendly disinfectant mediums:
    a. Entrance gate of work place, office, if any
    b. Cafeteria and canteens, if any
    c. Meeting room, conference halls/ open area available/ verandah/ entrance gate of site, bunkers, porta cabins, buildings, etc.
    d. Equipments and lifts
    e. Washroom, toilet, sink, water points, etc
    f. Wall/ all other surfaces

2. For workers coming from outside, special transportation facility shall be arranged without any dependency on the public transport system. These vehicles should be allowed to work only with applicable passenger capacity.
3. All vehicles and machinery entering the premise should be disinfected by spray mandatorily.
4. Mandatory thermal scanning of everyone entering and exiting the work place to be done.
5. Medical insurance for the workers to be made mandatory.
6. Provision for hand wash & sanitizer preferably with touch free mechanism shall be made at all entry and exit points and common areas. Sufficient quantities of all the items should be available.
7. Work places shall have a gap of one hour between shifts and will stagger the lunch breaks of staff, to ensure social distancing.
8. Large gatherings or meetings of 10 or more people to discouraged. Seating at least 6 feet away from others on job sites and in gatherings, meetings and training sessions.
9. Not more than 2/4 persons (depending on size) will be allowed to travel in lifts or hoists.
10. Use of staircase for climbing should be encourages.
11. There should be strict ban of gutka, tobacco, etc. and spitting should be strictly prohibited.
12. There should be total ban on non-essential visitors at sites.
13. Hospitals/ clinics in the nearby areas, which are authorized to treat COVID-19 patients, should be identified and list should be available at work place all the times.

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1.3 FACILITIES & CONSUMABLES IN THE SCOPE OF CONTRACTOR / BHEL

(SCOPE MATRIX)

Sl.No	Description **1.3.1** PART **I**	Scope to be taken care by		Remarks
		BHEL	**Bidder**	
	ESTABLISHMENT			
1.3.1.1.1	FOR CONSTRUCTION PURPOSE:			
A	Open space for office	Yes		As provided by TANGEDCO
B	Open space for storage	Yes		
C	Construction of bidder's office, canteen and storage building including supply of materials and other services		Yes	At Bidder's Own Cost
D	Bidder's all office equipments, office / store / canteen consumables		Yes	
E	Canteen facilities for the bidder's staff, supervisors and engineers etc.		Yes	
F	Firefighting equipments like buckets, extinguishers etc.		Yes	
G	Fencing of storage area, office, canteen, labour hutment, etc. of the bidder,		Yes	
1.3.1.1.2	FOR LIVING PURPOSES OF THE BIDDER			
A	Open space		Yes	At Bidder's Own Cost
B	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

Sl.No	Description **1.3.1** PART **I**	Scope to be taken care by		Remarks
		BHEL	**Bidder**	
1.3.1.2.1.1	Single point source (In general) For detail, refer clause no. 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. (in case BHEL provides this facility, the scope should be given without ambiguity)		Yes	
1.**3.1.3.0**	**WATER SUPPLY**			

Sl.No	Description **1.3.1** PART **I**	Scope to be taken care by		Remarks
		BHEL	**Bidder**	
1.3.1.3.1	For construction purposes:	Yes		Chargeable to bidder as per prevailing rate of TANGEDCO
1.3.1.3.1.1	Making the water available at single point	Yes		Chargeable to bidder as per prevailing rate of TANGEDCO
1.3.1.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	At Bidder's Own Cost
1.3.1.3.2	Water supply for bidder's office, stores, canteen etc.		Yes	
1.**3.1.4.0**	**LIGHTING**			
1.3.1.4.1	For construction work (supply of all the necessary materials) At office storage area At the preassembly area 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) At office storage area At the preassembly area At the construction site /area		Yes	
1.**3.1.5.0**	**COMMUNICATION FACILITIES for site operations of the bidder**			
1.3.1.5.1	Telephone, Fax, internet, intranet, email etc.		Yes	At Bidder's Own Cost

Sl. No.	Description 1.3.2 PART II	Scope to be taken care by		Remarks
		BHEL	Bidder	
	CONSTRUCTION FACILITIES			
1.**3.2.1.0**	**Engineering works for construction**			
1.3.2.1.1	Providing the construction drawings for all the equipment's covered under this scope	Yes		
1.3.2.1.2	Drawings for construction methods		Yes	In consultation with BHEL
1.3.2.1.3	As-built drawings – wherever deviations observed and executed and also based on the decisions taken at site- example – routing of small bore pipes	Yes	Yes	In consultation with BHEL
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 Sl No 1.3.2.1.5		Yes	
1.3.2.1.8	Daily construction / work plan based on Sl No 1.3. 2.1.7		Yes	For daily monitoring meeting at site
1.3.2.1.9	Periodic visit of the senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of		Yes	

Sl. No.	Description 1.3.2 PART II	Scope to be taken care by		Remarks
		BHEL	Bidder	
	the bidder should be done once in every two months.			

1.3.3 OPEN SPACE:

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

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

make his own arrangement for further distribution with necessary isolator/ LCB etc. Any dispute, BHEL engineer's decision shall be final and binding on contractor.

1.3.4.2 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.

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 174.00 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 Incase 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**.**

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 (applicable, if any) 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.

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

1.3.6.3 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).

1.3.6.4 Fine aggregate source shall be manufactured crushed stone or rock sand commonly known as M-sand, excluding fines which are by products/rejects of coarse aggregate production. The crushed stone sand shall be graded from fine to coarse with the coarse sizes predominating to give maximum density.

1.3.6.5 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.

1.3.6.6 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 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

1.3.7.1 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:

1.3.8.1 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**:

1.3.9.1 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

1.3.10.1 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 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

1.3.11.1 Bid drawings enclosed for information and this may get revised during execution.

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1.4 T&Ps TO BE DEPLOYED BY CONTRACTOR

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

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

Sr No	Major T&P	Mobilizing time from the date of commencement of work
A1	4 No. excavator equivalent to capacity of Pocklain CK90 or higher to suit the requirement of work at site	1 no. within 30 days, 2nd within 45 days and balance as per the requirement of work
A2	1 no. automatic concrete batching plant with printing facility (minimum capacity of 30 Cum/Hr each) with DG backup. With minimum 2 Nos of silo per batching plant (100MT each)	1 nos to be commissioned within 45 days
A3	1 Nos dozer	1 No within 45 days
A4	2 nos. concrete pump (60 cum/ hr min capacity & lift 90M) N.B. – Concrete pump can be replaced by providing additional concrete boom placer of adequate capacity with prior approval of Engineer In-Charge.	As per BHEL requirement at site
A5	5 nos. transit mixer (5/6 M3 capacity) including standby 1 nos.	3 no's within 45 days. Balance progressively as per BHEL requirement at site.
A6	1 nos Vibro roller/ Vibromax of minimum 10 ton capacity	1 nos within 45 days
Sl. No	**Other T&Ps**	**Mobilizing time from the date of start of work**

A7	4 No. back hoe cum loader like JCB	1 no. within 30 days, second within 45 days and balance as per BHEL requirement at site.
A8	6 nos. dumper (Min 15 cum each)	2 nos. Within 20 days. Balance as per BHEL requirement at site.
A9	2 nos. diesel Mixer machine of 0.5 cum capacity	As per BHEL requirement at site.
A10	3 nos. self-priming dewatering pump 5 HP (diesel)	As per BHEL requirement at site
A11	3 nos. self-priming dewatering pump 5 HP (electric)	As per BHEL requirement at site
A12	4 nos. curing pump – 1.5 /2 HP (pump for curing at heights)	As per BHEL requirement at site
A13	4 nos. reinforcement bending machine	2 nos. within 20 days and balance progressively as per BHEL requirement at site
A14	4 nos. reinforcement cutting machine	2 nos. within 20 days and balance progressively as per BHEL requirement at site
A15	MS scaffolding pipe / ACROW PIPE	As per BHEL requirement at site
A16	1 nos. power driven earth rammer (Roller Type 1/2 T)	As per BHEL requirement at site
A17	1 nos baby roller	As per BHEL requirement at site
A18	Civil laboratory equipment's as per list IN Sl 1.4.6 with temporary building one AC lab size 4.5mtrx6mtr and 1 non AC lab 4.5 mtrx4.5 mtr.	Within 55 days.
A19	1 no total station with adequate arrangement for Surveyors.	1 no. Within 15 days
A20	10 or more nos auto level & staff	6 nos. Within 15 days and balance as per BHEL requirement at site. No. of auto level shall be mutually agreed

		between bidder & Engineer In-charge.
A21	120 nos concrete cube moulds	90 nos within 30 days and balance progressively as per BHEL requirement at site
A22	Adequate no. of small trucks 2T/5T for shifting of reinforcement/cement/shuttering etc. within site	As per BHEL requirement at site
A23	2 nos. drinking water tank – 5000 lit.	1 nos. Within 30 days. Balance as per BHEL requirement at site
A24	4 nos. mobile toilet for labour use.	Within 30 days
A25	1 nos. truck mounted 125 KVA DG set	As per BHEL requirement at site
A26	Construction power cable	As per BHEL requirement at site
A27	Construction water Pipeline	As per BHEL requirement at site
A28	1 no. trailor for shifting of crawler mounted equipment's like Poclain, Dozer	As per BHEL requirement at site
A29	Concrete vibrator with adequate needle (Minimum 10 nos diesel/electric nos.)	8Nos (at least 4nos. diesel driven) within 45 Days. Balance as per BHEL requirement at site.
A30	Portable fire extinguishers as below: Soda acid – 8 sets. Dry chemical powder – 10 sets CO2 – 10 sets. Water & sand bucket (4 buckets in one stand) – 10 sets. Fire hose with nozzle (50 M length) – 5 sets.	25% within 30 days and balance progressively within 90 days.
A31	1 no. compression testing machine (200 T cap)	1 Nos. within 30 days
A32	1 nos. pick & carry crane (10/ 12 T cap)	As per BHEL requirement at site

Note:

1. 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, demobilization of T&P in total or in part can be done with the due approval of engineer in charge. Retaining of the T&P's during the contract period will be mutually agreed in line with construction requirement.
2. All T&P and all IMTEs, which are required for successful and timely execution of the work covered within the scope of this tender, shall be arranged and provided by the contractor at his own cost in working condition.
3. In the event of 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.
4. In the event of need of change of type of any of major T&Ps, approval shall be taken from BHEL Engineer in-charge prior to mobilization. The decision of Number of T&P required due to replacing the enlisted T&P as per above table, shall be taken after analyzing the production capacity and suitability of both the T&Ps.
5. Clause no. 1.6.1. of this specification (i.e. TCC) shall be referred for date of start of work.
6. Mobilization of concrete boom placer in place of concrete pump will be allowed based on site requirement of BHEL.

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

1.4.4 The Bidder shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time for testing.

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

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

	CONCRETE TESTING EQUIPMENT			
SL NO	**NAME OF TEST**	**NAME OF EQUIPMENT**	**SIZE OF EQIPMENT**	**IS REF.**
1	Initial & final setting time, Consistency of cement	Vicat Apparatus with desk pot	Standard	IS 5513
2	Shrinkage of cement, Auto Clave Test	Le Chatelier's appratus Auto Clave Equipment	Standard	IS 5514
3	Abrasion value test	Los Angles Abrasion testing machine	Standard	IS 2386
4	Aggregate Impact value test	Aggregate Impact value testing machine with blow counter	Standard	IS 9377
5	Aggregate crushing value test	Crushing value apparatus	Standard	IS 2386
6	Flakiness index	Thickness gauge for measuring flakiness index	Standard	IS 2386
7	Elongation Index	Elongation guage	Standard	IS 2386
8	Bulk density, voids and bulking apparatus	Measuring cylinders	3, 5,10 & 15 liters cylinders	
9	Workability of concrete	Slump cone	Standard, at least 04 no's	IS 456
10	Specific gravity of aggregates	Pycnometer	Standard, at least 02 no's	IS 383
11	Cement mortar cube vibrating	Motorised vibration machine for cement testing	Standard	IS 4031

12	Course aggregate Sieve analysis (Concrete & Road Works)	Sieve set	450mm dia GI Frames Size: 125 mm, 90 mm, 75 mm, 63 mm, 53 mm, 40 mm, 20 mm, 16 mm, 12.5 mm, 10 mm, 4.75 mm, Pan and cover	IS 383
13	Fine aggregate sieve analysis	Sieve set	200 mm dia Brass sieves; Size 4.75 mm, 2.36 mm, 1.18 mm 600 micron, 300 micron, 150 micron, 75 micron, 75 micron, Pan and cover	IS 383
14	Sieve Shaker	Motorized Sieve shaker	Mfg. Catalogue	
15	Silt content check	Sand silt content beaker	Standard	

	Soil Testing Equipment			
SL NO	**NAME OF TEST**	**NAME OF EQUIPMENT**	**SIZE OF EQIPMENT**	**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

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

1.4.8 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 etc. for safe operation / movement of equipment including cranes / trailers etc. shall be the responsibility of the contractor at his cost. No compensation on this account shall be payable.

1.4.9 In general, any crane for the tendered will not be provided by BHEL. However, if requirement of crane of higher capacity arises for any unforeseen circumstance (i.e. more than 150MT), bidder may request BHEL to provide crane on chargeable basis but BHEL reserves right of provision of crane. If provided, in that case, Crane operators deployed by the contractor shall be tested by BHEL before they are allowed to operate the cranes.

1.4.10 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.

1.4.11 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.

VOLUME-IA PART-I CHAPTER – V

1.5 T&Ps provided by BHEL

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.

VOLUME-IA PART-I CHAPTER – VI

1.6 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 as detailed in the Tender Specification shall be completed within **18 Months (Eighteen months)** from the date of commencement of work with intermediate milestones as mentioned below,

1.6.3 Intermediate Milestones -

1.6.3.1 Completion of RCC works of all peripheral road works –by 10th Month

1.6.3.2 Completion of 80% of all plant road works – by 15th month

1.6.3.3 Also please refer relevant clause in Vol IA Part II Chapter 1 for Penalty of Intermediate Milestones.

1.6.4 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.

1.6.5 The contractor is required to refer Form 15 in Volume I A Part II for all the instructions to be taken immediately after receipt of LOI.

1.6.6 MOBILISATION

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

1.6.7 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.

1.6.8 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.

1.6.9 SUBMISSION OF L3 SCHEDULE

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 1.6.11. 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.

1.6.10 GUARANTEE PERIOD

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

1.6.11 CONSTRUCTION SCHEDULE

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

Sl. No	Area	Completion from date of commencement of civil work
1.	Completion of drain for peripheral road	8th Month
2.	Completion of drain for plant roads	13th Month
3.	Completion of RCC works of all peripheral road works	10th Month
4.	Completion of 80% of all plant road works	15th Month
5.	Completion of 100% of all plant road works	17th Month
6.	Completion of murram blanketing works, area as handed over at site	17th Month
7.	Completion of pending points, Documentation, final reconciliation and submission of final bill	18th Month

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

1.6.13 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.

1.6.14 The area for roads, drains & murram blanketing 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.

1.6.15 The left out minor finishing works shall also be completed and handed over to BHEL within the contract period.

1.6.16 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.

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

1.6.18 The bidder must submit a detail schedule (area wise) for completion of work to meet civil work schedule given in CLAUSE 1.6.11 within 15 days from the date of issue of LOI.

1.6.19 The major activities as mentioned against the work schedule given in clause No.1.6.11 are to be indicated in detailed schedule which shall be prepared by the bidder.

1.6.20 RECORDS TO BE MAINTAINED AT SITE:

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

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

a) Hindrance Register.

b) Site Order Book.

c) Test Check of measurements.

d) Steel & Cement Supply and Consumption Daily Register

e) Records of Test reports of Field tests.

f) Records of manufacture's test certificates.

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

h) List of T&Ps and MMEs

1.6.20.2 Other documents / records as specified in chapter -Progress of work in PART- I of Technical conditions of Contract Volume IA (Volume I Book I).

1.6.20.3 Schedule as specified in chapters of Technical conditions of Contract Volume IA (Volume I Book I).

VOLUME-IA PART-I CHAPTER – VII

1.7 TERMS OF PAYMENT

1.7.1 Secured Advance

Not applicable

1.7.2 Advance for Mobilization

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

1.7.2.2 2% of contract value after receipt of initial Security Deposit, security deposit for consortium and additional security deposit as applicable if any, 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. Excavator equivalent to capacity of Pocklain CK90 or higher to suit the requirement of work at site – 1 No
2. Dozer-1 no.
3. Vibro roller/ vibro max as mentioned in list of T&Ps – 1 nos.
4. Back hoe cum loaded like JCB – 2 No.
5. Dumper – 3 nos

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. Batching plant as mentioned in list of T&Ps – 1 Nos.
2. Concrete pump (60 cum/ hr minimum capacity) – 1 No.
3. Pick & carry crane (10T/ 12T capacity) – 1 No.
4. Dewatering pump (Minimum 5 HP capacity)– 4 nos
5. Compression testing machine – 1 nos.

6. Excavator equivalent to capacity of Pocklain CK90 or higher to suit the requirement of work at site – 1No.

1.7.2.5 Note: With prior approval of BHEL site in-charge, contractor may mobilise concrete boom placer of suitable capacity in place of concrete pump (Mentioned in Sl. No. 2). Capacity of boom placer shall be mutually agreed between BHEL site in-charge and contractor.

1.7.2.6 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.

1.7.4 For Retention amount: Please refer Sl No.16 of Vol-1A Part II Chapter-1.

1.7.5 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.

1.7.6 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 herein is indicative

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)	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	
4	Murram	30% (thirty per cent of the local market value of the murram at pit mouth) or as applicable as per latest Tamilnadu govt. order	Actual volume of filling shall be considered	

1.7.7 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.

1.7.8 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.

VOLUME-IA PART-I CHAPTER - VIII

TAXES AND OTHER DUTIES

1.8.1 Goods and service Tax (GST) & Cess

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

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

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

BHEL GSTN - 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.

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

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

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

1.8.2 All taxes and duty other than GST & Cess

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

1.8.3 Statutory Variations

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

1.8.4 New Taxes/Levies

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

1.8.5 Direct Tax

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

VOLUME-IA PART-I CHAPTER -IX

1.9.0 BILL OF QUANTITY

As mentioned in the Volume II, Price Bid

VOLUME-IA PART-I CHAPTER -X
GENERAL

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

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

I. Security Deposit and Additional Security Deposit (As applicable).
II. Unqualified Acceptance for Detailed LOI/ Work Order.
III. Rs.100/- Stamp Paper for preparation of Contract Agreement.
IV. Option (whether a or b of said clause) exercised towards Performance Security Deposit for the subject contract as per Sl. No. 16 of Volume IA Part II Chapter 1 of TCC.

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

I. PF Regn No.
II. Labour License No.
III. Workmen Insurance Policy No.

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

1.10.4 BOCW Act & BOCW Welfare Cess Act

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

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

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

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

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

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

1.10.4.5 Contractor shall make remittance of the BOCW cess as per 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, fess paid towards registration of beneficiaries and contribution of beneficiaries remitted.

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

1.10.5 PROVIDENT FUND

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

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

1.10.6 OTHER STATUTORY REQUIREMENTS

1.10.6.1 The Contractor shall submit a copy of Labour License obtained from the Licensing Officer (Form VI) u/r25 read with u/s 12 of Contract Labour (R&A) Act 1970 & rules

and Valid WC Insurance copy or ESI Code (if applicable) and PF code no along with the first running bill.

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

1.10.6.3 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 contactor, BHEL will reserve its right to pay the workmen under the orders of Appropriate authority at the risk and cost of the Contractor.

1.10.6.4 The Contractor shall submit copies of Final Settlement statement of disbursal of retrenchment benefits on retrenchment of each workman under I D Act 1948, copies of Form 6-A (Annual Return of PF Contribution) along with Copies of PF Contribution Card of each member under PF Act and copies of monthly return on ESI Contribution – Form 6 under ESI Act1948 (If applicable) to BHEL along with the Final Bill.

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

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

1.10.7 DEPLOYMENT OF SKILLED / SEMI-SKILLED TRADESMEN

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

The contractor shall, at all stages of work deploy skilled / semi-skilled tradesmen who are qualified and possess certificate in particular trade from CPWD Training Institute / Industrial Training. Institute / National Institute of Construction Management and Research (NICMAR), National Academy of Construction, CIDC or any similar reputed and recognized Institute managed / certified by State / Central Government. The number of such qualified tradesmen shall not be less than 20% of total skilled / semi-skilled workers required in each trade at any stage of work. The contractor shall submit number of man days required in respect of each trade, its scheduling and the list of qualified

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

1.10.8 RECOVERY OF COMPENSATION PAID TO VICTIM(S) BY BHEL IN CASES OF DEATH/ PERMANENT INCAPACITATION OF PERSON DUE TO AN ACCIDENT DURING THE WORKS

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

1.10.8.1 Victim: Any person who suffers permanent disablement or dies in an accident as defined below.

1.10.8.2 Accident: Any death or permanent disability resulting solely and directly from any unintended and unforeseen injurious occurrence caused during the manufacturing / operation and works incidental thereto at BHEL factories/ offices and precincts thereof, project execution, erection and commissioning, services, repairs and maintenance, trouble shooting, serving, overhaul, renovation and retrofitting, trial operation, performance guarantee testing undertaken by the company or during any works /during working at BHEL Units/ Offices/ townships and premises/ Project Sites.

1.10.8.3 Compensation in respect of each of the victims:

(i) In the event of death or permanent disability resulting from Loss of both limbs: Rs. 10,00,000/- (Rs. Ten Lakh)

(ii) In the event of other permanent disability: Rs. 7,00,000/- (Rs. Seven Lakh)

1.10.8.4 Permanent Disablement: A disablement that is classified as a permanent total disablement under the proviso to Section 2 (I) of the Employee's Compensation Act, 1923.

1.10.9 GENERAL

1.10.9.1 Site Visit by the Bidder

Prior to submitting his tender for the work, the bidder shall visit, examine and acquire full knowledge & information of 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.

1.10.9.2 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 there-from.
iv) Source and extent of availability of suitable materials, including water etc., and labour (skilled and unskilled) required for work, and laws and regulations governing their use and employment.
v) Geological, meteorological, topographical and other general features of the site and its surroundings as are pertaining to and needed for the performance of the work.
vi) The limit and extent of surface and subsurface water to be encountered during the performance of the work, and the requirement of drainage and pumping.
vii) The type of equipment and facilities needed, for and in the performance of the work;
viii) The extent of lead and lift required for the work in complete form over the entire duration of the contract, and
ix) All other information pertaining to and needed for the work including information as to the risks, contingencies and other circumstances which may influence or affect the work or the cost thereof under this contract.

1.10.9.3 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.

1.10.9.4 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.

1.10.9.5 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.

1.10.9.6 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.

1.10.9.7 It is not the intent to specify herein all details of all material. Any item related this work not covered by this but necessary to complete the system will be deemed to have been included in the scope of the work.

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

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

1.10.9.10 The contractor shall carryout additional tests, if any, which the Engineer feels necessary because of site conditions and also to meet system specification.

1.10.9.11 The work shall be executed under the usual conditions without affecting power plant construction / operation and in conjunction with other operations and contracting agencies at site. The contractor and his personnel shall co-operate with the personnel of other agencies, co-ordinate his work with others and proceed in a manner that shall not delay or hinder the progress of work as a whole.

1.10.9.12 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.

1.10.9.13 Wherever Construction sequences are furnished by BHEL, the contractor shall follow the same sequence.

1.10.9.14 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.

1.10.9.15 If required by BHEL, the contractor shall change the sequence of his operation so that work on priority sectors can be completed within the projects schedule. The contractor shall afford maximum assistance to BHEL in this connection without causing delay to agreed completion date.

1.10.9.16 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.

1.10.9.17 Contractor shall retain all T&P / Testing instrument / Material handling equipment's etc. at site as per advice of BHEL engineer and same shall be taken out from site only after getting the clearances from engineer in charge.

1.10.9.18 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.

1.10.9.19 The Contractor may have to execute work in such a place and condition where other agencies also will be under such circumstances. However, completion time for construction, agreed will be subject to the condition that contractor's work is not hampered by the agencies.

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

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

1.10.9.22 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.

1.10.9.23 The contractor shall ensure that his premises are always kept clean and tidy to the extent possible. Any untidiness noted on the part of the contractor shall be brought to the attention of the contractor's site representative who shall take immediate action to clean the surroundings to the satisfaction of the Engineer-in-Charge.

1.10.9.24 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.

1.10.9.25 No member of the already erected structure / buildings, other component and auxiliaries should be removed / modified without specific approval of BHEL engineer.

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

1.10.9.27 Some time it may be required to re-schedule the activities to enable other agencies to commence / continue the work so as to keep the overall project schedule.

1.10.9.28 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.

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

1.10.9.30 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.

1.10.9.31 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.

1.10.9.32 If any item not covered but requires being executed, same shall be carried out by the contractor. Equivalent or proportional unit rate shall be considered wherever possible from the BOQ. The rates quoted by the contractor shall be uniform as far as possible for similar items appearing in rate schedule.

1.10.9.33 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 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.

1.10.9.34 SITE INSPECTION

1.10.9.34.1 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.

1.10.9.34.2 BHEL / Customer 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 customer / BHEL.

1.10.9.34.3 Wherever the performance of work by the contractor is not satisfactory in respect of workmanship, deployment of sufficient labour or equipment, 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.

1.10.9.35 DOCUMENTATION

1.10.9.35.1 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.

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

i) Hindrance Register.

j) Site Order Book.

k) Test Check of measurements.

l) Steel & Cement Supply and Consumption Daily Register

m) Records of Test reports of Field tests.

n) Records of manufacture's test certificates.

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

p) List of T&Ps and MMEs

1.10.9.35.3 Other documents / records as specified in chapter -Progress of work in PART- I of Technical conditions of Contract Volume IA (Volume I Book I).

1.10.9.35.4 Schedule as specified in chapters of Technical conditions of Contract Volume IA (Volume I Book I).

VOLUME-IA PART – I CHAPTER - XI

1.11.0 PROGRESS OF WORK

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

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

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

1.11.3 The contractor shall submit daily, weekly and monthly progress reports, manpower reports, materials 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 ending on 24th of every month shall be submitted as a booklet and shall contain the following details:

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

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

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

d) Category- wise man hours engaged during the previous month under the categories like fitters, electricians, welders, riggers, khalasis, grinder-men, gas-

cutters, crane operators, store keepers, lab technicians, helpers, security etc. Data will be spilt up under the work area.

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

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.

VOLUME-IA PART- I CHAPTER-XII

1.12.0 MATERIAL HANDLING

1.12.1 Open land as available shall be provided by BHEL on free of cost basis as provided by TANGEDCO. Contractor shall maintain one centralized fenced store cum bar bending yard at his own cost. Hard surfacing of this yard and all-round drain shall be carried out by the contractor at his own cost within the quoted rate. 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 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 Materials shall not under any circumstances taken out of the project site unless otherwise permitted by BHEL.

1.13ACCOUNTING OF MATERIAL 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**

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

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

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

IS: 808 (Latest revision)	Beams, Channels and Angles
IS: 1730 (Latest revision)	Plates, Sheets and Strips/Flats
IS: 1732 (Latest revision)	Rounds including deformed high yield strength bars.
IS:1786 (Latest revision)	Reinforcement steel

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

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

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

1.13.2.6 The contractor shall submit to the engineer, a statement indicating estimated quantity of steel required during a quarter, at least two months in advance of the quarter. In

addition, the contractor shall also furnish the estimated requirement of steel during a month by the third week of the previous month indicating his requirement.

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

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

1.13.2.8 Bidders to ensure that no lamination materials are taken over by them from BHEL. Fabrication wastage, if any due to above, shall not be compensated by BHEL. Bidder to note that steel materials required for MS Grating, Galvanised Grating, GI Handrail, Stainless Steel Handrail, Stop Lock Gate, Stationery Screen, fasteners like MS/ HT/ HSFG bolts/ nuts, lock nuts, washers and foundation bolts, embedded items, etc. other than those supplied by BHEL, etc. shall be supplied by the bidder. However, Bidder shall use the scrap materials (if issued by BHEL) for their use in the permanent works as embedment/ inserts etc. after necessary store issue formalities and shall be accounted for monthly reconciliation.

1.13.3 **RETURN OF MATERIALS**

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

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

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

1.13.4 **SCRAP & SERVICEABLE MATERIALS:**

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

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

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

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

1.13.5 **STEEL CONSUMPTION AND WASTAGE**

1.13.5.1 **REINFORCEMENT AND EARTHING ROD MS ROUND STEEL CONSUMPTION AND WASTAGE**

a) CONSUMPTION.

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

i. Actual consumption = Issue – Surplus.
ii. Surplus = Un-tampered & unused quantity of steel and Serviceable materials as stipulated under clause "Scrap and Serviceable Materials (Refer Clause 1.13.4 above)" returned by the contractor to BHEL store along with relevant documents.
iii. Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE

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

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

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

a) CONSUMPTION: -

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

i) Actual consumption = Issue – Surplus.

ii) Surplus = Un- tampered, unused, uncut quantity of steel and

Serviceable materials as stipulated under clause "Scrap and Serviceable Materials (Refer Clause 1.13.4 above)" returned by the contractor to BHEL store along with relevant documents.

ii) Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE

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

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

1.13.6 **RECONCILIATION OF MATERIALS**

The contractor shall submit a reconciliation statement of steel issued to him along with each RA Bill. At the time of submission of bills, the contractor shall properly account for the material issued to him as specified herein to the satisfaction of BHEL certifying that the balance materials are available in contractor's custody at site. At the time of submission of bills by the contractor, if it is noticed by BHEL that the wastage is high and calls recovery at the penal rate, then, BHEL will proceed for recovery for the excess wastage as per penal recovery rates as specified. The reference drawings for actual material consumption to be used for the purpose of reconciliation shall be drawings prepared by the BHEL and drawings approved by BHEL for fabrication works and such other drawings approved by BHEL. This shall also include the bar bending schedule prepared by the contractor and approve by BHEL.

1.13.7 **RECOVERY OF MATERIAL**

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

1.13.8 **PENAL RATE OF MATERIALS**

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 the wastage exceeds specified limit

b) If the wastage not exceeded specified limit, but not returned to BHEL store except

invisible wastages

c) For the not returning the surplus serviceable materials

A	**REINFORCEMENT STEEL** Cold rolled steel, high strength, deformed bar or mild steel round bars including earthing rod MS round	**Rs. 42,285/- per MT** **+ GST and/or other taxes & duties**
B	**STRUCTURAL STEEL** MS plates, MS flats, rolled steel joists, channels, and angles, MS pipes, Chequered Plates, etc. in sizes and lengths as available	**Rs. 48,667/- per MT** **+ GST and/or other taxes & duties**

VOLUME-IA PART – II CHAPTER 1

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

Sl No: 1

Clause 4.1.11 of SCC is deleted.

Sl No: 2:

OCCUPATIONAL HEALTH, SAFETY & ENVIRONMENT MANAGEMENT/ QUALITY ASSURANCE PROGRAMME

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

Chapter IX Clause 9.1 is modified as below:

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

Chapter IX Clause 9.1.1 to 9.1.25 stands deleted.

Chapter IX Clause 9.2 to 9.62 stands deleted.

Sl No: 3:

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

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

Sl No: 4

The EARNEST MONEY DEPOSIT (EMD) clause 1.9 published in General Conditions of Contract (Volume I Book-II) is revised as under.

1.9 EARNEST MONEY DEPOSIT

1.9.1 Every tenderer must furnish the prescribed amount of Earnest Money Deposit (EMD) to BHEL PSSR, only in the following forms: -

i. Electronic Fund Transfer credited in BHEL account (before tender opening).

iii. **Name of the Beneficiary** -: Bharat Heavy Electricals Limited

iv. Bank Particulars

a. Bank Name -: State Bank Of India
b. Branch Address-: SBI Saidapet Branch, EVR Periyar Building, Nandanam, Anna Salai, Chennai - 600035
c. Bank Account Number -: 10610819499
d. 11 Digit IFSC Code of Beneficiary Branch-: SBIN0000912

ii. Through Online EMD payment portal, before tender opening, by following these steps.

1. Visit www.onlinesbi.com -> Go to State Bank Collect (In the tab section)
2. Click Check box to proceed for payment -> Click on Proceed
3. Under State of Corporate/Institution ->Select Tamilnadu
4. Under Type of Corporate/Institution -> Select PSU – Public Sector Undertaking ->Go
5. Under PSU – Public Sector Undertaking Name -> Select BHEL PSSR CHENNAI and Submit
6. Under Select Payment Category ->-> SCT Tender EMD & Tender Fees

v. Banker's cheque or Pay order or Demand Draft in favour of 'Bharat Heavy Electricals Limited' (along with offer) and payable at Chennai.

vi. Fixed Deposit Receipt (FDR) issued by Scheduled Banks/ Public Financial Institutions as defined in the Companies Act (FDR should be in the name of the Contractor, a/c BHEL) along with the offer.

vii. In case EMD amount is more than Rs. Two Lakhs, Tenderer has the option to submit Rs. Two lakhs in the forms described above in clause no. 1.9.1. (i) to (iv) and the remaining amount over and above Rs. Two Lakhs in the form of Bank Guarantee from Scheduled Bank (along with the Offer).

Note:

a) Proforma for Bank Guarantee for EMD- Form WAM 23 is enclosed with this Tender in Volume-1A Part II Chapter 9.
b) The Bank Guarantee shall be valid for at least six months from the due date of tender submission mentioned in the Notice Inviting Tender.
c) Date of Expiry of Claim shall be as given in Proforma of Bank Guarantee (in lieu of Earnest Money)-Form WAM 23.

Bank Details for the purpose of Taking EMD BG

Name and Address of Beneficiary:	Bharat Heavy Electricals Ltd. Tek Towers, No.11, Old Mahabalipuram Road, Okkiyam Thoraipakkam, Chennai - 600097.
Name of Bank of Client :	State Bank Of India
Bank Branch Address:	SBI Saidapet Branch, EVR Periyar Building, Nandanam, Anna Salai, Chennai - 600035
IFSC Code :	SBIN0000912
Account No. :	10610819499

Details for SFMS (Structured Financial Messaging System) transmission of BG

Bank and Branch	SBI TFCPC Branch
Branch Code	5056
IFSC Code	SBIN0005056

1.9.2 EMD shall not carry any interest.

1.9.3 EMD by the Tenderer will be forfeited as per NIT Conditions, if:

i. After opening the tender and within the offer validity period, the Tenderer revokes his tender or makes any modification in his tender which is not acceptable to BHEL.

ii. The Contractor fails to deposit the required Security deposit or commence the work within the period as per LOI/Contract

1.9.4 EMD given by all unsuccessful tenderers will be refunded normally within 15 days of award of work.

1.9.5 EMD of successful tenderer will be retained as part of Security Deposit.

1.9.6 EMD by the tenderer shall be withheld in case any action on the tenderer is envisaged under the provisions of extant" Guidelines on Suspension of Business dealings with suppliers/contactors" and forfeited / released based on the action determined under these guidelines.

Sl No: 5

SECURITY DEPOSIT: The SECURITY DEPOSIT (SD) clause 1.10 published in General Conditions of Contract (Volume I Book-II) is revised as under.

1.10 Security Deposit:

1.10.1 Upon acceptance of Tender, the successful Tenderer should deposit the required amount of Security Deposit for satisfactory completion of work, as given below:

1.10.2 The total amount of Security Deposit will be 5% of the contract value. EMD of the successful tenderer shall be converted and adjusted towards the required amount of Security Deposit.

1.10.3 The security Deposit should be furnished before start of the work by the contractor.

1.10.4 Modes of deposit:

1.10.4.1 The balance amount to make up the required Security Deposit of 5% of the contract value may be furnished in any one of the following forms

i. Cash (as permissible under the extant Income Tax Act)
ii. Local cheques of Scheduled Banks (subject to realization)/ Pay Order/ Demand Draft/ Electronic Fund Transfer in favour of BHEL
iii. Bank Guarantee from Scheduled Banks / Public Financial Institutions as defined in the Companies Act. The Bank Guarantee format for Security Deposit shall be in the prescribed formats.
iv. Fixed Deposit Receipt issued by Scheduled Banks/ Public Financial Institutions as defined in the Companies Act. The FDR should be in the name of the contractor, A/C BHEL, duly discharged on the back.
v. Securities available from Indian Post offices such as National Savings Certificates, Kisan Vikas Patras etc. (Certificates should be held in the name of Contractor furnishing the security and duly endorsed/ hypothecated/ pledged, as applicable, in favour of BHEL and discharged on the back)

(Note: BHEL will not be liable or responsible in any manner for the collection of interest or renewal of the documents or in any other matter connected therewith)

1.10.5 At least 50% of the Security Deposit including the EMD should be deposited in any form as prescribed before start of the work and the balance 50% of the Security Deposit will be recovered by deducting 10% of the gross amount progressively from each running bills of the contractor till the total amount of the required Security Deposit is collected.

1.10.6 The recoveries made from running bills (cash deduction towards balance SD amount) will be released against submission of equivalent Bank Guarantee in the prescribed formats, but only once, before completion of work.

1.10.7 The Security Deposit shall not carry any interest.

1.10.8 If the value of work done at any time exceeds the contract value, the amount of Security Deposit shall be correspondingly enhanced and the excess Security Deposit due the

enhancement shall be immediately deposited by the Contractor or recovered from payment/s due to the Contractor.

1.10.9 The validity of Bank Guarantees towards Security Deposit shall be initially upto the completion period as stipulated in the Letter of Intent/Award + 3 months, and the same shall be kept valid by proper renewal till the acceptance of Final Bills of the Contractor, by BHEL Date of Expiry of Claim shall be as given in the prescribed formats for Bank Guarantee towards Security Deposit.

1.10.10 BHEL reserves the right of forfeiture of Security Deposit in addition to other claims and penalties in the event of the Contractor's failure to fulfill any of the contractual obligations or in the event of termination of contract as per terms and conditions of contract. BHEL reserves the right to set off the Security Deposit against any claims of other contracts with BHEL.

1.10.11 Penalty for Delayed Remittance of Security Deposit

If the contractor fails to furnish SD before start of work, in line with 1.10.3 above, Simple Interest against delayed remittance of the Security Deposit shall be deducted from the sub-contractor at the rate of SBI PLR + 2% on the value of 50% SD of the contract, for the delayed period (i.e., period between start of work and date of remittance of Initial SD, i.e., atleast 50% of SD). In case, the delayed period has different SBI PLR rates, Simple Interest shall be calculated based on different rates by considering the corresponding time period. On similar lines Penalty shall be levied for delayed remittance of Additional Security Deposit (if applicable).

Note: - Bank details & SFMS details provided above in Sl. No. 04 Earnest Money Deposit) may be used for the purpose of arranging Bank Guarantees towards Security Deposit / Additional Security Deposit also.

Sl No: 6

Clause 2.7.1, 2.7.2 and 2.7.3 in GCC regarding Rights of BHEL is revised as under:

2.7.1 In case of inadequate manpower deployed by the contractor, BHEL reserves the right to deploy additional manpower through any other agency for expediting the activities in the interest of the project. Supplied manpower shall be put on job by the contractor and payments and other statutory compliances related to manpower shall be the contractor's responsibility. In case of contractor's failure to fulfill his obligations in respect of manpower, BHEL reserves the right to take necessary action as per contract obligations.

To withdraw any portion of work and / or to restrict / alter quantum of work as indicated in the contract during the progress of work and get it done through other agencies to suit BHEL's commitment to its customer or in case BHEL decides to advance the date of completion due to other emergent reasons / BHEL's obligation to its customer.

2.7.2.

2.7.2.1 To terminate the contract or withdraw portion of work and get it done through other agency, at the risk and cost of the contractor after due notice of a period of 14 days' by BHEL in any of the following cases:

i. Contractor's poor progress of the work vis-à-vis execution timeline as stipulated in the Contract, backlog attributable to contractor including unexecuted portion of work does not appear to be executable within balance available period considering its performance of execution.
ii. Withdrawal from or abandonment of the work by contractor before completion of the work as per contract.
iii. Non-completion of work by the Contractor within scheduled completion period as per Contract or as extended from time to time, for the reasons attributable to the contractor.
iv. Termination of Contract on account of any other reason (s) attributable to Contractor.
v. Assignment, transfer, subletting of Contract without BHEL's written permission.
vi. Non-compliance to any contractual condition or any other default attributable to Contractor.

Risk & Cost Amount against Balance Work:

Risk & Cost amount against balance work shall be calculated as follows:

Risk & Cost Amount= [(A-B) + (A x H/100)]

Where,

A= Value of Balance scope of Work (*) as per rates of new contract

B= Value of Balance scope of Work (*) as per rates of old contract being paid to the contractor at the time of termination of contract i.e. inclusive of PVC & ORC, if any.

H = Overhead Factor to be taken as 5

In case (A-B) is less than 0 (zero), value of (A-B) shall be taken as 0 (zero).

* Balance scope of work (in case of termination of contract):

Difference of Contract Quantities and Executed Quantities as on the date of issue of Letter for

'Termination of Contract', shall be taken as balance scope of Work for calculating risk & cost amount. Contract quantities are the quantities as per original contract. If, Contract has been amended,

quantities as per amended Contract shall be considered as Contract Quantities.

Items for which total quantities to be executed have exceeded the Contract Quantities based on drawings issued to contractor from time to time till issue of Termination letter, then for these items

total Quantities as per issued drawings would be deemed to be contract quantities.

Substitute/ extra items whose rates have already been approved would form part of contract quantities for this purpose. Substitute/ extra items which have been executed but rates have not been approved, would also form part of contract quantities for this purpose and rates of such items shall be determined in line with contractual provisions.

However, increase in quantities on account of additional scope in new tender shall not be considered for this purpose.

NOTE: Incase portion of work is being withdrawn at risk & cost of contractor instead of termination of contract, contract quantities pertaining to portion of work withdrawn shall be considered as 'Balance scope of work' for calculating Risk & Cost amount.

LD against delay in executed work in case of Termination of Contract:

LD against delay in executed work shall be calculated in line with LD clause no. 2.7.9 of GCC, for the delay attributable to contractor. For limiting the maximum value of LD, contract value shall be taken as Executed Value of work till termination of contract.

Method for calculation of "LD against delay in executed work in case of termination of contract" is given below.

i). Let the time period from scheduled date of start of work till termination of contract excluding the period of Hold (if any) not attributable to contractor = T1

ii). Let the value of executed work till the time of termination of contract= X

iii). Let the Total Executable Value of work for which inputs/fronts were made available to contractor and were planned for execution till termination of contract = Y

iv). Delay in executed work attributable to contractor i.e. T2=[1-(X/Y)] x T1

v). LD shall be calculated in line with LD clause (clause 2.7.9) of the Contract for the delay attributable to contractor taking "X" as Contract Value and "T2" as period of delay attributable to contractor.

2.7.2.2 In case Contractor fails to deploy the resources as per requirement, BHEL can deploy own/hired/otherwise arranged resources at the risk and cost of the contractor and recover the expenses incurred from the dues payable to contractor. Recoveries shall be actual expenses incurred plus 5% overheads or as defined in TCC.

2.7.3 **Recoveries arising out of Risk & Cost and LD or any other recoveries due from Contractor**

Following sequence shall be applicable for recoveries from contractor:

a) Dues available in the form of Bills payable to contractor, SD, BGs against the same contract.

b) Demand notice for deposit of balance recovery amount shall be sent to contractor, if funds are insufficient to effect complete recovery against dues indicated in (a) above.

c) If contractor fails to deposit the balance amount to be recovered within the period as prescribed in demand notice, following action shall be taken for balance recovery:

i) Dues payable to contractor against other contracts in the same Region shall be considered for recovery.

ii) If recovery cannot be made out of dues payable to the contractor as above, balance amount to be recovered, shall be informed to other Regions/Units for making recovery from the Unpaid Bills/Running Bills/SD/BGs/Final Bills of contractor.

iii) In-case recoveries are not possible with any of the above available options, Legal action shall be initiated for recovery against contractor.

SL No: 7

In addition to clause 2.7.9 of General Conditions of Contract (GCC), a New clause 2.7.9.1 is added as below.

2.7.9.1 Penalty for Intermediate Milestones

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

2.7.9.1.2 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.

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

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

2.7.9.1.5 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.

2.7.9.1.6 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.

2.7.9.1.7 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.

2.7.9.1.8 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.

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

SL No: 8

OVERRUN COMPENSATION (ORC)

The **OVERRUN COMPENSATION (ORC)** clause 2.12 published in General Conditions of Contract (Volume I Book-II) is revised as under.

2.12 OVERRUN COMPENSATION (ORC)

2.12.1 **ORC during original contract period:** No ORC shall be applicable during the original contract period.

2.12.2 **ORC during extended period for the reasons solely attributable to contractor:** No ORC shall be applicable during the extended period granted for the reasons solely attributable to contractor and work executed during this period shall be paid as per original contract rates.

2.12.3 **ORC during extended period for the reasons not attributable to contractor:** ORC shall be payable as per following procedure:

2.12.3.1 For initial period of twelve months of extended period, ORC rate applicable over executed value shall be 5%. For every subsequent period of twelve months, ORC rate shall be further increased by 5% over the previous rate. For example, ORC rates applicable for initial period of 12 months and subsequent period of 12 months are given below.

Sl. No.	Extended Period for the reasons attributable to BHEL	ORC rate applicable over executed value
1	First 12 months	5%
2	13^{th}-24^{th} month and so on	10.25% {[(1.05 x 1.05)-1] x 100}

This process of increasing ORC rate for each subsequent period of 12 months shall continue till applicability of ORC.

2.12.3.2 On completion of original contract period as well as on completion of each subsequent period of twelve months i.e. at the time of change in applicable ORC rate, Delay Analysis shall be carried out and percentage shortfall attributable to both BHEL & Contractor shall be calculated.

2.12.3.3 For the purpose of calculation of ORC, executed value of work in the month shall be divided in Part-1 and Part-2 in proportion of percentage shortfall attributable to BHEL and contractor respectively, based on the last delay analysis as worked out in 2.12.3.2.

ORC shall be payable only on Part-1 and no ORC shall be payable on Part-2.

Value of Part-1 shall be further limited to the value of actual inputs provided by BHEL i.e. "Plan - Shortfall attributable to BHEL" for the month, as per Form-14 for calculation of ORC.

2.12.3.4 Payment of ORC amount shall be further regulated as follows:

(i) 50% of the ORC is allocated for deployment of matching resources (with weightages) agreed as per the joint programme drawn vide 2.11.4. ORC Payment against resources shall be calculated in proportion to percentage of resources actually deployed w.r.t. planned resources, as per Form-14.

(ii) 50% of ORC is allocated for achieving of planned progress agreed as per the joint programme drawn vide 2.11.4. ORC Payment shall be reduced in proportion to percentage shortfall attributable to contractor w.r.t.–"Plan - Shortfall attributable to BHEL" for the month, as per Form-14.

2.12.3.5 The maximum amount of ORC payable for the month shall be limited to Rs. 5,00,000/- .

2.12.3.6 In case, there is no shortfall attributable to contractor for the month and also contractor has deployed the resources as agreed in Form-14 but ORC amount payable for the month worked out as per procedure mentioned in clause 2.12.3.3, 2.12.3.4 and 2.12.3.5, is less than Rs.1,00,000/-, then ORC amount payable for the month shall be Rs.1,00,000/- otherwise ORC amount payable for the month shall remain same.

2.12.3.7 In case execution is on **HOLD** (Other than Force Majeure), ORC shall be payable as per following:

i). Contractor has not been permitted by BHEL to de-mobilize

a) ORC amount of Rs. 1,00,000/- per month shall be applicable during the period of HOLD provided resources as planned are deployed (not demobilized) during the period of hold.

b) Subsequent to lifting of HOLD, Period of HOLD shall not be excluded in calculation of period for deciding applicable ORC rate as per clause 2.12.3.1.

ii). Contractor has been permitted to demobilize and to remobilize after lifting of HOLD

a) No ORC shall be payable to contractor for the period of HOLD.

b) Subsequent to lifting of HOLD, Period of HOLD shall not be excluded in calculation of period for deciding applicable ORC rate as per clause 2.12.3.1.

2.12.3.8 In case **Force Majeure** is invoked:

i). No ORC shall be applicable during the period of Force Majeure.

ii). Subsequent to revocation of Force Majeure, period of Force Majeure shall be excluded in calculation of period for deciding applicable ORC rate as per clause 2.12.3.1.

2.12.4 Applicability of ORC: ORC shall not be applicable for following activities.

(i) Area cleaning, removal of temporary structures and return of scrap.
(ii) Punch list points / pending points liquidation pending due to reasons attributable to contractor
(iii) Submission of "As built Drawing"
(iv) Material Reconciliation
(v) Completion of Contract Closure formalities like HR Clearance/ No dues from various dept./ Statutory Authorities etc.

2.12.5 Total Over Run Compensation shall be limited to 10% of the cumulatively executed contract value till the month (excluding Taxes and Duties if payable extra). For this purpose, executed contract value excludes PVC, ORC and Extra/Supplementary Works.

Sl No: 9

Clauses 2.13.1, 2.13.6 & 2.13.7 in GCC on Interest Bearing Recoverable Advances,

9.1 Clauses 2.13.1,2.13.6 & 2.13.7 in GCC is revised as under:

9.1.1 Clause 2.13.1 in GCC is revised as "Normally no advance payment shall be payable to the contractor. Mobilization advance payment in exceptional circumstances shall be interest bearing and secured through a Bank Guarantee and shall be limited to a maximum of 5% of contract value. This 'Interest Bearing Recoverable Advance' shall be payable in not less than two installments with any of the installment not exceeding 60% of the total eligible advance".

9.1.2 Clause 2.13.6 in GCC is revised as "The rate of interest applicable for the above advances shall be the Base rate of State Bank of India prevailing at the time of disbursement of the advance + 6%, and such rate will remain fixed till the total advance amount is recovered".

9.1.3 Clause 2.13.7 in GCC is revised as "Unadjusted amount of advances paid shall not exceed 5% of the total contract value at any point of time. Recovery of advances shall be made progressively from each Running Bill such that the advance amounts paid along with the interest is fully recovered by the time the contractor's billing reaches 90% of contract value."

Sl. No: 10:

Clause 2.14.1 on Quantity Variation in General Conditions of Contract (GCC), Volume-IC, Book-II, is revised as under:

2.14.1 The quantities given in the contract are tentative and may change to any extent (both in plus side and minus side). The quoted rates for individual items shall remain firm irrespective of

any variations in the individual quantities. No compensation becomes payable in case the variation of the final executed contract value is within the limit of Minus (-) 30% of awarded contract value."

Sl No: 11

PRICE VARIATION COMPENSATION (PVC)

The PRICE VARIATION COMPENSATION (PVC) clause 2.17 published in General Conditions of Contract (Volume I Book-II) is revised as under.

2.17 PRICE VARIATION COMPENSATION

2.17.1 In order to take care of variation in cost of execution of work on either side, due to variation in the index of LABOUR, HIGH SPEED DIESEL OIL, WELDING ROD, CEMENT, STEEL, MATERIALS, Price Variation Formula as described herein shall be applicable (only for works executed during extended period, if any, subject to other conditions as described in this section).

2.17.2 **85%** component of executed Contract Value shall be considered for PVC calculations and remaining 15% shall be treated as fixed component. The basis for calculation of price variation in each category, their component, Base Index, shall be as under:

Sl. No.	CATEGORY	BASE INDEX	PERCENTAGE COMPONENT ('K')				
			CIVIL PACKAGES (See Note A/B/C)			MECHANICAL PACKAGES	Electrical, C&I, Material Management / Handling and other labour oriented packages
			A	**B****	**C**		
i)	LABOUR (ALL CATEGORIES)	'MONTHLY ALL-INDIA AVERAGE CONSUMER PRICE INDEX NUMBERS FOR INDUSTRIAL WORKERS' published by Labour Bureau, Ministry of Labour and Employment, Government of India. (Website: labourbureau.nic.in)	**40**	**25**	**30**	**65**	**80**
ii)	HIGH SPEED DIESEL OIL	Name of Commodity: HSD Commodity code: 1202000005 (**See Note E**)	**5**	**3**	**5**	**5**	**5**

iii)	WELDING ROD	Name of Commodity: MANUFACTURE OF BASIC METALS Commodity code:1314000000 (**See Note E**)				**15**	
iv)	CEMENT	Name of Commodity: ORDINARY PORTLAND CEMENT Commodity code: 1313050003 (**See Note E**)		**20**	**30**		
v)	STEEL (Structural and Reinforcement Steel)	Name of Commodity: MILD STEEL: LONG PRODUCTS Commodity code: 1314040000 (**See Note E**)		**25**			
vi)	ALL OTHER MATERIALS (Other than Cement & Steel)	Name of Commodity: ALL COMMODITIES Commodity code: 1000000000 (**See Note E**)	**40**	**12**	**20**		

Note: A) Cement & Steel: Free Issue (BHEL Scope)

B) Cement & Steel: In Contractor Scope

C) Cement in Contractor Scope, and Steel is Free Issue (BHEL Scope)

D) For Composite packages (i.e. Civil + Mechanical + Electrical and / or CI or Civil + Mechanical or Mechanical + Electrical and / or CI), the Component ('K') for various categories shall be as per respective packages as above

E) As per the 'MONTHLY WHOLE SALE PRICE INDEX' for the respective Commodity and Type, published by Office of Economic Adviser, Ministry of Commerce and Industry, Government of India. (Website: http://www.eaindustry.nic.in/downloaddata_0405.asp). Revisions in the index or commodity will be re adjusted accordingly.

2.17.3 **Void**

2.17.4 Payment / recovery due to variation in index shall be determined on the basis of the following notional formula in respect of the identified component ('K') viz LABOUR, HIGH SPEED DIESEL OIL, WELDING ROD, CEMENT, STEEL, MATERIALS.

$$P = K \times R \times \frac{(X_N - Xo)}{Xo}$$

Where

P = Amount to be paid/recovered due to variation in the Index for Labour, High Speed Diesel Oil, Welding Rod, Cement, Steel and Materials

K = Percentage component ('K') applicable for Labour, High Speed Diesel Oil, Welding Rod, Cement, Steel and Materials

R = Value of work done for the billing month (Excluding Taxes and Duties if payable extra)

XN = Revised Index for Labour, High Speed Diesel Oil, Welding Rod, Cement, Steel and Materials for the billing month under consideration

Xo = Index for Labour, High Speed Diesel Oil, Welding Rod, Cement, Steel and Materials as on the Base date.

2.17.5 **Base date shall be the calendar month of the schedule completion date (i.e. Actual Start date + Scheduled Contractual Completion period as per Letter of Intent / award and / or work order).**

2.17.6 PVC shall not be payable for the ORC amount, Supplementary / Additional Items, Extra works. However, PVC will be payable for items executed under quantity variation of BOQ items under originally awarded contract.

2.17.7 The contractor shall furnish necessary monthly bulletins in support of the requisite indices from the relevant websites along with his Bills.

2.17.8 The contractor will be required to raise the bills for price variation payments on a monthly basis along with the running bills irrespective of the fact whether any increase/decrease in the index for relevant categories has taken place or not. In case there is delay in publication of bulletins (final figure), the provisional values as published can be considered for payments and arrears shall be paid/recovered on getting the final values.

2.17.9 PVC shall be applicable only, during extended period of contract (if any) after the scheduled completion period and for the portion of work delayed/backlog for the reasons not attributable to the contractor.

However, the total Quantum of Price Variation Amount payable/recoverable shall be regulated as follows:

i) For the portion of shortfall/backlog not attributable to contractor, PVC shall be worked out on the basis of indices applicable for the respective month in which work is done. Base index shall be applicable as defined in clause 2.17.5

ii) In case of Force Majeure, the PVC shall be regulated as per (a) or (b) below.

a) Force Majeure is invoked before “Base Date” / “revised base date” (as explained below) OR immediately after “base date” / “revised base date” in continuation (i.e. during the period when PVC is not applicable):

vii. Base date shall be revised: Revised Base date = Previous base date + duration of Force Majeure.

No PVC will be applicable for the work done till revised base date.

viii. PVC will be applicable for the work done after "base date"/" revised date" as the case may be (during extended period when delay is not attributable to contractor). PVC shall be worked out on the basis of indices applicable for the respective month in which work is done with base index as on "base date"/ "revised base date" as the case may be.

b) Force Majeure is invoked after "base date"/ "revised base date" as the case may be (during extended period when delay is not attributable to contractor).

2. PVC shall be applicable for the work done after revocation of Force Majeure.

3. PVC for the work done after revocation of Force Majeure shall be worked out on the basis of indices applicable for the respective month on which work is done excluding the effect of change in indices during total period of Force Majeure(s) invoked after "base date" / "revised base date" as the case may be. Base index shall be taken as on "base date" / "revised base date" as the case may be.

The total amount of PVC shall not exceed 15% of the cumulatively executed contract value. Executed Contract value for this purpose is exclusive of PVC, ORC, Supplementary / Additional items and Extra works except items due to quantity variation

Sl No: 12

Clauses 2.21 in GCC regarding Arbitration is amended as below

2.21 ARBITRATION & CONCILIATION

2.21.1 ARBITRATION:

2.21.1.1 Except as provided elsewhere in this Contract, in case Parties are unable to reach amicable settlement (whether by Conciliation to be conducted as provided in Clause 2.21.2 herein below or otherwise) in respect of any dispute or difference; arising out of the formation, breach, termination, validity or execution of the Contract; or, the respective rights and liabilities of the Parties; or, in relation to interpretation of any provision of the Contract; or. in any manner touching upon the Contract (hereinafter referred to as the 'Dispute'), then, either Party may, commence arbitration in respect of such Dispute by issuance of a notice in terms of section 21 of the Arbitration & Conciliation Act, 1996 (hereinafter referred to as the 'Notice'). The Notice shall contain the particulars of all claims to be referred to arbitration in sufficient detail and shall also indicate the monetary amount of such claim. The arbitration shall be

conducted by a sole arbitrator to be appointed by the Head of the BHEL Power Sector Region issuing the Contract within 60 days of receipt of the complete Notice. The language of arbitration shall be English.

The Arbitrator shall pass a reasoned award.

Subject as aforesaid, the provisions of Arbitration and Conciliation Act 1996 (India) or statutory modifications or re-enactments thereof and the rules made thereunder as in force from time to time shall apply to the arbitration proceedings under this clause. The seat of arbitration shall be **Chennai** (the place from where the contract is Issued). The Contract shall be governed by and be construed as per provisions of the laws of India. Subject to this provision 2.21.1.1 regarding ARBITRATION, the principal civil court exercising ordinary civil jurisdiction over the area where the seat of arbitration is located shall have exclusive jurisdiction over any DISPUTE to the exclusion of any other court.

2.21.1.2 In case of Contract with Public Sector Enterprise (PSE) or a Government Department, the following shall be applicable:

In the event of any dispute or difference relating to the interpretation and application of the provisions of commercial contract(s) between Central Public Sector Enterprises (CPSEs)/ Port Trusts inter se and also between CPSEs and Government Departments/Organizations (excluding disputes concerning Railways, Income Tax, Customs & Excise Departments), such dispute or difference shall be taken up by either party for resolution through AMRCD (Administrative Mechanism for Resolution of CPSEs Disputes) as mentioned in DPE OM No. 4(1)/2013-DPE(GM)/FTS-1835 dated 22-05-2018 as amended from time to time.

2.21.1.3 The cost of arbitration shall initially be borne equally by the Parties subject to the final allocation thereof as per the award/order passed by the Arbitrator.

2.21.1.4 Notwithstanding the existence of any dispute or differences and/or reference for the arbitration, the Contractor shall proceed with and continue without hindrance the performance of its obligations under this Contract with due diligence and expedition

in a professional manner unless the dispute inter-alia relates to cancellation, termination or short-closure of the Contract by BHEL.

2.21.2 CONCILIATION:

If at any time (whether before, during or after the arbitral or judicial proceedings), any Disputes (which term shall mean and include any dispute, difference, question or disagreement arising in connection with construction, meaning, operation, effect, interpretation or breach of the agreement, contract), which the Parties are unable to settle mutually, arise inter-se the Parties, the same may, be referred by either party to Conciliation to be conducted through Independent Experts Committee (IEC) to be appointed by competent authority of BHEL from the BHEL Panel of Conciliators.

Notes:

1. No serving or a retired employee of BHEL/Administrative Ministry of BHEL shall be included in the BHEL Panel of Conciliators.
2. Any other person(s) can be appointed as Conciliator(s) who is/are mutually agreeable to both the parties from outside the BHEL Panel of Conciliators.

The proceedings of Conciliation shall broadly be governed by Part-III of the Arbitration and Conciliation Act 1996 or any statutory modification thereof and as provided in Procedure 2.3 enclosed in Vol 1A Part II. The Procedure 2.3 together with its Formats will be treated as if the same is part and parcel hereof and shall be as effectual as if set out herein in this GCC.

The Contractor hereby agrees that BHEL may make any amendments or modifications to the provisions stipulated in the Procedure 2.3 enclosed in Vol 1A Part II from time to time and confirms that it shall be bound by such amended or modified provisions of the Procedure 2.3 with effect from the date as intimated by BHEL to it.

2.21.3 No Interest payable to Contractor

Notwithstanding anything to the contrary contained in any other document comprising in the Contract, no interest shall be payable by BHEL to Contractor on any moneys or balances including but not limited to the Security Deposit, EMD, Retention Money, RA Bills or the Final Bill, or any amount withheld and/or appropriated by BHEL etc., which becomes or as the case may be, is adjudged to be due from BHEL to Contractor whether under the Contract or otherwise.

Sl No: 13: Reverse Auction

Reverse Auction is not applicable for this tender.

Sl No: 14

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

Sl No: 15

Existing format on Monthly Performance Evaluation of Contractor, as available in Form No F-15 of Volume ID Forms and procedure stands Deleted. Form No.- F-15 (Rev 02) is enclosed.

Sl No:16

Clause 2.22 in GCC regarding Retention Amount is revised as under:

2.22 Performance Security Deposit

2.22.1 After award of work, Vendor shall submit 5% of the contract value towards Performance Security Deposit, in the form of (a) or (b) below.

(a) CASH (DD/ Online payment), 5% of the contract Value towards Performance Security Deposit, before commencing the contract

(or)

(b) Recovery 5% from Each Running Bill towards Performance security deposit.

(Note: Subcontractor has to choose either Option (a) or (b) before issue of Detailed LOI).

(c) However, Performance Security Deposit on part of PVC will be recovered at the rate of 5% from every running bill towards performance security deposit.

2.22.2 Refund of Performance Security Deposit:

a) 50% of Performance Security Deposit shall be released along with the final bill.

b) Balance 50% will be released after completion of Performance Guarantee Period (i.e., after expiry of Guarantee period), provided all the defects noticed during the guarantee period have been rectified to the satisfaction of BHEL Site Engineer/ BHEL Construction Manager, and after deducting all expenses/ other amounts due to BHEL under the contract/ other contracts entered into by BHEL with them. This portion of Performance Security Deposit, amount can be released on commencement of the Guarantee Period, on submission of equivalent Bank Guarantee.

The performance security deposit mentioned herein above, is in addition to Security Deposit as per Sl No. 5 above.

Sl No: 17

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

Sl No: 18

Existing format for BANK GUARANTEE FOR SECURITY DEPOSIT, as available in Form No. F-11 (Rev 00) of Volume ID Forms and procedures stands deleted. Refer Proforma of Bank Guarantee (in lieu of Security Deposit)-Form WAM 22 provided in Chapter-7, Part-II of Volume-IA Technical Conditions of Contract.

Sl No: 19

Clause 2.15.5 of GCC in Extra Works is revised as under:

2.15.5: After eligibility of extra works is established and finally accepted by BHEL engineer / designer, payment will be released on competent authority's approval at the following rate.

MAN-HOUR RATE FOR ELIGIBLE EXTRA WORKS:

Single composite average labour man-hour rate, including overtime if any, supervision, use of tools and tackles and other site expenses and incidentals, consumables for carrying out any major rework / repairs / rectification / modification / fabrication as certified by site as may arise during the course of erection, testing, commissioning or extra works arising out of transit, storage and erection damages, payment, if found due will be at Rs 108/- per man hour.

VOLUME-IA PART – II

CHAPTER 2-9

In the next 543 pages as below:

CHAPTER	Details	No. of sheets
CHAPTER 2	Technical Specifications and Plot Plan	422
CHAPTER 3	HSE Plan For Site Operations By Subcontractor	82
CHAPTER 4	Form 15 Rev 02	06
CHAPTER 5	Form 14 Rev 01	06
CHAPTER 6	Proforma Of Bank Guarantee (In Lieu Of Earnest Money)-Form WAM 23	03
CHAPTER 7	Proforma Of Bank Guarantee (In Lieu Of Security Deposit)-Form WAM 22	03
CHAPTER 8	Procedure For Conduct Of Conciliation Proceedings	11
CHAPTER 9	T&P Hire charges	10

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE :- N = 3820.773
E = (-) 2738.473

Registered Office
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Kolkata - 700 092

Title : **BORE LOG DATA SHEET**

DOC No. : CET/STF/01/0C
Page : 01/02

Project : GTI Work for 2x660MW Selo Ennor SEZ Coal Based STPP at ASH Dyke of NCTPS, Chennai.

Job No. 3388 Bore Hole No. 95(R1) (ID FAN AREA) Date 21.11.14.

Made by Shibaram Ghosh. Checked by .....

No. of SP Tests	21	Samples	Nos.	Commencement Date	: 19.11.14
No. of Vane (V) Test	-	Undisturbed (UDS)	07	Completion Date	: 21.11.14
Length of Casing SX:-	18.00M	Penetrometer (SPT)	21	Bore Hole Diameter	: 150M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 9.265M
Method of Boring	Shell & Wash	Water Sample (WS)	-	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15 Cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
Filled up Soil Consist of light grey, fly ash.			DS-01	0.50
		0 0 1 - - N=0 1	SPT-01	1.00 — 1.45
			UDS-01	2.00 — 2.45(S)
3.45 M		0 1 0 - - N=0 1	SPT-02	3.00 — 3.45
			UDS-02	4.00 — 4.45
Very Soft, Deep grey, Clayey Sandy Silt.		0 0 1 - - N=0 1	SPT-03	5.00 — 5.45
			UDS-03	6.00 — 6.45
7.00M		2 2 4 - - N=0 6	SPT-04	7.00 — 7.45
			UDS-04	8.00 — 8.45
Medium, light grey, Clayey Silt, with sand mixture		2 3 3 - - N=0 6	SPT-05	9.00 — 9.45
			UDS-05	10.00 — 10.45
			DS-02	11.00
11.50M		2 3 14 - - N=1 7	SPT-06	11.50 — 11.95
			DS-03	12.50
Very Stiff to Hard, Steel grey, clayey Silt with sand mixture			UDS-06	13.00 — 13.45
			DS-04	14.00
		6 8 8 - - N=1 6	SPT-07	14.50 — 14.95
			DS-05	15.50
			UDS-07	16.00 — 16.45
			DS-06	17.00
		11 19 24 - - N=4 3	SPT-08	17.50 — 17.95
			DS-07	18.50
			UDS-08	19.00 — 19.45
20.00M			DS-08	20.00
		13 20 32 - - N=52	SPT-09	20.50 — 20.95
			DS-09	21.50
Very dense, light brownish grey, Silty medium Sand.		15 33 61 - - N=94	SPT-10	22.00 — 22.45
			DS-10	23.00
		20 39 63 - - N=102	SPT-11	23.50 — 23.95
			DS-11	24.50
25.00M		17 28 32 - - N=60	SPT-12	25.00 — 25.45

'S' = Slip

C. E. Testing Company Pvt. Ltd.

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CO-ORDINATE:- ~~N = 3822·000~~ ~~E = (-) 2736·000~~

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Title : **BORE LOG DATA SHEET**

DOC No. : CET/STF/01/0C
Page : 02/02

Project : GTI Work for 2x660 MW Selā Ennor SEZ Coal Based STPP at Ash dyke of NCTPS Chennai.

Job No. 3388 Bore Hole No. 95 (R1) (ID FAN AREA) Date 21.11.14

Made by Shibaram Ghosh. Checked by .....

		Samples	Nos.		
No. of SP Tests	21			Commencement Date	: 19.11.14
No. of Vane (V) Test	—	Undisturbed (UDS)	07	Completion Date	: 21.11.14
Length of Casing 8"ϕ	18.00 M	Penetrometer (SPT)	21	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 9.265 M
Method of Boring Shell &	Wash	Water Sample (WS)	—	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15 cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
			DS-12	26·00
			UDS-09	26·50 — 26·62(R)
			DS-13	27·50
Hard, light brownish grey, silty clay.		13 21 31 - - N = 52	SPT-13	28·00 — 28·45
			DS-14	29·00
		10 22 32 - - N = 54	SPT-14	29·50 — 29·95
			DS-15	30·50
31·00 M		16 21 30 - - N = 51	SPT-15	31·00 — 31·45
Very dense, yellowish brown, silty course sand. obs:- kankars.			DS-16	32·00
		17 30 32 - - N = 62	SPT-16	32·50 — 32·95
34·00 M			DS-17	33·50
		10 21 20 - - N = 41	SPT-17	34·00 — 34·45
Hard, yellowish brownish grey, silty clay.			DS-18	35·00
35·60 M		31 43 59 - - N = 102	SPT-18	35·50 — 35·95
Very dense, brownish grey, silty course sand. obs:- kankars.			DS-19	36·50
		32 44 60 - - N = 104	SPT-19	37·00 — 37·45
			DS-20	38·00
		30 47 54 6cm 5cm N > 100 Penetration	SPT-20	38·50 — 38·85
39·50 M			DS-21	39·50
Hard, light grey, silty clay with course sand mixture		13 37 45R - - N = 82	SPT-21	40·00 — 40·45
40·00 M				
The bore hole is terminated at the depth of 40·00 m below EGL.				
FOR C.E. TESTING CO. PVT. LTD. Shibaram Ghosh.				

R = Refusal (Sample could not be recover due to hard strata).

C. E. Testing Company Pvt. Ltd.

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CO-ORDINATE :- N = 3790·000
E = (-) 2720·000

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Title : **BORE LOG DATA SHEET**

DOC No. : CET/STF/01/0C
Page : 01/02

Project : G.T.I. Workshop 6x660MW Solar Ennore SEZ Coal Based STPP at ASH Dyke of NCTPS Chennai

Job No. 3388 Bore Hole No. 97 (CHIMNEY AREA) Date 18.11.14

Made by Shibaram Ghosh. Checked by .....

		Samples	Nos.		
No. of SP Tests	20			Commencement Date	: 16.11.14
No. of Vane (V) Test	-	Undisturbed (UDS)	05	Completion Date	: 18.11.14.
Length of Casing SX!-	18·00m	Penetrometer (SPT)	20	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 9.320 m
Method of Boring Shell & Wash.		Water Sample (WS)	01	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15 cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
Filled up Soil Consist of light grey, fly ash.			DS-01	0·50
		0 0 1 - - N = 01	SPT-01	1·00 — 1·45
			UDS-01	2·00 — 2·45(S)
3·45 m		0 0 1 - - N = 01	SPT-02	3·00 — 3·45
Very Soft, deep grey Clayey Sandy Silt.			UDS-02	4·00 — 4·45
		0 0 1 - - N = 01	SPT-03	5·00 — 5·45
			UDS-03	6·00 — 6·45(S)
7·20m		2 4 4 - - N = 08	SPT-04	7·00 — 7·45
			UDS-04	8·00 — 8·45
Stiff to medium, light grey, Clayey Silt with Sand mixture.		7 8 8 - - N = 16	SPT-05	9·00 — 9·45
			UDS-05	10·00 — 10·45
			DS-02	11·00
		2 3 4 - - N = 07	SPT-06	11·50 — 11·95
12·50m			DS-03	12·50
			UDS-06	13·00 — 13·45
Medium dense, Steel grey to yellowish grey, Silty Sand.			DS-04	14·00
		7 8 13 - - N = 21	SPT-07	14·50 — 14·95
			DS-05	15·50
			UDS-07	16·00 — 16·45(S)
			DS-06	17·00
17·50m		9 19 24 - - N = 43	SPT-08	17·50 — 17·95
Hard, brownish grey, Clayey Silt with Sand mixture.			DS-07	18·50
			UDS-08	19·00 — 19·45
			DS-08	20·00
20·50m		14 17 17 - - N = 34	SPT-09	20·50 — 20·95
			DS-09	21·50
Dense, brownish grey, Silty medium Sand.			UDS-09	22·00 - 22·45(S)
			DS-10	23·00
		11 19 23 - - N = 42	SPT-10	23·50 — 23·95
			DS-11	24·50
		9 21 26 - - N = 47	SPT-11	25·00 — 25·45
			DS-12	26·00

'S' = Slip

C. E. Testing Company Pvt. Ltd.

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Registered Office
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Kolkata - 700 092

CO-ORDINATE:- N = 3790'000
E = (-) 2720'000

Title : **BORE LOG DATA SHEET**

DOC No. : CET/STF/01/0C
Page : 02/02

Project : G.T.I Work for 6X660MW Selo Ennor S.E.Z. Coal Based STPP at ASH Dyke of NCTPS. Chennai

Job No. 3388 Bore Hole No. 97 (CHIMNEY AREA) Date 18.11.14.

Made by Shibaram Ghosh. Checked by .....

No. of SP Tests	20	Samples	Nos.	Commencement Date	: 16.11.14
No. of Vane (V) Test	–	Undisturbed (UDS)	05	Completion Date	: 18.11.14.
Length of Casing SX:-	18.00M	Penetrometer (SPT)	20	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 9.320 m
Method of Boring Shell & Wash		Water Sample (WS)	01	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15Cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
← 26'50M →		14 30 36 – – N=66	SPT-12	26'50 – 26'95
Hard, light brownish grey, clayey Silt.			DS-13	27'50
			UDS-10	28'00 – 28'15(R)
			DS-14	29'00
		14 25 29 – – N=54	SPT-13	29'50 – 29'95
			DS-15	30'50
← 31'00M →		15 27 38 – – N=65	SPT-14	31'00 – 31'45
Very dense, brownish grey, Silty medium Sand.			DS-16	32'00
		14 27 43 – – N=70	SPT-15	32'50 – 32'95
			DS-17	33'50
← 34'00M →		17 19 26 – – N=45	SPT-16	34'00 – 34'45
Hard, light brownish grey, clayey Silt with kankars & calcarious.			DS-18	35'00
		17 25 31 – – N=56	SPT-17	35'50 – 35'95
			DS-19	36'50
		17 19 32 – – N=51	SPT-18	37'00 – 37'45
			DS-20	38'00
		19 21 33 – – N=54	SPT-19	38'50 – 38'95
			DS-21	39'50
← 40'00M →		40 76 52 for 3cm Penetration N/100	SPT-20	40'00 – ~~40'45~~ 40'33
The bore hole is terminated at the depth of 40'00M below EGL.				

FOR C.E.TESTING CO. PVT. LTD.
Shibaram Ghosh

'R' = (Refusal (Sample could not be collected due to hard strata).

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
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CO-ORDINATE :- N = 3410·000
E = (-) 3182·000

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Title : **BORE LOG DATA SHEET** (Cooling Tower Area)

DOC No. : CET/STF/01/0C
Page : 01/02

Project : GTI Work for 2X660 MW Sets at Ennor SEZ Coal Based STPP at Ash Dyke of NCTPS, Chennai

Job No. 3388 Bore Hole No. 114 (Cooling Tower Area) Date 26.11.14

Made by Shibaram Ghosh. Checked by

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 24.11.14.
No. of Vane (V) Test	-	Undisturbed (UDS)	03	Completion Date	: 26.11.14
Length of Casing SX:-	24'00m	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 8·935 M
Method of Boring Shell & Wash		Water Sample (WS)	-	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
Filled up Soil consist of light grey, fly ash			DS-01	0'50
2·45M		0 0 0 - - N= 0 0	SPT-01	1·00 — 1·45
Very Soft ~~to medium~~, steel grey to deep grey, Silty clay with Sand mixture			UDS-01	2·00 - 2·45(S)
		0 0 0 - - N= 0 0	SPT-02	3·00 - 3·45
			UDS-02	4·00 - 4·45 (S)
		0 0 1 - - N= 0 1	SPT-03	5·00 - 5·45
			UDS-03	6·00 - 6·45(S)
obs:- Micasist from SPT-04 - (7·00-7·45m)		0 1 1 - - N= 0 2	SPT-04	7·00 - 7·45
			UDS-04	8·00 — 8·45
9·00M		2 2 3 - - N= 0 5	SPT-05	9·00 — 9·45
Medium, light grey, clayey Silt with Sand mixture.			UDS-05	10·00 — 10·45(S)
			DS-02	11·00
obs:- Steel grey Patches		1 3 3 - - N= 0 6	SPT-06	11·50 — 11·95
			DS-03	12·50
			UDS-06	13·00 — 13·45(S)
			DS-04	14·00
14·50M		6 6 9 - - N= 1 5	SPT-07	14·50 — 14·45
Medium dense, Steel grey. Silty Sand with clay lamination			DS-05	15·50
			UDS-07	16·00 — 16·45
			DS-06	17·00
17·50M		8 7 12 - - N= 1 9	SPT-08	17·50 — 17·95
Very Stiff light grey, Silty Clay.			DS-07	18·50
			UDS-08	19·00 - 19·45
obs:- Steel grey Patches.			DS-08	20·00
20·50M		10 18 26 - - N= 4 4	SPT-09	20·50 — 20·95
Dense, light brownish grey, Silty Sand with clay lamination			DS-09	21·50
		10 18 28 - - N= 4 6	SPT-10	22·00 - 22·45
			DS-10	23·00
23·50M		10 21 26 - - N= 4 7	SPT-11	23·50 — 23·95

S = Slip

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE :- N = 3410·000
E = 3182·000

Registered Office
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Kolkata - 700 092

Title : **BORE LOG DATA SHEET**

DOC No. : CET/STF/01/0C
Page : 02/02

Project : GI Work for 2X660MW Sleo at Ennore SEZ Coal Based STPP at ASH Dyke of NCTPS. Chennai

Job No. 3388 Bore Hole No. 114 (COOLING TOWER AREA) Date 26.11.14

Made by Shibaram Ghosh Checked by

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 24.11.14
No. of Vane (V) Test	—	Undisturbed (UDS)	03	Completion Date	: 26.11.14.
Length of Casing SX:-	24·00m	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 8·935 M
Method of Boring Shell & Wash		Water Sample (WS)	—	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15 cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
Hard, light brownish grey, Silty clay / Clayey Silt with Sand mixture			DS-11	24·50
		12 24 26 — — N= 50	SPT-12	25·00 – 25·45
			DS-12	26·00
		12 20 25 — — N= 45	SPT-13	26·50 – 26·95
28·00M			DS-13	27·50
Hard, light brownish yellowish brown, clayey Silty (Sand mixture)		14 26 30 — — N= 56	SPT-14	28·00 – 28·45
			DS-14	29·00
		15 27 33 — — N= 60	SPT-15	29·50 – 29·95
			DS-15	30·50
31·00M		14 23 38 — — N= 61	SPT-16	31·00 – 31·45
Very dense, yellowish brown, clayey Silty Sand.			DS-16	32·00
		23 39 45 — — N= 88	SPT-17	32·50 – 32·95
			DS-17	33·50
34·00M		21 34 42 — — N= 76	SPT-18	34·00 – 34·45
Very dense, yellowish brown, Silty Sand.			DS-18	35·00
		20 40 54 — — N= 94	SPT-19	35·50 – 35·95
			DS-19	36·50
		25 45 60 — — N= 105	SPT-20	37·00 – 37·45
			DS-20	38·00
39·50		27 50 60 — — N= 110	SPT-21	38·50 – 38·95
Very dense, brownish grey, Silty Sand.			DS-21	39·50
		30 60 54 for 5cm N= 100 Penetration	SPT-22	40·00 – 40·35
40·00M				
The bore hole is terminated at the depth of 40·00M below EGL.				

FOR C.E. TESTING CO. PVT. LTD.
Authorised Signatory

C. E. TESTING COMPANY PVT. LTD.

Laboratory & Godown:-
Sardarpara, Brahmapur
Kolkata - 700 096

Co-ordinate
N: 3869
E: 12846

Registered Office: -
124-A, N.S.C. Bose Road, Kolkata – 92

Title: DYNAMIC CONE PENETRATION TEST DATA SHEET

DOC No. CET/STF/10/00
Page 1 of 1

Project: GTI work for 2×660MW sets at Ennore SE2 coal based STPP at ASH Dyke of NCTPS, Chennai.

Job No: 3388 Test No. : DCPT-12 (Power Head Area) Date: 04.12.14

Tested By: Rundu

Depth (M) From	Depth (M) To	No. of Blows Required	Depth (M) From	Depth (M) To	No. of Blows Required
0.00	0.10	0	2.30	2.40	2
0.10	0.20	0	2.40	2.50	1
0.20	0.30	0	2.50	2.60	1
0.30	0.40	0	2.60	2.70	2
0.40	0.50	1	2.70	2.80	1
0.50	0.60	1	2.80	2.90	1
0.60	0.70	1	2.90	3.00	1
0.70	0.80	1	3.00	3.10	0
0.80	0.90	1	3.10	3.20	1
0.90	1.00	1	3.20	3.30	0
1.00	1.10	2	3.30	3.40	1
1.10	1.20	1	3.40	3.50	0
1.20	1.30	2	3.50	3.60	1
1.30	1.40	1	3.60	3.70	0
1.40	1.50	2	3.70	3.80	2
1.50	1.60	2	3.80	3.90	1
1.60	1.70	2	3.90	4.00	2
1.70	1.80	1	4.00	4.10	2
1.80	1.90	1	4.10	4.20	1
1.90	2.00	2	4.20	4.30	1
2.00	2.10	1	4.30	4.40	1
2.10	2.20	1	4.40	4.50	1
12.20	2.30	1	4.50	4.60	1

C. E. TESTING COMPANY PVT. LTD.

Laboratory & Godown:-
Sardarpara, Brahmapur
Kolkata - 700 096

Co-ordinate :
N : 3869
E : 12846

Registered Office: -
124-A, N.S.C. Bose Road, Kolkata – 92

Title: DYNAMIC CONE PENETRATION TEST DATA SHEET

DOC No. CET/STF/10/00
Page 1 of 1

Project: GT 1 work for 2×660MW set at Ennore SEZ coal based STPP at ASH Dyke of NCTPS, Chennai.

Job No: 3388 Test No. : DCPT-12 (Power House Area) Date: 04.12.14

Tested By: Ramdev.

Depth (M)		No. of Blows Required	Depth (M)		No. of Blows Required
From	To		From	To	
4.60	4.70	1	6.90	7.00	1
4.70	4.80	1	7.00	7.10	2
4.80	4.90	1	7.10	7.20	2
4.90	5.00	0	7.20	7.30	2
5.00	5.10	1	7.30	7.40	2
5.10	5.20	1	7.40	7.50	3
5.20	5.30	0	7.50	7.60	2
5.30	5.40	1	7.60	7.70	3
5.40	5.50	1	7.70	7.80	3
5.50	5.60	1	7.80	7.90	3
5.60	5.70	1	7.90	8.00	2
5.70	5.80	1	8.00	8.10	4
5.80	5.90	2	8.10	8.20	3
5.90	6.00	2	8.20	8.30	3
6.00	6.10	2	8.30	8.40	3
6.10	6.20	2	8.40	8.50	4
6.20	6.30	1	8.50	8.60	3
6.30	6.40	1	8.60	8.70	4
6.40	6.50	2	8.70	8.80	4
6.50	6.60	1	8.80	8.90	4
6.60	6.70	1	8.90	9.00	5
6.70	6.80	2	9.00	9.10	5
6.80	6.90	2	9.10	9.20	5

C. E. TESTING COMPANY PVT. LTD.

Laboratory & Godown:-
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Kolkata - 700 096

Co-ordinate
N : 3869
E : (-) 2846

Registered Office: -
124-A, N.S.C. Bose Road, Kolkata – 92

Title: DYNAMIC CONE PENETRATION TEST DATA SHEET

DOC No. CET/STF/10/00
Page 1 of 1

Project: GTI work for 2X660 MW Sets at Ennore SEZ coal based STPP at Ash Dyke of NCTPS, Chennai

Job No: 3388 Test No. : DCPT-12 (Power House Area) Date: 04.12.14

Tested By: Munda

Depth (M)		No. of Blows Required	Depth (M)		No. of Blows Required
From	To		From	To	
9.20	9.30	5	11.50	11.60	17
9.30	9.40	6	11.60	11.70	34
9.40	9.50	6	11.70	11.80	43
9.50	9.60	7	11.80	11.90	31
9.60	9.70	7	11.90	12.00	24
9.70	9.80	7	12.00	12.10	35
9.80	9.90	9	12.10	12.20	28
9.90	10.00	8	12.20	12.30	29
10.00	10.10	8	12.30	12.40	27
10.10	10.20	7	12.40	12.50	25
10.20	10.30	7	12.50	12.60	30
10.30	10.40	8	12.60	12.70	29
10.40	10.50	9	12.70	12.80	27
10.50	10.60	8	12.80	12.90	30
10.60	10.70	7	12.90	13.00	35
10.70	10.80	8	13.00	13.10	27
10.80	10.90	8	13.10	13.20	36
10.90	11.00	9	13.20	13.30	24
11.00	11.10	10	13.30	13.40	25
11.10	11.20	13	13.40	13.50	29
11.20	11.30	14	13.50	13.60	24
11.30	11.40	14	13.60	13.70	26
11.40	11.50	18	13.70	13.80	33

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Laboratory & Godown:-
Sardarpara, Brahmapur
Kolkata - 700 096

Co-ordinate :
N : 3869
E : 2846

Registered Office: -
124-A, N.S.C. Bose
Road, Kolkata – 92

Title: DYNAMIC CONE PENETRATION TEST DATA SHEET

DOC No. CET/STF/10/00
Page 1 of 1

Project: GT1 work for 2X660MW set at Ennore SEZ coal based STPP at Ash Dyke of NCTPS, Chennai.

Job No: 3388 Test No. : DCPT-12 (Power House Area) Date: 06.12.16

Tested By: Mundu.

Depth (M) From	Depth (M) To	No. of Blows Required	Depth (M) From	Depth (M) To	No. of Blows Required
13.80	13.90	37			
13.90	14.00	42			
14.00	14.10	45			
14.10	14.20	52			
14.20	14.30	48			
14.30	14.40	57			
14.40	14.50	61			
14.50	14.60	55			
14.60	14.70	58			

for C.E. Testing Co(P) Ltd.
Mundu.

C. E. Testing Company Pvt. Ltd.

Phones : 2428-6221
2428-6222
2428-6223
Fax : (033) 2428-6220

Laboratory & Godown:-
Sardarpara, Brahmapur
Kolkata - 700 096

Registered Office: -
124-A, N.S.C.Bose Rd.,
Kolkata - 700 092

DOC No. CET/STT/08/00

Page of

FIELD DATA SHEET FOR ELECTRICAL RESISTIVITY TEST (ERT)

Project : GTI Work for 2X660 MW Ennore SEZ at ~~NTPEL~~ NCTPS, Chennai.

Job No. 3388 | ERT No. 24 (ID Fans) | Date : 6/12/19

Co ordinates : N = 3668.000, E = 2730.000 | R.L. 9.270 m | Tested by.

Direction: N – S

Sl. No.	S (Mtr.)	K (2.π.S.)	C (Current unit)	P (Potential Unit)	R (Resistance in Ohm.)	ξ (Resistivity in Ohm.- m.)	ξ (Average Resistivity in Ohm.- m).
1	1.0	6.29	0.10	1.0	0.85	0.53	
2	2.0	12.57	0.10	1.0	0.35	0.44	
3	3.0	18.86	0.10	1.0	0.25	0.47	
4	4.0	25.14	0.10	1.0	0.20	0.50	
5	5.0	31.43	0.10	1.0	0.16	0.50	
6	7.0	44.00	0.10	1.0	0.13	0.57	
7	10.0	62.86	0.10	1.0	0.12	0.75	

Direction: E – W

Sl. No.	S (Mtr.)	K (2.π.S.)	C (Current unit)	P (Potential Unit)	R (Resistance in Ohm.)	ξ (Resistivity in Ohm.- m.)	ξ (Average Resistivity in Ohm.- m).
1	1.0	6.29	0.10	1.0	0.78	0.49	
2	2.0	12.57	0.10	1.0	0.31	0.39	
3	3.0	18.86	0.10	1.0	0.24	0.45	
4	4.0	25.14	0.10	1.0	0.19	0.48	
5	5.0	31.43	0.10	1.0	0.13	0.41	
6	7.0	44.00	0.10	1.0	0.11	0.48	
7	10.0	62.86	0.10	1.0	0.10	0.63	

ERT_Format

Page 1 of 1

for CETEST

C. E. Testing Company Pvt. Ltd.

Phones : 2428-6221
2428-6222
2428-6223
Fax : (033) 2428-6220

Laboratory & Godown:-
Sardarpara, Brahmapur
Kolkata - 700 096

Registered Office: -
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Kolkata - 700 092

FIELD DATA SHEET FOR ELECTRICAL RESISTIVITY TEST (ERT)

DOC No. CET/STT/08/00

Page of

Project :

Job No. 3388 ERT No. 24 (ID Fans) Date : 6/12/14

Co ordinates : N= 3668.000 E=(-) 2730.680 R.L. 9.270 m

Tested by.

Direction: NE-SW

Sl. No.	S (Mtr.)	K (2.π.S.)	C (Current unit)	P (Potential Unit)	R (Resistance in Ohm.)	ξ (Resistivity in Ohm.- m.)	ξ (Average Resistivity in Ohm.- m).
1	1·0	6·29	0·10	1·0	0·79	0·50	
2	2·0	12·57	0·10	1·0	0·34	0·43	
3	3·0	18·86	0·10	1·0	0·24	0·45	
4	4·0	25·14	0·10	1·0	0·19	0·48	
5	5·0	31·43	0·10	1·0	0·15	0·47	
6	7·0	44·00	0·10	1·0	0·13	0·57	
7	10·0	62·86	0·10	1·0	0·11	0·69	

Direction: NW-SE

Sl. No.	S (Mtr.)	K (2.π.S.)	C (Current unit)	P (Potential Unit)	R (Resistance in Ohm.)	ξ (Resistivity in Ohm.- m.)	ξ (Average Resistivity in Ohm.- m).
1	1·0	6·29	0·10	1·0	0·82	0·52	
2	2·0	12·57	0·10	1·0	0·34	0·43	
3	3·0	18·86	0·10	1·0	0·26	0·49	
4	4·0	25·14	0·10	1·0	0·21	0·53	
5	5·0	31·43	0·10	1·0	0·16	0·50	
6	7·0	44·00	0·10	1·0	0·15	0·66	
7	10·0	62·86	0·10	1·0	0·12	0·75	

for, CETEST

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Laboratory & Godown:-
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Kolkata - 700 096

Registered Office: -
124-A, N.S.C. Bose Rd.,
Kolkata - 700 092

Title:PERMEABILITY TEST(FALLING HEAD METHOD) DATA SHEET	DOC No. CET/STF/03/00 Page 1 of 1

1) Test No: 01
2) Test Location : BH=>81 (1'5M) ESP, ESP CR, Bkr. Boiler
   a) Coordinates : N=> 3816'000.E=>(-) 2846'000
   b) Elevation of Ground : 9'173 M
   c) Elevation of Ground Water Table : 1'30 M below EGL
   d) Diameter of the Intake Pipe (d) : 150 M.M.
   e) Length of the Test Section (L) : 2'00 M – 1'30M = 0'70M
   f) Water Level at Time t_0 (h_0) : 00

Job No: 3388

Project : G.T.I. Work for 2X660MW Sets at Ennor SEZ Coal Based STPP at ASH Dyke of NCTPS. Chennai.

Date: 02.12.14.

Made by : Shibaram Ghosh .Checked by: .....

Sl. No.	Time in Min	Water level in the Intake Pipe In cm	Height of water level at Time t, H_t = Water Level in the intake Pipe – Elevation of the Ground Water Table.
1	1	4'0	
2	2	9'0	
3	3	13'0	
4	4	16'0	
5	5	19'0	
6	10	35'0	
7	15	43'0	
8	20	52'0	
9	25	62'0	
10	30	69'0	
11	45	75'0	
12	60	84'0	
13	90	102'0	
14	120	115'0	
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

FOR C.E. TESTING CO. PVT. LTD.
Shibaram Ghosh

C. E. TESTING COMPANY PVT. LTD.

Laboratory & Godown:-
Sardarpara, Brahmapur
Kolkata - 700 096

Registered Office: -
124-A, N.S.C. Bose Rd.,
Kolkata - 700 092

Title:PERMEABILITY TEST(FALLING HEAD METHOD) DATA SHEET	DOC No. CET/STF/03/00 Page 1 of 1

1) Test No: 02
2) Test Location : BH => 81 (4'5M) ESP, ESPCR, Aux. Boiler
   a) Coordinates : N => 3816'000 . E => (-) 2846'000
   b) Elevation of Ground : 9'173 M.
   c) Elevation of Ground Water Table : 1'30 M below EGL.
   d) Diameter of the Intake Pipe (d) : 150 M.M.
   e) Length of the Test Section (L) : 5'00M – 4'30M = 0'70M
   f) Water Level at Time t_0 (h_0) : 00

Job No: 3388

Project : G.T.I. Work for 2x660MW Sets at Ennor SEZ Coal Based STPP at ASH Dyke of NCTPS, Chennai

Date: 03.12.14.

Made by : Shibaram Ghosh ..... Checked by: .....

Sl. No.	Time in Min	Water level in the Intake Pipe In cm	Height of water level at Time t, H_t = Water Level in the intake Pipe – Elevation of the Ground Water Table.
1	1	5'0	
2	2	10'0	
3	3	15'0	
4	4	19'0	
5	5	25'0	
6	10	36'8	
7	15	47'2	
8	20	56'6	
9	25	64'4	
10	30	70'8	
11	45	85'7	
12	60	97'0	
13	90	112'0	
14	120	121'6	
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			

FOR C.E.TESTING CO.PVT.LTD.
Shibaram Ghosh

ANNEXURE-I

Page (1/3)

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE :- N = 3410·000
E = (-) 3182·000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : **BORE LOG DATA SHEET** (Cooling Tower Area)

DOC No. : CET/STP/01/00
Page : 01/02

Project : GTI Work for 2X660 MW Sets at Ennor SEZ Coal Based STPP at Ash Dyke of NCTPS, Chennai

Job No. 3388 Bore Hole No. 114 (Cooling Tower Area) Date 26.11.14

Made by Shibaram Ghosh. Checked by .....

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 24.11.14.
No. of Vane (V) Test	-	Undisturbed (UDS)	03	Completion Date	: 26.11.14
Length of Casing S/-	24'00m	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 8'935 M
Method of Boring	Shell & Wash	Water Sample (WS)	-	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
Filled up Soil consist of light grey, fly ash.			DS-01	0'50
2·45M		0 0 0 - - N= 0 0	SPT-01	1'00 — 1·45
Very Soft to medium, steel grey to deep grey, Silty clay with Sand mixture			UDS-01	2'00 - 2'45(S)
		0 0 0 - - N= 0 0	SPT-02	3'00 - 3·45
			UDS-02	4'00 - 4·45(S)
		0 0 1 - - N= 0 1	SPT-03	5'00 - 5·45
			UDS-03	6'00 - 6·45(S)
OBS:- Micasist from SPT-04-(7·00-7·45M)		0 1 1 - - N= 0 2	SPT-04	7·00 - 7·45
9·00M			UDS-04	8·00 — 8·45
		2 2 3 - - N= 0 5	SPT-05	9·00 - 9·45
Medium, light grey, clayey Silt with Sand mixture.			UDS-05	10'00 - 10·45(S)
			DS-02	11'00
OBS:- Steel grey Patches		1 3 3 - - N= 0 6	SPT-06	11·50 — 11·95
			DS-03	12'50
			UDS-06	13'00 - 13·45(S)
			DS-04	14'00
14·50M		6 6 9 - - N= 1 5	SPT-07	14·50 - 14·45
Medium dense, Steel grey. Silty Sand with clay lamination			DS-05	15·50
			UDS-07	16·00 — 16·45
			DS-06	17·00
17·50M		8 7 12 - - N= 1 9	SPT-08	17·50 - 17·95
Very Stiff light grey, Silty Clay.			DS-07	18·50
			UDS-08	19·00 - 19·45
OBS:- Steel grey Patches.			DS-08	20·00
20·50M		10 18 26 - - N= 4 4	SPT-09	20·50 - 20·95
Dense, light brownish grey, Silty Sand with clay lamination			DS-09	21·50
		10 18 28 - - N= 4 6	SPT-10	22·00 - 22·45
			DS-10	23·00
23·50M		10 21 26 - - N= 4 7	SPT-11	23·50 - 23·95

S = Slip

ANNEXURE-I

Page 2/8

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE :- N = 3410·000
E = 3182·000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : **BORE LOG DATA SHEET**

DOC No. : CET/STF/01/0C
Page : 02/02

Project : GI Work for 2X660MW Stage at Ennore SEZ Coal Based STPP at ASH Dyke of NCTPS, Chennai

Job No. 3388 Bore Hole No. 114 (Cooling Tower Area) Date 26.11.14

Made by Shibaram Ghosh Checked by

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 24.11.14
No. of Vane (V) Test	–	Undisturbed (UDS)	03	Completion Date	: 26.11.14.
Length of Casing SX:-	24·00m	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 8·935 M
Method of Boring Shell & Wash		Water Sample (WS)	–	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15 cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
Hard, light brownish grey, Silty clay / Clayey Silt with Sand mixture			DS-11	24·50
		12 24 26 – – N=50	SPT-12	25·00 – 25·45
			DS-12	26·00
		12 20 25 – – N=45	SPT-13	26·50 – 26·95
28·00m			DS-13	27·50
		14 26 30 – – N=56	SPT-14	28·00 – 28·45
Hard, Light brownish yellowish brown, clayey Silty (Sand mixture)			DS-14	29·00
		15 27 33 – – N=60	SPT-15	29·50 – 29·95
			DS-15	30·50
31·00m		14 23 38 – – N=61	SPT-16	31·00 – 31·45
Very dense, yellowish brown, clayey Silty Sand.			DS-16	32·00
		23 39 45 – – N=88	SPT-17	32·50 – 32·95
			DS-17	33·50
34·00m		21 34 42 – – N=76	SPT-18	34·00 – 34·45
Very dense, yellowish brown, Silty Sand.			DS-18	35·00
		20 40 54 – – N=94	SPT-19	35·50 – 35·95
			DS-19	36·50
		25 45 60 – – N=105	SPT-20	37·00 – 37·45
			DS-20	38·00
39·50		27 50 60 – – N=110	SPT-21	38·50 – 38·95
Very dense, brownish grey, Silty Sand.			DS-21	39·50
		30 60 54 for 5cm N=190	SPT-22	40·00 – 40·35
		Penetration		
40·00m				

The bore hole is terminated at the depth of 40·00m below EGL.

FOR C.E. TESTING CO. PVT. LTD.
Authorised Signatory

ANNEXURE – I – Page – (3/8)

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE : N = 3345'000
E = (+) 3294'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : **BORE LOG DATA SHEET**

DOC No. : CET/STR/01/0C
Page : 01/02

Project : GTI Work for 2x660MW Set5 at Ennore S.E.Z. Coal Based S.T.P. at ASH Dyke of NCTPS, Chennai

Job No. 3388 Bore Hole No. 115 (Cooling Tower) Date 03/12/14

Made by Shibaram Ghosh Checked by Rendu

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 01.12.14
No. of Vane (V) Test	–	Undisturbed (UDS)	03	Completion Date	: 03.12.14
Length of Casing SX'-	20'00M	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 9.239 M.
Method of Boring Shell & Wash		Water Sample (WS)	–	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15 Cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
Filled up Soil Consist of light grey, fly ash.			DS-01	0'50
2'45M		0 0 0 – – N= 0 0	SPT-01	1'00 – 1'45
			UDS-01	2'00 – 2'45(S)
		0 0 0 – – N= 0 0	SPT-02	3'00 – 3'45
Very Soft, Steel grey to deep grey, Silty Clay with Sand mixture.			UDS-02	4'00 – 4'45(S)
		0 0 0 – – N= 0 0	SPT-03	5'00 – 5'45
			UDS-03	6'00 – 6'45(S)
		0 0 1 – – N= 0 1	SPT-04	7'00 – 7'45
9'00M			UDS-04	8'00 – 8'45(S)
		0 0 1 – – N= 0 1	SPT-05	9'00 – 9'45
Very Soft, deep grey, Clayey Silt with Sand mixture; 065'- Micaceous.			UDS-05	10'00 – 10'45
11'50M			DS-02	11'00
		0 1 1 – – N= 0 2	SPT-06	11'50 – 11'95
Very Soft to medium, Steel grey, Clayey Silt with Sand mixture			DS-03	12'50
			UDS-06	13'00 – 13'45
			DS-04	14'00
		3 4 4 – – N= 0 8	SPT-07	14'50 – 14'95
			DS-05	15'50
			UDS-07	16'00 – 16'45
17'50M			DS-06	17'00
Very Stiff, brownish grey, clayey silt.		8 11 17 – – N= 2 8	SPT-08	17'50 – 17'95
065'- Steel grey Patches			DS-07	18'50
19'00M			UDS-08	19'00 – 19'45(S)
Brownish grey, Silty fine Sand.			DS-08	20'00
20'50M		11 23 23 – – N= 4 6	SPT-09	20'50 – 20'95
Dense to very dense, brownish grey, Silty Coarse Sand with Clay lamination			DS-09	21'50
		12 22 25 – – N= 4 7	SPT-10	22'00 – 22'45
			DS-10	23'00
		14 21 26 – – N= 4 7	SPT-11	23'50 – 23'95
25'00M			DS-11	24'50
		24 33 40 – – N= 7 3	SPT-12	25'00 – 25'45

S = Slip

ANNEXURE-I — Page 4/8

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE:- N = 3345·000
E = (-) 3294·000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : BORE LOG DATA SHEET

DOC No. : CET/STR/01/0C
Page : 02/02

Project : G.T.Z Works for 2X660MW Sets at Ennat SEZ Coal Based STPP at ASH Dyke of NCTPS, Chennai

Job No. 3388 Bore Hole No. 115 (Cooling Tower) Date 03/12/14

Made by Shibaram Ghosh Checked by Bandu

		Samples	Nos.		
No. of SP Tests	22	Undisturbed (UDS)	03	Commencement Date	: 01.12.14
No. of Vane (V) Test	–	Penetrometer (SPT)	22	Completion Date	: 03.12.14
Length of Casing SX'-	20·00M	Disturbed (DS)	21	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Water Sample (WS)	--	Level of Ground	: 9·239 m.
Method of Boring Shell &	Wash			Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15 cm Penetration)				SAMPLES	
						Ref. No.	Depth (m)
Very dense, brownish grey, Silty Course sand. Obs: Kankars.		26	39	45	N = 84	DS-12	26·00
						SPT-13	26·50 – 26·95
29·00M		22	40	48	N = 88	DS-13	27·50
						SPT-14	28·00 – 28·45
Hard, yellowish brown Silty clay. Obs:- Steel grey Patches.		11	21	27	N = 48	DS-14	29·00
						SPT-15	29·50 – 29·95
31·00M		10	26	20	N = 46	DS-15	30·50
						SPT-16	31·00 – 31·45
		11	20	26	N = 46	DS-16	32·00
						SPT-17	32·50 – 32·95
Hard, yellowish brown Silty clay with Course Sand mixture. Obs:- grey Patches. Kankars.		13	22	27	N = 49	DS-17	33·50
						SPT-18	34·00 – 34·45
		10	21	30	N = 51	DS-18	35·00
						SPT-19	35·50 – 35·95
		11	20	32	N = 52	DS-19	36·50
						SPT-20	37·00 – 37·45
38·50M		12	22	37	N = 59	DS-20	38·00
						SPT-21	38·50 – 38·95
Very dense, light brownish grey, Silty medium Sand. Obs:- Clay lamination		17	30	51	N = 81	DS-21	39·50
						SPT-22	40·10 – 40·55
40·10M							
The bore hole is terminated at the depth of 40·10M below E.G.L.							

FOR C.E. TESTING CO. PVT. LTD.
Shibaram Ghosh

ANNEXURE-I — Page-5/6

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATES: N = 3390'000
E = (-)3340'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : **BORE LOG DATA SHEET**

DOC No. : CET/STR/01/0C
Page : 01/02

Project : GTI Work for 2X660 MW Sets at Ennore SEZ Road Based STEP at ASH Dyke of NCTPS, Chennai

Job No. 3388 Bore Hole No. 116 (Cooling Tower) Date 29.11.14

Made by Shibesram Ghosh Checked by

		Samples	Nos.		
No. of SP Tests	22	Undisturbed (UDS)	04	Commencement Date	: 27.11.14
No. of Vane (V) Test	–	Penetrometer (SPT)	22	Completion Date	: 29.11.14
Length of Casing SX:-	24'00m	Disturbed (DS)	21	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Water Sample (WS)	00	Level of Ground	: 10.186 M
Method of Boring	Shell & Auger			Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15 Cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
Filled up Soil Consist of light grey, fly ash		0 0 0 – – N= 0 0	DS-01	0'50
			SPT-01	1'00 — 1'45
			UDS-01	2'00 — 2'45 (S)
3'00M		0 0 0 – – N= 0 0	SPT-02	3'00 — 3'45
Very Soft, brownish grey, Clayey Silt with Sand mixture.			UDS-02	4'00 — 4'45 (S)
		0 0 1 – – N= 0 1	SPT-03	5'00 — 5'45
			UDS-03	6'00 — 6'45 (S)
7'00M		0 1 1 – – N= 0 2	SPT-04	7'00 — 7'45
			VDS-04	8'00 — 8'45
Soft ~~to Medium~~, light grey clayey Silt with Sand mixed, obs:- Steel grey Patches.		0 1 1 – – N= 0 2	SPT-05	9'00 — 9'45
			UDS-05	10'00 — 10'45
			DS-02	11'00
11'50M		1 1 2 – – N= 0 3	SPT-06	11'50 — 11'95
			DS-03	12'50
			UDS-06	13'00 — 13'45 (S)
Soft to Medium, light grey, Clayey Silt with Sand mixed.			DS-04	14'00
		1 2 3 – – N= 0 5	SPT-07	14'50 — 14'95
			DS-05	15'50
			UDS-07	16'00 — 16'45
			DS-06	17'00
		3 4 4 – – N= 0 8	SPT-08	17'50 — 17'95
			DS-07	18'50
19'00M			UDS-08	19'00 — 19'45
Brownish grey, Silty clay.			DS-08	20'00
20'50M		11 20 29 – – N= 4 9	SPT-09	20'50 — 20'95
			DS-09	21'50
Dense to Very dense, brownish grey, Silty Course Sand.		13 22 52 – – N= 5 4	SPT-10	22'00 — 22'45
			DS-10	23'00
obs:- Steel grey Patches, Clay Lamination, Kankars.		12 21 29 – – N= 5 0	SPT-11	23'50 — 23'95
			DS-11	24'50
		12 22 30 – – N= 5 2	SPT-12	25'00 — 25'45

S = Slip

ANNEXURE-I — Page No. 6/8

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE :- N = 3390'000
E = (-) 3340'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : **BORE LOG DATA SHEET**

DOC No. : CET/STR/01/0C
Page : 02/02

Project : GTI Work for 2X660 MW Sets at Ennore SEZ Coal Based STPP at Ash Dyke of NCTPS, Chennai.

Job No. 3388 Bore Hole No. 116 (Cooling Tower.) Date 29.11.14

Made by Shibaram Ghosh. Checked by .....

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 27.11.14
No. of Vane (V) Test	-	Undisturbed (UDS)	04	Completion Date	: 29.11.14
Length of Casing SX:-	24'00m	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 MM
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 10.188 M.
Method of Boring	Shell & Wash	Water Sample (WS)	-	Water Struck At	: -
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15cm Penetration)							SAMPLES Ref. No.	SAMPLES Depth (m)
Very dense, brownish grey, Silty Course Sand, obs:- Steel grey patches, clay laminations, Kankars.									DS-12	26'00
		13	24	38	-	-	N=	62	SPT-13	26'50 — 26'95
									DS-13	27'50
		14	23	40	-	-	N=	63	SPT-14	28'00 — 28'45
29'00m									DS-14	29'00
Hard, yellowish brown, Silty clay. obs:- grey patches, Sand mixed.		12	22	30	-	-	N=	52	SPT-15	29'50 - 29'95
									DS-15	30'50
		13	24	32	-	-	N=	56	SPT-16	31'00 - 31'45
									DS-16	32'00
		14	27	40	-	-	N=	67	SPT-17	32'50 - 32'95
34'00m									DS-17	33'50
Very dense, brownish grey, Silty Course Sand, obs:- Clay laminations, Kankars.		14	27	41	-	-	N=	68	SPT-18	34'00 — 34'45
									DS-18	35'00
		26	60	45	-	-	N=	105	SPT-19	35'50 — 38'95
37'00m									DS-19	36'50
Very dense, yellowish, brownish grey, Silty Course Sand obs:- Kankars.		22	44	51	-	-	N=	95	SPT-20	37'00 — 37'45
									DS-20	38'00
		24	39	48	-	-	N=	87	SPT-21	38'50 — 38'95
40'10m									DS-21	39'50
		29	38	42	-	-	N=	80	SPT-22	40'10 — 40'55
The bore hole is terminated at the depth of 40'10m. below EGL.										

FOR C.E. TESTING CO. PVT. LTD.
Shibaram Ghosh

ANNEXURE-I Page - (41/8)

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE: N = 3345'000
E = (-) 3294'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : BORE LOG DATA SHEET

DOC No. : CET/STH/01/0C
Page : 01/02

Project : G.T.I. Work for 2X660 MW at Eamor SEZ Coal based TPP at ASH Dyke of NCTPS...

Job No. 3388 Bore Hole No. 117 (Cooling Tower) Date 01.12.14

Made by Shibaram Ghosh Checked by Mandy.

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 29.11.14
No. of Vane (V) Test	–	Undisturbed (UDS)	03	Completion Date	: 01.12.14
Length of Casing SX:-	20'00M	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	–	Disturbed (DS)	21	Level of Ground	: 10'775 M.
Method of Boring Shell & Wash		Water Sample (WS)	–	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15 cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
Filled up Soil Consist of light grey, fly Ash			DS-01	0'50
		0 0 0 – – N=0 0	SPT-01	1'00 – 1'45
2'00M		0 0 0 – – N=0 0	SPT-02	2'00 – 2'45
Very Soft, Stiff grey to deep grey, Silty Clay with Sand mixture		0 0 0 – – N=0 0	SPT-03	3'00 – 3'45
			UDS-01	4'00 – 4'45(S)
5'00M		0 0 0 – – N=0 0	SPT-04	5'00 – 5'45
Very Soft, brownish grey, Silty Clay.			UDS-02	6'00 – 6'45(S)
		0 0 1 – – N=0 1	SPT-05	7'00 – 7'45
			UDS-03	8'00 – 8'45
9'00M		0 0 1 – – N=0 1	SPT-06	9'00 – 9'45
			UDS-04	10'00 – 10'45
Very Soft, deep grey, Silty Clay.			DS-02	11'00
		0 0 1 – – N=0 1	SPT-07	11'50 – 11'95
			DS-03	12'50
			UDS-05	13'00 – 13'45
14'00M			DS-04	14'00
Loose, yellowish grey, Silty Sand.		3 4 5 – – N=0 9	SPT-08	14'50 – 14'95
			DS-05	15'50
			UDS-06	16'00 – 16'45(S)
17'50M		12 20 24 – – N=4 4	DS-06	17'00
Hard, light brownish grey, Silty Clay with high Percentage of Sand.			SPT-09	17'50 – 17'95
			DS-07	18'50
			UDS-07	19'00 – 19'45
20'50M		12 18 22 – – N=4 0	DS-08	20'00
Hard, yellowish grey, Silty Clay with high Percentage of Coarse Sand.			SPT-10	20'50 – 20'95
		14 24 30 – – N=5 4	DS-09	21'50
23'00M			SPT-11	22'00 – 22'45
Very dense, brownish grey, Silty Coarse Sand.			DS-10	23'00
		16 27 38 – – N=6 5	SPT-12	23'50 – 23'95
		20 32 45 – – N=7 7	DS-11	24'50
			SPT-13	25'00 – 25'45
			DS-12	26'00

S = Slip

ANNEXURE-I Page 98

C. E. Testing Company Pvt. Ltd.

Laboratory & Godown
Sardarpara, Brahmapur
Kolkata - 700 096

CO-ORDINATE:- N = 3345'000
E = (-) 3294'000

Registered Office
124-A, N. S. Bose Road
Kolkata - 700 092

Title : BORE LOG DATA SHEET

DOC No. : CET/STR/01/0C
Page : 02/02

Project : G.T.I. Work for 2x660 MW Sets at Ennore SEZ Coal Based STPP at ASH Dyke of NCTPS Chennai

Job No. 3388 Bore Hole No. 117 (Cooling Tower) Date 01.12.14

Made by Shibaram Ghosh Checked by

No. of SP Tests	22	Samples	Nos.	Commencement Date	: 29.11.14
No. of Vane (V) Test	–	Undisturbed (UDS)	03	Completion Date	: 01.12.14
Length of Casing SW	20.00M	Penetrometer (SPT)	22	Bore Hole Diameter	: 150 M.M.
SPT done by (M/H)	H	Disturbed (DS)	21	Level of Ground	: 10.775 M.
Method of Boring Shell	Wash	Water Sample (WS)	–	Water Struck At	:
				Standing Water Level	:

DESCRIPTION	SYMBOL	N-VALUE (Each 15 cm Penetration)	SAMPLES Ref. No.	SAMPLES Depth (m)
Very dense, brownish grey, Silty Course Sand.		21 30 42 – – N= 72	SPT-14	26.50 – 26.95
			DS-13	27.50
27.00 M		11 19 27 – – N= 46	SPT-15	28.00 – 28.45
Hard, yellowish brown, Silty clay, obs:- Steel grey Patches			DS-14	29.00
		12 20 26 – – N= 46	SPT-16	29.50 – 29.95
			DS-15	30.50
			UDS-08	31.00 – 31.15 (R)
			DS-16	32.00
32.50 M Hard, brownish grey, Silty clay, obs:- yellowish Patches.		13 21 27 – – N= 48	SPT-17	32.50 – 32.95
34.00 M			DS-17	33.50
		22 30 35 – – N= 65	SPT-18	34.00 – 34.45
Very dense, brownish grey, Silty Course Sand. obs:- Kankars.			DS-18	35.00
		27 43 57 – – N= 100	SPT-19	35.50 – 35.95
			DS-19	36.50
		20 38 56 – – N= 94	SPT-20	37.00 – 37.45
			DS-20	38.00
		22 40 59 – – N= 99	SPT-21	38.50 – 38.95
40.00 M			DS-21	39.50
		25 35 40 – – N= 75	SPT-22	40.00 – 40.45
The bore hole is terminated at the depth of 40.00 M below EGL.				

FOR C.E. TESTING CO. PVT. LTD.
Shibaram Ghosh

R = Refusal (Sample could not be recover due to hard strata)

	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 plasti9c cisterns
	f)	IS-783	:	Code of practice for laying of concrete piles
	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 (Part-XVI)	:	Method of measurement : Laying of water and sewer lines including appurtenant items
q)	IS-1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage
r)	IS-1537	:	Vertically cast iron pressure pipe for water, gas and sewage
s)	IS-3486	:	Cast iron spigot and socket drain pipes
t)	IS-5329	:	Code of practice for sanitary pipe work above ground for buildings
u)	IS-3076	:	Low density polyethylene pipes for potable water supplies
v)	IS-1538	:	Cast iron fittings for pressure pipes for potable water supplies
w)	IS-1230	:	Cast iron rainwater pipes and fittings
x)	IS-1729	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
y)	IS-784	:	Pre-stressed concrete pipes
z)	IS-1726	:	Cast iron manhole covers and frames
aa)	IS-5961	:	Cast iron grating for drainage purposes
bb)	IS-5219 [Part-I)	:	"P" and "S" traps
cc)	IS-772	:	General requirements for enameled cast iron sanitary

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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

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

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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.

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	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) under-coating, (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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2.00.00 SCOPE OF CIVIL & STRUCTURAL WORKS

2.01.00 This specification is to cover design, preparation of general arrangement, construction as well as fabrication drawings, supply of all labour as well as materials and construction of all civil, structural as well as architectural work on EPC basis.

2.02.00 The work to be performed under this specification consist of design, engineering as well as providing all labour, materials, consumables, equipment, temporary works, temporary labour, constructional plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications and including revisions and amendments thereto as may be required during the execution of the work.

2.03.00 All materials including cement, reinforcement steel, structural steel etc. shall be arranged by the Contractor.

2.04.00 The scope shall also including setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests as per BIS or other international standards required for the civil works for the project.

2.05.00 The work shall be carried out according to the design/drawings to be developed by the Contractor and approved by the Purchaser. For all building and structures, foundations, etc. necessary layout and details are to be developed by the Contractor keeping in view the statutory & functional requirements of the plant & facilities and providing enough space & access for operation, use & maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the Contractor's offer shall cover the complete requirements of the plant & facilities and providing enough space & access for operation, use & maintenance. Also the Contractor's offer shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the Purchaser.

2.06.00 Description of various items of work under this specification and nature of work in detail are given hereinafter, but not limited to the items listed below. The complete work under this scope is referred to as CIVIL WORKS. List of various civil works covered under the scope is given below:

1. Turbine building foundation including Turbo-generator foundation and superstructure including service and maintenance bays.
2. Switch Gear and Control Room including Compressor house, D.G. set room and Co2 room.
3. Steam Generator Elevator supporting structure.
4. Foundation for steam generator / ESP / duct supporting structure & other equipments.
5. ESP control room.
6. Mill and bunker building including bunker structures & Mill Foundations.
7. Steel Mill reject silo and foundations to be provided for the same.

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8. Foundations for various fans and fan handling system.
9. RCC chimney of 275m height with twin flues.
10. Ash pipe supporting structure both for bottom ash and fly ash (100% dry collection) from plant area upto RCC silo & wet fly ash slurry pipe & supports from silo to ash dyke.
11. Ash / mill reject handling system structures.
12. Fly ash silos.
13. Ash slurry pump house & ash compression house.
14. Buffer hopper tower.
15. Ash handling electrical/ Control room.
16. Intake pump house & channel near existing cooling water forebay of NCTPS-stage II with modification of existing forebay at intake point.
17. Pipe line to carry water from proposed pump house near existing forebay of NCTPS-stage II to proposed power plant area. Pipe line will be supported on RCC piers.
18. Cooling water (CW) pump house, sump including forebay, CW inlet and outlet conduits.
19. Cascade aerator, partial flume, clarifier, reject sump, RO Plant stage –I, RO stage-II, Permeate storage tank , Pump house.
20. RCC CW ducts from CW pump house to Turbine building, Turbine building to cooling tower and RCC channel from cooling tower to CW pump house forebay.
21. Natural draft cooling tower including basin and other apparatus.
22. Service water overhead tank, DM water storage tank, potable water tank, Condensate storage tank & Condensate polishing unit. Capacity to be provided for overhead water tank shall be 500m3 are as mechanical requirement whichever is higher.
23. Filtered Water Pumphouse/ fire water pumphouse & Filtered water reservoir/ fire water storage tank.
24. Clarified water storage tank and pump house.
25. Dual Media filters.
26. DM Plant – Eye washer & whole body shower shall be provided in DM plant area for emergency. Also a building for testing lab for coal, water, chemicals etc., in DM plant should be provided.
27. Electrochlorination Building.

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28. Chemical house and bulk chemical area.
29. Neutralization pit, effluent treatment plant & sewage treatment plant.
30. Rain water harvesting pond **earthen construction.**
31. Guard pond and pump house.
32. Foundation of various water pumps.
33. Fuel oil tank (2x3000 KL) Foundation, Fuel oil pump house, fuel oil storage tank dyke area.
34. **External Coal Handling System from JTB-3** upto western side NCTPS Stage I compound wall and pipe conveyors from NCTPS Stage I to plant area with trestles and necessary transfer points.

    From JTB-3 to TH1 -open belt conveyor with all sides completely covered as indicated in layout of ICHP drawing.

    From TH1 to crusher house -pipe conveyor shall be proved by EPC contractor.

    All civil works including foundation for above itemsis in the scope of EPC contractor.

a) Rails complete with fixing accessories for stacker / reclaimer machines and travelling trippers.

b) Crusher house and CHP control room.

35. **IN-Plant Coal Handling System:-** Junction towers (underground and above ground) in plant area, trestles and coal Conveyor galleries, cable galleries, stacker reclaimer, emergency reclaim hoppers with RCC water tight pit, underground tunnels, coal stockyard, coal run off pit, dust suppression / extraction and ventilation system, switchgear room, pump houses, cable trays, cable supports, underground cable trenches with cover, monorails, beams for hoists etc.
36. Switchyard control building and all works for GIS switchyard.
37. Transformer yard structures including rail track foundation for transformer.
38. Transformer Maintenance Building, Mill & Boiler Maintenace Building & FGD provisions.

39. Auxiliaries buildings

- Service building.
- Administrative building
- Air washer building and Plant air compressor building.
- Hydrogen generation plant (H_2 Plant)
- Workshop

- Canteen building
- Dozer shed and repair shed
- Fire station
- DG House
- Bank extension counter with ATM and Post office **200sqm**
- Field maintenance building – 3 no.(20 x 10 m^2) **- RCC Buildings**
- Main gate and Time office cum security complex with two no. of dormitory (100 m^2 each) with toilet and change rooms for security persons in the first floor. Steel building shall be provided for CW Pump House,

  Workshop (Excluding Stores and Office area), D.M Plant, Parking sheds. The Structural Steel shall be confirm to IS 2062. The side wall shall be brick cladding for a height of 1.0m above that color coated galvalume sheets of minimum thickness not less than 0.6mm shall be provided. The roof shall be covered with same sheet of adequate thickness to suit the design requirement. Transparent / Translucent sheet may be used to permit natural lighting. Sufficient number of roof extractor shall be provided for effective ventilation. Aluminum glazed windows shall be provided for natural ventilation and lighting.

  All other civil items not covered above but required for completion and proper functioning of plant shall form part of scope.

40. Trenches, tunnels, channels, duct banks etc.
41. Structural steel pipe rack and cable racks for pipes and cables for clarified water, D.M. Water, steam pipes, fuel oil pipes and other areas(if required). with walkways.
42. RCC paving from Transformer Yard to chimney including Boiler area.
43. Parking sheds for four wheelers and two wheelers
    a) Car park – Partly covered parking – total parking area 3000 Sq.M.
    b) Covered car parking with roof only and sides open shall be provided adjacent to the administrative building for minimum 20 Cars.
    c) Parking area indicated are net areas only (i.e.) excluding ramp, etc.
    d) Scooter and Cycle shed shall be provided with roof cover only.(Area 1250 Sq.M).
44. RCC storm water drainage system for the entire plant.

    a) Site shall be graded upto **+9.5m** level with available material from existing bund and the balance depth i.e up to +10.00m (+ 10.00m corresponds to RL +

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10.00m) shall be filled with approved good quality murram / gravel (Gravel Blanketing).

Site shall be graded upto **+9.2m** level by the OWNER. The EPC contrtactor has to carry out site grading work for the entire plant from **+9.2m** level to +9.50 m level with approved quality of murrum/gravel. The finished floor level of Plant shall be +10.00m elevation.

45. Dispensary and first aid centre. **150sqm**
46. Service water system / make up water pipelines.
47. Rain Water Harvesting for all buildings. All roofs tops shall have RWH with filter arrangement. Filtered water shall be pumped to Raw Water Reservoir for its utilization.

    Rain Water Harvesting should be implemented as per the scheme / design approved, Central ground water Authority / Board or State ground water authority or MoEF authorized agency shall be consulted for finalization of appropriate rain water harvesting technology. The necessary consultancy charges for the above agency for preparing rain water Harvesting method / scheme for the project to be borne by the Bidder.
48. Site illumination work.
49. All the civil works related to arrangement for lifting of stator.
50. Clearing and removing the buried items if any in the whole proposed plant area and the same is to be deposited to the NCTPS existing stores.
51. The contractor has to fill or excavate the areas to the required formation levels as indicated in the plot plan.
52. 30 metre high lighting towers shall be provided in Coalyard area and Switchyard area.
53. Road Weigh Bridge and Control Room
    These shall be RCC framed structure with RCC roof and brick cladding. Adequate windows shall be provided for ventilation & lighting. Roof shall be given liquid membrane water proofing treatment. Flush welded steel doors shall be provided for personnel movement. Toilet facilities shall be provided.
54. All underground structures such as basement, sump etc. and water retaining structures shall be water proofed as per specification.
55. For under deck insulation, Fire Resistant Under deck insulation such as Lloyd foam or equivalent PUF may considered with suitable specification.
56. Modular furniture of approved make and model with electrical wiring and network cabling shall be provided in all office/operating personnel rooms/conference hall as per owner's requirements.
57. All the building shall have one dining room of owner's requirement.
58. Necessary lift/elevators for the buildings as per standard code shall also be provided by EPC contractor apart from the specifically mentioned lifts/ elevators.
59. Outfall structure- CT blowdown water, RO stage-II reject shall be let out into the seal well of stage-I. Necessary repair work required in seal well of stage-I shall be carried out by EPC contractor.

61. The Work also Includes:

(a) Site surveying.

(b) Soil investigation and preparation of soil investigation report and suggestion of type of foundations including design of piles.

(c) Implementation of ground improvement techniques and post improvement evaluation of sub surface properties up to 15.0 m below the existing Ground level.

(d) Preparation of Architectural drawings.

(e) Design, preparation of drawings and construction of all structures.

(f) Preparation of as built drawings of all structures and facilities to reflect as built status of construction.

(g) Submission of as built drawings in Autocad in CDs.

(h) Plumbing & sanitary works.

(i) Painting.

(j) Anti-termite and anti-weed treatment in all areas / buildings as per IS: 6313. **(Anti-weed treatment for Switchyard area)**

(k) All temporary roads and approach roads necessary for construction purpose shall be of WBM for a minimum width of 4m. All permanent min roads inside the plant, cross road to auxiliary buildings and inspection road around compound wall will be provided by bidder.

(l) Green belt development-30% of total plant area shall be developed as green belt by the EPC contractor

(m) Internal compound wall required based on plot plan and layout. External compound wall is in the scope of bidder. Compound wall shall be provided all around the plant boundary. The wall will be 230 thick brick infill/Rcc slab of suitable thickness. Height of wall will be 4.50 m above FGL. Over the 4.5 m high wall 1 m high of 8 string barbed wire of 6 guage with 8 strands and with anti climbing arrangement of 50x50x8 Y shaped angles placed at 2.5 c/c shall be provided.

It is not the intent to specify herein all the works in the scope of this contract. All other buildings, structures and works that are necessary which are not specifically mentioned here but required for construction, operation and maintenance of the power plant or mentioned elsewhere in the specification are deemed to be included in the scope of the Contractor.

In the event of conflict between requirement of any two clauses of this specification, or different codes / standards, the more stringent requirement as per the interpretation of Owner is to be followed by EPC contractor.

All works shall conform to the specification. The works shall conform to high standards of design, engineering and workmanship. Design and construction shall conform in every respect to all local and state regulations governing such works and to stipulations of Indian Standards unless stipulated otherwise in detail specification.

General

It is preferable to adopt Pre fabricated / Pre Engineering structures for CW Pump House, Fire Water Pump House, Workshop (Excluding Stores and Office area), D.M Plant, Parking sheds.

2.07.00 Protection of existing utilities and services

During construction, the contractor shall provide all protection for existing utilities and services as may be required by his construction operations. Permanent protection of certain items shall be as included under other sections or as instructed by the Owner.

In addition to the requirements as specified, herein the contractor shall comply with the following requirements:-

a) Use all necessary precautionary and protective measures required to maintain existing utilities, services and appurtenances that must be kept in operation. In particular, the contractor shall take adequate measures to prevent undermining of utilities and services presently in services.

b) Protect existing or new utilities and services where required by the contractor's operations and/or as directed by the Owner. The contractor shall be responsible for bracing and supporting utilities and services to prevent settlement, displacement or damage.

c) If any existing structure such as Pipe line, Road drain, Culvert, Towers, Light Posts, Underground Structures, Buildings, Tanks, Rail line etc are damaged during execution of project, same shall be reconstructed by EPC Contractor at his own cost at locations wherever approved by owner.

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3.00.00 INSTRUCTION TO BIDDERS

3.01.00 Data to be furnished by Bidder at the time of Bid

3.01.01 A write-up on survey to be undertaken indicating grid, intervals for taking spot levels, contour intervals, precision of surveying instruments proposed to be used, drawings that will be prepared, details to be covered by survey etc.

3.01.02 Detail general arrangements / architectural drawings of all buildings and structures showing dimensions, levels, plans, sections, elevations, loadings, materials proposed, types of framings, wall / cladding, floors, roofs, types of finishes etc.

3.01.03 Detail design criteria proposed to be adopted for each building, structures, foundations, facilities etc.

3.01.04 A write-up with schematic drawings of cooling water (CW) system indicating size and details of cooling tower, CW conduits, channels and forebay along with method of construction etc.

3.01.05 Organisation chart with no of Engineers to be furnished by EPC Contractor.

3.01.06 A write up on size and construction details of 275m high RCC chimney with steel twin flue and along with appurtenances shall be furnished.

3.01.07 Details of thermal insulation for ceiling and detail of false ceiling assumed with manufactures catalogue and areas where they propose.

3.01.08 All deviations from bid document shall be furnished by the Bidder.

3.01.09 List of equipment to be deployed and rates of labour assumed by the bidder and by other sub-contractors to be associated with him-in is to be furnished.

3.01.10 List of softwares proposed to be used against various areas for analysis, design, drafting and project monitoring along with their source and validation report for the softwares.

3.01.11 The list of documents indicated elsewhere of this section to be submitted by the contractor to the Owner for his approval and manner in which the same need to be submitted. No construction shall commence at site without obtaining approval from the Owner on these documents. Therefore, it is necessary that bar charts for buildings / structures / area wise shall be submitted for design / drawing activity indicating.

a) A Level-1 pert chart showing the starting and completion date of all civil construction activities.

b) A Level-2 pert chart showing the time required for preparation of design criteria, for approval of design criteria by Owner, time required for detailed design and drawing preparation and time required for approval of design and drawing by Owner. This part shall taken into account the construction schedule (Level – 1 part).

c) A Level-3 pert chart for all civil works shall be submitted to Owner for monitoring of progress of works at site.

3.01.12 A detail note on quality plan both for design and construction activity proposed to be adopted for obtaining quality works.

3.01.13 List of all sub-contractors/Consultants/Architects that the bidder proposes to employ, in case the contract is awarded to him, indicating their addresses with telephone number, experience on similar jobs, name, qualification and experience of persons who shall be involved in the job on behalf of the contractor etc. shall be submitted to Owner. Only the sub-contractor approved by Owner shall be engaged by the contractor on the job.

3.01.14 Write-up on proposed storm water drainage system furnishing layout of the drains, types of drains and suggested disposal system.

3.01.15 A write-up on dewatering system proposed at the time of construction where deep construction such as for reclaim hoppers pit/track hopper pit, conveyor tunnels, CW forebay and pump house etc. are to be executed.

3.01.16 Tentative plot plan showing location of all buildings, structures, roads, site office, storage etc. with plan dimensions.

3.02.00 Inspection of Site by Bidder

3.02.01 Bidder shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, sub-soil conditions, natural drainage etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time.

3.02.02 The submission of a bid by the Bidder will be considered as an evidence that such an examination was made and any later claims / disputes in regards to rates quoted shall not be entertained or considered by the Owner.

The contractor shall organize his own arrangement to transport his equipment, men and materials so as to match the construction schedule.

3.03.00 Construction Tools & Materials Supplied by Contractor

3.03.01 Contractor shall provide and maintain at the site necessary number and type of machinery and equipment including survey instruments in good working condition for proper setting out and timely completion of the various works cover under this specification. All arrangements for transporting the equipment to and from the site shall be done by the Contractor at his own expenses. No claim shall be entertained for mobilizing additional equipment and/or personnel to complete the work within the stipulated time.

3.03.02 Contractor shall provide all fuels and lubricants required for the operation and maintenance of construction machinery and equipment as well as his transport vehicles at his own cost.

3.03.03 The contractor shall ensure that the work shall proceed uninterrupted even in the event of power failure. As such, adequate number of diesel operated equipment shall be provided by the contractor at his own cost as an alternative arrangement, in case electrically operated equipment are proposed to be brought to site.

3.03.04 The contractor shall maintain sufficient stock of material so that there is no interruption of works at any point of time during the contract period & extended period if any.

3.03.05 All materials supplied by the contractor shall be original, new and of the best quality and shall conform to the given specifications. Approval in writing shall be obtained from the Owner before any alternative or equivalent material is used other than what is specifically mentioned in the drawings.

3.03.06 Contractor shall furnish manufacturer's test certificate for all the manufactured items supplied by him. Representative specimens of the material shall also be submitted to the Owner and shall be tested at a recognized testing laboratory at Contractor's cost in case Owner so desire.

3.03.07 The Owner reserves the right to test any construction material supplied by the Contractor in an established testing laboratory at Contractor's cost and to instruct the Contractor to remove all materials, which do not meet the specification requirements.

3.03.08 EPC Contractor to arrange third party quality inspection & audit of all construction material at site.

3.03.09 Contractor has to set-up a testing laboratory equipped with the following minimum apparatus, materials and competent trained staff required for carrying out field tests:

a) Slump cone apparatus to measure slump.

b) Concrete cube testing machine with adequate number of moulds of (15cmx15cmx15cm) to measure compressive strength of concrete.

c) Vicat apparatus to find initial and final setting time of cement.

d) IS sieves with vibrating machine to determine fineness modulus of coarse and fine aggregate.

e) Abrasion & impact testing equipment for testing coarse aggregate and apparatus to determine flakiness index of aggregates.

f) Complete apparatus for the test of air content of concrete by pressure method as per IS:1199.

g) Density bottle to determine sand bulkage.

h) Hydrometer for testing pH value of water

i) Thermometer for checking temperature

j) Apparatus for measuring proctor density, water content of compacted soil determining CBR values.

k) All apparatus for determining dry density and water content of sand/soil and aggregates. Any other equipment felt appropriate by the Owner for measurement of paint thickness, testing of structural members, welding etc. The testing machines shall be recalibrated periodically and as directed by Owner to detect errors. The moulds for cubes shall be checked frequently and made to conform to specifications contained in IS-516.

3.04.00 Work Execution and Supervision

3.04.01 Contractor shall have at the site accredited and qualified engineers and foremen / supervisors with adequate number of years of experience in execution of similar works and also operators of machinery and equipment, for satisfactory progress and timely completion of the work.

3.04.02 Contractor's Engineer-in-charge of the work at site shall be capable of interpreting the specification and drawings and make adequate site decisions as and when required. He shall also take instructions from the Owner and be responsible for carrying out the instructions.

3.04.03 Contractor shall be fully responsible for the correctness and accuracy of the tests performed, results obtained / tabulated, interpretation of test results and recommendations made. The work shall be executed in a professional manner, with fully understanding of the importance of work for a project of this magnitude.

3.04.04 In the event of occurrence of any accidents at / near the site of the work or in connection with execution of the work, a report shall be made immediately to the Owner, giving full details of the accidents. He shall also report such accidents to all the competent authorities wherever such reports are required by them.

3.04.05 All temporary electrical installation shall be supervised by a qualified electrical supervisor of the Contractor.

3.04.06 Owner reserves the right to order in writing, from time to time, during the progress of the work, removal and re-execution of any work which in the opinion of the Owner, is not in accordance with the specification.

3.04.07 During inclement weather, rains etc. contractor shall suspend all works for such time as the Owner may direct and shall protect from damage all works already in progress or completed just then. All such temporary protective measures shall be at contractor's cost and any damage to works shall be made good by the contractor at his own expense.

3.04.08 Should the work be suspended by reasons of strikes / riots by Contractor's own employees or any other causes whatsoever save and except the force majeure condition, Contractor shall take all precautions necessary for the protection of works and make good, at his own expenses, any damage arising from any of these causes.

3.04.09 During the course of contractor's works, other works either by the Owner or by the Contractors or by both simultaneously will be in progress within the project area.

Contractor shall make his best effort to work in harmony with others in the best overall interest of the project and towards its speedy completion.

3.04.10 The Contractor shall be responsible for maintaining cleanliness of the site. The site shall be free of unwanted rubbish or filth, which is hazardous & detrimental to health, and affect safety of the work place. Proper watering to be done for dust suppression.

3.04.11 All material supplied shall conform to the specification. Entry of unwanted materials shall be prohibited.

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4.00.00 SUBMISSION

The following documents are to be submitted for the approval of the OWNER, prior to commencement of fabrication & erection / construction. All drawings shall be of standard sizes (metric system) and shall be made on AUTOCAD. Software used for design shall be validated and established ones like STAAD Pro, NISA, and ANSYS. Hard and soft copies of all the drawings / document shall be submitted to the OWNER. The following list is not exhaustive but indicative only.

1) The analysis of TG building, Mill building, ESP control room, Chlorination building, Switchyard control building, CW pump house, Raw water pump house, Ash water pump houses and Service building are to be done by developing 3D mathematical model adopting response spectra method of analysis as per IS: 1893-2002 & 2005, in addition to wind load analysis as per IS: 875 Part-3.

2) Preparation of design drawings with maximum detailing possible and developing all possible connection / joint details for all the buildings within the scope of civil / structural works.

3) General plant layout drawing with coordinates of roads, boundary wall and facilities, piping / cable corridors, pipe and cable trestles, provision of landscaping and green belt development, diversion roads and drains, equipment lay down areas etc.

4) Drawing showing underground facilities with coordinates like buried pipes, buried cables, trenches, ducts, sewer, drains, sumps pits, culverts, foundations etc.

5) Soil investigation report based on additional geo-technical investigation carried out by CONTRACTOR along with foundation recommendation for various buildings / structures / facilities.

6) Site Grading and storm water drainage study furnishing levels of various terraces arrangement and details of drains, culverts etc for storm water drainage system.

7) Study note on disposal of sewage and other effluent from the plant to satisfy the statutory requirement.

8) Design basis memorandum for all buildings, facilities, services and structures.

9) Drawing showing loading data at various levels for all buildings and structures.

10) Architectural floor plans, elevations, cross sections and perspective view in colour scheme of all buildings. For main plant building CONTRACTOR shall submit two different schemes along with a report elaborating the underlying philosophy of the proposed architectural concepts.

11) Design calculations and drawings for foundations / substructure and superstructure of all buildings including pump houses and other structures.

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12) Design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundations for TG, BFP, Mill, Fans (PA, FD, ID), Crushers etc.

13) Design calculations and drawings for all facilities and services like roads, culverts, bridges, pavings, road / rail crossings, drainage pump house (if required), drains, sewers, sewage pump house, sewage treatment plant, water supply, water tank, sumps, tunnels, trenches, ducts etc.
The contractor shall resubmit the design document and drawings within a maximum period of 3week from the date of receipt of comments by the contactor. Timely submission of design/drawings to the owner for review/approval is the sole responsibility of the contractor and postal or other dealys as resons for late/non submission shall not be entertain by the owner.

14) Drawings of all architectural works including finishing schedule, colour schemes (both internal and external), doors & windows, flooring and false ceiling shall be submitted by EPC Contractor to owner along with or before releasing of construction drawings.

15) Design calculations and drawings for plumbing and building drainage.

16) Design calculations and drawings for switchyard structures, transformer yard, etc.

17) Design calculations and drawings for structures pertaining to condenser Cooling water system.

18) Design calculation and drawings / document for the sea water system structures is covered within the scope of the Contractor.

19) Design calculations and drawings for civil structures / works associated with fuel oil handling system, ash handling system, coal handling system, Ash disposal system, etc.

20) All other designs, details / drawings or any other submissions as indicated else where in this specification and as required by the Owner.

21) Details of corrosion protection measures for all structures.

22) All design and drawings for the natural draught Cooling towers.

23) All design and drawings for RCC Twin flue chimney.

24) All design calculations and drawings for foundation of Boiler and ESP area structures.

25) Preparation & Review of structural steel fabrication drawings is entirely of the responsibility of contractor & will not be approved by the owner. However, all fabrication drawings shall be submitted by the contractor for owner's reference & records prior to the commencement of fabrication.

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26) Construction and erection procedure for all major structure with specific reference to main plant building, bunker structures, transfer towers, conveyor galleries, TG foundation and other machine foundations.

27) Write up on various statutory requirements and their compliance for various buildings and facilities.

28) Quality assurance and Quality Control procedures. Third party quality audit is required.

29) Copies of all reports on investigation and studies carried out by the CONTRACTOR as per the scope.

30) Soft copies of all design calculation and drawings shall be submitted for records after approval of the OWNER.

31) EPC Contractor to ensure that photograph of progress of work at site with required album is being submitted to owner once in every month in soft & hard copy.

32) EPC Contractor to ensure that Bar Bending Schedule & Bill of quantities has been furnished in various construction drawings.

33) All drawings are approval category except fabrication drawings which are information category.

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5.00.00 GEO-TECHNICAL INVESTIGATION

5.01.00 M/s TANGEDCO, owner of this project has carried out preliminary soil investigation work in power block area i.e. from power house to chimney. Few boreholes and static cone penetration tests were performed. The borelog datas are enclosed in soil report attached along with specification.

As per the soil consultant's report for main plant building structures, TG foundation, boiler foundation, ESP foundation, mill building foundation, mill foundation, ID, FD & PA fan foundation, chimney foundation, conveyor gallery trestle foundation, junction tower foundation, crusher house foundation, stacker reclaimer foundation, fly ash silo foundation etc. pile foundation is recommended. Piles will be bored cast-in-situ.

5.02.00 Recommended safe load carrying capacity of Bored Piles will be as follows:

S.No.	Location	Length of Pile below E.G.L (m)	Length of Pile below Cut off (m)	Dia. of Pile (mm)	Safe Load Carrying Capacities (kN)		
					Vertical	Pull Out	*Horiz-ontal
1	Main Plant (Ash Pond Area)	30	27	500	1000	260	50
2				600	1100	340	55
3				700	1500	400	75
4				800	1600	420	80
5				900	1900	500	95
6	Balance Plant Area	30	27	500	1000	260	50
7				600	1100	340	55
8				700	1500	400	75
9				800	1600	420	80
10				900	1900	500	95
11	Coal Conveyor Belt Area	30	27	500	1000	260	50
12				600	1100	340	55
13				700	1500	400	75
14				800	1600	420	80
15				900	1900	500	95

*Horizontal Capacity is considered 5% of Vertical Compression Capacity.

Note :- *The Above load carrying capacities are valid only if ground improvement technique is adopted and post improvement properties are estimated to validate the improvement.*

Above informations regarding soil investigation is only for the guidance of the bidders. Owner does not take any responsibility for the correctness and interpretation of the result. Any variation of the said information shall not constitute a valid reason in affecting the terms and condition of the bid. The bidder shall fully satisfy himself about the nature of soil expected to be encountered, including the type of foundation, bearing capacity, sub-soil water etc. prior to the submission of his bid.

5.03.00 Detailed geotechnical investigation shall be carried out by the Contractor on award of work. Based on the plot plan developed, the contractor shall identify proposed borehole locations and obtain the approval of Owner prior to commencing the investigation. In the power block bore holes shall be provided and spread judiciously to cover all major building as well as equipment foundations. Generally, a grid of 50 metres c/c both ways is recommended from Chimney to end of Switchyard. In the offsite areas also it shall be ensured that the bore holes are provided near all major structures. If the final geotechnical investigation report is found to be in variance with the assumptions / preliminary investigations made during bid stage, the contractor is not eligible for any extra claim or time extension.

Geotechnical investigation must be completed by EPC Contractor within 3 months from the date of handing over the site to the contractor & same should be wetted by IIT / Anna University before submission to the owner for review / approval.

5.04.00 Following field tests shall be conducted:

- Bore holes and standard penetration tests
- Static plate load tests
- Cyclic plate load test
- Cross hole shear velocity test
- Field permeability tests
- Field density tests
- Vane shear tests
- Static cone and dynamic cone penetration tests
- Electric resistivity tests
- Pressure meter tests
- Percolation test
- California bearing ratio tests

5.05.00 Bore holes shall be located to cover the entire area. All bore holes shall be sunk up to a depth of 40.0 m or 'N' value greater than 100 is obtained for 4 consecutive intervals.

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

5.07.00 **Dynamic Cone Penetration Test (DCPT)**

The test equipment and procedure shall meet the requirement of IS:4968 (Part II). The driving shall not be done for more than 30 cm at a time after which it shall be stopped for a minute or two. The tests shall be terminated when the blow counts exceed 35 for 100 mm. penetration when the cone is dry and 20 for 100 mm. penetration when the cone is penetrated by circulating slurry.

The results shall be reported in a suitable tabular form giving below counts for every 30 cm. penetration supplemented by a graphical plot of blow count versus depth.

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

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

5.10.00 Following laboratory tests shall be conducted: (preferably on Undisturbed soil samples and if UDS is not possible, on remoulded soil samples)

i) Grain size analysis

a) Hydrometer analysis

b) Sieve analysis

ii) Field density and moisture content.

iii) Specific gravity.

iv) Chemical analysis of soil and ground water including sulphates, chlorides, pH value etc.

v) Chemical analysis of 2:1, water:soil extract of the samples giving SO_3 content.

vi) Consistency Index: Liquid limit, plastic limit, plasticity index, shrinkage ratio.

vii) Consolidation test giving all relevant information.

viii) Swelling pressure and free swell index for expansive soils.

ix) Unconfined compressive strength on undisturbed soil samples

x) Direct shear test.

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xi) Triaxial compressive strength tests:

a) Unconsolidated undrained test

b) Consolidated undrained test

c) Consolidated drained test

xii) Moisture density relations for Standard Proctor and Modified Proctor tests.

xiii) Crushing strength, specific gravity, unit weight, water absorption test of rock specimens of NX size.

xiv) Permeability test.

5.11.00 The Geotechnical investigation report shall necessarily include but not be limited to the following information:

a) Recommended types of foundation.

b) Allowable safe bearing capacities and settlement values in different strata for shallow foundations indicating relevant design criteria adopted, method of analysis adopted etc.

c) Type of piles recommended with reasons for the same, length, diameter, allowable capacity (vertical lateral and pullout) of individual and groups of piles, negative skin friction, if any, and magnitude of estimated negative skin friction.

d) Recommendations for values for modulus of sub grade reaction for foundation design by elastic method.

e) Type of cement to be used for concrete substructures and in stone/ brick masonry foundations with reference to the chemical nature of subsoil and ground water.

f) Recommendations regarding excavations (shallow & deep), embankment, safe sides slopes for excavation and embankment, dewatering, site drainage etc.

g) Recommended soil properties such as density, specific gravity, cohesion, angle of internal friction etc. for design.

5.12.00 The Bidder shall carry out the topographical survey of the area within boundary.
The survey map should identify all topographical features such as but not limited to buildings, structures, burial grounds, wells, natural drains, roads, footpaths, depressions, underground sources, overhead transmissions lines, telephone lines or any other obstruction, trees and prominent vegetation. In addition, all wet land and marshy stretches shall also be identified. CONTRACTOR shall prepare contour map to a scale of 1 in 1000 in AUTOCAD. In addition, CONTRACTOR shall prepare LS and CS of the site at suitable intervals to adequately represent actual topography. For natural drains and water courses, sections at closer intervals shall be provided.
For further detail refer section 19.0 of part B.

5.13.00 SOIL IMPROVEMENT

Since soil is having very low bearing capacity hence Implementation of ground improvement techniques and post improvement evaluation of sub surface properties upto 15.0 m below ground level is a part of foundation design, which is in the scope of contractor. Method of stabilization / improvement of soil to be used by contractor shall be got wetted by IIT / Anna University before submission to owner / owner's consultant for approval.

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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 bellow 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 750diameter 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 belimited to 150mm and tread width of 300mm. Minimum width of stairs shall be 1200mm generally. All stairs normally shall have not morethan 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 be150mm 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 thickness125 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 nm 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.

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

Provisions of safety, health and welfare according to Factories act shall be complied with at design stage. These shall include provision of continuous walkway (minimum 750 mm wide) along crane-girder at crane girder level on both sides of the building, comfortable approach to **EOT** crane. cabin, railings, fire escape locker room for workmen, pantry, toilets, rest rooms etc.

Adequate no. of fire escapes shall be provided in a building. Fire proof doors, no. of staircase, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall. be made according to the recommendation of TAC.

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

For fire safety requirements of buildings IS: 1641 and IS: 1642 shall be followed in addition to TAC requirements. All masonry firewalls shall be minimum 345 thick and RCC firewall shall be minimum 200 mm thick.

7.00.00 MATERIAL

7.01.00 Structural Steel

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

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

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

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

a) For welding of stainless steel to stainless steel : E308L

b) For welding of stainless steel to mild steel : E309

7.02.00 Cement

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

7.03.00 Reinforcement

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

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

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

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

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

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8.00.00 LOADING

8.01.00 Dead Loads

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

8.02.00 Imposed Loads

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

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

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

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

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

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NOTE :

1. Additional load for cable, piping / ducting, shall be considered as applicable.

2. Hung load shall be based on minimum loading equivalents of 1 kN/ m^2 for piping and 0.5 kN/m^2 for electrical ventilation and air conditioning.

3. Loading resulting from concentrations of facilities in specific areas shall be substituted where listed base loadings are excluded

4. Cantilever loads of not less than 2000 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the ESP, for cable trays and walkways.

5. Cantilever loads of not less than 500 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the boiler, for cable trays and walkways.

6. All ESP hoppers filled up with ash upto the top of the hoppers or the bottom of the electrodes (whichever is more) using a bulk density of not less than 1600 kg/cum for the ash, along with additional ash build-up from the end of the third field upto the inlet duct bottom level at a natural repose angle (not less than 30 degree to horizontal in any case)

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

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

8.03.00 Equipment, Piping and Associated Loads

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

8.04.00 Crane Loads

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

8.05.00 Seismic Load

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

Zone factor Z = 0.16
Importance factor = 1.75

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

8.06.00 Wind Load

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

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

8.07.00 Damping in Structures

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

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

8.08.00 Temperature Load

For temperature loading, the total temperature variation shall be considered as 2/3 of the average maximum annual variation in temperature. The average maximum annual variation in temperature for this purpose shall be taken as the difference between the mean of the daily minimum ambient temperature during the coldest month of the year and mean of daily maximum ambient temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation.

Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint shall be as per the provisions of IS:800 and IS:456 for steel and concrete structures respectively.

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

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

(a) For volume calculations : 800 kg/cum

(b) For structural design : 1200 kg/cum

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

8.10.00 Loading for Switch Yard

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

(a) Dead load due to equipment and dead load due to structure

(b) Wind load on towers, conductors, ground wires and insulator strings calculated as per clause 8 and 9 of IS:802

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

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

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

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

(g) Construction and maintenance loads

(h) Seismic loads as per IS:1893

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

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

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

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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.

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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)	Guessets	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.

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9.09.00 Slenderness and Depth Ratio

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

The following limiting ratios of depth to span shall 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 filet 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 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

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shall be provided with an additional double coil helical spring washer conforming to IS:6755. The threaded portion of the bolt shall project through the nut at least by one thread.

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

g) All butt welds shall be full penetration butt welds.

h) The connection between top flange and web of crane girder shall be full penetration butt weld. Bottom flange, connection with web can be fillet weld or butt weld as directed by Purchaser. Bearing edges of crane girders shall be machine finished.

i) Connection of base plate and associated stiffeners with the columns shall be designed considering the total load transferred through welds. However, minimum weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners.

j) Splicing: All work shall be full strength. Field splicing shall be done with web and flange cover plates for full strength. In exceptional cases, the field splicing shall be designed for 50% of load carried by the cover plates and remaining 50% load through full penetration butt weld. Shop splicing for all sections other than rolled shall be carried out by full penetration butt welds with no cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plates.

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

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

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

b) Others --- 80%

9.11.00 Specification for Painting of Steel Structures / Material

Refer Volume-VI, Part-B

10.00.00 REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS

10.01.00 General

All structures, building foundation, machines / equipment foundation, water retaining structure, trenches, pits, etc., shall be designed as per relevet IS codes in general. Construction in general shall follow provisions of IS :456 and IS:3370 for normal and water retaining structures respectively

10.02.00 Design Methodology

a) The design and construction of RCC structures shall be carried out as per IS: 456-2000. Working stress method shall be adopted for the design wherever specifically mentioned in this specification.

b) For all concrete structures, ductile detailing has to be done as per IS: 13920 and IS: 4326.

c) For reinforcement detailing, IS: 5525 and SP34 shall be followed.

d) Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150mm or more.

10.03.00 Foundation and Underground structures

a) Foundation system to be adopted for structures shall be based on loading arrangement , load intensity and soil strata**.**

b) All RCC liquid retaining / conveying structure / slurry pump house / underground structures, such as conveyor tunnel, reclaimer hooper pit, etc., shall be designed in accordance with IS:3370 (Part 1 to 4) . For under ground structures not in contact with liquid on inside face may be designed as cracked sections with crack width limited to 0.1mm for both faces.

c) All liquid retaining / carrying structures shall be tested for water tightness as per the provisions of IS:3370 and IS:6494 and in case of leakage, the same shall be rectified by chemical injection grouting through nozzles.

d) Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest. Co-efficient of passive earth pressure shall be used only in design of shear keys for stability against sliding.

e) In all liquid retaining strucures , pvc water bar shall be provided at each construction / expansion joint. No pressure releaving 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

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surcharge load of 2 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 considerd. Imposed loads shall not be considerd 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 atleast 50 mm for building columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting shall not be less than 25 mm thick.

10.05.00 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

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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

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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
	Peripherial 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

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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^2 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, CWPH 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 eleminator 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.

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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 building 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 7 00 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.

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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.

A roof shall be provided with roof water proofing treatment using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM-C-836 & 898. Thickness of the membrane shall be 1.5mm (min.). This treatment shall include application of polymerized mastic over the roof to achieve smooth surface and primer coat. Wearing course on the top of membrane shall consist of 25 mm thick PCC (1:2:4) cast in panels of maximum 1.2x1.2m size and reinforced with 0.56mm dia galvanized chicken wire mesh and sealing of joints using sealing compound/ elastomeric water proofing membrane. However, chequered concrete tile flooring 22mm (min.) thick of approved colour and shade conforming to IS:13801 shall be provided for path way of 1m width for access of personnel and handling of equipment and for the entire area of the roof where equipment like A/C ventilation plant, cooling towers, etc. are provided in place of PCC wearing course. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future. HDPE rain water pipe of min. 150 dia OD conforming to IS:4984 shall be provided to drain off the rainwater from roof. They shall be suitably concealed from the façade.
Adequate no of roof extractors shall be provided As/mech layout details.

Thickness of structural RCC floor shall be minimum 150 mm above the steel floor beams for the intermediate floors with an additional 50 mm floor finish, which shall be provided later.

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

In operating floor the design live load shall be painted on the floors prominently showing the extent of the area where such loading is permitted.

Wherever openings are provided in the floor for handling of equipment using EOT cranes such openings shall be covered with gratings provided over removable steel beams.

Expansion joint shall be provided in the building to satisfy the requirements of IS:800 and IS:3414.

Suitable provision for future expansion shall be made by BIDDER while designing / executing the foundation system for last grid of main plant building.

In any case auxiliary columns shall not be supported on TG foundation. Preferably auxiliary columns shall be fabricated box section.

Separate Maintenance room for Turbine and Generator are to be provided.

11.03.00 CONTROL ROOM / ELECTRICAL BAY STRUCTURE

The building framing shall be structural steel with moment connection in the transverse direction and bracing in longitudinal direction located by the side of turbine building. It shall be ensured that in front of control room no cross bracing is provided.

A minimum headroom of 3000 mm below beam bottom shall be given in the cable vaults. In control room false ceiling level shall be kept 4000 mm above furnished floor level

All floors shall be of deck RCC slab provided over structural steel beams with colour coated permanently laid deck sheet shuttering. Minimum uniform thickness of structural concrete above deck corrugation shall be 150 mm with an additional 50 mm provided for finish. Roof shall also be of in-situ concrete with colour coated permanently laid deck sheet shuttering. The concrete shall be given a slope of minimum 1 in 100 to effect proper drainage. No openings will be permitted on the roof of control room except possible opening for A/C duct to exercise proper control on air conditioning.

Cladding shall be of brick walls. Windows from switchgear room and control room / electronic cubicle room will not normally be allowed on the Boiler side to avoid coal dust nuisance. Walls shall normally be supported on wall/floor beams.

All the wall beams shall be provided with 50mm gunniting using Lugs and steel mesh.

Portion of the structural steel column projecting into the room shall be encased with brick masonry to shield it from fire hazards.

Cable vault in ground and second floor shall be provided with minimum 2 doors per unit. The doors shall be flush steel doors. No windows shall be provided on the turbine bay side

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

Main entrance to control room shall be provided with air locked lobby with automatic closing sliding glass doors. Lobby shall be formed of anodized aluminium framing with toughened sheet glass 6 mm thick. Partition between control room and adjoining rooms shall be of glazed aluminium partition with 300 mm high brick wall at bottom for toe protection. All the doors shall be single leaf glazed aluminium doors for all cabins. For movements of panels suitably sized double leaf aluminium glazed doors shall be provided. Control room wall upto the false ceiling level shall be of aluminium glazed partition on either side of air lock. In other area cladding shall be of brick wall. UPS room shall be provided with brick cladding all-round to reduce sound nuisance.

Battery room shall be provided with metal door. For Air washer room steel doors shall be used which shall be airtight. No window shall be provided in air washer room.

Necessary separation walls for the UPS charger, panels and the batteries in the battery room shall be provided.

Staircase properly enclosed to satisfy LPA regulations shall be provided at either ends of each unit. All doors leading to staircase shall be automatic closing fireproof door. Staircase shall not be provided around the passenger lift. Staircase shall extend upto roof. Toilets shall be provided at the switchgear room level and control room level. Toilet floors shall be sunk by 50mm and shaft shall be provided to route the soil pipe. Sunken floor shall be provided with damp proofing treatment.

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

Floor above control room where APRDS and other pipes are located as well as floor below the deaerator area shall be provided with proper drains to prevent any accumulation of water. This is very important to prevent seepage of water into the control room.

All openings in floor for switchgear and other panels shall be sealed with fireproof material after cables are connected. Adequately designed RCC storm water drains shall be provided to lead the roof drainage on to the plant drainage system. These drains shall have pre-cast RCC slotted cover. Plinth protection shall be given on the side of the drain up to the brick wall.
Provision of central control room shall be satisfied the requirement of vol. V also.

11.04.00 MILL AND BUNKER BAY BUILDING

The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coalbunkers, coal feeders and tripper arrangement to feed the coal into coal bunker.

The bunker shall be circular in plan and shall have the capacity as per the requirement of steam generator.

A mill maintenance platform shall be provided at appropriate elevation to attend to routine maintenance. This platform shall be of chequered plate over steel framing with handrail all around. Above this floor a framing shall be provided to support under slung crane used for handling mill maintenance work. The crane runway girders shall extend to the full length of mill bay to enable approach to the service bay also.

Framework for supporting the circular bunker are provided above the feeder floor based on geometry of the hopper. Preferably bunker shall be supported on equally spaced (min.) 8 supports.

Bunker shall be provided with a top steel cover with slit openings for entry of coal. On sides of the bunker necessary openings shall have to be provided for bunker ventilation / dust extraction.

Tripper floor is immediately above the bunker. This floor is of RCC supported on structural steel framework.

Tripper roof shall be of RCC supported on structural steel framework. A fall of about 300 mm is given for the roof framing to effect proper drainage. Tripper roof supports bunker ventilation / dust supporting structure. An RCC parapet shall be provided for the tripper roof. Access stair/ladder shall be provided from tripper floor to roof in each unit.

In addition to the above, framing arrangement for structural steel platform at various levels around the bunker shall be provided with proper access ladder, for poking, striking and attending to air canons

Tripper floor and roof shall be given access through boiler staircase / elevators.

Bunker supporting structure is normally left uncladded up to the bottom of tripper floor. For tripper floor upto 3000 mm above finished tripper floor level, brick wall shall be provided. Above this level permanent colour coated galvanized trough sheet cladding shall be provided. Fixed steel windows with 6mm thick wired glass shall be provided in the tripper house as per requirements for conveyor gallery

Roof slab will be sloped to one side to permit easy drainage. Liquid membrane water proofing treatment is to be provided. As the roof is accessible and maintenance crew is likely to work on this floor, the entire roof shall be provided with min. 50 thick screed over the water proofing treatment.

Rainwater down take pipes shall be UPVC pipe of class-3 conforming to IS:4985.

One number goods cum passenger elevator, and two nos. of staircase shall provide access to all floor/platforms extending upto the roof level. These structures primarily support coal bunkers, coal feeders and tripper arrangement to feed the coal into coal bunker. Requisite nos. of corridor as per operational requirements shall be provided to access steam generator building from Mill building. The Mill building and steam generator building shall have expansion gap and corridor shall be connected with sliding supports.

Stainless steel liners shall be provided in bunkers for the conical / hyperbolic as well as vertical portion of Bunker. The grade SS liner shall be SS316L.

Colour coated metal deck sheet will be used below RCC floors, it shall be treated as shuttering material only. Uniform thickness of slab, excluding corrugations shall be min. 150mm. In this case, top of steel of beam shall be decided carefully.

11.05.00 STEAM GENERATOR AREA PAVING

Entire steam generator area upto the end of chimney shall be provided with RCC paving over rubble stone soling (for the details of RCC paving refer clause 10.13 of Volume-VI, Part-A).

Paving shall be carefully planned such that maintenance access roads of minimum 4m wide to all major equipment are available. This area shall be designed for heavy loads similar to design of roads. Such approach road shall be provided to the SG elevator also

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to enable handling of equipment at higher level during maintenance. Such roadways shall be clearly identified with kerbs / painting. All drain / trench covers in these areas shall be designed to withstand truck loading.

The drainage of the entire SG area shall be properly planned. Network of RCC drains with RCC cover with slotted holes or MS grills shall be provided covering the entire area which lead the storm as well as process leakage water to the peripheral drains, which in turn will lead to plant drainage system. Where open drains are not permitted under ground pipes may be provided in which case at all junctions and ends proper manholes shall be provided to permit periodic cleaning of the pipes. All structural steel columns in the area shall be provided with encasing to a height of minimum 1000 mm above paving level and in addition the bases also need encasing if base plates are below paving level. For periodical cleaning of manholes suitable screens or baskets shall be provided for easy cleaning from time to time.

11.06.00 TRANSFORMER YARD

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

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

11.07.00 ESP Control Room

ESP panel control room buildings shall be RCC framed building with brick walls plastered on both faces, complete with drains, space conditioning, and building lighting. The building shall have a separate air-conditioned area; and a separate non air-conditioned area except as required for the contained equipment. The contractor shall ascertain the building size according to the design requirements. ESP Transformer yard, firewalls & fencing shall also be provided as per requirement.
One RCC maintenance room of size 20X10 m^2 shall be provided.

11.08.00 SWITCHYARD STRUCTURES & CONTROL BUILDING

Extent of GIS switchyard and number of towers and gantries and the size of switchyard control room will be as per the layout of the switchyard which has been outlined in Vol. IV of the specification.

Switchyard control building will be of concrete frame structure having brick wall cladding. A crane of suitable capacity will be housed in switchyard building.

The building shall be complete with toilets, drains, plumbing, sanitary drainage and treatment piping, space conditioning for a non-air-conditioned area, building lighting, station combinations and fire protection etc. An adequately sized dedicated air conditioning plant shall be provided for the control room. For switchyard Civil Work refer Section-28 of Part-B, Volume-VI. Epoxy flooring shall be provided in all switch yard control room buildings and GIS buildings.
Maintenance room, Mini conference hall, Pantry room, battery room and EPBAX room shall be provided in these area.

Necessary covered pathways shall be made for GIS and other adjacent buildings.

11.09.00 INTAKE WATER PUMP HOUSE (AT EXISTING COOLING WATER FOREBAY OF NCTPS STAGE-II)

Near existing cooling water forebay of NCTPS-stage II, a pump house is proposed for makeup water with necessary modification of existing forebay at intake point. Raw water would be conveyed through steel conduits / pipe to the plant area.

The pump house structures shall be designed in accordance with IS-3370 (Part -1 to 4) . Cladding shall be of brick work. Crane girder shall be of steel. Cage ladder shall be provided for access to crane platform. Side of the pump house up to motor floor level on the pump discharge side shall be of RCC. Maintenance bay of the pump house shall have RCC grade slab with granolithic finish and non-metallic floor hardener. Motor floor shall also have similar finish.

Pump sump shall be designed as water retaining structure. Each sump shall be provided with stainless steel (SS 316L) groove for inserting coarse screen, fine screen and stop logs. Grooves for stop log shall be provided before and after the screens. Number of pump sumps shall be minimum of 3. Stop logs, coarse screen and fine screen shall be of material as mentioned in mechanical part of the specification. Top of the sump floor shall be kept same as of the top of forebay. This floor shall have openings for lowering the lifting of stop logs and screens. These openings shall be covered with galvanized mild steel gratings when the screens are placed in position. Provision for handling of the screens and stoplogs shall be made. Sufficient paved space shall be provided to keep the stop log when not in use and also for maintenance of screens. Galvanized MS handrails shall be provided on 3 sides of the pump floor (sump roof). Each individual pump sump shall also be provided with a drain sump to empty the sump for attending maintenance of pump.
Vertical wet pit type of pumps are envisaged in the pump house.

Dimension of the pump sump shall be decided as per mechanical requirements.
EOT crane of adequate capacity shall be provided for maintenance of the pumps and other auxiliary equipments.

An annex to sea water pump house shall be provided in RCC framed structure to accommodate switchgear and control room with cable vault below, chlorinator room and toilet block. Side cladding shall be of brickwork. All floors and roofs shall be RCC. Roof shall have proper slope and Elastomeric Membrane water proofing treatment shall

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be provided and rain water down fall pipe shall be provided. Control room shall have false ceiling / false flooring and shall be air-conditioned.
Necessary office rooms 200m^2 and store room with adequate space shall be provided on the first floor of proposed pump house building annex as approved by Owner.

All doors shall be of aluminium for control room. For switchgear room, the main entrance door shall be of adequate size to facilitate movement of panels. All windows shall be aluminium glazed side hung.

Additional corrosion protection measures for steel, and concrete required if any due to the presence of sea water shall be submitted by BIDDER along with the bid.

11.10.00 CIRCULATING WATER SYSTEM

The circulating water system envisaged for the plant is sea water. From intake water pump house near the existing forebay of NCTPS STAGE-II , sea water will be pumped to CW forebay of proposed plant area. From CW pump house, water will be drawn by volute casing type CW pumps for condenser cooling.

From Intake water pump house to proposed CW forebay sea water will be conveyed through GRP pipes. The pipes shall be designed for worst possible combination of loads.

11.11.00 CW PUMP HOUSE , FOREBAY & COOLING WATER CHANNEL

The pump house and forebay structures shall be of RCC . Cladding shall be of brick work. Crane girder shall be of steel. Cage ladder shall be provided for access to crane platform. Side of the pump house up to motor floor level on the pump discharge side shall be of RCC. Maintenance bay of the pump house shall have RCC grade slab with granolithic finish with non-metallic floor hardener. Motor floor shall also have similar finish.

Pump sump, CW channel and forebay structure shall be designed in accordance with IS-3370 (Part 1 to 4). Each sump shall be provided with stainless steel (SS 316L) groove for inserting coarse screen, fine screen and stop logs. Grooves for stop log shall be provided before and after the screens. The stop log shall be epoxy painted and coarse / fine screens shall have stainless steel mesh over galvanized MS frame. Number and size of pump sump and stop log shall be as per the requirement of mechanical design. Top of the sump floor shall be kept same as of the top of forebay. This floor shall have openings for lowering the lifting of stop logs and screens. These openings shall be covered with galvanized mild steel gratings when the screens are placed in position. Provision for handling of the screens and stoplogs shall be made. Sufficient paved space shall be provided to keep the stop log when not in use and also for maintenance of screens. Galvanized MS handrails shall be provided on 3 sides of the pump floor (sump roof). Each individual pump sump shall also be provided with a drain sump to empty the sump for attending to maintenance of pump.

Since concrete volute pumps are envisaged separate pump floor, motor floor & valve floor shall be built in the pump house with proper access arrangements. Suitable staircase, ladders & cross-over platforms shall be provided.

An annex to the CW pump house shall be provided in RCC framed structure to accommodate switchgear room and control room and engine room with cable vault below, chlorinator room,Chlorine cylinder storage room and toilet block. Side cladding shall be of brickwork. All floor and roof shall be of RCC. Roof shall be given proper slope and heavy duty water proofing. Rain water down comers shall be of UPVC pipe of class-3 conforming to IS:4985. Roofs shall be made accessible by MS galvanized cage ladder. Staircase shall be provided from pump floor to operating floor.

Provision shall be made for installing three Nos. C.T blow down pumps at CW pump house to drain the C.T blow down water to sea.

All doors shall be of flush welded steel construction. For switch gear room, the main entrance door shall be of adequate size to transport the panels. All windows shall be steel glazed side hung. Wall in front of transformer yard shall be designed to satisfy fire rating as per TAC regulations with fencing.

An auxiliary transformer yard may be required in front of the switchgear room. Civil work similar to the transformer yard in front of ESP control room shall be included in the scope of work.

Outside the pump house support blocks for butterfly valves along with proper handling facility shall be provided.
Since soil is very soft in nature, piles shall be provided as a foundation system for CW pump house structures. PVC, PRV can be used to relieve uplift water pressure on the base slab of CW forebay. In this case, base slab of the CW forebay shall be designed for 60% of water uplift pressure.

Suitable thrust block to hold CW pipe line at various locations as per mechanical requirement is also in the scope of BIDDER.

RCC cooling water channel shall be rectangular shape and designed as a water retaining structure. Depth of channel and width of channel shall match with the width and depth of the cooling water channel from cooling tower. These branch channels shall join together and form common channel leading to the forebay of the pump house. Dimension of the channel to be decided on the basis of the quantity of water to be carried by the channel. Floor of the channel shall be given a mild slope to ensure necessary velocity of flow. The top of the channel shall be kept at least 500 mm above formation level with suitable galvanized MS pipe hand railing on either side. Expansion joint shall be provided at a spacing of about 30 m. Pedestrian cross over shall be provided across the channel at approximately 300 m centres. The channel shall smoothly diverge and form the forebay in front of the pump house.

Depth of the fore bay shall generally match with C.W. pump sump level, which shall be decided based on submergence requirement of the C.W. pups at the lowest water level in the sump. Forebay shall be provided with cage ladder at four corners constructed with galvanized steel. Top of the fore bay shall be kept 500 mm above grade level and handrail of galvanized M.S. pipes shall be provided for the entire length on either sides.

Water level indicators (float type) shall be provided in the forebay close to the pump sump on either side to observe the depth of water.

11.12.00 CW Inlet and Outlet conduits

RCC Cooling water closed conduits of adequate size shall be provided from C.W pumps to condenser and hot water conduits from condenser to cooling tower. The inside of conduits shall be given special painting as per cl10.15 of this spec. conduits shall be checked for uplift considering water at FFL/FGL considering inside empty. Further it has to be designed for traffic load at road crossing.. The conduits shall be tested before commissioning of the system . RCC Duct shall be designed in accordance with IS-3370 (Part 1 to 4). Stress in r/f shall be limited to 130n/mm^2 as / IS 3370. Expansion joints shall be provided at spacing of about 30 meter. Following design requirements shall also be met:

a) Provide a minimum clear distance of 1.5 m between ground level and the top of RCC.

Suitable protection devices such as air release valves shall be provided to ensure that design vacuum pressures are not exceeded.

b) Internal Pressure Condition:

The design of CW ducts shall be done for the following conditions:

i) Maximum design water pressure
ii) Surge or water hammer pressure
iii) Pressure, under testing condition.

c) External Pressure Condition:

i) It shall be designed for external pressure due to soil overburden, surcharge loading, ground water, applicable vaccum pressure etc. taken together.
ii) Additional traffic load at road crossings.

d) General Requirements:

It shall be designed as a RCC closed conduit water retaining structure subject to

i) Maximum external pressure when inside empty
ii) Maximum internal pressure in absence of outside soil
iii) Uplift when inside empty and ground water level upto finished ground level.

e) Maximum velocity of water in the duct shall not exceed 2.0 m/sec.

e) The conduit shall be designed for surcharge of 2 t/m^2

f) Manholes shall be provided at a maximum spacing of 150 m in

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straight reach of conduit. One manhole shall be provided at all horizontal bends and one at the lowest stretch between two vertical bends. Manhole size shall be provided of 1.0m diameter.

g) Thrust block/anchor blocks shall be provided at bends and other locations, if required, as per design.

11.13.00 FILTERED WATER/ **FIRE WATER PUMP HOUSE AND TANK FOUNDATIONS**

Dedicated Fire water storage shall be provided in the filtered water storage tank (RO Stage I Permeate) and the fire water pumps shall be installed in the filtered water pumphouse having two compartments with covered RCC roof. It will be over ground. Vent pipes shall be provided at the roof. The Filtered Water/ fire Water pump house shall be single storied flat roofed RCC building with brick as side cladding. Crane shall be provided for handling pumps in line with Vol III.
The building shall be complete with doors, windows and rolling shutter. Capacity shall be as per Vol. III and Composite Water Scheme.
The pump house shall include operator room, dinning room, maintenance room & toilet also.

11.14.00 NON PLANT BUILDING

11.14.01 Service building

The service building shall be a reinforced concrete framed building. The building shall be directly connected to the main plant building at operating floor. The floor area shall not be less than 1500 sqm in each floor. Number of floors shall be described by the Contractor depending upon the space requirements of various facilities. A minimum number of floors shall be 4 (four). The building shall generally be air conditioned with false ceiling. Elevators as indicated in Vol III shall be provided. Hence, clear head room below beams shall be designed to run AC ducts above false ceiling of these air conditioning areas. Level of false ceiling may be kept at 2700 mm in the ground floor and 2400 mm in upper floors in these air conditioned areas. For elevators, necessary civil works to be executed including foundation, roofing etc. based on Mechanical Specification. A grid of concrete beams and columns shall support the reinforced concrete roof (minimum 1% slope) and the floor slabs. The walls shall be of masonry construction, plastered internally and rendered externally. The service building shall have the following provisions:

a. Seating accommodation for senior O&M executive along with supporting staff including modular furniture of latest style. For the accommodation of all Executives permanent brick wall not to be provided, instead wooden partition wall of cubicle type is to be provided.
b. Safety and Welfare Cell, First aid room
c. Reception, drawing hall, library, printer rooms and records room/ archives.

d. Conference hall with all amenities like latest style modular furniture, loud speaker systems, Projector equipments, service room etc.

e. Mini conference hall with furniture.

f. Relay testing lab, electrical lab, C&I repair lab and transmitter lab.

g. Pantry in each floor.

h. Toilets – Ladies & Gents in each floor as per specification.

i. Switch yard control room.
j. Server room
k. Battery room
l. Simulator training room
m. Connecting platform between TG building and Service building
n. Electrical and LAN points at each seat in the cubicle, cabins & conference rooms with wiring and fittings.
o. Minimum clear width of staircase in service building shall be 1.5m.

p. Cabins for senior officers and conference rooms shall have attached Toilet. The cabins shall be provided wherever required as directed by the owner.
q. Entrance to the building shall have glazed aluminium door swing type with double leaf. Glazed aluminium partition shall be provided on either side of entrance door. Internal partition in the building shall be provided with a combination of pre-laminated particle board and frosted glass in anodized aluminium framework. All doors to the cabins shall be teak veneered flush plywood door. In other utility areas, aluminium glazed or steel flush doors shall be used. Toilet shall be provided with PVC doors. All windows shall be of glazed aluminium sliding types. For windows located in the ground floor, aluminium grills shall be provided for security.
r. The service building fascia shall have pleasing aesthetic. Landscaping shall be done around the area by developing garden with flowering plants and fountains etc.
s. Polished teakwood handrail with stainless steel post shall be provided. At least one staircase shall lead to the roof.

11.14.02 Administrative Building

The Administrative building shall be a reinforced concrete Framed building with two floors having a minimum area of 1000 sqm in each floor.The floor area shall be as per the specification. The building shall generally be air conditioned with false ceiling. Elevators as indicated in Vol III shall be provided. A grid of concrete beams and columns shall support the reinforced concrete roof (minimum 3% slope) and the floor slabs. The walls shall be of masonry construction, plastered internally and rendered externally. The Administrative building shall have the following provisions:

a. Safety and Welfare Cell, First aid room
b. Reception, drawing hall, library, printer rooms and records room/ archives.

c. Conference hall with all amenities like latest style furnitures, loud speaker systems, Projector equipments, service room etc.

d. Mini conference hall with furnitures.

e. Pantry

f. Toilets – Ladies & Gents in each floor as per specification.

g. Telephone Exchange of 500 lines

h. Electrical and LAN points at each seat in the cubicle, cabins & conference rooms with wiring and fittings.

i. Minimum clear width of staircase in administrative building shall be 1.5m.

j. Ceiling fans

11.14.03 MAINTENANCE OFFICE CUM STORES

Maintenance office cum stores with provision for tool room of adequate shall be provided in the following area. This can either be fully independent building or can be part of Pump house / MCC / other buildings nearby.

- Minimum size shall be 5m x 5m
- Mill area – may be accommodated in GF of bunker bay or power house building
- Boiler area – may be accommodated in GF of ESP control building
- ESP area – may be accommodated in GF of ESP control building
- Ash handling area
- Coal handling area
- Cooling water pump house / Fore bay area – may be accommodated in GF of CW pump house or MCC building
- Sea water intake pump house area
- Sea water outfall pump house area
- Common for transformer area and Switch area – may be accommodated in GF of Switch yard control building
- Common for desalination plant / DM plant / Water treatment plant – may be accommodated in GF of DM plant
- Fuel oil tank area – may be accommodated in GF of fuel oil pump house.

11.14.04 Storage Yard

A storage yard of 7000 sqm shall be provided with a provision 4000 sqm covered area. The storage yard shall have compound wall of 3m height with anti climbing devise. Covered area shall be of RC construction with RCC roof and brick wall for side cladding. Office space and toilets shall also be provided. Entry & exit of trucks shall be thru rolling shutters of adequate size. In addition a 2 single leaf steel flesh door shall be provided for entry of the staff. Adequate windows shall be provided. The covered sheds shall be connected with bituminous roads in side storage yards. The storage yard shall be provided with 150mm thick gravel paving along with suitable drainage arrangement connected to plant drainage system.

It is preferable to adopt Pre fabricated / Pre Engineering structures for covered area of storage yard. The Structural Steel shall be confirm to IS 2062. The side wall shall be

brick cladding for a height of 1.0m above that color coated galvalume sheets of minimum thickness not less than 0.6mm shall be provided. The roof shall be covered with same sheet of adequate thickness to suit the design requirement. Transparent / Translucent sheet may be used to permit natural lighting. Sufficient number of roof extractor shall be provided for effective ventilation. Aluminum glazed windows shall be provided for natural ventilation and lighting.

EOT crane of suitable capacity shall be provided in storage yard at appropriate locations.

11.04.05 Parking Sheds

Parking sheds shall be provided at service building, security complex, at CW pump house area etc., at all locations for operating staff. Parking shed shall be steel framed structure.

The bidder has to furnish the three dimensional architectural plans along with the colour codes for the above buildings for approval of the Purchaser for adopting one among the alternatives proposed.

11.14.06 Workshop

The building shall house electrical , mechanical workshops and shall comprise the following facilities as a minimum requirement.

Mechanical workshop – consisting of carpentry, Machine shop (for lathes, drilling machines, grinding machines etc.) ,Fabrication / welding and store.

b) Electrical room
c) Offices, rest room and toilet
d) Heavy vehicle shed
e) Dozer shed

The workshop building area shall be based on the equipment layout during detail engineering. Minimum area of workshop shall not be less than 1000m^2. The building must have provision of EOT crane for handling. The building shall be of RCC/ steel framed structures with brick masonry side cladding. For other detail and finishes refer to Architectural specification.

11.14.07 Fire Station

Fire station shall be single storey RCC framed building with brick walls in office area. Provision for parking of 2 fire tenders including 1 bay for maintenance with pit, office, duty room, stores, recreating room, record room and toilet blocks shall also be made. In addition adequate space shall be provided for hose drying and drill ground. The arrangement shall satisfy the requirement of local fire brigade. Minimum area for this facility shall be 150sq.m.

11.14.08 Canteen

Canteen building shall be provided at 2(two) locations as indicated below for all personnel working in the power plant area.

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1. Near the Admin Building with dining arrangement for 50 people at one time. This shall have a dormitory facility in the upper floor for 50 personnel (four separate halls for accommodating 5, 10, 10 and 25 personnel). Separate dining area for ladies with capacity of 20 personnel shall be provided.
   One hall shall be provided with furniture for conducting meetings, retirement functions, etc.

2. Near the Service Building - The Canteen Building will be able to cater for minimum 300 persons with staggered meal times in four group with an interval of 30 minutes. Seating arrangement of at least 100 persons shall be made. In the upper floor a conference hall shall be provided with A.C. and other facilities as provided for the conference hall elsewhere in this specification. Separate dining area for ladies with capacity of 30 personnel shall be provided.

Both these Canteen buildings shall have the following facilities provided as a minimum requirement

a) Kitchen
b) Pantry
c) Stores
d) Space for Plate , pot wash and hand wash.
e) Area for freezer / refrigerators
f) Staff rooms and toilets
g) General gents and ladies toilets
h) Administrator / caretaker room
i) Dining Hall and service counter
j) Parking area.

Tables and chairs in the dining hall shall be fixed to the floor and shall have heavy duty stainless steel topping.
Sinks and wash basins shall be of heavy duty stainless steel.

An Air-conditioned VIP Dining room shall be provided for 15 people. General Dining room shall be with Desert Coolers

The building shall be of RCC framed structure and flat roof with brick masonry as side cladding. Architectural details shall be as per specification.

11.15.00 MISCELLANEOUS PLANT BUILDING

11.15.01 Air Washer Room & Compressor House

This shall be a single/double storied steel framed building adjoining to the Turbo generator bay. Roof shall be of RCC supported on colour coated trough shaped permanent decking supported on steel beams. Side cladding shall be by brick supported on concrete encased steel beams. Internal wall surfaces shall receive cement mortar plastering mixed with water proofing compound. Water tank and RCC supporting structures for louvers, filter and foundation for equipment such as fans and pumps are also included in the scope. Proper drainage of the floor has to be provided for. Doors shall be of flush welded steel and they shall be made airtight. Rolling shutter of adequate size should be provided for taking the equipment inside and truck with compressor. The

roof framing shall support an underslung crane of adequate capacity. Compressor foundation shall be isolated from the grade slab. Air receiver and Air drier can be supported from RCC grade slab. All trenches shall be sloped towards drain sumps. Trenches shall be provided with chequered plate cover. Steel glazed windows shall be provided for ventilation and natural lighting. A minimum of 2 flush type steel door shall be provided for movement of personnel. Dimension of the building shall be decided by the CONTRACTOR to suit the dimension of the equipment he is supplying duly taking into account maintenance requirements.

11.15.02 Diesel Generator House

This shall be a single storied RCC framed structure with electric hoist. The dimension of the building shall be decided by the CONTRACTOR to suit equipment supplied. D.G set foundation shall be isolated from the floor.
All trenches shall be of RCC and shall be designed as water retaining structure. There shall be no entry of cables / pipes to these trenches below grade level from outside. All these trenches shall be covered with chequered plate over steel framing. Adequate number of sumps shall be provided to drain these trenches.

11.15.03 Pipe racks and cable racks

All cable and pipe routing in out lying area shall be clubbed and shall run over ground on structural steel 'pipe / cable' racks at a height not less than 4000 mm clear above grade level. Where the pipes cross roads / railway clear headroom shall be 8500 mm. The racks can be multi-tiered. Cable shall normally be laid above the pipes.

Pipe racks/cable racks shall be of structural steel frame and longitudinally braced and shall be designed for worst combination of loadings. Expansion provision shall be provided wherever there is a change in direction or where length of the rack exceeds 100 metres.

Pipe racks for all connections from the existing station, existing pipe racks is to be used with necessary modification (or) new rack is to be erected.

All pipe & cable racks shall be provided with minimum 750mm wide walkway.

Necessary access ladders and platforms to be provided for maintenance. Where so required chequered plate platforms shall be provided for maintenance purpose. Pipe rack columns shall be supported on RCC foundation with bottom of base plate 300mm above adjoining ground level.

11.1600 FUEL OIL HANDLING SYSTEM

Unloading pump house to unload oil from road tankers shall be of single storey structural steel frame structure with GI sheet roofing and Brick walls. A paved platform shall be provided between the pump house and the road tanker parking area with plain cement concrete over rubble soling, sloped towards a peripheral drain. The drain will be led to a sump with oil water separator. No cable trenches will be permitted in the pump house.

Road level of fuel oil handling area shall be decided carefully so that oil from tanker can flow to unloading house under gravity flow only.

Fuel oil pressurisation pump house will house fuel oil pumps, heaters, operator room, toilet and MCC's. This is a single storeyed RCC framed structure with RCC roofing. The pumps will be located in an R.C.C basement. Protective hand rail shall be provided all round the basement. MCC shall be located at plinth level. Proper access shall be given to the basement. Basement shall be given proper drainage facility. The oil / water mixture collected in the sump will be led to an oil water separator. The basement shall be designed as a water retaining structure. Electric hoist crane or monorail facilities will have to be provided in all the pump houses as specified in the Mechanical section of the specification.

Fuel oil tanks shall be of structural steel designed as per IS:803.
Foundation of the fuel oil storage tank shall be provided with bitumen sand mixture laid over confined river sand bedding formed with RCC ring beam.The type of foundation to be adopted will depend on the soil condition. Where soil is very poor, tank may have to be founded on concrete pad resting on piles or the bearing capacity will be improved using ground improvement technique.

The storage tanks shall be surrounded by RCC wall to prevent the spread of fire or leakage of oil from a leaking tank to other areas. The 750 mm wide walkway shall be provided on the dyke wall all-round. The height of the wall, c/c spacing of tanks as well as area provided within the concrete wall are to be decided based on the statutory requirements for the type of oil stored and the quantity of oil stored. The entire area outside the tank foundation and within the tank farm shall be paved with concrete. The paving shall slope towards RCC peripheral drains which shall lead to an oil water separator. RCC crossovers shall be provided at appropriate locations for entry of personal to the tank farm. Fuel oil storage area shall be protected by chain link fencing as in the case of Transformer yard. Extent of fencing shall be to satisfy statutory requirement. Foundations for trestles and pedestals for supporting the pipes, anchor blocks etc shall provided in RCC at appropriate locations.

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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 (All Parts)	:	Code of Practice for Design loads for buildings & Structures
e)	IS:1893-2002 (Part-1) Fifth revision	:	Criteria for earthquake resistant design of structures
f)	IS:1893-2002 (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

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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 (Part1 &2) : Design construction of steel chimney- code of Practice

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	:	

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 at top of raft (min.)	:	
14)	Minimum top shell thickness	:	400 mm
15)	Minimum bottom shell thickness	:	As per design requirement, but not less than 950mm.
16)	Chimney foundation type	:	
17)	Flue gas pressure at chimney 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 400kg/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^2. Design live load during construction / erection shall be considered as 1000 Kg/m^2.
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 ΔT, 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 127^0C (approx.)

The temperature gradient ΔT across the shell thickness of windshield shall be calculated as per IS: 4998 (Part-I) – 1975 but subject to a minimum of 20^0C. 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, ovalling, 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 Fck.

Where Fck – Characteristic compressive strength of concrete

12.07.00 Analysis

12.07.01 Wind Analysis

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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.
$5000\sqrt{fck}$ for instantaneous loadings.Where fck is the haracteristic 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 30^0 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) fluroelastomeric fabric expansion compensator.

2. Design of Steel Liners

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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/^{0}C at a mean temperature of 150^{0}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^{0}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 annulas 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 late 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^{o}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^{o}C and its coeff. of linear expansion not to exceed 1.2x10^{-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 Fortaxfix 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 land 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

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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 defection of main plate girders supporting flues and gratings shall be restricted to L/600, however maximum defection 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^2 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 configurated 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. codal) 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 fluro-elastomer having an approximate weight of 1.5 kg/sq.m.

c) Two layers of PTFE (Poly Tetra Flouro-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 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.

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

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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.

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13.00.00 NATURAL DRAUGHT COOLING TOWER

13.01.00 Scope

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

13.02.00 Codes and Standards

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

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

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oo. VGB Guidelines — Structural design of cooling towers.

pp. ATC - 105 — Specification for Cooling Towers - Cooling Tower Institute - USA

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

13.03.00 General

The cooling tower shall be capable of cooling the rated quantity of water through the specified thermal range at the design wet bulb temperature and it shall conform to the other design parameters as stipulated in Mechanical section of this document.

The scope of the Contractor's work for a cooling tower shall include preparation of detailed designs and construction drawings and execution of work including but not limited to supply of all material for foundations, shell, basin, fill with its supporting structure, staircases/walkways/platforms with handrailing, cold water outlet channels including gates, screens with handling arrangement, painting, access doors, water distribution system, aviation warning system, lighting, lightning protection system, with their associated hardware, etc., complete all as required to give satisfactory performance and as stipulated in various clauses in this document.

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

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

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

13.04.00 Grade of Concrete & Steel

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

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

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

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

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

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

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

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

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

All exposed steel work shall be protected by hot dip galvanising. The minimum coating of zinc shall be 910 gm/sq.m. and comply with the requirements of IS:2629 and IS:2633. In addition, galvanizing shall be followed by the application of one coat of etching primer conforming to IS:5666 and 2 coats of bituminous paint conforming to IS:9862.

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

13.05.00 Design Criteria

13.05.01 Wind Load

Basic wind speed as well as factors K1/K2/K3 shall be taken from IS:875. Additional intensification factor to be considered due to natural turbulence in the incident wind / induced turbulence owing to nearby tall structures shall be 1.43 or based on wind tunnel studies, whichever is higher. Further cyclonic risk factor as per IS:15498 shall also be considered.

Steady pressure distribution around the shell for the wind loading shall be as per clause 5.1.3 of IS:11504, for cooling towers not more than 120m in height and not more than 100 m in base diameter. The value obtained shall be increased by 10 percent to take into account any geometrical imperfections.

For cooling towers of height more than 120m and/or more than 100m in base diameter, wind pressure distribution shall be as determined by model test in a wind tunnel.

13.05.02 Earthquake Load

The coefficient of horizontal acceleration shall be for the appropriate seismic

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

13.05.03 Dead Load

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

The loadings brought upon the shell by permanent fixings shall be minimised to the greatest extent possible. However, when these attachments are made, their effect upon the structure shall be thoroughly investigated.

13.05.04 Constructional Loadings

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

13.05.05 Miscellaneous Loads

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

a) Thermal restraint loads

b) Subsoil deformation

13.05.06 Load Combinations and Permissible Stresses

All structural components except Fill Supporting Structures ,Stairs and Platforms of the cooling tower shall be designed by both working stress and limit state method. The following load / load combinations shall be followed in addition to codal requirement:

a. For working stress method
   i. DL + WL
   ii. DL + 1/3WL + EQ

b. For limit state method
   i. 1.5DL + 1.5WL
   ii. 0.9DL + 1.5WL
   iii. 1.5DL + 1.5EQ + 0.5WL
   iv. 0.9DL + 1.5EQ + 0.5 WL

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

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

combination.

Since cooling tower is more a wind predominant structure, increase in permissible stresses as per B – 2.3 Annexure – B of IS 456, shall not be allowed. Increase in safe bearing capacity for design of foundation under wind load combination shall also not be permitted.

13.06.00 Foundations

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

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

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

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

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

13.07.00 Basin and Cold Water Outlet

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

13.08.00 Tower Shell

13.08.01 Shell Geometry

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

13.08.02 Thickness

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

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

13.08.03 Design

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

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

a) The strain resulting from a temperature gradient across the shell thickness.

b) The strain resulting from moisture content variations through the shell thickness, and

c) The strain resulting from variations of conditions (a) and (b) caused by rain and sunshine on one side of the tower or partial operation of the tower.

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

13.08.04 Reinforcement and Cover

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

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

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

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

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

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

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

13.08.05 Tolerances

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

13.09.00 Fill

PVC splash type bars fill arrangement shall be provided.

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

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

Density of fill to be considered for the design of fill supporting structure shall be 100 kg/m^3 minimum

13.10.00 Fill Supporting Structure

Fill supporting structure with its foundation shall be of reinforced concrete construction.
Fill supporting structure, where formed of precast concrete units, shall be made stable by the use of either bolted, cast-in-situ or glued joints. Members of precast concrete structure shall be either pre-stressed or reinforced concrete units. Where bolts are used forpermanent connections, they shall be of a material highly resistant to corrosion or fully protected by embedment or coating.
The columns and beams supporting the Fill shall be adequately braced in all directions. The design of all members shall be checked for resistance to buckling.
The stability of the Fill support structure shall be checked for its capacity to resist a horizontal force of 2% of self-weight, the Fill and supporting structure, assumed to act horizontally in any direction. The structure shall also be checked for the appropriates earthquake loading as applicable.

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

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

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

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b) loading due to scaffolding for the erection crew if so envisaged to be supported.

c) loading of personnel during maintenance of pipe work and sprinkler system. The appropriate parts of the pack support structure shall be designed to support a point load of 1.5 kN at any position.

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

13.11.00 Maintenance Access Facilities

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

13.11.01 Stairs

The tower shall be provided with two numbers external RC staircase, leading to a heavy duty door giving access to the distribution system. Staircase shall be minimum 1000 mm wide (clear), with landings of minimum width of 1000 mm at not more than 2500 mm height intervals unless approved otherwise. The steps shall have a rise of about 125 mm and tread of about 250 mm.Anti-skid nosing at each step shall be provided.
All access doors shall be of size minimum 1200 mm wide and 2100 mm height, minimum.

13.11.02 Platforms

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

13.11.03 Walkways

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

13.11.04 Ladders

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

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

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

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

13.11.05 Handrailings

Handrailing shall be provided on both sides at the edges of platforms, landing slabs, sides of stairs, walkways and cold water outlet channel.
Handrailing shall be of hot dip galvanised construction and shall be out of 32 mm NB pipes of medium class conforming to IS:1239 and provided with etch primer and bituminous painting.
Handrailing shall be 1300 mm high with two intermediate rails at 450mm and 900 mm with the top rail at 1300 mm above the surface of slab/steps. Handrail posts shall be spaced at not more than1.5 m centres.
A toe plate of hot dip galvanised mild steel of size 65 mm x 8 mm shall be provided for all handrailing.

13.12.00 Painting To Concrete Surfaces

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

a) Basin floor

b) Internal surfaces of basin wall including the partition wall.

c) Diagonal columns over complete height.

d) Fill support columns and beams for the full height and length respectively.

e) Internal and external surfaces of hot water duct.

f) Internal and external surfaces of cold water channel upto the terminal point.

g) Internal and external surfaces of the drain chamber.

h) Complete internal surface of the shell. For external surface at least 1 metre on the shell at top.

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

remove all dirt and remains of loose or powdered materials.

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

13.13.00 Water Distribution System

The arrangement of water distribution system shall permit a satisfactory distribution of water over the whole area of the tower at all reasonable loads.
Hot water Inlet pipe shall conform to the requirements of Class I of IS:3589 and steel shall conform to IS:2062.
The distribution troughs/pipes shall be independently supported from the structures and shall be easily removable. Provision shall also be made for easy flushing or cleaning of all troughs/pipes.

13.1400 Lightning Protection

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

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

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

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

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

13.15.00 Aviation Warning System, Lighting and Power Receptacles

Refer Volume-III (Mechanical Section)

TECHNICAL DATA SHEET- A

13.22.00 Specific Technical Requirements

a) Number of cooling towers 2 nos

13.22.01 1. Design & Operating Conditions

Refer Volume-III (Mechanical Section)

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13.23.00 Features

Refer Volume-III (Mechanical Section)

13.24.00 Elevations

13.24.01	Grade level in m	To be decided during during detail engineering.
13.24.02	Sill level in m	-do-
13.24.03	Basin depth in m	-do-

13.25.00 Materials of Construction

Refer Volume-III (Mechanical Section)

13.26.00 Structural Concrete (Minimum Grade)

a)	Foundations	M30
b)	Basin	M35
c)	Diagonal Columns	M40
d)	Shell	M35
e)	Precast works (Fill Supporting Structure)	M35

13.2700 Type of Cement

a) Below ground

(i) Sulphate Resisting Portland cement with C_3A content 5 to 8%conforming to IS:12330

b) Above ground

(i) Sulphate Resisting Portland cement with C_3A content 5 to 8%conforming to IS:12330

13.28.00 Primary Loads

13.28.01 Wind load (as per IS 875)

a)	Basic wind speed	50 m /sec
b)	Factor K1	1.08
c)	Terrain category factor K2 Varies w.r.t. height	Category 1

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	d)	Factor K3	1.0
	e)	Intensification factor	as per spec.
13.28.02	**Earth quake load**.		
	a)	Zone as per IS:1893	III
	b)	Importance factor	as per code
13.2900	**Foundation Criteria**		
	Ground water table		At grade level.
	Type of foundation		Pile
	Safe bearing capacity of soil		As per soil report
	Type of pile		As per soil report
	Pile capacity and termination depth belowground level		As per soil report
	Minimum thickness of basin base slab		250mm
	Pressure relief valves in the basin floor slab		Not to be provided
13.3000	**Water Distribution Channel** Design Pressure		
13.3100	**Performance Test** Method Instrumentation		

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14.00.00 COAL HANDLING SYSTEM

14.01.00 External Coal Handling System From Coal Berth -3 to Plant Area:

External coal handling system will consist of conventional conveyor gallery from JTB-3, MCC / Electrical building in NCTPS Stage II. And thereafter pipe conveyor system upto Ennore SEZ.

The pipe conveyor will cross the Buckingham canal, Back water area, railway line, transmission line, oil pipe line & roads before entering Power plant area covering a distance of about 5-6 km.

The pipe conveyors will be supported on cross-over, trestles, piers etc. At the crossing of roads the cross-over should maintain 8.0m clear height from the crest of road and at the railway crossing the cross over should maintain the clear height from the top of rail as per railway norms. Bridge shall be provided for crossing of pipe conveyor, Sea water pipes (CT Make Up & Desal make up) and cables near canal crossing, road crossing & railway crossing.

Considering the declaration of Buckingham Canal & Pullicat back water as National Inland Waterway and Formation of terminal etc., at the crossing of Buckingham canal and Pullicat back water the span of the supporting cross-over and height of the pipe conveyors shall be decided with reference to the Water Resource Department, PWD guideline.

Necessary statutory clearances / approval from Railways / Highway Authority / PWD shall be obtained by Contractor at his own cost.

14.02.00 In-Plant Coal Handling System Necessary For The Proposed Plant:

In-plant coal handling will consist of junction towers (underground and above ground), sampling towers, underground / semi ground tunnels, pent house, conveyor galleries, trestles, MCC room, stacker reclaimer foundation, coal stock pile, stock yard drainage, water sprinkler system, dust extraction / suppression system, pump house, cable tray, cable support, underground cable trenches with RCC cover, rails etc.

14.02.01 Over Ground Transfer Points

Over ground TPs shall have RCC foundations and pedestals at (+) 500 mm above ground level. The superstructure for TPs shall be of steel framed structures with adequate bracing arrangement. The ground floor and all intermediate floors shall be of RCC and will be finished with IPS and metallic hardener having proper slopes for drainage. The roofs shall be of flat RCC slab with water proof treatment and drainage slope. The cladding shall be of permanently color coated zinc alum sheets of minimum thickness 0.6mm TCT. Plinth protection and storm water drain shall be provided around the structure suitably.

Roof and all intermediate floors will be of reinforced concrete minimum 150mm thick of concrete M25 grade. All grade floors will be 200mm thick of M-20 grade concrete with nominal reinforcement of 8 Tor @ 250 c/c top and bottom both ways over PCC, soling over sand cushion of required suitable thickness. However the codal regulations shall also be compiled with. Continuous handrails shall be provided for the staircase with 32 mm NB GI pipe hand rails.

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TPs shall be provided with independent steel staircase with steps of MS grating from ground to highest operating floor level. The clear width of the stair shall be minimum 1.0m. The tread shall be atleast 250 mm and riser shall be uniform throughout the height and shall not exceed 180 mm. However the codal regulations shall also be compiled with. Continuous handrails shall be provided for the staircase.

Drive units shall be directly supported on floor beams from suitable structural steel stools and not on concrete floors. All transfer houses shall be provided with adequate no. of windows and doors. The window area shall not be less than 10 percent of total wall area. Maintenance platform inside / outside of transfer house may have chequered plate floors with horizontal floor bracing.

Transfer points / crusher house with metal sheeting as cladding shall have 1.5m high 230 mm brick enclosure from finished ground floor around the building. Brick wall shall be inside face of sheeting with a lapping of 150mm.

Adequate floor washing arrangements shall be made in all TPS.

Provision of floor dust collection and removal by chute shall be made.

The Transfer house structure shall be so designed that transverse deflection at places where conveyor gallery meet, should be equal to the respective transverse deflection of conveyor trestles.

Monorail / beams for electric / manual hoists shall also be provided in junction tower wherever required.

Suitable overhead RCC / syntax water tank shall be provided for service / potable water system.

Piling shall be used for junction tower foundation.

14.02.02 Crusher House and Crusher Foundation

The crusher house will be braced structural steel structure with one brick thick (230 mm) upto 1.5 m from ground level and above 1.5 m the cladding shall be of pre-coated colour steel sheet . Floor and roofs shall be of RCC supported on steel beams. Roof will be provided with roof water proofing treatment in line with architectural requirements mentioned elsewhere in the specification. Adequate steel doors and windows shall be provided for natural lighting and ventilation as mentioned for TPs.

The crusher house shall have an independent staircase for general use like other TPs. In addition, it shall have a separate open staircase for fire escape suitably located to comply with fire fighting norms. An open elevator up to the top floor shall also be provided at suitable location at periphery of the building.

The crusher shall be supported on RCC M30 deck slab of designed thickness mounted on vibration isolation system of GERB comprising springs and viscous dampers, which in turn supported on steel girders. The framework of girders shall be an integral part of the building, which houses the machine. There shall be isolation gap between building floor slab and

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crusher deck slab. Suitable provision for maintenance platforms for springs and damper shall be provided.

Monorail / beams for electric / manual hoists shall also be provided in crusher house wherever required.

Piling shall be used for crusher house foundation.

14.02.02 Crusher Foundation

Detailed dynamic analysis shall be done for the top deck together with springs and dampers and the natural frequencies and amplitudes of vibration shall be determined. A mathematical model of the top deck shall be formulated with three dimensional beam / plate finite elements for the purpose of analysis with the spring idealized with vertical and horizontal stiffnesses. The mass of the machine together with that of the top deck shall be considered for the analysis.

Natural frequencies up to at least 10% above the operating speed shall be determined and three frequencies shall be checked against the design criteria.

Forced response dynamic analysis shall be carried out of for the operating condition unbalance forces using a sinusoldal forcing function. Unbalance forces as given by this specification shall be used for his purpose.

14.02.03 Isolation Efficiency

The vibration isolation system shall be designed for about 95% isolation efficiency.

14.02.04 De-Coupling

A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction of achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out.

14.02.05 Frequency Criteria

The frequency criterion has already been laid down implicitly foundation isolation efficiency criteria and de-coupling required.

The bending mode frequency of the top deck shall be atleast 20% above the operating speed.

14.02.06 Unbalance Forces

Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.

(a) Balance quality grade Q40 as per VDI 2060-1966.

(b) One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non-drive end of the crusher.

(c) Three hammers broken condition. All the three hammers broken shall be assumed to be from the same suspension bar and located at the non-drive end of the crusher.

14.02.07 Amplitude Criteria

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions:

1) Operating speed of 750 RPM.

(a) 150 microns for an unbalance force arising out of balance quality grade Q40 as per VDI 2060-1966.

(b) 300 microns in case of a one hammer broken condition.

(c) Amplitudes need not be checked for a three hammer broken condition.

2) Operating speed of 450 RPM.

(a) 200 microns for an imbalance force arising out of balance quality grade Q-40 as per VDI-2060-1966.

(b) 300 microns in case of a one hammer broken condition.

(c) Amplitudes need not be checked for three hammer broken condition.

For intermediate operating speed between 450 to 750 RPM, the amplitude limits can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitude shall be calculated at critical points on the top surface of the RCC deck. The amplitudes shall be checked for the most unfavourable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vector may be considered while superimposing the modes.

14.02.08 Transient Resonance

Transient resonance, which may occur during the start-up or coasting down condition of the crusher, shall be checked and the amplitudes in such a condition should not exceed one – and half times those at operating speed for each design condition.

14.02.09 Strength Criteria

The following criteria shall apply for the design of top deck:
Dead loads, live loads, seismic loads and dynamic loads shall be considered for the design. The most unfavourable combination shall considered for design.

Seismic loads shall be assumed to act together with dynamic loads for a one millimeter eccentricity in the rotor. However, seismic loads and dynamic loads arising out of hammer

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breakage need not be considered together.

Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.

Working stress method shall be used for the design of RCC deck. In survival condition, 10% overstressing may be permitted.

The RCC top deck shall be atleast of M30 grade of concrete as per IS:456-2000.
Fatigue need not be considered for the three hammer broken condition.

For calculating unbalance forces, the heaviest hammer (plain or toothed) shall not exceed the value specified by the manufacturer.

Loss of contact of foundations at founding level shall not be allowed for any combination of loads.

14.03.00 Coal Handling Control / Electrical Building

The control room for the coal handling plant shall be RCC framed structure with brick masonry walls or steel framed structures with brick masonry walls and RCC roof designed to be completely dust proof. Large glazed windows shall be provided for a complete view of the coal handling plant from the control room. Provision for fire escape stair shall be provided in accordance with TAC requirement. The building shall be provided with toilet/urinals at various locations as per owner's requirement. Air conditioning to be provided for the operators / working area suitably. All windows & doors shall be aluminium only.

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14.04.00 Foundations of Stacker-cum-Reclaimer

Foundations for Stacker - Reclaimer shall be designed as a continuous wall or RCC framed structures (in longitudinal and transverse direction). Lateral tie beams shall be provided between two rail supporting elements shall be provided at a regular interval of min. 3.0m center. The foundation shall be designed for the most critical combination of loads as prescribed by the manufacture. The foundation shall also be designed for deflection and settlement as required by the manufacturer.

Piling shall be used for Stacker-cum-Reclaimer foundation.

14.05.00 Over ground Galleries & Trestles

Overhead conveyor galleries shall be structural steel consisting of two vertical girders braced at top and bottom and having rigid jointed portal frame at both ends. Common end portal shall not be used for two adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed girder to form an enclosure. The maximum span of standard gallery shall be 24 m unless higher span is required due to the site condition, which shall be subjected to approval of the engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The Gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection

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shall be made.

The galleries for double stream conveyors shall have one central walkway and two side walkways of clear width 1100 mm and 800 mm respectively. Single stream conveyors shall have two side walkways. Both sides of walkways shall be provided with pipe handrails all along the conveyor. Walkway shall be of chequered plate with anti-skid arrangement. Conveyor gallery having slopes grater than 10 degree, stepped walkways of tread 250 mm of chequered plates with nosing and toe guard shall be provided all along the conveyor.

Each conveyor gallery shall be provided with seal plate (throughout gallery length) of minimum 12 gauge thickness. The conveyor galleries shall be designed for adequate ventilation and natural lighting.

Suitable floor washing arrangement shall be made in the conveyor gallery with down comers. Down comer shall lead the water/coal slurry to pit (of 2.0 cum capacity) to allow settling of coal, which will further discharge into RCC drains.

Cross-over with chequered plate platform, ladder and hand railing for crossing over the conveyors shall be provided at approximately every 100 M intervals of conveyor. Cross over shall be preferably located over four legged rigid trestle locations.

Location of trestles shall be decided carefully so that there is no interference with underground and over ground structures, tunnels, trenches, drains etc. However at the location where overhead conveyor gallery crosses road/ rail line, The minimum clearance of 8.0 m above road crest and 10 m above rail shall be provided. Necessary statutory clearances / approval from Railways / Highway Authority / PWD shall be obtained by Contractor at his own cost.

For calculation of coal load on moving conveyor, a multiplication factor 1.6 shall be used to take care of inertial force, casual overburden and impact factor etc.

Thus coal load per unit length of each moving conveyor shall be

$$1.6 \times \frac{\text{Rated Capacity of Conveyor System}}{\text{Conveyor Belt Speed}} \times \frac{1200}{800}$$

It should be noted that for structural design, Unit weight of coal shall be assumed as 1200 Kgs/ Cu M. instead of 800 Kgs/Cu M. considered for system sizing purpose.

Conveyor gallery shall be designed considering both conveyors operating simultaneously.

In between transfer house / buildings four legged trestles shall be place at a maximum interval of 90m. The arrangement shall be such as to ensure that force in the longitudinal direction (i.e along conv. Length) of conveyor gallery of length not more than 90m will be transferred to four legged trestle. Two legged trestles at regular interval may be placed between four legged trestles. The end supports resting on the four legged trestles can have either ends hinged or one hinged and the other on slide type. Slide type support shall be with PTFE bearing to allow both rotation and logitudnal movement.

End of conveyor gallery which will be supported over transfer points, shall be so detailed

that only vertical reaction is transferred from gallery and no horizontal force in longitudinal direction is transferred from gallery to transfer points and vice-versa.

Transverse deflection of trestle due to wind /seismic load shall not exceed trestle height/1000 as stipulated in IS 11592. Longitudinal deflection of trestle shall also be within limits.

All RC trestle pedestals should be raised to (+) 0.5 m above FGL. Trestles shall be of structural steel braced adequately and provided at suitable locations.

Piling shall be used for trestles foundation.

14.06.00 Coal stock yard

Entire area shall be excavated to average 250mm depth and given slope of 1 in 100 in suitable directions as approved. Entire excavated area shall be watered and rammed and compacted with 10 tonne roller. 100mm thick river sand cushion layer shall be placed over compacted subgrade and consolidated by flooding 150mm thick boulder soling shall be laid over sand cushion, joints filled with river sand. Over boulder soling, 75mm thick lean concrete (1:4:8) shall be spread. Final layer shall be minimum 150mm thick RCC slab of grade M20 having double layer reinforcement. Slope is to be maintained through all layers. The coal stack area shall be graded with suitable slope for draining the surface by longitudinal drains shall be of RCC trenches with graded gravel packets at about 1.5m intervals on the sides to trap coal dust. Weepholes shall be provided in the trench walls at the locations of filter pockets for collecting surface water in the longitudinal rains for discharging into the main surface drain to be provided by the Contractor by the side of the road. Retaining wall 1m depth to be provided around the crushed coal pile to prevent coal spillage into the drain. Necessary control joints in the grade slab shall be considered to avoid temperature and shrinkage cracks in the slab. The design of coal stack area should take care of loads arising due to dozer movement and shall be designed to sustains coal water pressure.

Suitable soiling with mortar cover shall be provided between rails for stacker reclaimer and reclaimer machines.

14.07.00 Cable gallery

Cable galleries shall made of tubular steel sections. The tubular steel sections shall be of circular/ rectangular/ square shape. The circular steel tube shall conform to IS:1161 and rectangular/ square steel sections shall confirm to IS:4923. The steel structures using tubular sections shall be designed and fabricated as per IS:806 – "Code of practice for use of steel tubes in general building construction." And EN 1993-1-8:2005.

14.08.00 Drainage of CHP Area

Suitable drainage arrangement shall be provided for underground structures if any with sump pumps. Coal stockyards and surrounding areas also shall have suitable surface drainage facilities.

14.09.00 Road / Rail Crossings:

Hume pipes of appropriate size of class NP2 shall be provided under the roads and rail tracks for pipe and cable crossings at the required locations.

14.10.00 Loadings

For different loads on structures, latest IS:875 shall be followed. All structures shall be designed for dead load, live equipment load (including impact / vibration), erection load etc. in addition, seismic load (as per IS:1893) or wind load (as per IS:875) shall also be considered.
The following minimum live loads shall be adopted for design of buildings / structures.

a)	Flat Roof	:	Accessible roof – 200 Kg/m^2 (150kg/m^2 for L.L. & 50 Kg/m^2 for dust load)
		:	Non-accessible roof–125 Kg/m^2 (75 Kg/m^2 for L.L. & 50 Kg/m^2 for dust load).
b)	Inclined roof (including roof for Conveyor Galleries)	:	A per IS:875 for live load plus 50 Kg/m^2 for dust load to be Considered on plan area.
c)	All building floors & stairs	:	500 Kg/m^2
d)	Toilet rooms	:	200 KG/m^2
e)	Walkways of Conveyor Galleries	:	300 Kg/m^2 (including Coal dust load) or a concentrated load of 300 Kg. at centre whichever is critical.
f)	M.C.C. Floor	:	1000 Kg/m^2
g)	Equipment Load	:	As applicable
h)	Tunnels under roads, culverts per & its allied Structures including hume pipes.	:	Class "A" or class "70R" as IRC Standard whichever is higher or load due to bulldozers.
i)	Underground basement tunnel trenches etc.	:	A surcharge pressure of 2T/m^2.
j)	Tunnel	:	The loading shall be highest of the following:

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i) Two bulldozers (maximum capacity indigenously available) operating side by side without any coal heap over reclaim tunnel & surroundings and uncrushed coal storage area.

ii) Two bulldozers operating side by over a coal heap of 4.0m.

k) Rail loads : As per I.R.S. including latest amendments

All structures under influence of Railway load shall be designed as per provisions of Indian railway code of practices and the contractor shall get the designs and drawings of structures approved by railway authorities also.

l) Other loads : As per IS:875 or as decided by the Purchaser

m) Seismic Loads : For design purpose the values for Seismic Zone – III as per IS:1893 shall be considered. Importance factors for all buildings shall be considered as 1.75. In addition, provision contained in IS:4326 & 13920 shall also be considered.

n) Wind Load : As per IS:875. Basic wind speed = 50 m/s.

o) Minimum thickness of walls / raft for all underground structures will be as follows:

Minimum thickness of R.C.C. raft at bottom shall be 600 mm. Minimum thickness of RCC side walls shall be 600 mm at bottom and 300 mm at top.

p) A minimum safety factor of 1.2 against uplift of due to underground water shall be ensured during execution and after execution, considering dead weight of the structure to be 0.9 times only, ground water table at adjoining formation level and soil wedge angle of not more than 15 degress. Also FOS against uplift to be taken as 1.0, considering the dead weight of structure and soil resting on side projections, if any in the vertical plane. Inclined wedge action of soil shall not be considered in this case.

q) For Underground structures, earth pressure to be considered for design shall be due to earth pressure at rest (K_0) condition only. Earth pressure due to surcharge intensity of Railway Loads (where applicable) or Uniformly Distributed Load (UDL) of intensity 2T/sqm whichever is critical, shall be considered in the design.

r) For design of coal hoppers, bulk density and angle of repose for coal shall be considered as 1.2 MT/cum and 31 deg. respectively.

s) For deep underground structures, minimum clear cover for reinforcement shall be 50 mm unless otherwise stated.

For Design of Liquid storage structures , IS: 3370 (Part-I to IV) (Latest) shall be followed. Face of the structure in contact with the water shall be designed as uncracked section.

For design of underground structures/ foundations,
ground water table shall be considered at FFL of respective structure.
Face of the structure in contact with earth shall be designed with crack width limiting to 0.1 mm

t) Water proofing of underground structures shall be done as /clause 6.11 of this specification.

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15.00.00 ASH HANDLING SYSTEM

15.01.00 Specification for Civil, Structural and Architectural Works will be referred

Ash handling system shall comprise of fly ash handling systems, ash slurry pump house, ash water pump house, ash compressor house, ash pipe supports including culverts, bridges etc. upto the specified terminal points.

Works shall include dry bottom ash hopper supports, scraper chain conveyor foundation & supports, transition chute foundation & supports, seal trough foundation & supports, clinker grinder, jet pump supports & foundation, bottom ash pipe supports, bottom ash extraction equipment supports, ash slurry pipe supports from ash slurry pump house to ash pond, surge tank, dry fly ash & bottom ash pipe supports, supporting structure for buffer hopper, fly ash silos, wet fly ash slurry pipe & supports from silo to ash dyke. Development of silo area (including paving, fencing, access roads, office block and watchman cabin), pump and equipment foundations,
Vacuum pump foundation, BA over flow sump, drain sumps, compressor house, MCC room, RCC thrust blocks, 100 tonne electronic weigh bridge and other buildings, supporting structure facilities required to complete the system upto terminal points.

Structural arrangement, pile foundation system, if required, cladding interior and exterior finishes, area paving etc., shall be as per total plant building design and finish schedule furnished elsewhere in the specification.

Pipelines shall be supported on RCC structures and pile foundations, if required. Pipes shall be suitable anchored with RCC pedestals to resist lateral and vertical movements. For crossing of the pipe lines and maintenance road with nallahs, canals etc. and / or for road / rail crossings, pipes shall be laid through RCC box culverts / bridges. Road leading to silos shall have minimum width of 7.5m with both sides berms 1m and drains.

The compressors and their associated equipments shall be housed in RCC building along with requisite MCC room. Crane / monorail of adequate capacity shall also be provided in all pump / compressor house.

15.02.00 Following facilities shall be provided as per Vol. III of specification.

i) Ash slurry sump with pump house.

ii) Ash water sump house with pump house.

iii) MCC Room / Control room.

iv) Pipe Rack / trenches etc. in the plant area.

v) RCC paving in Silo area.

vi) Office block of minimum 50 sqm and Watchman cabin of minimum 5 sqm area shall be provided.

vii) Dry ash storage silo area shall have compound wall all around with gate.

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

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(a) For volume calculation of fly ash silo : 750 kg/cum

(b) For load calculation of both types of silos : 1600 g/cum

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

x) Clarifier.

xi) Ash compressor house.

xii) Fly ash silos, water wash arrangement lorries shall be provided in the flyash silo area

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16.00.00 PLANT WATER PRE-TREATMENT AND DM PLANT SYSTEM

16.01.00 Sea water pre-treatment for CW and DM plant will generally consist of the following facilities / buildings, which will be located in two areas. However, the bidder may add / delete / club facilities as per approved system:

1. **Sea Water Intake & Water Treatment In NCTPS Stage – II**
   - Sea water intake pump house including channel & forebay.

2. **Water Treatment Facility Located In Ennore SEZ**
   - Cascade aerator & stilling chamber.
   - Inlet channels.
   - Filtered sea water tank & pump house.
   - Dual Media Filters
   - UF building.
   - UF permeate tank & pump house.
   - Cartridge filter building.
   - RO Stage I building.
   - RO Stage I Permeate tank & Pump house.
   - Reject sump.
   - Filtered water tank & pumphouse.
   - RO stage II building including MB.
   - DM building for SAC, SBA & MB chain.
   - RO Stage II permeate tank & DM water storage tanks.
   - Pump foundations in water treatment area.
   - Electro chlorination building for CW system.
   - Regeneration & bulk chemical storage area.
   - CPU regeneration (if separate).
   - Neutralization pit.

The stilling chamber and aerator shall be of RCC structure. The chambers and water channels shall be watertight structures.

The high rate solid contact clarifier shall be of RCC construction. The watertight circular RCC structures shall have continuous platform with handrail along periphery at the top. At least 3 nos. ladder shall be provided at the outside and vertical rungs shall be provided inside for maintenance.

The sludge sump (reject sump) shall be an underground RCC pit, part of the pit shall be cover with RCC slab for supporting the vertical sludge pumps. The sludge pumps shall be housed in a pump house with RCC roof supported on RCC columns and beams. There will be hoist and monorail of required capacity for handling of pumps. Capacity of reject sump is indicated in Vol. III & Composite Water Scheme.

Filtered sea water tank/ UF permeate tank/ RO Stage I Permeate tank/ Filtered water tank shall be of water tight RCC construction having two compartments covered with RCC roof. It will be aboveground. Vent pipes shall be provided at roof. The tanks including RCC roof shall be designed as uncracked structure as per IS:3370. The pump house structure shall be of RCC framed construction with RCC flat roof. Side cladding shall be

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of brick masonry. Cranes & hoists as indicated in Vol. III shall be provided for handling pumps. The building shall be complete with doors, windows and rolling shutter. Floor and other finishes shall comply with architectural specification. Capacity of the tanks is indicated in Vol. III & Composite Water Scheme.

Pretreatment chemical house shall be a two storied concrete RCC framed building. Clear height of 5.5m (minimum) shall be provided in each floor. The building shall be complete with brick work, plastering, doors, windows, rolling shutters, flooring, plaster, painting, roofing etc. and all other items necessary for satisfactory performance of the building. The building shall have toilets and the scope shall include supply and fixing W.C.'s urinals, showers and all plumbing sanitary and other work required for satisfactory completion of the above building. The tanks and parts of floor slabs shall be lined with acid / alkali proof tile lining. Monorails of adequate capacities shall be provided as per functional requirements. The building shall be provided with adequate toilet facilities.

Near the chemical house there will be a single storeyed RCC framed building housing the electro-chlorination plant. Hoists with monorail shall be provided for normal plant operation and for handling of equipment during erection / maintenance. The building shall be complete with brick work, plastering, doors, windows, rolling shutters, flooring and painting, roofing etc. and all other items necessary for safety and satisfactory performance of the building. Brick masonry wall with suitable windows and doors will be provided in accordance with architectural specification.

Water treatment facility including RO stage I, UF building, Electrochlorination & Sea water intake PH, and DM plant building in Ennore SEZ will be RCC framed building having brickwork cladding on all four sides. Ground floor shall house MCC and control room. Control Room which shall have false ceiling and shall be air-conditioned. Central chemical laboratory and office rooms etc. shall be at first floor level, which will also have false ceiling and air condition provision. Equipment foundations & trenches in ground floor slab shall be of reinforced cement concrete. Ground floor shall have ironite flooring except at locations, which may come in contact with acid/ alkali where acid / alkali resistant tile lining with epoxy mortar shall be provided. Effluent drain trenches shall also have acid proof lining at inside surfaces of drain as well as soffit of pre-cast removable covers. The building shall be provided with adequate toilet facilities. The lab shall be provided separately in NCTPS & Ennore SEZ.

Floor where acid / alkali spillage are expected shall be isolated with RCC kerb.
Neutralizing pit shall be of watertight RCC construction. Internal surfaces shall be lined with acid / alkali proof lining with matching epoxy mortar. Neutralization pit shall be designed as uncracked section. Ceiling as well as floor, supporting pumps shall be given epoxy lining.

Acid / alkali storage tanks shall be resting on RCC saddles on elevated RCC platform. The platform shall be supported on RCC beams, columns with RCC foundations. The saddles along with platforms shall be lined with acid/alkali proof tiles.
Acid / alkali storage and handling area shall also be lined with acid / alkali resistant tiles.

The DM storage tanks shall rest on thoroughly compacted fill of gravel, coarse sand or other stable material topped with minimum 75 mm thick compacted crushed stone, screenings, fine gravel, clean sand or similar material mixed in hot asphalt (8 to 10

percent by volume) and rolled or compacted. This filling shall be confined within a RCC ring wall with foundation. The tank shall have complete bearing with the foundation fill. All backfilling within tank foundation shall be done by compacted sand. Degasser shall be supported on RCC framed structure. Minimum 2.5m wide RCC pavements shall be provided around each outdoor equipment.

The capacity of all tanks and equipment shall be as per VOL III.

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.

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Top level of parking area shall be flushed with crown connecting roads with cross slow. 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 least1m 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.

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 been 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 intersticies 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 garde 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.

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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 quantiy. 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^{o}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 retension 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

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 60^0C) water shall be first cooled down to less than 60^0C 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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18.00.00 ARCHITECTURE

18.01.00 Architectural Concepts

a) Layout of the plant area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building back drops, building frames. General layout shall be evolved taking over the basis of landform & local climate & due consideration shall be given to orientation & wind direction. The resulting built mass shall present a definite image width in distinct vocabulary in the form of landmarks, nodes & skyline.

b) Main Plant Building shall be architecturally treated in such a way that it retains a monumental scale, yet presents a pleasing composition of mass and void with suitable and functionally designed projections and recesses. The overall impact of the building shall be one of aesthetically unified architectural composition having a comprehendible scale, blending tonal values with the surroundings and taking full consideration of the climatic conditions, the building orientation and the existing structures nearby.

c) All other buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters and materials may be judiciously imbibed. The building shall be designed initiating an architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man & form.

d) Overall colour scheme and finish schedule of the plant and other buildings shall be designed judiciously and in a comprehensive manner taking into a account the mass and void of buildings, its façade, equipments, exposed structural elements, piping, trestles, bus ducts and other service elements.

e) Overall emphasis shall be on developing an eco-friendly architecture, merging with the nature with its own sustainable energy management systems.

The scheme shall be conceptually finalized in totality including that of equipments so that the proper coordination with other agencies can be taken up at appropriate time.

18.02.00 Architectural Design

i) Natural light shall be used to the maximum extent specially in the form of north light / sky light. For adequate light & ventilation, National Building code recommendations shall be followed.

ii) Entrance canopies, chajjas (projections, recesses) over openable windows and door openings on exterior facades shall be provided.

iii) All the buildings shall be architecturally designed to meet the National Building Code (SP:7) norms and local building bye laws, wherever applicable.

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iv) Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect. Statutory requirements and any clearances from local authority may be required to be met with, wherever essential. The Architect Consultant shall be of National / International repute having experience in similar kind of works. The consultant shall evolve the design philosophy based on Employer's guidelines and shall present it in the form of presentation drawings, Prospective views, 3-D Models & detail drawings.

v) Minimum 1000mm high (from floor / roof level) hand railing shall be provided around all floor / roof openings, projections / balconies, walkways, platforms, steel stairs, etc., All handrails and ladder pipes (except at operating floors) shall be 50mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanized as per IS:4736 treated with etch primer and finished with suitable paint. All rungs and ladders shall also be galvanized. Minimum weight of galvanizing shall be 610 g/sqm.

All stairs and around all floor openings at operating floors, 1000mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided.

vi) All stairs shall have a maximum riser height of 180mm and a minimum tread width of 250mm. Minimum clear width of stair shall be 1200mm unless specified otherwise.

vii) All buildings having metal cladding shall be provided with a 150mm high RCC toe curb at the edge of the floor along the metal cladding. 900mm high hand railing shall be provided on this RCC curb, wherever required from the safety point of view.

viii) In all buildings, structures, suitable arrangement for draining out water collected from equipment blow downs, leakages, floor washings, fire fighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or pre-cast RCC panels.

ix) RCC staircase shall be provided for all RCC construction buildings and structural steel staircase for all structural steel buildings.

x) Parapet, Chajjas over window and door heads, architectural facias, projections, etc., shall be provided with drip course in cement sand mortar 1:3.Cut lintels over windows/doors shall be avoided as far as possible.

xi) All fire exits shall be painted with P.O red/signal red colour shade which shall not be used anywhere except to indicate emergency or safety measure. Fire safety norms shall be followed as per National Building Codes and fire safety requirements for providing fire exits, escape stairs and firefighting equipment. In detailing of all buildings, fire safety requirements conforming to IS:1641 and IS:1642 shall be followed.

xii) All windows shall be provided with granite slab at sill level.

xiii) All grills of window shall be of 12 mm square MS bars both ways.

18.03.00 Interior Design

A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the multidisciplinary engineering activities involving power plant technology, and architectural and civil engineering for a smooth control hierarchy and man machine inter face. All the design aspects such as flooring, false ceiling, furniture, colour scheme, equipment design, layout, illumination, fire fighting, acoustics and ergonomics requirements shall be detailed out so as to present an overall unified aesthetic spatial appearance. The areas to be undertaken for this interior design process shall be control room complex including common control room, computer room, conference rooms and office areas in the main plant building and the following aspects shall be reviewed and evaluated for design. Furniture to be supplied by Bidder for the control room complex shall be as specified under C&I specification.

a) Layout, keeping in view the main-machine interface and suitable ergonomic practices.
b) Integration of civil engineering with architecture and interior design.
c) Illumination levels, noise levels, electromagnetic interference levels, taking into account the equipment and furniture.
d) Comfort and safety requirements such as air conditioning, fire fighting, fire escapes etc.
e) Microprocessors based control system to control the functional requirements.

The above design philosophy put into practice shall be detailed out through presentation drawings, perspective views, scale models, detail drawing etc.

18.04.00 Sealant

Silicone sealant or polyurethane shall be used in all expansion joints exposed to weather. All joints around exterior doors, windows and expansion joints shall be sealed for proper water tighteness.

18.05.00 Damp Proof Course

50mm thick 1:1.5:3 concrete with water proofing admixture shall be used. Water proofing compound shall be of Zydex, Sikka or similar make.

18.06.00 Finishing Schedule

The minimum quality of finishes used for various building areas are furnished in Table-1 in this section. The Bidder is at liberty to use superior finishes provided all specific requirements for the finish specified in Part-B of Vol-VI.

18.07.00 Roof Drainage and Water Proofing

a) Roof drainage system shall be provided for quick and efficient draining of rainwater from roof to avoid seepage and damage to roof. The runoff gradient for the roof shall

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not be less than 1 in 100. Roof drainange system shall consist of roof drain heads, rain water down comer and fixtures. System shall be designed to handle design rainfall for the specific site and shall be in accordance to stipulations of IS: 1742 and IS: 2527. The down comer pipes shall be suitably concealed with masonry work, cement concrete or sheeting to match with the exterior finish.

b) Multiple drains (minimum 2) shall be provided for all roof areas. Any roof more than 8 m above grade shall have access from within the building for cleaning of roof drains.

c) Rain water down comers shall be of HDPE pipe conforming to IS: 4984.

d) All roofs shall be provided extra with heavy duty water proofing treatment comprising of

i. Seven courses as per IS:1346 using layer of Type 2 Grade 1 glass fire based felt as per IS:7193.
ii. 50mm thick foam concrete as per IS:6598 for thermal insulation
iii. 15mm thick cement sand plaster 1:4.
iv. Chequered cement tiles as per IS:13801 shall be provided over water proofing treatment in areas where movement of personnel is expected. Minimum width of pathway if provided only locally shall be 1000mm.
v. In areas such as roof of control room bay of Main Turbine building, Bunker bay roof etc where handling of equipment is anticipated, the foam concrete may be replaced by 40mm screed concrete.

Roof water proofing may also be provided using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM C-898. Thickness of the membrane shall be a minimum of 1.5mm. The treatment includes application of polymerized mortar over sloped roof to achieve a smooth surface and a primer coat. Wearing course shall be 40mm screed of 1:2:4 concrete as above cast in panels of 1.2m x 1.2m and reinforced with 0.56mm dia galvanised chicken wire mesh and joints sealed using sealing compound. Accessible roof shall be provided with chequered tiles as above.

18.08.00 Sumps

In case of underground structures, sumps with pumping arrangement shall be provided at suitable location to collect and pump out any incidental water collection to nearest storm water drain.

18.09.00 Master Key System

An appropriate serviceable and functional master key system for the whole plant shall be installed. The elaboration of the system itself shall be made in close co-ordination with the Purchaser / Consultant and only after obtaining the Purchaser's / Consultant's approval in writing shall the order of production be placed.

The following requirements shall be met:

- The general master key shall operate all locks
- The main key shall open all locks of one building
- The single key shall open the lock of a single room.

Necessary attention shall be paid to later extensions of the master key system, which shall be suitable for the entire plant including all final stages.

The profile cylinders shall be sea water resistant and shall suit all plant requirements. The material of the cylinders shall be of massive brass, nickel-plated with six security pawl studs.

The keys shall be made of material approved by the Purchaser / Consultant and shall have an engraved indication of the applicable key system and the building or door number.

Keys shall be supplied in the following numbers:

General Master Key	10	nos
Main keys	10	nos. per each building
Single keys	3	nos. per each door

18.10.00 Land Scaping

18.10.01 General

This specification covers broadly the requirements for Landscaping within the Plant Area. Landscaping shall be carried out after all the underground utilities and drainage systems are in place. The entire work of Landscaping shall be carried out to the satisfaction of the Engineer and in a manner to have a beautiful appearance after completion of the work.

The Landscaping plan should be prepared by the Contractor with the help of an expert Horticulturist with due considerations for Fauna & Flora grown in the adjacent area and which can sustain in the saline climate.Minimum 30% of total plant area shall be covered with grass belt. In addition approximately 1000sqm of area shall be landscaped with Korean grass & latest flowers.

The area to be landscaped shall be clearly demarcated at site and got approved by the Engineer and the work shall be divided into following sub-items.

18.10.02 Preparing Lawn

For this purpose, within the area where lawn is to be grown, about 0.3 metres of earth shall be removed. This shall be replaced by fresh garden soil and manure in 2: I proportions spread evenly. Fresh garden soil & manure shall be mixed thoroughly, well watered and left overnight. The next morning, the variety of lawn, as per approved plan and as directed by the Engineer, shall be planted. This grass shall be maintained till well established by watering, weeding, clipping, rolling etc.

18.10.03 Preparing Clipped Hedges

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Hedges made of Casuarinas or other shrubs as directed by the Engineer shall form borders between footpath and the Lawns. The shrubs shall be planted at spacing not more than 25 cms.

18.10.04 Planting Shrubs

Shrubs with coloured leaves like Crotons, Acalyphia, Oleander and Bougainvillea, Hibiscus etc. which are perennial shall be planted in clusters or over a large area at locations and in the manner as per approved layout. These shrubs shall be planted at spacing of not more than 25 cms.

18.10.05 Installation of Watering System

Shall prepare and submit watering System for the Plants. Drip Irrigation and Spray System consisting of complete PVC pipe with all necessary bends, Tees, Elbows etc., valves, stop cocks, Spray nozzles, sufficient lengths of Flexible PVC pipes to reach all area of Landscaping shall be included in the watering system. Only after approval of the Engineer, the Contractor shall commence the work.

TABLE – 1

FINISHING SCHEDULE

Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
STG Building					
Ground Floor: Maintenance Bay & Unloading Areas	Acrylic washable distemper	Granolithic with non-metallic hardner	Acrylic washable distemper	--	Water proof cement based paint
Ground floor general area	Acrylic washable distemper	Granolithic Flooring	Acrylic washable distemper	--	Water proof cement based paint
Mezzanine Floor	Acrylic washable distemper	Granolithic flooring	Acrylic washable Distemper	--	Water proof cement based paint
Operating Floor 1. Operating Area, laydown area	Acrylic washer distemper	Corborandum tiles	Acrylic washable Distemper	--	Water proof cement based paint
2. General circulation and movement	Acrylic washable	Glazed vitrified ceramic tiles	Acrylic washable	--	Water proof cement based

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Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
areas	distemper		Distemper		paint
3. Heater area	Acrylic washable distemper	Heavy duty cement concrete tiles (Carborandum)	Acrylic washable Distemper	--	Water proof cement based paint
Toilet	Dadoing for 2100 mm high + Acrylic distemper	Heavy duty ceramic tiles (Anti skid only.)	Acrylic washable Distemper	--	Water proof cement based paint
Roof	--	--	--	Elastomeric water proofing treatment	--
Clarified Water Pump House	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Cooling Water Pump House	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Raw Water Pump House	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Control Rooms	Acrylic emulsion paint	Glaze vitrified ceramic tiles	Aluminum Fall Ceiling	--	Water proof cement based paint
MCC Switchgear Room	Acrylic washable distemper	Granolithic floor with non metallic floor hardener & top finished with epoxy coating.	Acrylic washable Distemper	--	Water proof cement based paint
Office Areas	Acrylic emulsion paint	Heavy duty Ceramic Ties	Acrylic washable Distemper	--	Water proof cement based paint

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Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
Cable Vaults	Acrylic Distemper	Granolithic floor with non metallic floor hardener	Acrylic washable Distemper	--	Water proof cement based paint
Control & Switchgear Building					
Central Control Room	Acrylic emulsion paint	Anti skid Marbonite tiles	Aluminum False Ceiling	Elastomeric water proofing treatment	Water proof cement based paint
Electronic cubicle room & Computer room	Acrylic emulsion paint	Heavy duty ceramic tiles	Aluminum False Ceiling	--	Water proof cement based paint
Conference room, senior executive room	Acrylic emulsion paint	Glazed vitrified ceramic tiles	Aluminum False Ceiling	--	Water proof cement based paint
Switchgear room	Acrylic washable distemper	Granolithic with non-metallic floor hardner & top finished with epoxy coating.	Acrylic washable Distemper	--	Water proof cement based paint
Battery Room	Acid & alkali tile dadoing for 2100 mm high + Chlorinated rubber based paint	Acid / alkali resistant tiles	Chlorinated rubber based paint	--	Water proof cement based paint
SWAS room	Acrylic washable distemper	Glazed vitrified ceramic tiles for dry areas. For wet areas Heat resistant, anti skid of approved brand & colour.	Acrylic washable Distemper	--	--
Office, Common areas & corridor	Acrylic emulsion paint	Heavy duty ceramic tiles	Acrylic washable Distemper	--	Water proof cement based paint

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Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
Cable Room	Acrylic distemper	Granolithic with non-metallic floor hardener	Acrylic washable Distemper	--	Water proof cement based paint
Toilet	Dadoing for 2100 mm high + Acrylic distemper	Heavy duty matt finish ceramic tiles	Acrylic washable Distemper	--	Water proof cement based paint
Lockers room	Acrylic washable distemper	Kota stone.	Acrylic washable Distemper	--	--
Pantry	Dadoing for 2100 mm high + Acrylic distemper	Heavy duty matt finish ceramic tiles	Acrylic washable Distemper	--	--
Laboratory room	Acrylic washable distemper	Heavy duty ceramic tiles	Acrylic washable Distemper	--	Water proof cement based paint
Records Room	Acrylic washable distemper	Kota stone.	Acrylic washable Distemper	--	--
Other Buildings					
Bunker Building	Acrylic washable distemper	Granolithic floor with non metallic floor hardener	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Chlorination Building	Chlorinated rubber based paint	Acid / Alkali resistant tiles	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Chemical House	Acid/Alkali resistant tiles on wall up to 1500mm height & chemical resistant paint above.	Acid/Alkali resistant Tiles	Chemical resistant paint	Heavy duty water proofing as per IS:1346	Water proof cement based paint

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Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
DM Plant	Chlorinated rubber based paint	Granolithic	Chlorinated rubber based paint	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Switchyard control room building and GIS building	Acrylic emulsion paint in control room and Acrylic washable distemper in other areas.	Epoxy finish on Granolithic flooring.	Aluminum false ceiling in control room and acrylic distemper in other areas.	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Workshop	Acrylic washable distemper in Workshop area and Acrylic emulsion paint in office area.	Granolithic flooring with non metallic floor hardener in workshop area and Heavy duty ceramic tiles in office area.	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based paint
Canteen : General Area Kitchen	Dadoing for 2100mm high & Acrylic Distemper above. Dadoing for 2100mm high & Acrylic Distemper above.	Heavy Duty Ceramic Tiles Terrazo Tiles	Acrylic washable Distemper Acrylic washable Distemper	Elastomeric water proofing treatment	Granular finish Granular finish
Fire Station Building	Acrylic washable distemper	Vitrified ceramic tiles in office, dormitory area & granolithic flooring with non metallic floor hardener in parking & equipment store area.	Acrylic washable Distemper	Heavy duty water proofing as per IS:1346	Water proof cement based Paint
Service building: Ent.	Acrylic	20mm thick polished granite	Acrylic washable	Roof of service	Granular finish (Vineratex) or

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Building / Area	Wall (Internal)	Floor Finish	Ceiling	Roof Treatment	Wall (External)
Lobby, Reception, Portico, staircase & Lift Area Office area	emulsion paint Acrylic emulsion paint	stone Glaze vitrified Ceramic tiles	Distemper Acrylic washable Distemper	building shall be provided with Elastomeric water proofing treatment	equivalent.
Administrative Building : Ent. Lobby, Reception, Portico, staircase & Lift Area Office area	Acrylic emulsion paint Acrylic emulsion paint	20mm thick polished granite stone Glaze vitrified Ceramic tiles	Acrylic washable Distemper Acrylic washable Distemper	Roof of service building shall be provided with Elastomeric water proofing treatment	Granular finish (Vineratex) or equivalent.

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	TITLE: **2X660 MW ENNORE SEZ SUPERCRITICAL TPP, UNIT# 1 & 2**	SPECIFICATION NO. PE-TS-412-600-C002 VOLUME - II B SECTION - D 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 – D
GENERAL TECHNICAL SPECIFICATION

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

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19.00.00 SURVEYING WORKS

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

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

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

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

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

i) Provision and maintenance of survey instruments and accessories.

ii) Provision of skilled personnel, supply of all material required for the survey exposing covered survey points.

iii) Shifting of any machinery used for construction out of the sight lines.

iv) Stopping all drilling, blasting, driving and any other works.

v) Causing soil vibrations and stopping during instrument observations.

vi) Removing all obstructive accumulation of water.

vii) Taking all necessary safety precautions.

viii) Furnishing any marking material requested by the Consultant in connection with control surveys.

ix) Providing additional survey points in accordance with the consultant's instruction.

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20.00.00 EXCAVATION AND FILLING

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

a. Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, equipment, tools and plants, transportation etc. required for the work.

b. Prepare and submit working drawings showing the approaches, slopes, beams, shoring, sumps for dewatering including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing etc. and all other details as may be required by the Engineer.

c. To carryout sampling and testing and submit to the Engineer, results of soil compaction tests if required by the Engineer to assess the degree of compaction.

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

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

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

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

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

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

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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 lose watch should be kept on it and corrections done to optimize the moisture content.

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

c. Plinth filling: The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slopes intended to be given to the floor.

d. Filling in trenches for water pipes and drains: Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

e. Filling in disposal area: Surplus material from excavation which is not required for backfilling shall be disposed of in designated disposal areas within the lead for disposal as 5 km crow fly distance from the site. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas, rollers shall be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by the contractor.
In certain cases, the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

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

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

20.09.00 Testing and Acceptance Criteria

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

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

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

21.00.00 CEMENT, CONCRETE & ALLIED WORKS

21.01.00 a. This part covers the requirements for general use of Plain and Reinforced Cement Concrete work in structures at all locations, cast-in-situ or precast, including all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. The special requirements of structures covered in latest IS:456 should also be complied with.

b. The works to be provided by Contractor:

i) Furnish all labour, supervision services including facilities as required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids,construction equipment, tools and plant, transportation etc. required for the work.

ii) Prepare progressively detailed drawings and bar bending schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

iii) Submit shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedment, hangers, openings, frames etc.

iv) Submit detailed drawings of supports, templates, hangers etc. required for installation of various embedment like inserts, anchor bolts, pipe sleeves, joint seals, hangers, openings, frames etc.

v) Submit detailed schemes of all operations required for executing the work e.g. material handling, concrete mixing, placement of concrete, compaction, curing, services, approaches etc.

vi) Design and submit concrete mix designs required to be adopted on the job.

vii) Provide all incidental items necessary for successful completion of the work in accordance with the drawings, specifications and schedule of Items.

ix) Supply of specialized materials as directed by the Engineer with a guarantee in approved performa for satisfactory performance.

x) Furnish samples and submit for approval the results of various properties of the following materials :

a. The various ingredients of concrete including concrete
b. Embedments.
c. Joint seals

21.02.00 AFTER AWARD OF WORK ACTIVITIES

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

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

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

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

b) **Samples**

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

i) Coarse and fine aggregates.

ii) Cement.

iii) Reinforcement.

iv) Admixtures.

v) Plywood for formwork.

vi) Embedded & anchorage materials as may be desired by the Engineer in Charge.

vii) Joint sealing strips and other waterproofing materials.

viii) Joint filling compounds.

ix) Foundation quality Rubber Pads.

c) Design mix

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

a. Detailed drawings & designs of formworks to be used.

b. Detailed drawings for templates & temporary supports for embedments.

c. Test reports for cement, reinforcement steel and formwork including inspection reports.

d. Any other data as per specification.

d) Conformity with Design

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

21.03.00 Materials to be Used / Supplied by Contractor

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

a) **Cement**

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

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

b) **Coarse Aggregate**

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

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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 its otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately. The contractor shall maintain up-to-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

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

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

c) Aggregates shall be stored on planks or on steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in stockpiles stacks and sufficient care shall be taken to prevent the material at the edges of the stockpiles from getting intermixed. Stacks of fine & coarse aggregate shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths

d) Reinforcing shall be stored consignment –wise and size wise off the ground & under cover. It shall be protected from rusting, oil, grease and distortions.

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

21.05.00 Quality Control

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

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

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 and 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.

f) **Minimum cement content**

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

TAB L E – 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

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

unless otherwise directed by the Engineer:

Reinforced concrete except foundation mm	-	20
Ordinary Plain concrete and Reinforced concrete foundations mm	-	40

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

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

In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into20 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 conctete.

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 by 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, inspite 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 atleast 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

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

i) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

ii) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.

iii) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.

iv) Feather-edges in concrete shall be avoided while forming a joint.

v) A construction joint should preferably be placed in a low stress zone and at right angles to the direction of the principal stress.

b) Cold Joint

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

i) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete should be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible, and the joint thoroughly and systematically vibrated.

ii) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, shall be placed on the cold joint, fresh concrete shall be placed on the mortar layer and the joint shall be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

iii) In case the concrete at the joint has become so stiff that it cannot be remolded and mortar or slurry does not rise inspite of extensive vibration, the

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

c) Expansion And Isolation Joints

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

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

Commercial quality of expanded polystyrene products commonly used for thermal insulation can also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material should 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 vulcanished 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

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

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

b) **Bar Bending Schedules**

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

c) **Bending**

Reinforcing steel shall be bent in accordance with the procedure specified in IS:2502. Bends and shapes shall comply strictly with the dimensions corresponding to the approved bar bending schedules which shall be rechecked by the contractor before any bending is done.
No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Re-bending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent.

d) **Placing in position**

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

e) **Welding**

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

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

f) **Control**

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

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

g) **Cold Weather Concreting**

When conditions are such that the ambient temperature may be expected to be

4.5 Deg.C or below during the placing and curing period, the work shall conform to the requirements of clause 13 of IS: 456 and IS: 7861.

h) **Hot Weather Concreting**

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

21.10.00 Form Work

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

b) The centering shall be true to vertical, rigid and thoroughly braced both

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

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

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

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

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

d) Cleaning and Treatment of Forms

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

e) Design

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

f) Inspection of Forms

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

g) Removal of Forms

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

SCHEDULE OF REMOVAL OF FORM

Part of Structure	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
	Temperature (^{O}C)				Temperature (^{O}C)			
	Above 40^{O}C	40^{O}C to 20^{O}C	20^{O} to 5^{O}C	Below 5^{O}C	Above 40^{O}C	40^{O}C to 20^{O}C	20^{O} to 5^{O}C	Below 5^{O}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	

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

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

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

h) Tolerance

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

i) Sectional dimension - ± 5 mm

ii) Plumb - 1 in 1000 of height

iii) Levels - ± 3 mm before any deflection has taken 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

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

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

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

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

i) Inserts, hangers, anchors, frames around openings, manhole covers, Frames, floor clips, sleeves conduits and pipes.

ii) Anchor bolts and plates for machinery, equipment and for structural steel work.

iii) Dowel bars, etc. for concrete work

iv) Lugs or plugs for door and window frames occurring in concrete work. v) Flashing and jointing in concrete work.

vi) Any misc. embedments and fixture as may be required.

vii) Convextra-GP2, Sikka grout or equivalent grouting material shall be used as per manufacturer's specification.

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

21.12.00 Precast Concrete

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

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

21.13.00 Sampling and Testing

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

a) Cement

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

b) Aggregates

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

c) Water

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

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

21.15.00 Tolerances

The permissible tolerances are as follows :-

a) Tolerances for RC buildings

b) Variation from the plumb

c) In the lines and surfaces of columns, piers, walls and in arises 5mm per 2.5m but not more than 25mm.

d) For exposed corner columns and other conspicuous lines:

In any bay upto 5m	=	5mm
In 10m or more	=	10mm

e) Variation from the level or from the grades indicated on the drawings:

i. In slab soffits, ceilings, beam soffits and in arises:

In 2.5m	=	5mm
In any bay upto 5m	=	8mm
In 10m or more	=	15mm

ii. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines:

In any bay upto 5m	=	5mm
In 10m or more	=	10mm

i. Variation of the linear buildings lines from established position in plan and related position in plan and related position of columns, walls and partitions.

In any bay upto 5m	=	10mm

In 10m or more = 10mm

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

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

Minus = 5mm
Plus = 10mm

f) Footings

g) Misplacement or eccentricity

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

h) Reduction in thickness

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

i) Variation in steps

In a flight of stairs

Rise = 3mm

Tread = 5mm

In consecutive steps

Rise = 1.5mm

Tread = 3mm

j) Tolerances in other concrete structures

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

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

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

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

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

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

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

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

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

Minus	=	5mm
Plus	=	10mm

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

Minus	=	5mm
Plus	=	10mm

vii. Misplacement of eccentricity:

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

viii. Reduction in thickness:

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

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

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

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

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

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

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

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

21.16.00 Special Conditions For Construction of TG Foundation

a) Scope

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

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

b) Form Work

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

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

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

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

iii) Concrete surface shall not normally be patched or otherwise treated after the removal of forms. Where the surfaces exposed on stripping is not of a satisfactory nature, owing to the contractors failure to take necessary precaution before, during or after the concrete placing, such surfaces shall be worked and finished in accordance with the instructions of the Purchaser / Consultant at the cost of the contractor. The pores shall be filled in with a neat solution of cement and water applied by brush and when dry the surface shall be rubbed down with carborundum stone. The cost of the above treatment shall be deemed to be included in the unit rate entered by Contractor. The top surface of the T.G. deck shall be float-finished, unless otherwise specified to the required levels. There must be no surface grouting are 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 party as the Engineer in Charge directs. All costs involved in repairing defect shall be borne by the Contractor.

iv) The arrangement and method for movement of workers during TG construction to various levels of the TG foundations shall be submitted well in the advance to the Engineer- in – Charge for his approval far taking up the work.

v) In addition to the above paras the contractor shall also satisfy all other requirements for formwork mentioned in elsewhere in the specification.

c) Staging

i) The entire staging for supporting the formwork, walkways and platforms for placing concreting equipments such as vibrators, etc., shall be of structural steel. The staging shall be designed for the worst combination of loading as specified hereinafter.

ii) The Contractor shall submit 6 copies of design calculations and drawing to prove adequacy of the staging for approval of the consultant. On receipt of final approval, the contractor shall supply 20 copies of approved drawings for distribution.

iii) The staging shall be so designed that no load from platforms are passed on to the formwork at the top.

iv) All platforms, walkways etc. shall be clear of the formwork and at least
200 mm above it. The width of platforms and walkways shall be at least 1.2 metres for easy movement of labour both ways.

v) The platforms shall be of planks or bamboo mats (clamped with steel strips suitably stiffened to avoid springing).

vi) The form work and staging shall be designed for a live load of 1000 Kg/m2.

vii) Unit weight of green concrete shall be considered as 2500kg/m3 for design of form work and staging.

viii) The staging shall be braced in both the directions.

ix) The staging shall be supported on rigid surfaces at ground level.

x) The staging shall be sufficiently rigid to prevent any distortion in the form work.

d) Special Precautions

i) The contractor shall take all precautions to ensure concreting of TG Raft, columns and TG Deck in one pour each. Concreting shall be continuous and no break in concreting shall be permitted.

ii) The Contractor shall prepare a scheme for concreting giving details of number of mixers, labour, vibrators, pouring schedule and obtain prior approval of the same from the Engineer-in-Charge before starting of concreting.

iii) The Contractor shall ensure that at no time the temperature of the green concrete exceeds 38 degree C by taking proper precautions. If required, ice shall be added to control the temperature at no additional cost to the Purchaser.

vi) Approved "Retarders" shall be used by the contractor in the proportions specified by the manufacturer for total concreting work of the TG foundation. The cost of the admixture shall be included in unit rates quoted by the Bidders.

e) Test for Soundness of Concrete

i) After completion of the construction of TG foundations and all major machine foundation like BFP,FANS, MILLS etc, the contractor shall get the Deck and column tested for soundness of concrete by "ultrasonic wave – non – destructive test method" from reputed research institutions like "SERC-CHENNAI" "CWPRI – POONA", at no extra cost to the Purchaser.

ii) If the test report calls for any rectification in the concrete works by way of pressure grouting or otherwise, the same shall be carried out by the contractor at no additional cost to the Purchaser to the satisfaction of the Purchaser / Consultant

iii) If require, any additional test to establish the adequacy of the rectification works carried out shall be done by the contractor at no extra cost to the Purchaser

f) List of Codes and Standards

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

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

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

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IS : 2514	-	Indian Standard Specification for Concrete VibratingTables
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.

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 Prosed 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 40oC.

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

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

d) From the creep point of view, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 400 kg per cum of concrete.

e) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slip form proceeds should be between 0.1 to 0.2 Newton/sq.mm.

f) Large diameter vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter – only in exceptional cases. Atleast two nos. standby vibrator units should always be maintained on top of working deck at all times during the entire period of slip form operation.

g) It is preferable to have membrane curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curing at greater heights.

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

h) If slip forming is carried out in summer, rate of slipping should be around 400 mm per hour. If lesser value is contemplated appropriate retarders should be specified.

i) Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.

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

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

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

diameter for 6 tonne jacks.

j) Atleast 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump along with a set of loose pipes in perfect working condition on top of working deck.

k) In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slip form yoke.

l) For effective utility of this technique following areas need careful attention at the very conceptual stage:

i Detailed quality assurance programme

ii Advance planning and preparations

iii Arrangement for on site supervision and adequate access facilities.

m) Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, descriptions and frequency of various checks and tests for slip form technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared before hand by executing agency and to be approved by Engineer before starting the actual work.

n) Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.

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

o) It is desirable to have a break of atleast one day for every two weeks of continuous operation. Such break should be utilized for various maintenance activities, removal of jacks rods etc.

p) Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. It felt necessary one hoist may be exclusively earmarked for transporting concrete.

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

q) The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system along with slip form.

r) Winches for lifting men and material and mixers, if located within unsafe area around chimney, should be protected by adequate shelter from possible damage.

s) Proper telecommunication system has to be established between the personnel working on top of chimney and control room below.

t) A small laboratory should be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube testing machine may also be installed at site for getting quick feed back results.

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

u) In case of interruption in the course of slipping of formwork following measures should be taken:

i Provision of a key and additional reinforcement at the junction of new and old concrete.

ii Slip form system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete.

iii Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout.

iv Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer.

v Neatly preferable the interface of old or new concrete as soon as it comes out of shutter panel.

v) It is preferable to suspend the construction work under high wind condition.

w) It is of utmost importance that for effective implementation of this system an Engineer fully conversant with slip form technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators.

x) Operation of slip form method of construction is a continuous one and it demands continuous / intermediate inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.

y) While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety engineer.

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

i. Safety helmets and belts to be provided to all supervising staff and workers.

ii. Safety nets to be provided below both inside and outside platforms as instructed by Engineer.

iii. Hand railing and toe guard to be provided around all openings and platforms.

iv. Regular maintenance of equipment, checking of hoists, scaffolding etc.

v. Passenger hoist must have multiple ropes with adequate factor of safety.

vi. Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the specification and to be operative in case of sudden power failure emergency standby generator must be kept ready during the entire period of slip form method or construction.

vii) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

22.05.00 Construction tolerances

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

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

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

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of plumb w.r.t. each other

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

i. Particular requirement of type and brand of cement, if any.

ii. Special admixture to be added to concrete

iii. Any change required in the geometry of the chimney including the shell thickness or side slope from that shown in the NIT drawing.

iv. Any change/special requirement in the arrangement of reinforcement.

v. Implications if any of necessary in-situ bending of rebars for /brackets etc. and straightening/cleaning of the same prior to casting of brackets.

vi. Any additional constructional opening in the shell required at ground level for concreting.

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

23.00.00 FABRICATION OF STRUCTURAL STEEL WORK

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

a) Preparation & submission of complete detailed fabrication drawings and erection marking drawings as required including design calculations.

b) Furnish all materials, labour, tools & plant and all consumables required for fabrication and supply of all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections.

c) Furnish shop painting of all fabricated steelwork as specified.

d) Suitably mark, bundle and pack for transport all fabricated materials.

e) Prepare and furnish detailed bill of materials, dispatch lists (including bought out items) as required for fabrication of structural steelwork.

f) Load and transport all fabricated steelwork to site with field connection materials.

g) Maintain a fully equipped fabrication shop at site for modification and repairs as required.

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

23.02.00 Codes and standards

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

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

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

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

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

23.03.00 Conformity with designs

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

23.04.00 Materials to be used

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

a) All steel materials required for the work shall be supplied by the contractor. All steel materials shall comply with the following IS:-

i) IS:801 - Cold formed light gauge steel structural member.

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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/mm2; and minimum elongation of 23 per cent on a gauge length of 5.6 ÖA, where 'A' is the cross sectional area of the test specimen :

i)	IS:1367	-	Technical supply conditions for threaded fasteners.
ii)	IS:1608	-	Method for tensile testing of steel other than sheet, strip,wire and tube.

iii) High tensile steel material shall have the mechanical properties as per IS:1367 or as approved by the Engineer.

d **Washers**

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

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

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

23.05.00 Painting

a) All steel structures shall receive two primer coats and two finish coats of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two finish coats shall also be applied after erection.

b) Steel surface which is to painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted to Sa-2½ finish as per SIS05-5900. Primer paint shall be zinc silicate of approved brand . Dry film thickness of each primer coat shall be 50 microns.

c) Finish paint shall be 2 coats of High built epoxy finish of approved brand. Dry film thickness of each finish coat shall be 90 microns. The undercoat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 300 microns . All paints shall be of approved brand and shade as per the OWNER's requirement.

d) Joints to be site welded shall have no paint applied within 100 mm of welding zone.

Similarly where Friction grip fasteners are to be used no painting shall be provided. On completion of the joint the surfaces shall receive the paint as specified.

e) Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

Surfaces inaccessible after erection including top surfaces of floor beams supporting gratings or chequered plate shall receive one additional coat of finish paint over and above number of coats specified before erection. Portion of steel member embedded / to be encased in concrete shall not be painted.

23.06.00 Storage of Materials

a) All materials shall be stored to prevent deterioration ensuring the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately. The contractor shall maintain upto date account in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials shall be stacked separately with easily identifiable marks.

b) The steel used for fabrication shall be stored in separate stacks off the ground section-wise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials should be stored under cover; and suitably painted for protection against weather.

c) The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition [if necessary by resorting to heating].

d) Bolts, nuts, washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

e) Paints shall be stored under cover in airtight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

23.07.00 Quality Control

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

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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.

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. Occasio- nal notches or gauges not more than 4 mm deep will be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

d) Finishing of sheared or cropped edges of plates or shapes of edges gas-cut with mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed.

e) The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

f) Bolted construction:

i) Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching shall be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size; and reamed after assembly to the full diameter.

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

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

ii) Drifting to enlarge 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 bereamed. 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.

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

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

g) Welded Construction

i) Welding shall be in accordance with relevant IS. Welding shall be done by experienced and good welders qualified by tests in accordance with IS:817. Surfaces to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

ii) Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected; and in making the correction, the parts shall not be drawn into a sharper slope than two degrees (2 Deg.). The work shall be positioned for flat welding whenever practicable.

iii) In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

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

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

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

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

v) If welding is to be undertaken at low temperature, adequate precautions as recommended in relevant IS shall be taken. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20oC, 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.

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,

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

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 x 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:

i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld

ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.

Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc., exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld and shall be re-welded. Defective weld shall be removed by chipping hammer gouging torch wheel. Care shall be taken not to damage the adjacent material.

24.00.00 ERECTION OF STRUCTURAL STEELWORK

24.01.00 The works related to the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete are detailed below:

a) Providing all construction & transport equipment, tools, tackles, consumables, materials, labour and supervision as required for the erection of the structural steelwork.

b) Receiving, unloading, checking and moving to storage yard at site including prompt attendance to all insurance matters as necessary.

c) Transportation of all fabricated structural steel materials from site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation in proper location as per approved erection drawings. If necessary suitable temporary approach roads should be built for transportation.

d) Checking centerlines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be brought to the notice of the Engineer. The contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, bolting, welding and securely fixing the fabricated steel structures as per drawings.

f) Painting of the erected steel structures.

g) Minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:-

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size bolt if required.

iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication.

v) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts which are incorrectly fabricated.

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vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vii) Drilling of holes which are either not drilled at all or drilled in incorrect location during fabrication

24.02.00 **a)** The work shall conform to the latest revisions of the following IS Codes:

IS-800	:	Code of Practice for general construction in Steel
IS-456	:	Code of Practice for plain or reinforced concrete
IS-7205	:	Safety Code for erection of Structural Steel work
IS-12840	:	Tolerance for erection of Steel Structures

b) Conformity with designs: The contractor should erect the fabricated steel structures, align all the members, complete all field connections as per approved drawings. All works shall conform to the provisions of the relevant IS. The testing and acceptance of the erected structures shall be in accordance with the provisions of this specification.

24.03.00 **a)** The contractor should take delivery of all the materials at site. He shall unload the materials and perform all formalities such as checking of materials and attend to insurance matters as specified above.

Contractor shall make good any such deficiency, if detected later, either by repair or with fresh material as may be directed by the Engineer at the contractor's own cost. All field connection materials such as bolts, nuts, washers and electrodes, other consumables such as oxygen and acetylene gas, paints, fuels, lubricants, oil, grease and any other material as required for the execution of the works shall be supplied by the contractor for erection work.

b) All materials shall be stored preventing deterioration and ensuring the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site. The contractor should establish a suitable yard at site for storing the fabricated steel structures and other materials. The yard shall have proper facilities such as drainage, lighting, suitable access for large cranes, trailers and other heavy equipment. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding. All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building.

c) The contractor shall establish and maintain quality control procedures for different items of work and materials; and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following:

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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 exceeding 8 times dia or 200mm	Bolt	Bolts length not exceeding 8 times dia or 200mm	Bolt	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

bolt tensions, the bolts shall be tightened to the torques as below. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia; 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening shall be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be as per IS.

e) Field Welding: All field assembly and welding shall be carried out as specified for fabrication work, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

f) Holes, cutting and fitting: No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done. The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified. Wherever such work is specified the contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work.

24.05.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock shall be considered as permissible. For this, light drifting shall be used to draw holes together; and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any shop work error which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

24.06.00 Testing and Acceptance Criteria

a) Loading tests shall be carried out on erected structures to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall be dismantled and replaced with suitable member. On the basis of the tests, the Engineer will decide and his decision will be final. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing; and the tests shall be conducted as indicated below:-

i) Stiffness Test: In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

ii) Strength Test: The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

b) Structure of same design:

Where several identical same design structures exists as a prototype, one structure shall be fully tested, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

c) Repair for subsequent test and use after strength tests: The structure passed the "Strength Test" as above and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in above.

24.07.00 Tolerances

Considering expected variation in the finished dimensions of structural steel frames, these shall be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabrication tolerances for the finished parts; and the rolling tolerances for the profile dimensions permitted under the specification for fabrication of structural steelwork shall be as indicated below:

	Component	Description	Variation Allowed
a	**For Buildings Containing Cranes**		
	i) Main Colomn	a) Shifting of column axis at foundation level withrespect to building line	
		i) In longitudinal direction	(+/-) 3.0mm
		ii) In lateral direction	(+/-) 3.0mm
		b) Deviation of both major column axis from vertical between foundation and	

	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 which ever 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

	Component	Description	Variation Allowed
		d) Deviation of crane rail axis from centre line ofweb.	(+/-) 3.5 mm
	iv) Setting of expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per Deg.C per unit length.	
b	**For Buildings without Cranes**		
	The maximum tolerances for line and level of the steel work shall be ±3mm 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.		

25.00.00 MASONRY AND ALLIED WORKS

25.01.00 The masonry and allied works associated with the offered power plant cover furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of all the associated works for use in structures as per the locations shown in approved drawings in accordance with latest IS:2212/IS:2250/ IS:5134.

25.02.00 Brick masonry

i) All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

ii) **Mortar**

Mix for mortar shall be as specified. Cement sand mortar cement and sand in 1:4 proportions shall be mixed dry in a mechanical mixer; and then water added and mixed further to achieve working consistency. Surplus mortar droppings from masonry, if received on surface free from dirt shall be mixed with fresh mortar with additional cement. No mortar which has stood for more than half an hour shall be used.

iii) **Brick**

Fly ash Bricks shall be soaked by submergence in clean water for at least 2 hours in approved vats before use. Bricks shall be laid in English bond. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks are placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool with green mortar to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. 2 brick thick or more brickwork shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

iv) **Exposed Brickwork**

Almost all the brickwork shall be plastered with cement mortar. Brickwork in superstructures uncovered by plaster shall be executed by skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons should check workmanship frequently with plumb, spirit level, rule and

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string. All brick work shall be cleaned at the end of day's work. In case of face bricks involvement the brickwork shall be in composite shape with face bricks on the exposed face and balance in routine bricks, maintaining the bond fully; using carborandum stone for rubbing down. Where face bricks are not needed, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified.

v) **Reinforced Brickworks**

Reinforcements shall be as specified. The reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions. For partition walls 2 reinforcement bars shall be placed at every fourth layer.

vi) **Encasement of Structural Steel**

The fixtures shall generally be embedded in mortar and masonry units shall be cut as required. Encasement of structural steel shall be done by brick masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh with a lap of 50 mm.

vii) All wall beams shall be provided with gunniting of 50 mm thick alround with nominal reinforcement and chicken mesh. Also, chicken wire mesh shall be provided at the junction of RCC & brick work. The wall beam/tie beam shall be provided at every 2.5 meter height of the brick wall. Chicken wire mesh shall be provided at the joints of brick masonry and RCC beams/column.

vii) **Curing**

The brick masonry works shall be cured for a period of fourteen (14) days after laying and the plaster shall be cured for a period of seven (7) days.

26.00.00 ARCHITECTURAL FINISHES

26.01.00 Plastering

a) The plastering work including the application of cement punning (Neru) or plaster of Paris treatment on brick or concrete faces with architectural features shall be executed as per in accordance with the following latest IS codes: POP shall be used only on inside surfaces of ceiling and walls for aesthetic and architectural requirement.

IS:1542	: Sand for plastering
IS:1661	: Code of practice for application of cement and cement lime plaster finishes.
IS:2333	: Plaster of Paris
IS:2402	: Code of practice for external rendered finishes
IS:2394	: Code of practice for application of lime plaster finishes

b) Mortar for plastering shall be mixed in the proportion in a dry state and then wetted and mixed thoroughly to obtain the required consistency. The mortar shall be mixed in an approved manner including machine mixing in batches for its consumption within half an hour of mixing. Any mortar for partially set plaster shall be rejected and removed from site. The mix for plastering shall be as follows:

Brick wall:

i) Outside plaster (or rough side): 20 mm thick in 2 coats, 1st coat of 12 mm thick in C:M 1:3 & 2nd coat of 8 mm thick in C:M 1:2 sand faced.
ii) Inside plaster (or plain face) : 12 mm thick (1 cement : 3 sand)
iii) Concrete ceiling: Plaster : 6 mm thick (1 cement : 3 sand)

c) Before application of plaster, the surface shall be prepared as per IS:1661. In all plaster work, mortar shall be applied in an uniform layer slightly more than the required thickness and well pressed into the joint and in the surface and rubbed & levelled with a flat wooden rule to give required thickness.

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Plaster, when more than 15 mm thick, shall be applied in two coats, base coat followed by the finishing coat. Thickness of base coat shall be just sufficient to fillup all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The under-coat shall be thicker than the upper coat. The overall thickness of the plaster shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key.

The method of application shall be" thrown on" rather than "**applied by trowel**".

The finished surface shall be true to line & plumb; and the contractor shall make up any irregularity in the masonry/concrete work with plaster. The mortar shall adhere to the surface intimately when set; and there should be no hollow sound when struck.

All vertical edges of pillars, door jambs etc. shall be chamfered or rounded off. All corners must be finished to their true angles or rounded. Any plastering damaged shall be repaired and left in good condition at the completion of the job.

d) All plastered surfaces after laying and sufficiently hardened shall be cured for a minimum period of seven days and shall be protected from excessive heat and sunlight by suitable approved means.

e) Plaster of Paris Finish: The plaster of Paris shall be calcium sulphate hemi-hydrate variety. Its initial setting shall be less than 13 minutes. The material shall be mixed with water to workable consistency. Plaster of Paris shall be applied to the surface in the uniform layer slightly more than 2 mm thick and shall be finished to an even and smooth surface with a steel trowel. Thickness of finish shall not be less than 2 mm. All corners, arises, angle and junctions shall be carefully and neatly finished.

26.02.00 Wall Cladding

26.02.01 Permanent colour coated sandwiched insulated metal cladding system

a) Permanent colour coated sandwiched (insulated) M.S. / High tensile steel metal cladding of approved colour combination shall be provided for main plant building and any other building with metal cladding where thermal insulation is required as per thermal requirements.

b) Troughed zinc-aluminum alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150gms /sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF2) of Dry Film Thickness

(DFT) 20 microns (min) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

c) Galvanised M.S. sheets of minimum 0.6 mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT microns (min) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 180 gm/sq.m.

d) The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.

e) Inner sheet shall fixed directly to side runner and Z spacers made of at least 2 mm thick galvanized sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50m centre top centre to hold the insulation and external sheeting.

26.03.0 Permanent colour coated non-insulated metal cladding system

a) Permanent colour coated (non-insulated) M.S / High tensile steel metal cladding of approved colour combination shall be provided for bunker building and cladding over parapet walls of buildings where metal cladding is specified0.8mm with galvanization rate of 275 gm/sqm.

b) Troughed zinc-aluminum alloy coated not less than 150 gm/sqm M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used for cladding system.The outer side (exposed face) shall be permanently colour coated with with PVF2 paint of minimum DFT 20 microns over primer and the inner side (internal face shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirements of IS: 14246 and shall conform to class 3 for the durability. For roof sheeting the specification remains same as that of side cladding except the thickness and galvanization. The minimum thickness of roof sheeting shall be be 0.8mm with galvanization rate of 275 gm/sqm.

26.04.00 Roof Decking And Suspended Ceiling

a) The roof decking includes furnishing of cold rolled formed troughed profile sheets manufactured from tested quality CR rolls conforming to IS:513 including fixing. The profile sheet section shall be obtained from feeding strips of uniform coil thickness through successive pairs of shaped rollers, each pair of rollers progressively forming the sheet until finished section is obtained.

In general the troughed profile shall have minimum depth of valley 44mm and center to center of valley about 130mm. The thickness of sheet shall be 0.8 mm (minimum). To suit the spacing of purlin, the length of sheet may vary between 1.50 to 2.00 m. The overall minimum width of sheet

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shall be 824.20mm and covering width as 780mm i.e. side overlap shall be 22.10 mm.

b. Pre-Treatment & Phosphating: The pre-treatment process shall conform B to medium class–B conforming to IS:3618. Next operation of rust removal shall be done by dipping in a tank containing highly diluted hydrochloric acid (HCL); and traces of HCL shall be removed by double rinsing in a water tank for about 5 minutes each. Subsequently sufficient conditioning shall be done by dipping in the next tank containing surface conditioner. Hot phosphating shall be accomplished in the next tank followed by water rinsing and finally passivated by heat process in the passivation tank. Thereafter traces of moisture shall be removed by hot compressed air before application of primer and final paint coating as required. In general the pre- treatment stages shall be as under :

SI.NO	STAGES	CHEMICALS	PROCESSING	PROCESSING
1	Degreasing	Cleaner	55 to 75° C	3 to 10 mins
2	Water Rinsing	-	Room Temp	-
3	Derusting	Rust remover	R. Temp to $60^{O}c$	1 to 10 Mts
4	Water Rinsing	-	Room Temp	-
5	Surface conditioning	Surface conditioner	Room Temp	15 to 30 sec
6	Phosphating solution	Phosphating	50 to 55° C	3 to 5 Mins
7	Water Rinsing	-	Room Temp	-
8	Passivation solution	Passivation	Room Temp	15 to 30sec
9	Water Rinsing	-	Room Temp	-
10	Defonised water	-	Room Temp	-
11	Drying	-	-	-

After pre-treatment, the sheet shall be painted with a coat of zinc chromate red oxide primer on both faces.

26.05.00 Flooring

The nominal total thickness of floor finish shall be 50 mm including under bed and topping. The flooring shall be laid on already matured concrete base. The under bed for floors shall consist of cement concrete 1:2:4 with stone chips 12.5 mm down graded as coarse aggregates.The under bed shall be provided with appropriate slope towards catch pit for floor drainage.

26.05.01 False Flooring System

Removable type false flooring system shall be provided in computer rooms and control rooms as required. RCC floor slab shall be sunk to a depth 800 mm which shall be height of the false floor system. The flooring shall consist of fire resistant phenol formaldehyde bonded particle board panels 600x600x35mm size, mounted on steel pedestals of adjustable height and supporting steel grid system to provide under floor space. 2 mm thick flexible anti-static pvc topping on top and

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pvc strip edging on sides of each panel shall be provided .

26.05.02 PVC Floor Finish

Two mm thick PVC as per IS:3462 laid as per IS:5318 over concrete under bed of 48 mm .

26.05.03 Carborandum Tiles

Polished heavy duty cement concrete tiles (carborandum) of 300x300x22 mm thick manufactured as per IS:1237 using colouring pigment and hard chips like carborandum, quartz etc shall be laid as per IS:1443 over concrete under bed to result in overall thickness of 50 mm.

26.05.04 Terrazzo Tiles

Tiles shall generally be of size 250 x 250 x 20 mm laid over concrete bedding to result in an overall thickness of 50 mm.

26.05.05 Granolithic flooring

a) Granolithic flooring (cement concrete flooring in 1:1:2) with non metallic floor hardener topping 12 mm thick with a total thickness of 50 mm shall be provided in maintenance and unloading area of Station building, Mill and bunkerbay, Workshop floors, operating floor of pump house,

b) Granolithic flooring without floor hardener shall be provided in all MCC and switch gear rooms which are not air-conditioned.

c) Granolithic flooring shall also be provided in areas which are not provided with any special finish. Areas which are likely to be subjected to oil spillage shall be provided with two coats of oil resistant painting over Granolithic flooring.

26.05.06 Heavy Duty Ceramic Tiles

Heavy duty anti skid ceramic tiles with matt finish shall be used in toilets, pantry, dining hall of canteen, locker rooms etc. The tiles shall be 300 x 300 x7 mm of approved shade brand and colour.Dado in toilets and pantry ,locker rooms etc shall also be of similar finish.

26.05.07 Acid / Alkali resisting Tiles

Battery rooms, and other areas coming into contact with acid / alkali vapors or fumes shall be given acid / alkali resistant tiles 25 mm thick, jointed with acid / alkali resistant cement slurry. Bedding shall

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comprise ofpotassium silicate mortar conforming to IS:4832 (Part-I) and resin based mortar like epoxy for jointing. Total thickness of flooring shall be 50 mm. Ceramic unglazed vitreous tiles conforming to IS:4457 with minimum thickness of 20 mm may also be used as acid / alkali resistant tile. The above specification do not apply to D.M. Plant.

26.05.08 Integral floor finish

For cable vaults room, floors of wagon tripler shed, reclaim hopper shed ,crusher house, junction towers, pent house shall be provided with floor finish integral to the concrete base shall be provided as per IS:2571.

26.05.09 Cast-in-situ Terrazzo

Cast in situ terrazzo flooring shall be laid as per IS:2114, using white cement or cement with colouring pigment. Chequered finish shall be provided for treads. Total thickness of the finish shall be 25 mm.

26.05.10 Acid / Alkali resistant Tiling / Brick lining in D.M Plant

a) Bitumen primer followed by 12 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 38 mm thick alkali / acid resistant bricks as per IS:4860 shall be provided for CPU regeneration area, Chemical house floor, effluent drains, floors around equipment & chemical handling vessels, chemical storage area for the floor, curbs and sumps ,all as per the acid / alkali proofing specialist Contractor's requirement.

b) For floor of neutralizing pit the finish shall be as follows. Bitu men primer followed by 18 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 75 mm thick acid / alkali resistant brick as per IS:4860.

c) For walls of neutralizing pit, the same specification as 1.10.2 shall apply except that thickness of the brickwork shall be 115 mm with suitable pilasters at 2000 mm c/c.

d) Special instruction to be followed for acid resistant lining in neutralizing pit shall be as follows.

i) The structures shall be tested for water tightness.

ii) Surface on which lining is to be applied shall be prepared as per IS:2395.

iii) Joints between acid resistant bricks / tiles shall be filled with resin type mortar conforming to IS:4832 (Part II). Seal coat of ready made epoxy paint shall

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be provided at the joints to cover up any porosity.

iv) Acid resistant bricks shall be laid with 6 mm wide and 20 mm deep pointing. Pointing shall be with epoxy / furane / CNSL as per the requirement of the agency guaranteeing the performance of lining.

v) Under side of all precast slabs / steel covers over effluent drains shall be given two coats of epoxy coating, 150 microns thick.

vi) Acid / alkali resistant treatment shall extend at least 1 meter on all sides from the outermost periphery of pedestals / saddles for indoor installations and 2 meters all round for outdoor installations.

26.05.11 Glazed vitrified tiles

Polished vitrified tiles shall be of 600 mm x 600 mm x 7.5 mm in size and shall be approved shade , brand and colour and shall be laid with CM 1:3. These are proposed in the following areas:
Operating floor, Control room area including control room ,computer room, control equipment room, SWAS Room and Conference room, senior executive room – The floor shall be vitrified tiles of size 2 feet X 2 feet

26.05.12 Miscellaneous

a) PVC nosing / Aluminum angle nosing with minimum size (150 x 25 x 3) shall be provided for edge protection of R.C.C. stair treads.

b) Angles 50x50x6 mm(min) with lugs shall be provided for edge protection of cutouts / openings in floor slabs, edge of drains covering gratings, edge of R.C.C cable / pipe trenches and at any other place where breakage of edges / corners is expected.

c) Floors of switchgear rooms shall have embedded steel channel suitable for easy movement of breaker panel.

26.06.00 Skirting / Dado

a) 150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.

b) Toilets & locker rooms shall be provided with dado of 2100 mm high .

c) For main Control room and control equipment room minimum 5 mm thick decorative coloured ceramic tiles shall be provided upto false ceiling level.

d) For battery room and other areas coming in contact with acid / alkali spillage/ fume, dado of acid / alkali resistant tiling as per IS:4457 shall be provided to a height of 2100 mm set in potassium silicate mortar and joints pointed with resin bonded mortar.

e) Staircase wall shall be given dado of cast in situ terrazzo to a height of 2100mm. If Entrance lobby and lift area in Service building and Admin building shall be provided with granite tile dado to a height upto false ceiling level.

26.07.00 Doors, Windows, Ventilators, Louvers Etc.

26.07.01 Unless specified all doors, windows and ventilators of air conditioned areas, entrance lobby of all buildings and windows/ventilators provided on the outer face of all buildings shall have, electro colour coated (anodized) aluminum framework with glazing. All doors of office areas shall be of factory made pre-laminated particle board (MDF exterior grade).All other doors (unless otherwise specified)shall be of steel.

Main entrance of the control room and control equipment room shall be provided with air-locked lobby with provision of double doors / glazed panels of aluminum frame work with toughened safety double glass glazing confirming to IS 2553 hermitically sealed and separated by 12 mm thick cup for thermal insulation. Doors shall be of double swing type or sliding type.

For common control building, double glazed wall panels with aluminum frame shall be provided between air-conditioned and non air- conditioned areas and on the side of control room and control equipment room facing the operating floor to have a clear view.

Single glazed panels with aluminum frame work shall be provided as partition between two air-conditioned areas wherever clear view is necessary.
Coal conveyor galleries shall have steel windows/ventilators shall be asper IS 1038

All steel doors shall consist of double plate flush door shutters. The door shutter shall be 45 mm thick with two outer sheets of 18 G rigidly connected with continuous vertical 20 G stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 18 G. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, etc.

Steel windows and ventilators for coal conveyor gallery shall be as per IS:1361 and for all other areas as per IS:1038. Windows of coal galleries shall be provided with wire mesh.

Wherever functionally required rolling shutters with suitable operating arrangement Manual / Electric shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248.

All windows and ventilators on ground floor of all buildings located in isolated areas shall be provided with suitable anodized aluminum grill.

Fire proof doors with panic devices shall be provided at all fire exit points as per the recommendations of Tariff Advisory Committee (TAC).These doors shall generally be as per IS:3614 (Part I and Part II). Fire rating of the doors shall be as per TAC requirements However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral wool insulation.

Hollow extruded section of minimum 3mm wall thickness as manufactured by INDAL or equivalent shall be used for all aluminum doors, windows and ventilators.

All door sizes shall be decided carefully, keeping in view the size of the machinery/panels to be erected inside the building. In any case opening height shall not be less than maximum height of machinery/panel installed inside the building.

IS Codes

Following are some of the important IS codes (latest edition) applicable to this section:

IS:204 (Part-II) : Tower bolts non ferrous metals

IS:208 : Door handles

IS:2002 (Part-I) : Flywood face panels

IS:1341 : Steel butt hinges

IS:1868 : Anodic coatings on aluminum and its alloys

IS:3564 : Door closers (hydraulically

regulated) IS:5187 : Flush bolts

IS:6315 : Floor springs (hydraulically regulated) for heavy doors

IS:7195 : Hold fast

IS:7452 : Hot rolled steel sections for doors, windows and ventilators

IS:10019 : Mild steel stays and fasteners

IS:1038 : Steel doors, windows and ventilators

IS:1361 : Steel windows for industrial ventilators

IS:1948 : Aluminum doors, windows and ventilators

IS:1949 : Aluminum windows for industrial buildings

IS:4351 : Steel door frames

IS:3614 (Part-I) : Fire check doors

IS:10451 : Steel sliding shutters (top hung type)

IS:4021 : Timber door, window and ventilator frames

IS:1003 (Part-I) : Timber paneled and glazed shutters– door shutters.

26.07.02 Wall paneling

All the exposed structural steel i.e. wall, columns, bracings in STG control room and air-conditioning areas shall be provided with wooden wall paneling. The wall panel shall consist of teak wood batten grid of size 600x600 mm or as per site requirement. The size of batten shall be 2 inch x 1 inch. BWP grade plywood conforming to IS:710 shall be fixed on this grid. The Venner of approved quality and shade shall be fixed on the plywood as exterior finish with suitable adhesive. The entire work shall be carried out to the satisfaction of engineer.

26.08.00 Glass and Glazing

All ventilators and windows on external face of turbine building, conveyor gallery, pump house, compressor house, DG set building, transfer points, workshop building, fire escape staircase and those buildings located in fire prone areas shall be provided with wired glass of minimum 6 mm thickness conforming IS:5437.

Glazing in control room between AC and Non AC areas shall be double glazing consisting of two 6 mm thick clear toughened safety glass conforming to IS:2553, hermetically sealed and separated by 12 mm thick gap for thermal insulation.

For single glazed aluminum partitions and doors, Float glass or flat transparent sheet glass of minimum 6 mm thickness shall be used.

Ground glass / frosted glass of minimum 4 mm thickness shall be used for all windows / ventilators in toilets.

Unless specified otherwise in this specification minimum thickness of plain sheet glass used for windows/ventilators shall be 4 mm.

Float glass or flat transparent sheet glass shall conform to IS:2835. All

glazing work shall conform to IS:1083 and IS:3548

26.09.00 False Ceiling and Under Deck Insulation

All air conditioned areas shall be provided with the suspended false ceiling system. Under deck insulation system shall be provided on the under side of the roof / floor slab of the air conditioned areas based on the functional requirement. Ceiling of air washer room shall also be provided with under deck insulation.

Aluminum false ceiling system shall comprise of 84 mm wide 12.5 mm 6 deep closed type plain panels of approved colour, roll formed out of 0.5 mm thick corrosion resistant aluminum alloy AA 5050 fixed on roll formed carriers. Additional hangers and height adjustment clips shall be provided for return air grills, supply air diffusers, light fixtures, AC ducts etc.

Gypsum board false ceiling system shall consist of 600x600x12 mm board with one coat of primer and two or more coats of acrylic emulsion paint. The suspension system shall consist of 6 mm dia galvanized steel rods suspended from ceiling supporting aluminum grid of 38x25x1.5 mm and cross tie of 25x25x1.5 mm and aluminum angle of 25x25x1.5 mm.

Suitable M.S channel (minimum ISMC100) grid shall be provided above false ceiling for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.

CONTRACTOR shall prepare a layout of the false ceiling system incorporating light fixtures, supply air diffuser, return air grills, fire protection sprinklers etc. such that the ceiling looks aesthetically pleasing. Work shall commence only after the OWNER approves the layout.

Under deck insulation shall comprise of 50 thick PUF material of density 36 kg/cubic meter . This mat shall be backed with 0.05 mm thick aluminum foil and 24 Gx25 mm wire mesh netting. They shall be fixed to ceiling or wall as the case may be with 100x50x6 slotted mild steel plate welded to M.S. plate inserts embedded at the soffit of the slab at 600 mm c/c and 14 G steel wire drawn through slots and fixed to wire netting.

26.10.00 Painting

Details furnished here in below are the minimum acceptable standard for painting. Superior finish if any required by CONTRACTOR to Enhance overall appearance will be permitted if such finish meet with the technical requirements.

Water proof cement based paint as per IS:5410 shall be provided on external faces of walls, sunshades etc.

Inside surfaces shall be provided with Acrylic washable distemper for all areas as per IS:428 except for Control room, Control equipment rooms, all air conditioned areas for which Acrylic emulsion paint shall be provided as per IS:5411.

Inside surfaces shall be provided with Acrylic distemper as per IS:428 for plant buildings like Workshop, Permanent stores, D.G. house, Compressor house, pump houses, Ash handling pump house etc.

Walls in D.M.Plant shall be provided with chlorinated rubber based paint as per IS : 9862 over walls. Walls above Dado in battery rooms shall also be provided with similar painting.

All plastered ceilings shall be provided with acryclic washable white distemper as per IS:42.

Oil resistant paint as per IS:161 shall be provided for oil canal and oil equipment room.

All wood work shall be provided with fire resistant transparent paint as per IS : 162 over french polish as per IS:348 or flat oil paint as per IS : 137.

Painting for structural steel have been specified else where in this

document.

Following general instruction for painting shall be followed.

i) For painting on concrete, masonry and plastered surfaces IS:2395 parts I and II shall be followed.
ii) For painting on wood work IS:2338 part I & II shall be followed.
iii) All paints shall be of brand and make to the approval of OWNER.
iv) A minimum of two finishing coats of paint over a primer shall be provided to give a smooth uniform finish for the painted surface.
v) All painting on masonry or concrete surfaces shall preferably be applied by rollers.

vi) Thinner shall not be used with textured paint (sandtex matt etc) finish.

vii) All fire exits shall be painted in Post office red colour shade which shall not be used any where except to indicate emergency or safety measure.

26.11.00 Sanitary Facilities

Toilet and shower facilities shall be provided for personnel in finished areas of all major buildings and in other areas as determined by project requirements.

Janitor closets and cleaning material storage areas shall be provided in finished areas of all major buildings.

Minimum one toilet block with all the facilities shall be provided on each floor of main plant building and service building. Separate toilets for ladies shall be provided wherever required. Attached toilets shall be provided for all senior executive rooms and conference rooms. One toilet shall be provided in the boiler area. All other buildings where toilet is specified shall have one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated below. IS: 1172 shall be followed for working out the basic requirements for Water supply, drainage and sanitation. In addition, IS: 2064 and IS: 2065 shall also be followed.

Each toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of chromium plated brass (fancy type).

i) WC (Indian type) Orissa pattern (580x440 mm) as per IS: 2556 (Part-3) and 1 no. bibcock with all fittings including flushing arrangement of appropriate capacity and type-1 no.

ii) WC (western type) 390 mm high as per IS: 2556 (part 2) with toilet paper roll holder and bibcock and all fittings including, flushing system of appropriate capacity and type-1 no.

iii) Urinal with all fittings with photo voltaic control flushing system as per IS: 2556 (Part-6, Sec. 1) – 2 nos. (Minimum).

iv) Wash basin (oval shape) with all fittings as per IS: 2556 to be fixed on concrete platform finished with 12 mm thick polished granite stone – 2 nos.

v) 1200x900x5.5 size Bathroom float glass mirror with beveled edges including all fittings.

vi) Stainless steel towel rail (600x20 mm) – 2 nos.

vii) Stainless steel liquid soap holder cum dispenser – 2 nos.

viii) Provision for installation of water cooler.

ix) Provision of ventilation shaft.

x) Attached toilets provided for senior executive rooms and conference rooms shall have 1 WC, 1 Urinal, 1 washbasin, 1 mirror, 1 no. towel rail, 1 liquid soap holder cum dispenser.

WC shall be of western type 390 mm high as per IS: 2556 (Part-2) with toilet paper roll holder and all fittings including flushing valve of appropriate capacity and type. All toilets shall have at least1 no. of exhaust fan.Final no. of exhaust fans shall be decided as per ventilation requirements to maintain hygienic conditions in the toilet.

xi) Unless specified all fittings and fixtures in the toilets shall follow technical specification.

xii) In main Turbine generator building, Service building and Administrative building at least one toilet block shall be provided for ladies.

xiii) Other buildings which are not specifically mentioned if found necessary shall be provided with adequate toilet facilities in accordance with NBC (National Building Code (latest)). Final requirement shall be as indicated by the owner.

All sanitary fittings and plumbing fixtures shall be of the best quality and make, and shall be subject to Owner's approval. All water supply fittings in toilets, kitchen etc viz., Bib cocks, pillar cocks, P-traps, towel rail, shower rose, gratings etc., shall be of best quality chromium plated brass of approved make.

Supreme B class stoneware pipes or equivalent shall be used for sanitary works above ground level.

26.12.00 Chemical Resistant Treatment Battery Room

a) Battery room floors and other surfaces as required shall be provided with acid/alkali resistant tiles and treated suitably as detailed below by supplying & furnishing of all labour, materials & equipment in accordance with the following latest codes:

1. IS:3384 : Specification for bitumen primer for use in water proofing & damp proofing
2. IS:4443 : Code of practice for use or resin type chemical resistant mortars
3. IS:4457 : Specification for ceramic unglazed vitreous acid resistant tiles.
4. IS:4832 : Specification for chemical resistant mortars (Part I to III).
5. IS:4971 : Recommendation for selection of Industrial floor finishes.

b) The surfaces to be treated against acid shall be levelled smooth, dry & clean. The entire surface shall be tapped by wooden hammer to determine hollows if any. In case hollows are found, they shall be suitably sealed with concrete or other approved materials.

c) The unsatisfactory surfaces shall be replaced by new concrete or other suitable material after ensuring proper bond between the new and old surface. Surface to be prepared shall be wetted for 24 hours; use of epoxy resins for bonding fresh concrete during repairs shall be permitted with Engineer's subject to its execution as per Manufacturer's instructions. All patched areas shall be properly cured by sprinkling water for a period of not less than 10 days.

26.13.00 Acid/Alkali Resistant Tiles on Floors & Walls

a.) The surface after preparation shall be applied with a coat of bitumen primer conforming to IS:3384 (latest). The primed surface shall be subsequently applied with a uniform coat of bitumen conforming to IS:1580.

b.) For bedding of tiles, potassium silicate based cement mortar [15 mm thick] as per IS:4832 shall be used spreading on the back & two adjacent sides of the tile. The tile shall be pressed on the floor or wall & push against floor or wall until the joint in each case of 6 mm thick & 6 mm width is maintained with spacers. Before the bedding mortar sets completely, the jointing material shall be removed to a depth of 20 mm. After the bedding mortar is properly set, the joints shall be cured with resin type mortar filling up the entire length of the joint. The excess mortar shall be trimmed off to make the joints smooth & place. Seal coat shall then be applied over the epoxy mortar to cover up porosity that may be left in mortar. Acid resistant tiles shall be provided for a height of at least upto lintel level on all the walls of battery room. The rest of the battery room walls & ceiling shall be provided with 2 coats chlorinated rubber paint. The tiles used for flooring & walls shall be 20 mm thick conforming to IS 4457. Tiles of approved quality and shade shall be used.

Acid curing shall be carried out as per manufacturer's directions using the safety precautions normally used when handling acids. The mortar joints shall be cured with 20 to 25 percent hydrochloric acid or with 30 to 40 percent sulphuric acid no sooner than 2 days and not later than 6 days after the masonry units are bonded with the mortar. The curing time shall be at least 60 minutes.

Performance guarantee: The contractor shall be responsible for the safety,suitability & efficient functioning of all the acid resistant treatment. He should guarantee for efficient performance of the treatment for a period of five years time from the date of the completion. During the guarantee period, if at any stage, it is found that any of such treatments has given way or has not been functioning satisfactorily, the same shall be made good by the contractor at his own cost.

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27.00.00 WATER SUPPLY, DRAINAGE AND SANITATION

27.01.00 The technical details of permanent water supply, storm water drainage, sewerage disposal system and sanitary appliances required for proper supply drainage, disposal and completion of buildings are detailed below:

27.02.00 Sewerage Pipes

a) Glazed Stoneware Pipes

Glazed stoneware pipes of diameter not exceeding 150 mm can be used in localized areas not subjected to any traffic loads. The glazed stoneware pipes with spigot and socket ends shall conform to IS: 651 Grade “A” or “AA” as specified. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipe shall be free from erasing. The pipes shall give a sharp clear note when struck with a light hammer. There shall be no broken blisters. The pipes shall be handled with sufficient care to avoid damage to them.

b) HDPE soil, waste, vent pipes and fittings

i) HDPE soil, waste, vent pipes and fittings shall be of “Approved make” conforming to I.S. 4984-1995. The outer and inner surfaces of the pipes and fittings shall be smooth and clean and shall in all respects be free from cracks, pin holes, laps or other imperfections, which may impair the strength and durability of the pipes and fittings. The ends of the pipes shall be reasonably square to their axes.

ii) The clamps for fixing the pipes to the external wall shall be of approved design and shall fit closely round the pipe or accessory directly beneath the socket.

iii) The HDPE. soil, waste and vent pipes shall normally be fixed externally to the wall or in suitably designed shafts as per alignment shown on the drawings or as directed by the Engineer. The pipes shall be fixed and kept in position by means of brackets or holder clamps which shall be securely embedded in the wall. For vertical runs, each pipe shall hang freely on its own brackets fixed just below the socket. For horizontal runs, an additional clamp shall be provided at the centre. The brackets or clamps should be of such a design so as to maintain a minimum distance of 50 mm between the surface of the pipe and the wall.

iv) The soil, waste or vent pipes shall be carried up, above the roof by a least 1.5 m and shall have a cowl of suitable design at the upper end.

c) RCC Pipes

i) RCC pipes shall be used below ground level for sewage disposal. Pipes connecting toilet facilities to manholes shall be minimum 100 mm diameter NB. Pipes connecting various manholes shall be minimum 150 mm diameter NB. RCC Hume pipes shall be supplied and laid as required as per latest editions of the following IS codes:

IS : 458 : Concrete pipes (with and without reinforcement)

IS : 783 : Code or practice for laying of concrete pipes

IS : 4111(Part-1) : Code of practice for ancillary structure in sewerage system

ii) The contractor shall supply the RCC hume pipes [to class NP3/NP2 of IS:458 as required] of various diameters along with fittings required for carrying out the work. The contractor should furnish manufacturer's test certificates from recognized authorities. PCC encasement shall also be provided whenever required as per design requirement.

iii) Alignment, Levels and Grade

The work shall be carried out in conformance to the alignments, levels and grades specified. The layout and levels shall be made by the contractor from one reference grid and bench mark given by the Engineer with the assistance of instruments, materials and men for checking the detailed layout and levels as and when required. Making of reference layout and level pillars along the pipeline route and maintaining them upto completion of the work shall be the Contractor's responsibility.

iv) Laying of Pipes

The laying of RCC pipes shall conform to IS:783. To suit the site conditions, the pipes should be laid as per drawings and instructions of the Engineer. Under the culvert condition, the pipe shall be laid under embankment and may project wholly or partly above the original ground surface.

Under trench condition, the pipe shall be laid in the excavated trench which shall be refilled with thoroughly tamped earth after laying and jointing of pipes in an approved manner. Adequate sand field

cushioning shall be provided below pipes. Minimum depth of cushion shall be 600 mm.

Under open condition, the pipe shall laid such that it projects wholly or partly above original ground surface, there being no super imposed over burden on the pipe.

v) Bedding and Supports

Under culvert condition, the pipes shall be laid generally on "First Class bedding" as per IS:783.Under trench condition, the pipes shall be laid generally on "First Class Bedding" as per IS:783. If shown on the drawing or so instructed by the Engineer, the pipes shall be laid on concrete cradles, conforming to IS:783. Minimum crushing strength shall be 140 Kg/sqm. Under open condition, the pipes shall be supported over rigid C.C. pedestals constructed at intervals not greater than the length of one individual piece of pipe, as per drawings and instructions of the Engineer.In no case shall the joint between two pieces of pipe shall lie at center of the span between the supports. The pedestal shall be of plain/reinforced concrete with a properly shaped out top to receive the pipe.Manholes shall be provided as per latest IS:4111 (Part-I) for pipe drains at the change of diameter of pipe, alignment and direction at a max. spacing of 30 m c/c upto 900 mm diameter and 45 m c/c for higher diameters of the pipe. Each manhole shall be provided with a heavy duty C.I. cover as per IS:1726.

d) Jointing

i) Glazed Stoneware Pipes

The cement mortar for jointing shall be 1:3 (1 cement: 3 fine sand) with spun yarn in neat cement. Tarred gasket or hemp/ spun yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed well into the socket of the pipe previously laid. Then pipe shall be adjusted and fixed in the correct position and gasket/ spun yarn caulked tightly so as to fill not more than ¼ th of the total depth of the socket.

The remainder of the socket shall be filled with stiff mixture of cement mortar in the proportion of 1:1 (1 cement: 1 fine sand). When the socket is filled, a fillet shall be formed round the joint with a trowel forming an angle of 45 Degree with the barrel of the pipe. After a day's work any extraneous material shall be removed from the inside of the pipe. The newly made joints shall be cured.

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ii) Jointing of RCC pipes

IS : 783 provisions shall be followed for jointing of pipes; and every possible care shall be taken to ensure that the joints made are leak proof. Curing of joints shall be done for a period of 10 days.

e) Testing of Joints

i) Stone Ware Pipes

Stone ware pipes used for sewers shall be subjected to test pressure of 1.5M head of water at the highest point of the section under test. The test shall be carried out by suitably plugging the low end of the drain and the ends of the connection if any and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head. Or this may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

ii) RCC pipes

All RCC pipe joints shall be checked for water tightness as per relevant IS code.

27.03.00 Internal Work

a) All water supply pipes for internal plumbing of buildings shall be of GI pipe of medium class conforming to IS : 1239 of approved make. Galvanizing of pipes shall conform to IS : 4736.

b) The pipes and sockets shall be cleanly finished, well galvanized in and out and free from cracks, surface flaws, laminations and other defects; all screw threads shall be clean and well cut. The ends shall be cut cleanly, and square with the axis of the tube. The thickness and weight of pipes and sockets shall be in accordance with IS : 1239.

All screwed tubes and sockets shall have pipe threads conforming to latest IS:554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

c) The pipe fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements of clause No.3 or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to IS: 554 (latest edition).

Female threads on fittings shall be parallel and male threads (except on running sipples and collars of unions) shall be taper.

d) Cutting, Laying and Jointing

Where the pipes have to be cut or rethreaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to IS: 554 (latest edition) with pipe dies and tapes carefully in such a manner as well not result in slackness of joints when the two pieces are screwed together. The tapes and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in a water tight joints. The screw threads of pipes and fittings shall be protected from the damage until they are fitted.

The pipes shall be cleaned and cleared of all foreign matter before being laid. In joining the pipes, the inside of the sockets and the screwed end of the pipes shall be oiled and rubbed over with white lead; and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the sockets, tee etc. with the pipe wrench. Care should be taken that all the pipes and fittings are properly jointed so as to make the joints completely water-tight; and pipes are kept at all times free from dust and dirt during fixing. Bore from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

Any threads exposed after joining shall be painted or in case of under-ground piping thickly coated with approved anticorrosive paint to prevent corrosion.

e) Fitting

(i) For internal work, the galvanized pipes fittings shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm. clear of the wall. When it is found necessary to conceal the pipes chasing may be adopted or pipes fixed in the ducts or recesses etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not be buried in walls or solid floors,where unavoidable pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer, a steel tube sleeve shall be fixed at a place a pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in wall or floors, it

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should be painted with anticorrosive bitumastic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling done under concrete floors.

ii) All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screw bolts. The clamps shall be embedded in brick work in cement mortar 1:3 (1 cement : 3 coarse sand) and shall be spaced at regular intervals in straight lengths as indicated below :-

Size of pipe (mm)	LENGTHS	
	Horizontal runs (m)	Vertical runs (m)
15	2	2.5
20	2.5	3
25	2.5	3
32	2.5	3
40	3	3.5
50	3.5	3.5
65	3.5	5
80	3.5	5

The clamps shall be fixed at shorter lengths near the fittings as directed by the Engineer.

iii) For G.I. Pipes 15mm to 25 mm dia, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes, the holes shall be carefully made of the smallest size as directed by the Engineer. After fixing the pipes, the holes shall be made good with cement mortar 1:3 (1 cement and 3 coarse sand) and properly finished to match the adjacent surface.

27.04.00 Trenches and Other Excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during handpacking with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

27.05.00 Sanitary Appliances

a) Water Closet

(i) **Water closet Pan :** The water closet shall be of Orissa pan/European type of approved make, Vitreous China conforming to IS: 2556 Part- III. The closet shall be of size as specified. The flushing rim shall be integral with the pan and shall be Self draining type. The closet shall be provided with a self cleaning trap of the same material as the pan. The trap shall be either a “P” or “S” outlet and with a vent hole. The effective depth of the water Seal shall not be less than 50 mm.

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(ii) The pan shall be fixed in position as shown on the drawing. It shall be embedded on a suitably prepared surface rendered smooth with neat cement or cement plaster so that uniform support is provided to the pan. The pan shall normally be at the floor level unless otherwise specified. The WC pan shall be fixed to the trap by means of a cement mortar joint as in the case of SW pipes; and the entire job carried out so that the effective seal is always kept maintained the vent of the trap being connected to Anti siphonage pipe.

(iii) While laying flooring, a section about 1 x 1.5 m or less of the part of the floor where WC is to be fixed shall be left out. This shall be finished only after the pan has been fixed and laid in position. The pan shall be kept suitably protected against all damages. It shall include both pan and trap, as well as fixing materials as needed.

b) Flushing Cisterns for Water Closets

The flushing cistern for water closet shall be PVC low level type of 10 Ltr. capacity (IS 2556 mark) with PVC bend of approved make. The cistern shall be secured on wall or supported on steel brackets which shall be well embedded in the wall. The height of the bottom of the cistern from the top of the pan shall be 30 cm for low level cistern. The cistern shall be provided with brass balcock with ball to IS:1703. It shall include brackets, screw, flush pipes, brass ball cock with ball as needed.

c) The Urinal shall be of first quality, WVC flat back (Large) or half shall type IS 2556 of size as specified of approved make. The urinal shall be fixed in position by means of four plugs embedded in wall and screws, the top of urinal lip being 65 cm from the floor level. Urinal bring a soil fitment should be connected to soil pipe. Each urinal shall be provided with 25 mm dia B Class GI Waste pipe connected to the pan by suitable joint and shall discharge in to a drain connected to a soil pipe through a trap. The flushing of urinal shall be with all fittings including voltaic control flushing system as per IS:2556 (Part-6 Section-1).

d) The wash basin (oval shape) with all fittings as per IS:2556 made of vitreous China clay to be fixed on a concrete plat form finished with 12 mm thick polished granite stone. The basin shall be provided with single tap connection. The washbasin shall have an integral soap holder recess or recesses which shall drain into the bowl.

Each Wash Basin shall be provided with :

i) 32 mm ø CP brass waste fitting with CP brass chain and 32 mm dia plug.

ii) 25 mm ø galvanized waste pipe "B" class discharging into a drain suitably connected to waste fitting by means of brass check nuts.

iii) 15 mm ø CP pillar taps of superior quality to IS-8994 of approved make.

The basin shall be connected to the waste pipe discharge in to drain, by means of the waste fittings and check nuts, the join being completely leak proof. The tap shall be connected to the water supply system by means of a lead connection. A stop cock shall be provided to regulate supply to the wash basin. It shall include fixing material complete with brackets, waste coupling, waste pipe, NP pillar tap, CC chamber and grating.

e) Wall to wall bath room mirror (5.5MM thick) float glass with beveled edges including all fittings shall be provided.

f) All toilets shall have at least one No. of exhaust fan. The No. of exhaust fan shall be decided as per ventilation requirements to maintain the high hygienic conditions in the toilet.

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28.00.00 SWITCHYARD CIVIL WORKS

28.01.00 The structural and civil works associated with erection and commissioning of station switchyard shall be executed as detailed below. The scope covers design, engineering, fabrication, galvanizing, supply and erection of:

a) Lighting mast, towers, beams, equipment lattice support, equipment pipe support inclusive of all fixtures such as nuts, bolts, hangers, shackles, clamps, anti-climbing devices, bird guards, step bolts/ladders, number plates, danger and phase plates, inserts in concrete, foundation bolts, base plates, stiffeners, dampers, fixtures for supporting and operating mechanism boxes, control cubicles etc.

b) Framed RCC switch yard building with brick cladding shall be proided to accommodate various equipments including GIS as per electrical drawing.Roof shal be of RCC. Size of building of building shall meet electrical requirements.

c) Cable tray supports, cable trays, embedments in cable trenches, bolts and nuts and any other accessories etc.

d) R.C.C. cable trench and pipe trenches with necessary precast R.C.C. covers with lifting facilities, sump pit, cable trays, supports etc. [wherever trenches cross road, the section below such crossings shall be designed as per Indian Road Congress Drainage of these trenches shall be suitable designed]. All precast slabs for trenches shall be provided with MS edge protection angle on all sides (min. size of angle 50x50x6 mm). The RCC trench edges shall be provided with MS angle protection (min. size of angle 50x50x6 mm)

e) Drainage and lighting of the area [cable trench should not be used for drainage purpose]. An approved system for draining the transformer and oil collection, and disposal system shall be provided.

f) For prevention of vegetation, the graded ground shall be covered with fly ash brick pavement over 300 mm ash filling is to be provided in the switchyard area. Each fly ash layer shall be compacted/ consolidated by using ½ ton roller with 4 to 5 passes and suitable water sprinkling. The method of application of chemicals used for soil sterilization/anti-weed treatment shall be as per manufacturer's recommendations. Also, the RCC pathway shall be provided in switchyard as per the requirement.

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g) Transformer foundations; RCC roads within switchyard, fire protection walls and chain link fencing for switchyard. RCC paving shall be provided in Transformer yard.

28.02.00 General Requirements

28.02.01 Steel shall conform to IS:226/IS2062. Where plate cut pieces are used to form a part of either flange plates or web plates of fabricated columns with butt joints, length of such pieces shall not be less than 3 (three) meters. When cut pieces out of rolled sections are to be joined by butt welding, the length of such pieces shall not be less than 3 (three) meters and the total number of pieces of any member shall not exceed three. The steel structures for the switchyard shall be double dip galvanized with zinc coating not less than 0.91 kg/m2.

All foundations for the switchyard structures (except transformer) shall be designed as per relevant IS:4091 "Code of practice for design and construction of foundations for transmission line towers and poles" and IS-456 (latest) "Code of practice for plain and reinforced concrete". All the foundations shall be protected by as per clause 6.11 of this specification.

28.02.02 Transformer / shunt reactor foundations

The transformer/shunt reactor foundations shall be designed as per relevant IS Code. This shall include collection of oil, drainage of oil along with rain water collected in such foundation; as well as necessary cable connection works.

28.02.03 a) The steel girders shall be designed for static tension dead load of conductors, insulators, and accessories, erection load, short circuit forces, wind/seismic loads and secondary stresses. The girders shall be connected with lattice columns by bolted joints.

b) The fabrication and erection of the works shall be carried out generally as per IS:802 Part-II, IS:800. All materials shall be completely shop fabricated. Towers, beams etc. shall be trial assembled at shop keeping in view the actual site condition for convenient pre-assembly during erection. Necessary match marks shall be made on these components before dismantling in the shop.

28.02.04 Bolting

Every bolt shall be provided with a steel washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together. Notwithstanding anything to the contrary contained in IS:1363, IS:1364 and IS:1367 the unthreaded length of

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the bolt shank shall be equal to total thickness of metal being bolted together plus 2 mm. The threaded length shall be equal to at least the diameter of bolt plus 6 mm.

a) Cable and pipe trenches shall be in R.C.C. with removable R.C.C. covers. (The top of trench shall be kept 150 mm above the grade level). The bed of trenches shall be slope 1 in 200 to drain water into a collection sump suitably. All trenches shall be given a slope of 1 in 500 along run of the trench. Cable trenches crossing the road shall be designed for class "AA" loading as per IRC standard. However, the design shall also be checked for class "A" loading as per IRC standard. All precast slabs for trenches shall be provided with MS edge protection angle on all sides (min. size of angle 50x50x6 mm). The RCC trench edges shall be provided with MS angle protection (min. size of angle 50x50x6 mm) Surcharge load of 2T /sqm. Shall be considered in design of trenches in switchyard area.

b) The design of foundation and all trenches should take care of sub-soil water pressure as per relevant IS Codes. If the ground water table is above the base level of the trench, PVC water stops (minimum 230 mm wide and 5 mm thick) should be provided at all construction and expansion joints to the approval of the Engineer.

28.02.05 All anchors, anchor bolts, insert pipes, conduits, sleeves, bolts, etc. required to be embedded in concrete shall be placed in position before concreting. These inserts shall be welded to the nearest reinforcement to keep them in position.

28.02.06 **a)** The fence around switchyard area shall comprise of 12 gauge G.I. chain link fencing of mesh size 75 mm to a height of 2.4 m above the toe wall with a 600 mm high galvanized concertina at the top such that total fence height of 3.0m above toe wall level is achieved. Toe wall shall be minimum 200 mm above the formation level.

b) The chainlink fencing shall comprise of size 2400x2000 mm size panel made from 75x75mm & 8 gauge GI chainlinks (including PVC coatings) and 50x50x6 mm angle including fixing the chainlink in angle frame by means of 40x3mm. MS flat welded to angle frame drilling to holes in angle frame & flat and fixing the same with angle post in the level and plumb by means of 10 mm dia bolts frames and flat & nuts, 3 coats of epoxy base paint to achieve required 250 DT to angle iron etc. completed.

This chainlink fencing panel shall be fixed with the fence posts of 65x65x6 MS angles spaced as per requirement.

c) Above the chain link fencing panel 3 horizontal rows of barbed wire of gauge 12/14 with 3 diagonal rows shall be fixed as per drawing.

d) All fence posts shall be 65 x 65 x 6 MS angles spaced at 2.5 m c/c distance. All straining posts i.e. end posts shall be 65 x 65 x 6 angles. Suitable concrete foundations for the angle iron posts and stays shall be provided based on the prevailing soil conditions. Toe walls either of bricks of minimum 50kg/cm2 compressive shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200 mm above the switchyard formation level with PCC coping (M-20) and minimum 300 mm below the switchyard formation level. All gates shall be of hot dipped galvanized structural steel as specified.

e) All structural steel work for the fencing shall be painted with chlorinated rubber paint over a suitable primer or epoxy based paint (of total DFT 250 microns) to withstand severe marine/corrosive exposure condition for protection.

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.

30.00.00 PILING

30.01.00 The detailed design, preparation of construction drawings, installation and testing of piles forming foundations to buildings and structures are detailed below conforming to the latest IS:2911 – Code of Practice for Design and Construction of Pile Foundations : Part I Concrete Piles and IS:2911 Part : IV Load test on piles and to this Specification. The contractor shall be responsible for all aspects of the pile performance installed including demonstration of the adequacy of his design by testing. During detailed design the contractor shall submit the proposed firm to undertake piling work with details piling system, method of installation, summary of design basis, number, type and size of construction plant items to be employed for the work including crane, piling equipment, concreting equipment and proposal for installation & testing of trial piles and tests on work piles.

30.02.00 Prior to installation of trial piles, the contractor shall submit final details of the trial piling installation including specifications, detailed design calculations and construction drawings for the trial piling together with associated equipment to be provided for construction and testing of the same.Design report discussing the overall results of the tests on trial piles and concluding with and justifying the proposed definition of reference piles; specification, with fully detailed construction drawings, supporting calculations for the final design of the working piles, and the field control procedures the contractor intends to use to verify that pile installation satisfies the requirements of his design should also be submitted.

30.03.00 Design Criteria

The following shall be the design criteria for the working piles :

a) Piles shall be designed in line with approved soil investigation report as single vertical piles acting under a design load as deemed fit.

b) Driving formula (where relevant) may be adopted interalia as a criteria for acceptance. But the minimum founding requirements shall be based on recognized methods of soil mechanics design, appropriate to the type of pile.

c) The piles shall be designed for a minimum factor of safety of 2.5 against failure under the design load specified.

d) Piles shall be designed for a limiting settlement of a single pile under vertical design load of 8 mm at the head.

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e) Piles shall be designed to resist a maximum force due to critical load combination in any direction applied to the head of the pile at cut-off level. For this design condition it shall be assumed that the pile head is effectively as a fixed-end by the pile-cap.

30.04.00 Tolerance

Setting out shall be carried out from the main grid lines of the proposed structure. Immediately before installation of the pile, the pile position shall be marked with suitable identifiable pins or markers. For a pile head cut-off, at or above ground level, the maximum permitted deviation of the pile head cut off center from the center point, shown on the setting out drawing shall be 75 mm in any direction. For a pile head cut-off below ground level, an additional tolerance will be permitted as below on the assumption that the pile head would have been within tolerance if the cut-off had been at ground level. The maximum permitted deviation of the finished pile from the vertical is 1 in 75. Forcible corrections to concrete piles shall not be made.

30.05.00 The contractor shall carry out the work to minimize noise and disturbance.

If during the execution of the work, damage is likely to be, caused to mains, services or adjacent structures, the contractor shall submit proposal for repair or avoidance of such damage. The contractor shall ensure that damage does not occur to completed piles.

30.06.00 Records

The contractor shall keep records as below of the installation of each pile and shall submit record to the Engineer.

Table 1.0

a)	Piles reference number (location)	*
b)	Piles cut off level	*
c)	Pile type	*
d)	Nominal cross-sectional dimensions or diameter	*
e)	Pile design capacity	*
f)	Standing groundwater level	*
g)	Date and time of driving, red riving or boring	*
h)	Date of concreting	*
i)	Ground level at commencement of installation of piles	*
j)	Working level	*
k)	Depth from working level to pile toe	*
l)	Toe level	*
m)	Depth from working level to pile head level	*
n)	Length of temporary / permanent casing	*
o)	Type weight, drop and mechanical condition of hammer	*

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p)	Number of type of packings used and type and condition of	*
q)	Record of blows per 300 mm over complete drive	*
r)	Set of pile or pile tube in mm per 10 blows or number of	*
s)	Temporary compression of ground and pile from time of	*
t)	Length and details of reinforcement	*
u)	Grade and slump of Concrete mix and control test	*
v)	Volume of concrete installed in pile	*
w)	Method of placing concrete	*
x)	Number of blows to form bulb where appropriate	*
y)	Level of water or drilling fluid at commencement of	*
z)	All information regarding obstructions delays and other	*

30.07.00 Driven Cast-in-situ Concrete Piles

a) Installation of piles shall be carried out as per layout construction drawings in accordance with latest IS codes as below:

i) IS:456-2000 :Code of practice for plain and Reinforced Concrete

ii) IS:2911-Part I : Code of Practice for Design and Section-I Construction of pipe foundation

iii) IS:2911-Part IV : Test load on piles

b) The sequence of installation of piles shall be to the approval of the Engineer.

c) The equipment and accessories required for the pile driving shall be standard type. The capacity of the pile frame shall be selected after considering the size and weight of the casing to be handled, the location of the work and the hardness of driving. The steel casing used for installing the piles shall be straight and shall have sufficient wall thickness and strength to prevent damage, distortion etc. Detachable shoes used with the temporary steel casing shall be fabricated steel or cast iron, double rimmed and of requisite strength, and of the standard sizes used with the respective steel casing. The shoe shall be co-axial with the steel casing.Casings distorted from true uniform shape whether caused by driving or earth and water pressure resulting in a reduction of the cross sectional area of the pile in excess of 10 percent shall not be used in the works.The nominal casing size shall be 500 mm diameter.

d) The pile shall be driven to a set proposed by the contractor. The final set values shall be repeated thrice before terminating the pile at that level. All relevant data with back up, computations pertaining to "set" shall be submitted before commencing piling work for Purchasers approval. Any sudden change in rate of penetration shall be brought to the notice of the Engineer.

e) Control of Pile Driving

Protection of pile heads and selection of pile hammer shall be as per IS:2911 Part I. The pile shall be driven as accurately as possible to the vertical. Piles shall be installed with due consideration for the safety of adjacent structures by a method leaving their strength unimpaired and which develops and retains the required load bearing capacity. In the case of piles close to existing plant and structures, the Engineer may specify suitable precautions which may call for additional working hours for the rig. The quipment and methods for installing piles shall be such that the loss of energy is limited to a minimum. Should the deviation of the installed pile be greater than the specified tolerances, the Engineer may at his discretion order the installation of additional piles after checking the design load on the pile group of which the particular pile forms part. Care shall be taken not to damage the piles by over driving. Any sudden change in the rate of penetration shall be noted and informed to the Engineer. Jetting of Pile by means of water shall not be permitted.

f) After complete installation of the casing before concreting, the contractor shall inform the Engineer to inspect the casing for proper plumb location and other conditions. Only after approval concreting should proceed. Level readings shall be taken on each pile after driving and again after all the piles in a group are driven. Piles which are found to have resin shall be driven to the original depth and set.

g) The main longitudinal reinforcing bars in piles shall be in one continuous length. In long piles, joints shall be permitted in main longitudinal bars but these shall be kept to a minimum. Joints in adjacent bars shall be staggered at least 1 meter part along the length of the pile. Joints in reinforcement shall be such that the full strength of the bar is effective across the joint.

Longitudinal reinforcement shall be provided for the full length of the pile extending above pile cut off level to provide adequate bond length into the pile cap. The minimum area of longitudinal reinforcement within the pile shaft shall be 0.4 percent of cross-sectional area of the pile on the basis of the nominal casing diameter. Longitudinal reinforcement shall be formed into a rigid cage to resist deformation during handling and installation by the use of links or helical reinforcement. The minimum diameter of links

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and helical reinforcement shall be 6 mm spaced at 150 mm and not more than 300 mm. The longitudinal reinforcement shall project 52 times its diameter; above the cut off level of the pile to ensure adequate bond length inside the pipe cap. Minimum 6 Nos. of longitudinal reinforcement shall be provided. Reinforcement provided in pile shall be symmetrical about any axis on the pile cross section. The diameter of longitudinal reinforcement shall not be less than 12 mm. Lap or splice joints shall be provided with sufficient link bars to resist eccentric forces. Minimum cover to main reinforcement in the pile shall be 75mm.

h) The method of placing and the workability of the concrete shall be such that continuous monolithic concrete shaft of the full cross-section is formed. Mechanical vibrators shall not be used to compact concrete. Concrete in piles shall be of design- mix with minimum grade M25 with minimum cement of 400 kg/cum water cement ratio within 0.45 to 0.55 using super plasticized Sikament 170 or equivalent. Generally the slump of the concrete shall be within the range 100 to 150 mm. The contractor shall ensure the minimum specified strength in accordance with IS:456, IS:10262 & SP. 23 shall be followed as guidance for mix design. Compaction of test cubes shall be done under same condition as followed for concreting of piles.

i) In soft clays or loose sands ,or where there is likelihood of danger to green concrete due to driving of adjacent piles, the designed reinforcement should be provided up to the full pile depth, regardless of whether or not it is required from uplift and lateral load considerations. Refer clause 5.11.2 of IS : 2911 (Part I / Sec-1)

j) Cleaning out of casing

Before placement of concrete ,it shall be ensured that the inside of the casing is free from sludge or any foreign matter. The contractor shall ensure that water does not enter the casing tube/pile shoe at the end of driving & during the concreting operations. The existence of water inside casing tube after driving and before executing the concrete operation, if any shall be checked by the contractor by suitable probe & concreting of pile work shall be allowed to proceed if water level is less than 15 cm measured above the inner surface at the top of the shoe. If the water level is more than 15 cm, contractor shall take remedial measures viz. bailing or pumping to reduce the depth of water before concreting & if it is not possible to do so then the contractor shall re-drive the casing at no extra cost to the Purchaser.

k) Concrete Level – finishing of pile head

The cut-off level shall be as shown on the construction drawings. Concrete shall be cast to minimum of 500 mm above the cut-off level, or local ground water level, whichever is higher. Withdrawal of temporary casing

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shall be carried out in stages during the concrete placing operation with utmost care maintaining an adequate head of concrete above the bottom of casing at each stage of withdrawal so as to prevent the inflow of soil and water into the bore. Section of empty hole remaining above the head of the pile shall be temporarily backfilled with sand or other approved material prior to excavation for pile cap construction.

l) Trimming of pile heads

Following excavation subsequently for pile cap construction, the contractor shall carefully remove excess concrete above specified cut-off level, without damaging the remainder of the pile including the projection reinforcement. Any cracked or defective concrete occurring below specified cut-off level shall be cut away and made good with new concrete properly bonded to the old. Piles that are defective shall be pulled out or left in place as judged by Engineer without affecting performance of adjacent piles. Also the contractor shall be bound to install additional piles to substitute the defective ones as per the directions of the Engineer.

m) The dynamic cone penetration tests shall be carried out for a depth of at least 2 meters from the termination depth. The number of such tests shall be as follows

a. One number dynamic cone penetration test for each pile group consisting of more than four piles.

b. For TG and Chimney pile groups the number of dynamic cone penetration tests shall be one per cent of the total number of piles.

30.08.00 Load Tests on Piles

a) Load test shall be in accordance with IS:2911 Part IV (latest revision) Initial load tests on “Trial Piles” shall be executed in advance of works pile construction and shall comprise vertical load tests at locations as directed. Load test on trial piles shall also include lateral load test and uplift load tests as directed by the Engineer. 6 number of trial piles shall be tested from each capacity of the pile. Out of the six (6) nos. of piles to be tested for two (2) nos. each capacity shall be tested for vertical load, two (2) nos. for lateral load and two (2) nos. for uplift load.

Routine load tests on “Works Piles” shall be vertical load test and lateral load tests on piles as directed by the Engineer. Number of routine tests to be conducted on work piles shall be equal to one and half (1.5) percent of the total number of piles used in the work for vertical load tests as well as lateral load tests.

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b) Load tests shall not normally be undertaken by the contractor within 28 days after the installation of the piles in position. However, the contractor may be allowed by the Engineer to use rapid hardening cement or add necessary admixtures to enable him to conduct the tests within a lesser period. Before any load test is done, the proposed arrangement for carrying out the load tests including the preparation of the structure to receive the loads and the type of loading to be adopted shall be furnished by the contractor.

c) Vertical Load Test on Trial Piles

Load tests to verify the contractor's design shall be carried out on piles of different capacities proposed to be used. The contractor shall commence testing as early as possible after installing the piles. The test shall be carried out by applying series of loads on RC cap over single pile. The load shall be applied by means of standard hydraulic jack reacting against a loaded platform which shall be preloaded platform which shall be preloaded to three times the estimated safe load carrying capacity of the pile. Reading of settlement and rebound shall be recorded with four dial gauges of 0.01 mm sensitively and resting on diametrically opposite ends of the pile cap. The dial gauge shall be fixed to a datum bar whose ends rest-upon non-movable supports. The supports for datum bar with reference to which the settlement of the pile is measured shall be at least 5 times diameter of pile away from the pile.

The test shall be conducted by the cyclic loading method. The test load shall be applied in equal increments of about one-fifth of the estimated safe load. Each stage of loading or unloading shall be maintained till the rate of movement of the pile cap is not more than 0.02 mm per hour. However, load shall be maintained for longer periods at 1 to 1.5 times the assumed safe capacity, and at final loads as directed by Engineer. The safe load on pile shall be the least of the following :

i Two third of the final load at which the total settlement attains the value of 12 mm.

ii Two third of the final load at which the net settlement attains a value of 6 mm.

iii 50 per cent of the final load at which the total settlement equals one-tenth of the pile diameter.

d) Lateral Load Test on Trial Piles

The test pile shall be decided by the Engineer. The test pile shall be cut off at the proper level and provided with a cap with vertical plane sides having

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an adequate area for proper seating of the jack and dial gauge. The lateral load shall be applied on the pile at or approximately at cut off level and the deflection shall be measured at a point diametrically opposite to the point of load application. The loading shall be applied by the hydraulic jack of adequate capacity, abutting the pile horizontally and reacting against a suitable system. The reaction may be provided by the well of the excavated pit when the test is being conducted below ground level or by a neighbouring pile in which case thrust pieces shall be inserted on either end of the jack to make up the gap. Lateral load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack, having a least count of 500 kg. Deflection of the pile head shall be measured by four dial gauges, fixed to datum bars & having a least count of 0.01 mm. The datum bars shall be provided with rigid supports. Loading shall be applied in increments of 500 kg.Each stage shall be maintained for a period till the rate of movement of the pile head is not more than 0.02 mm/hour or 1 hour whichever is greater .

Loading shall be continued till one of the following occurs :

i. Deflection of pile head exceeds 12 mm.

ii. The applied load on the pile is three times the assumed lateral load capacity of the pile.

The safe load shall be smaller of the following :

i. Half the final load for which the total deflection is 12 mm.

ii. Load at which the total displacement corresponds to 5 mm.

e) Pull-out Test

The test piles shall be decided by the Engineer. The test pile shall be built upto the proper length and the head provided with suitable arrangements for anchoring the load applying system. Loads shall be applied using a approved reaction system, uplift forces on the pile shall be applied directly to the test pile or through a lever system. The reaction shall be provided by neighbouring piles or blocks may be constructed for the purpose. Hydraulic jacks shall be used for load application. Load applied by the hydraulic jack shall be measured by a calibrated gauge with a least count of 100 Kg. Movement of the pile shall be measured by dial gauges, fixed to datum bar and having a least count of 0.01 mm. Four dial gauges placed diametrically opposite shall be used. Datum bars shall be provided with rigid supports. The load shall be applied along the longitudinal axis of the pile using method approved by the Engineer. Loading shall be applied to the pile top in increment of one-fifth of the expected safe capacity. Each stage shall be

maintained for a period till the rate of movement of the pile head is not more than 0.02 mm per hour or four hours whichever is greater. Loading shall be continued till one of the following occurs :

i. Yield of soil pile system occurs causing progressive movement of pile exceeding 12 mm.

ii. The loading on the pile top equals three times the estimated safe load or as specified in the case of separate test pile.

The safe capacity of the pile should be least of the following :

i. Two third of the load at which the total displacement is 12 mm or the load corresponding to a specified permissible uplift, and

ii Half of the load at which the load displacement curve shows a clear break (downward trend)

f) Routine Test on Working Piles

Three tests shall be carried out on working piles upto one and half times the design load and the maximum settlement of test loading in position being not exceeding 12 mm as per IS:2911 (Part IV). In case a pit foils under or during the load test, the Engineer shall select two additional piles in lieu of each of such foiled pipe and the contractor shall carryout load tests on such additional piles.

30.09.00 Cast-In-Situ Piling Bored

The following specification deals with the requirements of materials, workmanship and installation of Bore Cast-in-situ reinforced concrete piles.

The materials and workmanship shall conform with the provision of the latest IS:456, IS:2911 (Part I, Section 2) & IS:2911 (Part 4).

Care shall be taken while boring piles so that no existing foundations / sub-structures are disturbed by providing suitable arrangements like shoring etc.

a) Sequence of Piling

The sequence of piles installed shall be such that the adjacent piles already installed are not disturbed nor their carrying capacity reduced by subsequent boring operation. In a group the installation of the piles shall normally proceed from the center of the group towards the periphery.

b) Control of Alignment

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Piles shall be installed as accurately as possible as per the designs and drawings either vertically or to the specified batter. Great care should be exercised in respect of installation of single pile or piles in two pile group. For vertical piles a deviation of 1.5 percent should not normally be exceeded. Piles should not deviate more than 75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm from their designed positions at the working level of the piling rig. In the case of a single pile in a column, positional tolerance should not be more than 50 mm (100 mm in case of piles having diameter more than 600 mm).

For piles carried to substantial depth, the design should provide for the worst combination of the above tolerance in position and inclination. In case of piles deviating beyond these limits and to such an extent that the resulting eccentricity cannot be taken care of by a redesign of the pile cap and ties, the piles shall be replaced or supplemented by one or more additional piles, as directed by the Engineer, at no extra cost.

Any deviation from the designed location, alignment or load capacity of any piles shall be noted and brought to the attention of the Engineer and rectification and supplemental works carried out to the satisfaction of the Engineer at no extra cost.

A minimum length of one meter of temporary casing shall be inserted in each bored pile unless otherwise specifically desired. Additional length of temporary casing may be used depending on the condition of the strata etc.

Drilling mud of suitable consistency may also be used instead of temporary casings for stabilizing sides of the holes.

In case, a bored pile is stabilized by drilling mud the bottom of the hole shall be cleaned very carefully before concreting work is taken upon. The cleaning of the hole shall be ensured by careful operation of boring tool and / or flushing of the drilling mud thorugh the bottom of the hole. Flushing of bore holes before concreting with fresh drilling fluid/ mud is preferred.

In case a holes is bored by use of drilling mud, the specific gravity of the mud suspension near about the bottom of the hole shall, wherever practicable, be determined by suitable interval of piles and recorded. Consistency of the drilling mus suspension shall be controlled throughout the boring as well as concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with the thicker suspension of the mud.

The concreting operatings should not be taken up when the specific gravity of bottom slurry is more than 1.2. Concreting shall be done by tremie method in all such cases.

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The top of concrete in a pile shall be brought above the cut-off level as per cl. 7.8 of IS: 2911 (Part 1/sec.2).

In case, defective piles are formed, they shall be removed or left in place, if so directed by the Engineer, if these do not affect the performance of the adjacent piles or the cap as a whole. Additional piles shall be provided to replace them as directed by the Engineer.

Any deviation from the designed location alignment or load capacity of any pile shall be noted and adequate measures taken well before the concreting, of the pile cap and plinth beam if the deviations are beyond the permissible limit.

During chipping of the pile top manual chipping may be permitted after three days of pile casting, pneumatic tools for chipping shall not be used before seven days after pile casting.

After concreting the actual quantity of concrete shall be compared with the average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures taken.

The bentonite suspension used for piling work shall satisfy the following requirements:

i. The liquid limit of bentonite when tested in accordance with IS:2720 (Part V) shall be more than 300 percent and less than 450 percent.

ii. The sand content of the bentonite powder shall not be greater than 7 percent.

iii. Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared Bentonite solution should be between 1.034 and 1.10 gm/ml depending upon pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite solution after mixing with deleterious materials in the pile bore may be up to 1.25 gm/ml.

iv. The marsh velocity when tested by a Marsh cone should be about 37 seconds.

v. The differential free swell shall be more than 540 percent.

vi. The PH value of the bentonite suspension shall be between 9 & 11.5.

30.10.00 Codes and Standards

The following Indian Codes and Standards (Latest) shall be used for design of the structural elements:

IS:456 : Code of Practice for plain and Reinforced concrete

IS:875 : Code of Practice for Design loads (other than earthquake) for Buildings and structures.

IS:2911: Code of Practice for Design and Construction of Pile Foundations – Bored Cast-in-situ Piles (Part 1/sec. 2)

IS:2911 : Code of Practice for Design and Construction of Pile Foundation – Load Test on Piles (Part 4)

IS:1786 : Code of Practice for HYSD bars

IS:2751 : Code of Practice for welding of mild steel bars used for reinforced concrete construction

IS:2062 : Steel for general structural purposes

SP:16 : Design Aids for Reinforced Concrete to IS:456.

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	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002
		VOLUME II B
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VOLUME – II B

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

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

SECTION - D

GENERAL TECHNICAL SPECIFICATION

ROAD AND DRAINAGE

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

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	STANDARD TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-412-600-C002
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C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
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General Standard Technical Specification For Road And Drainage

1.00.00 Scope

The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc.

The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc.

1.01.00 Works To Be Provided By The Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work.

b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work To Be Provided By Others

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

1.03.00 Conformity With Designs

The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer.

1.04.00 Materials To Be Used

All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC

b) IRC: 19 - Standard specification and code of practice for Water bound Macadam

c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways

d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.

e) IS:2212 - Code of Practice for Brick work

f) IS: 783 - Code of Practice for Laying of Concrete Pipes

g) IS: 1201 - Methods of testing tar and bituminous materials to 1220

h) IS: 73 - Specification for paving bitumen

i) IS: 215 - Specification for Road tar

j) IS: 216 - Coal tar pitch

k) IS: 217 - Specification for cut-back bitumen

l) IS: 454 - Specification for cut-back bitumen from waxy crude

m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete

n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type
Part I Bitumen impregnated fibre

Part II CNSL Aldehyde resin and coconut pith

o) IS : 334 - Glossary of terms relating to bitumen and tar

p) IS: 1077 - Common burnt clay building bricks

q) IS : 3117 - Specification for bitumen emulsion roads (anionic type)

r) IS : 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements

s) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be ± 40mm.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade ± 25 mm
Sub-base ± 20 mm
Base course ± 15 mm

Wearing course ± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance on base course if the thickness of the wearing course is thereby reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8

6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6
8.	Semi-dense carpet	10	-	-	-	20***	6
9.	Asphaltic Concrete	8	-	-	-	10***	4

Notes:

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. 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 future checking. These permanent points and markers will be checked by the Engineer and certified by him after which 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 absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. Profiles of the embankment made with Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing

Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood etc shall be the property of the Owner and shall be stacked properly at the work site in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps and clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However the Engineer may at his discretion permit the use of material coarser than the specified if he is satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.

Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skews/curves. The actual profile of the embankment shall be made at every third centre line peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.

3.03.03 Stripping and Storing top soil

The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable materials and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceeding 150mm and stored for covering the embankment slopes where revegetation is desired.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum six passes of 8-10 tonne roller and as directed by the Engineer.

Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under

construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06 Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.

Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements For Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as

shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05 Top Dressing

After the sods have been laid in position, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.

3.04.06 Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00 Shoulder Construction

3.05.01 Description

This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02 Materials

Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.

3.05.03 Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside

edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm.The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)

3.07.01 Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV
Grading for Granular Sub-base Material

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm 63 mm 4.75 mm 75 micron	100 90 - 100 35 - 70 0 - 20	100 90 - 100 40 - 90 0 - 25	100 90 - 100 50 - 100 0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of

loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

Sl.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS : 2386 (Part IV) or IS : 5640**	40 percent maximum
2.	Base	a) Loss Angeles Abrasion value*	IS : 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS : 2386 (Part IV) or IS : 5640 **	40 percent maximum
		b) Flakiness Index ***	IS : 2386 (Part I)	15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS : 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

Table - VI
Grading Requirements of Coarse Aggregates

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.

Table - VII
Grading For Screenings

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS : 2720,Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading

shall be done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not

be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled

with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.09.00 Tack Coat

3.09.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.09.02 Materials

The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.

3.09.03 Construction Operations

a) Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.

b) Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.10.00 Bituminous Macadam Binder Course

3.10.01 Description

This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in

accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table – VIII
Physical Requirements of Aggregates For Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.

Table-IX
Aggregates Grading For 75mm Compacted Thickness Of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X
Aggregates Grading For 50mm Compacted Thickness Of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportio-

ning of materials and producing a uniform mix. A variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit

manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it.

3.11.00 Open Graded Premix Carpet

3.11.01 Description

This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification.

3.11.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable.

b) Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet.

Table - XI

Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick Open Graded Premix Carpet

Aggregates for Carpet

i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total	0. 27 Cu.m

Binder for premixing (quantities in terms of straight run bitumen)

i)	For 0. 18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
	Total	14.6 Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material are laid, rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be

painted with a thin surface coat of approved binder before the new mix is placed against it.

f) Seal Coat

A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

Type-A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type-B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.12.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03 Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present an uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable

design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments

as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown on approved drawing, drains shall be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the "Specification for Earthwork in Excavation and Backfilling", backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer's specification. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383.

3.16.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 and as per the specification given below.

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per "Specification for Earthwork in Excavation and Backfilling" to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the "Specification for Earthwork in Excavation and Backfilling". When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on the drawings and as instructed by the Engineer.

e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03 Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing And Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the "Specification for Roads and Bridge Works, 1983" published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00 MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.

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CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

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

SECTION - D

GENERAL TECHNICAL SPECIFICATION

CARPENTRY & JOINERY

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

	TECHNICAL SPECIFICATION FOR CARPENTRY & JOINERY	SPECIFICATION NO. PE-TS-412-600-C002 VOLUME - II B SECTION - D | SUB-SECTION – C12 REV.NO. 00 SHEET 2 OF 6

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TECHNICAL SPECIFICATION FOR CARPENTRY & JOINERY

1.0 SCOPE

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate. This shall also include the supply and fixing of all hardware and fixtures shown in drawing.

2.0 INSTALLATION

2.1 Materials

a) **Timber**

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenters work, the Tenderer shall have the rough timber approved by the Engineer.

b) **Plywood**

Plywood shall be commercial quality with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol-formaldehyde resin of B W R grade conforming to IS:848.

c) **Decorative Laminated Plastic Sheets**

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number or joints in one surface.

d) **Flush Doors**

Flush doors shall be hollow or solid core doors with commercial or decorative faces and hardwood edges. The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer.

The Contractor shall give a guarantee that the adhesive used is phenol formaldehyde of B W R grade, conforming to IS:848. The thickness shall be as specified in the drawing.

e) **Panel Doors**

Panel door shall be of teakwood shutter frame and panels of teakwood. Other considerations shall be as mentioned in item (d) above.

f) **Fixtures**

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing.

2.2 **Workmanship**

2.2.1 **General**

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blockboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M S grills or guard bars shall be provided to windows where called for in the drawings.

2.2.2 **Finish**

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those which shall be subsequently polished or covered with laminated plastic sheet.

2.2.3 **Surface Treatment**

When shown on drawings decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or beveled as shown on drawings.

3.0 **ACCEPTANCE CRITERIA**

3.1 **Door and Window Frames**

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.2 **Door and Window Shutters**

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.3 **Partitions, Paneling, Pelmets, Furniture, etc.**

3.3.1 **General**

These shall conform to drawings in all details. No unsightly nailmarks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.3.2 **Partition**

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.3.3 **Pelmets**

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.3.4 **Cupboard Shutters**

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.3.5 **Drawers**

Shall operate smoothly and have back stops to prevent them from being pushed too far. Locks shall engage securely.

3.3.6 **Loose Furniture**

When placed on a level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.0 **I.S. CODES**

Some of the important relevant Codes for the Section are:

IS:4021 - Timber door, window and ventilator frames.

IS: 1003 - Timber paneled and glazed shutters.

IS:2191 - Wooden flush door shutter (Cellular and hollow core type).

IS:2202 - Wooden flush door shutters (solid core type).

VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

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

SECTION - D

GENERAL TECHNICAL SPECIFICATION

ROOLING STEEL SHUTTERS/GRILS

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

	TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS/GRILLS	SPECIFICATION NO. PE-TS-412-600-C002 VOLUME - II B SECTION - D | SUB-SECTION – C16 REV.NO. 00 SHEET 2 OF 5

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TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS/GRILLS

1.0.0 SCOPE

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

2.0.0 INSTALLATION

2.1.0 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 2.25 mm thick for shutters 5.5 M wide and above, machine rolled at 75 mm rolling centres, 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 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm 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 in the Schedule.

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 or as specified in Schedule.

f) Shafts shall be of steel pipe of sufficient size to carry the torsion 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 described

in Schedule or as described by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall 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 drawing.

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.

j) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.2.0 **Manually Operated Shutters/Grills**

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 openings upto 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 described as desired by the Engineer.

2.3.0 **Power Operated Shutters/Grills**

These shall be operable from a push button station conveniently located beside the door or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for in Schedule, externally mounted shutters shall be operated by control mechanism located inside the building.

2.4.0 **Shop Coat**

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.

2.5.0 **Erection**

Door shall be installed by the manufacturer or his authorised 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 and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

3.0.0 ACCEPTANCE CRITERIA

3.1.0 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.

3.2.0 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.

3.3.0 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.

4.0.0 I.S. CODE

IS : 6248 - Metal rolling shutters and rolling grills.

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

SECTION - D

GENERAL TECHNICAL SPECIFICATION

MISCELLANEOUS METAL

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

	TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL	SPECIFICATION NO. PE-TS-412-600-C002 VOLUME - II B SECTION - D | SUB-SECTION – C17 REV.NO. 00 SHEET 2 OF 6

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TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL

1.0.0 SCOPE

This specification shall generally be read in conjunction with item nos. 6.01 & 6.03.

This shall include supply, fabrication and erection of miscellaneous metal items of light nature in gates, grills, balcony and stair handrails particulars, structural mullions and transoms, ladders hangers masonry anchors, shelf angles, anchor bolts, fasteners, etc. as shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast M.S/Aluminium/Brass, cast iron, M.S. and galvanised M.S. Sheets, aluminium sheets, expanded metal, wire mesh etc. as shown on drawings and/or described.

2.0.0 INSTALLATION

2.1.0 Fabrication/Casting

2.1.1 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.

2.1.2 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 the IS : 816. Use of metal arc welding for general construction in Mild Steel.

c) Welding of aluminium shall be done in 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.

2.1.3 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill/ scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. Steel work shall be galvanised or galvanized and painted with a coat of zinc chromate primer. Aluminium surfaces which shall come in contact with masonry shall be given one coat of zinc chromate primer.

2.2.0 **Erection**

2.2.1 **Bracing**

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected including erection of equipment and operation of the same.

2.2.2 **Temporary Bolting-Up**

As erection proceeds the Contractor shall plumb up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever piles of materials, erection equipment or other loads are carried during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.2.3 **Turned Bolt**

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.2.4 **Welding**

Where specified on drawings, welding shall be done in accordance with IS : 816 for steel and IS: 2812 for Aluminium and Alloys.

2.2.5 **Cutting and Fitting**

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings, holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

2.2.6 **Drifting**

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections. Reaming that weakens the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount or reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.2.7 **Grouting**

All bearing plates, loose lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1.5:3 or 1:1- 1/2:3 concrete with 6 mm down stone chips.

2.2.8 **Anchor Bolting**

When shown on drawings, the miscellaneous metal items shall be fixed to concrete by case hardened and drawn carbonizing steel expander nut and bolt. The Contractor shall submit the manufacturer's literature showing the average pull out and average shear values for bolts of various sizes. The bolts shall be fixed strictly as per the manufacturer's instructions.

2.2.9 **Pipe Joints**

M.S. Pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot jointed and caulked with hemp and molten lead.

2.2.10 **Spot Painting**

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials as used for the shop paint.

2.2.11 **Making Good**

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

3.0.0 **ACCEPTANCE CRITERIA**

a) All items shall be of correct shape, size, weight etc. shown on drawings.

b) For installed items, the tolerances shall be follows :

i) Permissible deviation from straightness - 1 in 1000.

ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.

c) All castings shall be free from blow holes, cracks and other blemishes.

4.0.0 **I.S. CODES**

IS : 226 - Structural Steel (Standard Quality)

IS:800 - Code of practice for use of structural steel in general building construction.

IS : 816 - Use of metal arc welding for general construction in mild steel.

IS : 2812 - Arc welding of Aluminium and Alloys

IS : 3150 - Hexagonal Wire Netting

IS : 4948 - Welded steel wire fabric for general use.

VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

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

SECTION - D

GENERAL TECHNICAL SPECIFICATION

ROOF WATER PROOFING, INSULATION AND ALLIED WORKS

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

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	TECHNICAL SPECIFICATION FOR ROOF WATER PROOFING, INSULATION AND ALLIED WORKS	SPECIFICATION NO. PE-TS-412-600-C002 VOLUME - II B SECTION - D | SUB-SECTION – C19 REV.NO. 00 SHEET 2 OF 7

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TECHNICAL SPECIFICATION FOR ROOF WATER PROOFING, INSULATION AND ALLIED WORKS

1.0.0 SCOPE

This specification covers furnishing, installation, repairing, finishing, curing, testing,, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract.

2.0.0 INSTALLATION

2.1.0 Grading Underbed

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete.

The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.1.1 The grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be throughly mixed dry and them water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.2.0 Concrete

The concrete shall be used where the subgrade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.
The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

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2.3.0 **Insulation**

The Tenderer shall along with the tender send specification of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thiner than 12mm and it shall be cured for seven days.

2.3.1 **Foam Concrete**

This shall be of light weight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m degree C. The weight of the insulating material shall be from 0.3 to 0.5 gm/cm.

Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to make the usual work load and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.3.2 **Expanded Polystyrene Blocks**

The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C. It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall have to secure manufacturer's supervision.

Either of above items (cl. No. 2.03.01 or 2.03.02) can be adopted subject to approval of engineer.

2. 4.0 **Fillets**

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Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

2.5.0 **Water proofing by epoxy resin based application**

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be throughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, light traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labours for the application.

2.6.0 **Flashing**

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer, instead of being finished with pea-sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.7.0 **Elastromeric Membrane**

2.7.1 **Primer Coat**

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with airless spray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 sq.m per litre depending on the surface porosity.

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The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by vigourous brushings, fungal growth with proprietary fungitide as recommended. Priming coat shall not be applied to damp substrate.

2.7.2 **Finishing Coats**

The finishing coats shall consist of two successive liquid coatings of high solid content urethane pre-polymers material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform jointless elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by atleast 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the suspension of approved authorized agency.

2.7.3 **Surface Finish**

Areas of roof treatment shall be provided with wearing course consisting of minimum 25 mm thick PCC 1:11/2:3(using 12.5 mm size aggregate) cast in panel of maximum size of 1.20 m x 1.20 m and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided. The tiles shall be laid as per IS 1443.

3.0.0 **ACCEPTANCE CRITERIA**

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and

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shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The Contractor shall give a guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water-proofing treatment work. The guarantee shall be for materials and workmanship for a period of minimum 10 years. The mode of execution of the guarantee shall be acceptable to the Owner.

4.0.0 **I.S. CODES AND STANDARDS**

a) IS:73 : Paving Bitumen

b) IS:702 : Industrial Bitumen

c) IS:1203 : Methods of testing tar and bitumen

d) IS:1322 : Bitumen felts for waterproofing and damp proofing

e) IS:1346 : Code of Practice for waterproofing of roofs with bitumen felts

f) IS:3384 : Bitumen primer for use in waterproofing and damp proofing.

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VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

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

SECTION - D

GENERAL TECHNICAL SPECIFICATION

ANTI-TERMITE TREATMENT

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

	TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT	SPECIFICATION NO. PE-TS-412-600-C002 VOLUME - II B SECTION - D | SUB-SECTION – C23 REV.NO. 00 SHEET 2 OF 5

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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 pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M^2 of surface area. Backfills around columns, walls etc. shall be

treated at the rate of 7.5 litres / M^2 of the vertical surface. 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.

2.02.02 **Treatment of Top Surface of Plinth Filling**

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^2 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.

2.02.03 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

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.

2.02.04 **Treatment of Expansion Joints**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.02.05 **Treatment at Junction of the Wall and the Floor**

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.
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.

3.00.00 **ACCEPTANCE CRITERIA**

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.

4.00.00 **RATES**

Rates shall be of complete work per unit area as stated in the Schedule.

5.00.00 METHOD OF MEASUREMENT

Complete work of anti-termite treatment shall be measured for plinth area treated.

This includes treatment, to foundations, walls, trenches, basements, plinth, burried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work.

6.00.00 I.S. CODE

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.

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CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

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

SECTION - D

GENERAL TECHNICAL SPECIFICATION

SITE LEVELING AND GRADING

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

	TECHNICAL SPECIFICATION FOR SITE LEVELING AND GRADING	SPECIFICATION NO. PE-TS-412-600-C002
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GENERAL TECHNICAL SPECIFICATION FOR SITE LEVELLING AND GRADING

1.00 GENERAL

This specification cover the works to be carried out for **"Site Levelling and Grading Works including Slope Protection"** etc for the entire plant and associated areas. The specified formation level(s) shall be achieved either by excavation or by raising with controlled fill with excavated/borrowed earth as the case may be.

2.00 SCOPE

2.01 The scope include all works involved in levelling the site to the lines, grades, cross sections and dimensions as shown on the approved drawings and/or as directed by the engineer including site clearance, setting out, earth work in excavation, stacking, loading, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus earth etc. It also include supplying and providing all labour, materials, supervision, services, equipments, tools and plants, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc.

2.02 All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof.

2.03 Work to be provided by the Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc required for the completion of the work.

b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

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.

2.04 Work to be provided by others

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

2.05 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise.

IS: 1200 Methods of measurement of building and civil engineering works, Part-1: 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 Code of practice for earthwork on canals

IS: 6922 Criteria for safety and design of structures subject to underground blasts

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 the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.

2.06 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

3.00 MATERIALS

All materials required for the work shall be of best variety and approved by the engineer.

3.01 Materials for Excavation

For the purpose of identifying the various strata met during the course of excavation, the following classification is to be followed.

a) Soil

It include all type of soil including laterite, moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under **clause** 3.01 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02 Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

a)Materials from swamps, marshes and bogs
b)Expansive clays
c)Peat, logs, sod and perishable materials
d)Materials susceptible to combustion
e)Any material or industrial and domestic produce which will adversely affect other materials of work
f)Materials from prohibited areas

The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with

the written permission of the engineer in the following 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 for as possible and the mixture shall then be used for filling. In case the earth required for filling 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. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm

layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire woods etc shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the 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 contractor at his own risk and cost shall rectify the same. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or 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. 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. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**

The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne

roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with 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.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to

transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.
The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be

present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

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.

5.03.04 Restrictions on Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as for as possible for ease of measurement. The materials heaped shall be utilised as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials

Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tonne roller. The approved earth/fill material shall then be spread in horizontal layers not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS:2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.

Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS:2720**,** part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate

of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, cross-sections and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and the sod shall be free of any

debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage.

The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be **roughned** and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance.

5.10 Approaches

The contractor shall provide proper approaches for workmen and inspection.

5.11 Lighting

Full scale lighting are 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 edges of excavations and fills.

6.00 RATES AND MEASUREMENTS

6.01 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 sections 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.

a) 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.

6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numericals 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 correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) 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.

d) 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 rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turfing, the measurement shall be made on the finished work in square meter.

BHARAT HEAVY ELECTRICALS LTD

STANDARD SPECIFICATION FOR GEOTECHNICAL INVESTIGATION

SPECIFICATION NO. PE-TS-999-603-002

JUNE, 2009

POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
PPEI BUILDING, PLOT NO. 25
SECTOR-16A
NOIDA (U.P.)-201301

STANDARD SPECIFICATION FOR GEOTECHNICAL INVESTIGATION

1.0 GENERAL

1.1 This specification covers the technical requirements for a detailed "geotechnical investigation and submission of a detailed geotechnical report". The detailed geotechnical investigation shall be carried out onshore to provide the designer with sufficiently accurate information both general and specific about the sub-strata profile and relevant soil and rock parameters at site on the basis of which the foundation for various structures and equipments of the power station can be designed rationally. Such structures would include main power house, chimney, boiler foundation, turbo-generator foundation, foundation for vibratory equipments, deep pits, reservoir, ash pond, pipe supports and all other related structures of the power station etc. The above list is indicative and not exhaustive. The range of load intensities from the various structures are expected to be between 50 kN/sqm and 500 kN/sqm.

2.0 SCOPE

2.1 The work shall include mobilization of all necessary equipments, providing necessary engineering supervision and technical personnel, skilled and unskilled labours, arranging water for drilling etc as required to carry out the entire field as well as laboratory investigation, analysis and interpretation of test data collected and preparation of a geotechnical report. The entire field as well as laboratory investigation work shall be supervised by a graduate/post graduate in civil engineering with atleast 5 years of site experience in respective areas of geotechnical investigation work. A geologist shall also be deputed at site during investigation whenever rock drilling is undertaken. The scheduling of laboratory tests, analysis and interpretation of test results, drafting of report and recommendations shall be carried out by a post graduate in geotechnical engineering with atleast 5 years of experience.

2.2 The contractor shall make his own arrangements for locating the co-ordinates and position of bore holes, trial pits and other field tests as per the drawings/sketches supplied to him and for determining the reduced levels at these locations with respect to a single bench mark indicated by the engineer-in-charge. Two established reference lines will be indicated to him. The contractor has to provide at the site all the required survey instruments to the satisfaction of the engineer-in-charge so that the work can be carried out accurately according to the specification and drawings.

2.3 All the field data shall be recorded in the proforma recommended in Indian Standard Codes and the field records shall be countersigned by the engineer-in-charge. The contractor shall submit two copies of the field borelogs to the engineer-in-charge soon after the completion of each bore hole. All the investigations are to be carried out by the contractor as per the priority requirements of the engineer-in-charge.

2.4 The contractor shall intimate the engineer-in-charge giving reasons if any additional specific tests he consider necessary to be carried out duly considering local sub-soil conditions. In case the proposal for conducting additional specific tests is approved by the engineer-in-charge then same shall also be carried out.

2.5 Whenever the contractor is unable to extract undisturbed samples he should immediately inform the engineer-in-charge. In such a case payment for boring charges shall be subject to the engineer-in-charge being satisfied that adequate effort has been made to extract undisturbed samples.

2.6 All the laboratory test data shall be recorded in the proforma recommended in the Indian Standard Codes and a copy of the se shall be sent to the engineer-in-charge every week during the progress of laboratory testing. Whenever desired during the progress of work the owner/engineer-in-charge may be present at the laboratory where the contractor is arranging for execution of the laboratory tests.

2.7 The contractor shall interact with the engineer-in-charge to get acquainted with the different type of structures envisaged and in assessing the load intensities on the foundation for the various structures of the power project in order to enable him/her to make

specific recommendation for t he depth & type of foundation and the allowable bearing pressure. The contractor shall subm it detailed geotechnical report after incorpora ting the comments (if any) on the draft report.

2.8 The "Standard Specification for Geotechnical Investig ation" shall be read in conjunction with the docu ment titled "Sche dule of Quantities for Geotechnical Investigation" and amendments (if any) which shall be furnished specific project wise separately.

3.0 TENDER DRAWING

3.1 A tender drawing titled "V icinity Map" or "Plot Plan" or "Geotechnical Investigation Layout" indicating the study area/tentative location of the bore holes and field test s/areas to be investigated for locating the project shall be furnished specific project wise separately. The location, extent and depth of bore holes and field tests/area(s) indicated in the drawi ng are subject to change that may be necessary during actual execution of the work. No clai m whatsoever shall be entertained fo r differences between the location, extent and depth/area(s) etc of tests indicated on the construction drawings and those shown on the te nder drawings. The work shall be carried out as per the instructions of the engineer-in-charge.

3.2 The bidder must visit the site pr ior to submitting his/her quotations to acquaint himself/herself fully with the nature, type, scope of work and invol vement therein. The rate s quot ed shall remain firm during the entire period of execution till com pletion of the work and any additional claim for lack of knowledge shall not be entertained.

4.0 GENERAL REQUIREMENTS

4.1 In areas which have already been developed, the contractor shall take advantage of existing local knowledge , record of tri al pits, bore holes etc in the vicinity and the type of foundations adopt ed and behaviour of existing structures particularly those of sim ilar n ature to the ones proposed for this project.

4.2 The contractor shall make use of information gathered from quarries, unlined wells, cuttings from nearby areas et c. The general

topography of the near by areas w ill often give some indication about the variation of the soil conditions which are likely to exist.

4.3 The contractor shall gather data regarding the rem oval of overburden by excavation, erosion or land slides in the areas which m ay give an idea of the am ount of reconsolid ation that the soil strata h as undergone. Sim ilarly data regarding recent fills shall also be studied to determine the characteristics of the fill as well as the original strata.

4.4 The water level in streams a nd water courses if any in the neighbourhood shall be noted. Reliable information regarding ground water level shall also be gathered fro m water lev el in the near by wells.

4.5 The contractor shall m ake enquiri es and verify regarding earlier use of the site which can have im portant bearing on its suitability for the proposed structures. This is im portant particularly in areas where there have been underground works e.g. worked out ba llast pits, quarries, old brick fields, m ines, mineral workings etc. The possibility of damage to the struct ures, sewers, conduits and drainage system by subsidence shall also be investigated.

4.6 It is essential that the equipm ents/instruments are properly calibrated at the co mmencement of the work so that they represent true values and submit the test reports to the engineer-in-charge. If the engineer-in-charge so desires, the contr actor shall arrange for having the instruments te sted i n presenc e of the engineer at an approved laboratory at the contractor's cost and the test reports shall be submitted to the engineer-in-charge.

4.7 When blasting with explosives is involved, agency/contractor shall arrange st atutory clearan ces and also the portable m agazine for storing/carrying the explosives.

5.0 CODES AND STANDARDS

5 .1 All standards, specification and codes of practice re ferred to herein shall be the latest editions in cluding all applicable offici al amendments and revisions.

5.2 In case of conflict between this specification and those (IS codes and standards etc) referred to herein, the former shall prevail.

5.3 All work shall be carried out as per the specification and the following standards and codes.

IS: 1080 Code of practice for design and construction of simple spread foundations

IS: 1498 Classification and identification of soils for general engineering purposes

IS: 1888 Method of load test on soils

IS: 1892 Code of practice for subsurface Investigation for foundation

IS: 1904 Code of practice for design and construction of foundations in soils: General requirements

IS: 2131 Method of standard penetration test for soils

IS: 2132 Code of practice for thin walled tube sampling of soils

IS: 2470 Part-I Code of practice for design and construction of septic tanks

IS: 2720 Method of test for soils (Relevant parts)

IS: 2809 Glossary of terms and symbols relating to soil engineering

IS: 2810 Glossary of terms relating to soil dynamics

IS: 2911 Code of practice for design and construction of pile foundations (Relevant parts)

IS: 2950 Part- I Code of practice for design and construction of raft foundation

IS: 3025 Methods of sampling and testing (Physical and chemical) for water used in Industry

IS: 3043 Code of practice for earthing

IS: 4078 Code of practice for indexing and storage of drill cores

IS: 4434 Code of practice for in-situ vane shear test for soils

IS: 4453 Code of practice for explor ation by pits, trenches, drifts and shafts

IS: 4464 Code of practice for presentation of drilling information and core description in foundation investigation

IS: 4968 Part -II Method for subsurface sounding for soils- Dynamic method using cone and bentonite slurry

IS: 4968 Part-III Method for subs urface sounding for soils-Static cone penetration test

IS: 5249 Method of test for determ ination of in-situ dynam ic properties of soil

IS: 5313 Guide for core drilling observations

IS: 5529 Part-I Code of prac tice for in-situ permeability test – Test in overburden

IS: 5529 Part-II Code of practice for in-situ permeability test - Test in bed rock

IS: 6065 Recommendation for the preparation of geological and geotechnical maps for river valley project

IS: 6403 Code of practice for dete rmination of allowable bearing pressure on shallow foundation

IS: 6926 Code of practice for diamond core drilling f or site investigation of river valley projects

IS: 6935 Method of determination of water level in a bore hole

IS: 6955 Code of practice of subs urface explorati on for earth and rockfill dams

IS: 7422 Symbols and abbreviations for use in geological m aps, sections and subsurface exploratory logs (Relevant parts)

IS: 8009 Part-I Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads - Shallow foundations

IS: 8009 Part-II Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads – Deep foundations

IS: 8763 Guide for undisturbed sampling of sands

IS: 8764 Method for determination of point load strength index of rocks

IS: 9143 Method for the determination of unconfined compressive strength of rock materials

IS: 9179 Method for preparation of roc k specimen for laboratory testing

IS: 9198 Compaction rammer for soil testing

IS: 9214 Determination of modulus of sub-grade reaction in field

IS: 9259 Specifications for liquid limit apparatus

IS: 9640 Specifications for split spoon sampler

IS: 9669 Specifications for CBR mould and its accessories

IS: 10050 Method for determination of slake durability index of rocks

IS: 10060 Code of practice for subsurface investigation for power house sites

IS: 10074 Specification for compaction mould assembly for light and heavy compaction

IS: 10108 Code of practice for sampling by thin wall sampler with stationary piston

IS: 10589 Equipment for determination of subsurface sounding of soils

IS: 10837 Specifications of moulds for determination of relative density and its accessories

IS: 11229 Specifications for shear box testing of soils

IS: 11315 Part-II Description of discontinuities in rock mass - Core recovery and rock quality

IS: 12070 Code of practice for design and construction of shallow foundations on rocks

IS:13372 (Part I & II) Seismic testing of rock mass – Code of practice

6.0 FIELD INVESTIGATION - SOIL

6.1 Boring

6.1.1 General Requirements

a) Bore holes shall be drilled at specified locations to obtain information about the sub-soil profile, its nature, strength and to collect soil samples for strata identification and conducting laboratory tests. The minimum diameter of the bore hole shall be 150 mm and boring shall be carried out in accordance with the provisions of IS: 1892 and as per this specification.

b) All bore holes shall extend up to the depths shown on the construction drawings or as directed by the engineer-in-charge. If the strata with standard penetration test (SPT) 'N' value greater than 100 with characteristics of rock is met with earlier, the bore hole shall be advanced further by chiselling. Chiselling shall be continued for a maximum depth of 20cm or upto 2 hours whichever is earlier. During chiselling rock fragments/ rock cores shall be collected. Identification of rock strata shall be on the basis of visual examination of SPT sample and rock fragments. After it is established that rock is met with, the borehole shall be advanced further by drilling in rock as specified in Clause-7.0 and cores shall be collected. When the bore hole is terminated in soil strata, an additional standard penetration test shall be carried out at the termination depth.

c) Casing pipe shall be used in the borehole to support its sides when side fall is suspected to occur inside the borehole. When casing pipe is used, it shall be ensured that its bottom end is at all times 15 cm above the bottom of the bore hole. In case of cohesionless soils the advancement of the casing pipe shall be such that it does not disturb the soil to be tested or sampled. The casing shall be advanced by slowly turning the casing pipe and not by driving.

d) In-situ tests and collection of undisturbed samples (UDS) shall be carried out at regular intervals and at change of strata or as decided by the engineer-in-charge. Representative disturbed and undisturbed samples shall be preserved for conducting various tests in the laboratory. Water table in the bore hole shall be carefully recorded and reported. No water/drilling mud shall be added while boring above ground water table. For cohesionless soil below water table, the water level in the borehole shall all times be maintained at slightly above the water table.

e) The bore hole shall be cleaned using suitable tools up to the depth of testing or sampling ensuring that there is minimum disturbance of soil at the bottom of the bore hole. The process of jetting through an open tube sampler shall not be permitted. In cohesive soils, the borehole may be cleaned using a bailer with a flap valve. Gentle circulation of drilling fluid shall be done when rotary mud circulation boring is adopted.

f) On co mpletion of the borehole, the portion drille d in soil shall be backfilled with sand unless o therwise specified and as directed by the engineer-in-charge.

g) Wash boring shall not be adopted.

6.1 .2 Auger Boring

Auger boring can be adopted in soft t o stiff cohesive soils above water table. Augers shall be of helical or post hol e type which may be manually or power operated. Wh ile boring care shall be taken to minimise the disturbance to the deposits below the bottom of the borehole. The cuttings brought up by t he auger shall be carefully examined in the field and the description of all the strata shall be duly recorded in the field borelog as pe r IS:1498. No w ater shall be used while auger boring.

6.1.3 Shell and Auger Boring

Shell and Auger boring can be used in all types of soil free fro m boulders. For cohesionless soil belo w ground water table, the water level in the bore hole shall always be m aintained at or above the ground water level. The use of chis el bit shall be perm itted in hard strata with SPT 'N' value greater th an 100. Chisel b its may also be used to extend the borehole t hrough local obstruction such as old construction, boulders, rocky form ations etc. All other requirements in clause 6.1.2 shall apply for this type of boring also.

6.1.4 Percussion Drilling

This method can be adopted in soil with gravel and boulders when the boring has to be done at a faster rate. This me thod consists of breaking of the strata by repeated blows fro m a chisel or drilling bit and bailing out the debris at interv als by adding water into the bore hole. This method is not suitabl e for careful and very reliable sampling operation becau se of the disturbance cau sed during boring. This method shall not be adopted unless otherwise specified or permitted by the engineer-in-charge.

6.1.5 Rotary Mud Circulation Drilling

This method can be used in all types of soil below water table. In this method boring shall be done by rotating the bit fixed at the bottom of the drill rod. Proper care shall be taken to keep a firm contact between the bit and the bottom of the borehole. Bentonite or mud laden fluids shall be used as the drilling fluid to serve as the protective surface inside the borehole.

6.2 Standard Penetration Test (SPT)

This test shall be conducted in all types of soil deposits met within the bore hole to find the variation in the soil stratification by correlating with the number of blows required for unit penetration of a standard penetrometer. This test shall be conducted at every 1m interval alternate to collection of UDS upto 10m depth below ground level and at every 1.5m interval alternate to collection of UDS beyond 10m depth, at every change of strata, at depths wherever undisturbed soil samples could not be collected and as per the directions of the engineer-in-charge. The starting depth of performing SPT shall be 1m below ground level unless otherwise specified. The depth interval between the top level of standard penetration test and to that of (next) undisturbed sampling shall not be less than 1m. The specification for equipments and other accessories, procedure for conducting the test, presentation of test results and collection of disturbed soil samples etc shall conform to IS: 2131.

This test shall be carried out by driving a standard split spoon sampler in the borehole by means of a 63.5 kg hammer having a free fall of 0.75m. The sampler shall be driven using the hammer for 450 mm penetration. While driving, the number of blows for every 150 mm penetration and the penetration for every 50 blows shall be recorded. The number of blows for the last 300 mm drive shall be reported as 'N' value. This test shall be discontinued when the blow count is equal to 100 and the penetration shall be recorded. Refusal shall be considered to be met with when the blow count is equal to 100. At the location where the test is discontinued, the penetration and the corresponding number of blows shall be reported. Sufficient quantity of disturbed soil samples shall be collected from the split spoon

sampler for identification and laboratory testing. The samples shall be visually classified & recorded at the site and shall be properly preserved and labelled for future identification & testing.

6.3 Sampling

6.3.1 General

a) Sufficient number of soil samples shall be collected for reliable estimation of soil properties. The samples collected shall be either disturbed or undisturbed. Disturbed soil samples shall be collected for field identification and conducting laboratory tests such as sieve analysis, index properties, specific gravity, chemical analysis etc. Undisturbed samples shall be collected to estimate physical, strength and settlement properties of the soil.

b) All the accessories required for sampling and the method of sampling shall conform to IS: 2132. All disturbed and undisturbed samples collected in the field shall be classified at site as per IS: 1498.

c) All the samples shall be identified with date, bore hole or trial pit number, depth of sampling etc. It is also essential to mark an arrow pointing towards the top surface of the undisturbed sample as the soil was in-situ. Care shall be taken to keep the undisturbed soil samples and box samples vertically with the arrow directing upwards. The tube samples shall be properly trimmed at both ends and suitably sealed with molten paraffin wax at both ends immediately after extracting the samples from the bore hole/trial pit and suitably capped on both sides.

d) When the contractor fails to collect undisturbed soil sample at a specified depth, the borehole shall be advanced by 0.50m and shall be performed with a standard penetration test. The reason for not obtaining the undisturbed soil sample shall be indicated in the borelog.

e) Precaution shall be taken to ensure that there shall not be any change in moisture content and disturbance of the soil samples and they shall be placed in a temporary store at the end of the day's work.

All the samples shall be kept over a bed of sand, jute bags, saw dust etc and covered over the top with similar material. The bed and top cover shall be kept moist till they are properly packed in wooden boxes. The contractor shall be responsible for packing and transporting of all the samples from site to the laboratory within seven days after sampling with proper protection against loss and damage.

f) All the samples shall be suitably packed in wooden boxes using sand, saw dust etc all around the samples before transporting to the laboratory for testing.

6.3.2 Disturbed Samples

a) Disturbed soil samples shall be collected from cuttings and from split spoon sampler in boreholes at regular intervals to provide complete description of soil profile and its variation. The samples shall be immediately stored in air tight jars or polythene bags and labelled with borehole/trial pit number and depth.

b) In elevated areas, if superficial material is available in plenty, then bulk samples from a depth of about 0.5m below ground level shall be collected to establish all required properties to use it as a fill material. Disturbed samples weighing about 250N shall be collected at shallow depths and immediately stored in polythene bags as per IS: 1892. The bags shall be sealed properly and shall be kept in wooden boxes.

6.3.3 Undisturbed Samples

In each borehole UDS shall be collected at regular interval of 1m alternate to conducting SPT upto 10m depth below ground level and at every 1.5m interval alternate to conducting SPT beyond 10m depth and as directed by the engineer-in-charge. The starting depth of collecting UDS shall be 2m below ground level unless otherwise specified and as directed by the engineer-in-charge. Undisturbed samples shall be of 100mm diameter and 450mm length. Samples shall be collected in such a manner that the structure of soil and its moisture content do not get altered. The specification for the accessories required for sampling and the sampling procedure shall

conform to IS:1892 and IS:2132. Undisturbed sampling in sand shall be done using com pressed air technique as men tioned in IS:8763. Thin walled sam pler shall be used to collect undisturbed sam ples by pushing the tube into the soil. The sampling tube shall have a smooth finish on both surfaces and m inimum effective length of 450mm . The area ratio of sam pling tubes sh all be less than 12.5% . However in case of very stiff soils area ratio upto 20% shall be permitted.

a) Undisturbed Sampling in Cohesive Soil

Undisturbed sam ples in soft to stif f cohesive soils shall be obtained using a thin walled sampler. In order to reduce wall friction, suitable precautions such as oiling the surface s shall be tak en. The bore hole shall be cl eaned and the depth of sampling below ground level shall be noted. The sampl er shall then be attached to the bottom of boring rods and lowered into the borehole. The sampler sh all be pushed into the clay layer by hand or by jack ing and soil sam ple of specified length shall be collected without disturbi ng the soil. The distance by which the sampler penetrates into the soil strata shall be check ed. Care shall be taken to ensure that th e sampler is not dri ven too far as this will com press the soil. The sam pler shall be rotated to break the core at bottom of the sampler and then steadily drawn up.

b) Undisturbed Sampling using Piston Sampler

Undisturbed samples in very loose saturated sandy & silty soils and very soft clays shall be obtained by using a piston s ampler consisting of a sampling cylinder and piston system. In soft clays and silty clays with water standing in the casing pipe, piston sampler shall be used to collect undisturbed samples. Duri ng this method of sam pling expert supervision is called for.

The interior surface of the sampler shall be sm ooth, clean and corrosion resi stant. Its cutting e dge and the ri ng seals shall be inspected for wear and rejected if worn. Ch eck shall be done to ensure that the m oving parts of th e sampler function freely before the sampler is lowered into the borehol e. While pushing the sy stem into the soil and till the beginning of the sampling operations, the bottom of the piston shall be flushed with th e cutting edge of the sampler. At the depth of sam pling, the piston should be fixed relative to t he

ground and the sampler cylinder shall be independently pressed down smoothly and continuously into the ground. If an obstruction is met, the sampler shall be withdrawn and another sample be taken after the obstruction is removed.

Accurate measurements of the depth of sampling, height of sampler, stroke and length of sample recovery shall be noted and recorded. After the sampler is pushed to the required depth, both the sampler cylinder and the piston system shall be drawn up together ensuring that there shall not be any disturbance to the sample which shall then be protected from changes in moisture content.

c) Undisturbed Sampling in Cohesionless Soils

Undisturbed samples in cohesionless soils shall be obtained as per the procedure given in IS:8763. Compressed air sampler shall be used to take the samples of cohesionless soil below water table. Precautions shall be taken to clean the borehole before sampling. Thin walled tube samplers of 60mm internal diameter shall be used. The height and other dimensions of the sampler shall be recorded before use. Proper care shall be taken to maintain the water level in the bore hole slightly above the ground water table before and during sampling operations. Immediately after the sample is obtained, the ends of the sample shall be waxed and capped to avoid moisture content changes.

6.3.4 Relaxation During Sampling

a) The sampler shall be pushed into the soil and driving of sampler shall be resorted to only when it cannot be pushed into the soil. This shall be done only with the permission of the engineer-in-charge and all the details about the same shall be recorded in the bore logs.

b) In clays when 'N' value is greater than 50, the undisturbed sampling may be replaced by standard penetration test.

6.4 Ground Water

6.4.1 One of the following methods shall be adopted for determining the ground water table in bore holes as per IS:6935 and as per the instructions of the engineer-in-charge.

a) In permeable soils, the water level in borehole shall be allowed to stabilize after lowering it adequately by bailing. When water level inside the borehole is found to be stable, the depth of water level below ground level shall be measured. Stability of sides and bottom of the borehole shall be ensured at all times.

b) For both permeable and impermeable soils, the following method shall be suitable. The borehole shall be filled with water and then bailed out to various depths. Observation on the rise or fall of water level shall be made at each depth. The level at which neither a fall nor a rise is observed shall be considered as the water table elevation. This shall be established by three successive readings of water level taken at an interval of two hours.

6.4.2 In case any variation in the ground water level is observed in any specific boreholes then the water level in these bore holes shall be recorded daily during the course of field investigation. Levels in nearby wells, streams etc if any shall also be noted whenever these readings are taken. If so called for, observation wells shall be drilled for the purpose of long term studies on the fluctuation in ground water levels and pressure. Either stand pipe or piezometer shall be installed at the specified depths in the selected previously drilled bore holes or specially drilled bore holes for this purpose as per the specification and instructions of the engineer-in-charge. Daily water level readings shall be recorded immediately following the installation upto the time of leaving the site. At the end of field work, these installations shall be handed over in satisfactory working condition to the engineer-in-charge without disturbing their position so that the owner can continue further observations.

6.4.3 Stand pipes and piezometers shall consist of 19mm internal diameter rigid unplasticised (UPVC) tubing. All the joints in the tubing shall be made of coupling sleeves. The top of UPVC tubing shall be enclosed in a 75mm diameter galvanised steel pipe of 1.5m length

having a galvanised steel screw cap with well greased threads and the caps shall be tightened such that it would be impossible to loosen by hand. The lower end of the pipe shall have four legs of 6mm thick and 100mm long and welded to have projection of 25mm . The pipe shall be sealed into the ground with cement grout so that it does not rotate. The top end of the pipe shall project about 300mm above ground level unless otherwise specified by the engineer-in-charge. The perforated tubing for the porous element shall be surrounded by a response zone of well graded sand from 500mm below to 150mm above the lower end of the stand pipe or piezometer and the bore hole above the response zone shall be back filled with natural soil or well graded sand.

a) Stand pipe

Stand pipes shall be installed to measure the water level in soils with high permeability such as sand and gravel. The stand pipe shall consist of a perforated tubing attached to the bottom of the UPVC tubing. The perforated tube shall be 150mm long having perforations of diameter not greater than 1mm.

b) Piezometers

Piezometers shall be installed to measure the pore pressures in soil with medium to low permeability. Piezo meter shall consist of a porous filter attached to the bottom of the UPVC tubing. The filter shall be 300mm in length and shall be placed in the bore hole and sealed at top and bottom by grouting. Hydraulic piezometers with double line are to be used to remove the air trapped in the system.

6.4.4 Sub-Soil Water Samples

a) Sub-soil water samples shall be collected for carrying out chemical analysis. Representative samples of ground water shall be collected when it is first encountered in bore holes before the addition of water to aid boring or drilling. Water samples shall not be collected when bentonite slurry or mud has been used for drilling operations. If water has been added for drilling purposes or if ground water has been diluted by surface rain water then the bore hole shall be

dewatered and wate r be allowed to rise from which the sample may be taken.

b) The sampling apparatus shall be such that the water at the desired depth can be collected directly without any disturbance and any change in concentration of c onstituents like dissolved gases etc . Undue agitation shall be avoided. An ordinary suction pump with its suction end inserted upto t he required depth in the borehole shall be used for this purpose.

c) The sample shall be collected in a clean vessel and allowed to settle so that the supernatural liqui d can be poured into a clean well rinsed glass or polythene bottl e. Sufficient quantity and num ber of samples shall be collected to carry out the chemical analysis and sent to a laboratory in airtight bot tles with proper labelling. Chem ical analysis o f water sam ples sh all in clude determ ination of pH value, turbidity, sulphate, carbonate, nitrate & chloride contents, presence of organic matter and suspended solids etc.

d) In some cases constituents may be m ixed and analysed later as specified in the specific test methods. Chemical preservatives may be added to the sample for cases as specified in the test method/IS codes. This shall only be done if analysis cannot be conducted within an hour of collection and shall have the prior written perm ission and approval of the engineer-in-charge.

6.5 In-situ Permeability Test

6.5.1 In-situ permeability test shall be conducted to determ ine the water percolation capacity of overburden soil. This test shall be perform ed inside the bore hole/trial pit at specif ied depths or in each layer or as per the directions of th e engineer-in-charge. The type of test shall be either pump-in or pump-out test depending on the subsoil and ground water conditions. Pum p-in test shall be conducted whether ground water in borehole exists or not. Pu mp-out test shall be conducted to obtain data for dewatering purposes when ground water is met in the borehole. The specification for e quipments required for t he test and the procedure of testing shall be in accordance with IS: 5529, Part-1. When it is required to carry out the permeability test for a p articular section of the soil strata above ground water ta ble, bentonite slurry shall not be used while boring.

6.5.2 Pump-in-Test

Pump-in test shall be conducted in the bore hole/trial pit by allowing water to percolate into the soil. Choice of the method of testing shall depend on the soil permeability and prevailing ground water level.

Only clear water shall be used for conducting the test. Before conducting the test, the borehole shall be cleaned as specified in clause 6.1.1 (e). Water shall be allowed to percolate through the test section for sufficient period of time to saturate the soil before starting the observation.

a) Constant Head Method (In Bore Hole)

This test shall be conducted in boreholes where soil has a high permeability. Water shall be allowed into the borehole through a metering system ensuring gravity flow at constant head so as to maintain a steady water level in the borehole. A reference mark shall be made at a convenient level which can be easily seen in the casing pipe to note down the fluctuations of water level. The fluctuations shall be counteracted by varying the quantity of water flowing into the borehole. The elevation of water shall be observed at every 5 minute interval. When three consecutive readings show constant value, the necessary observations such as flow rate, elevation of water surface above test depth, diameter of casing pipe etc shall be made and recorded as per the proforma recommended in IS: 5529, Part-1, Appendix-A.

b) Falling Head Method (In Bore Hole)

This method shall be adopted for soils of low permeability and which can stand without casing. The test section shall be sealed at the bottom of the borehole and a packer at the top of the test section. If the test has to be conducted at an intermediate section of a pre-bored hole then double packers shall be used. Access to the test section through the packer shall be by means of a pipe which shall extend above the ground level. Water shall be filled in to the pipe upto the level marked just below the top of the pipe and water be allowed to drain into the test section. The water level in the pipe shall be

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recorded at regular intervals as mentioned in IS: 5529, Part-1, Appendix-B. The test shall be repeated till constant records of water level are achieved.

c) Percolation Test (In Trial Pit)

Percolation test shall be conducted in trial pit in areas where water/effluent is stored/discharged in ground level tanks. The loss of water due to percolation into the soil shall be estimated by the soil absorption capacity.

6.5.3 Pump-Out Test

This test shall be carried out at site to determine the co-efficient of permeability of soil below water table. This test shall be conducted by continuous pumping out of water from a well so as to maintain a steady water level at the desired depth in the well. The fluctuations in the water level shall be counteracted by varying the quantity of water pumped out of the well. The specification for the equipments & accessories required for performing the test, the procedure of testing, field observations and reporting of results shall conform to IS: 5529, Part-1. The well shall be of 400mm in diameter to be installed with a 250mm diameter perforated GI/MS pipe. Observation pipes of 50mm diameter shall be installed at regular intervals along three radial lines extending from the well at 120 degrees to each other. Length of these pipes shall depend upon the ground level, estimated depth of lowering the ground water and the distance from the well. Sufficient number of observation pipes shall be installed along each of the radial lines so as to assess the zones of influence due to dewatering. Draw down depth in the well shall be as specified in the drawing.

6.6 TRIAL PIT

6.6.1 Trial pits shall be of 3m x 3m size so as to permit easy access for visual examination of walls of the pit and to facilitate sampling and in-situ testing operations. Pits shall be excavated upto a maximum depth of 4m below ground level or as per the directions of the engineer-in-charge. Precautions shall be taken to ensure the stability of pit walls including provision of shoring if necessary as per IS:

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4453. Precautions shall be taken to prevent surface water draining into the pit. Arrangements shall be made for dewatering if the pit is extended below water table. Trial p its shall be kept dry and a ladder shall be provided for eas y access to the bott om of the pit. ln-s itu tests shall be conducted and undist urbed samples shall be collected immediately on reaching the speci fied depth so as to avoid substantial changes in moisture content of the subsoil. Arrangements shall be made for barriers, pr otective measures and lighting necessary for the period the pits remain open.

6.6.2 A note on the visual exam ination of soil strata sh all be prepared. This should include the nature, colour, consistency and visual classification of the soil, thickne ss o f soil strata, thickness o f expansive soil & ground water table if any etc.

6.6.3 Undisturbed samples shall be co llected at 1 m, 2 m, 3 m depth and at the termination depth in all the pits.

a) Chunk Samples

In cohesive soils, undisturbed sam ples of regular shapes shall be collected. The samp les shall be cut and trimmed to a size of 0.3m x 0.3m x 0.3m. A square area of 0.35m x 0.35m shall be marked at the centre o f the levelled surface at the bottom o f th e pit. Without disturbing the soil inside the ma rked area, the soil around this marking shall be carefully remove d upto a depth of 0.35m . The four vertical faces of the soil block protruding at the centre shall be trimmed slowly so that its size reduces to 0.3m x 0.3m. Wax paper cut to suitable size shall be wrapped uniformly and covered with two layers of thin cloth over all the five exposed surfaces of the soil block and sealed properly using m olten wax. A firm ly constructed wooden box of size 0.35m x 0.35m x 0.35m (internal dimensions) with the t op and bottom open shall be placed around t he soil bloc k and held such that its top edge protrudes just above the surface of the block. The space between the soil block and the box shall be filled uniformly and tightly with moist saw dust. The top surface shall also be covered with saw dust before na iling the wooden lid to c over the box firmly taking care that the soil block is not disturbed. The area of contact between the bottom portio n of the block and the ground shall be reduced slowly by re moving soil in small quantities using

small rods so that the block can be separated from the ground slowly without disturbance. After inverting the wooden box along with the soil block, the bottom portion shall be trimmed and covered with wax paper, cloth and to be sealed with molten wax. A wooden lid shall be nailed to the box after providing proper saw dust cushion below it. An arrow mark shall be made on the vertical face of the wooden box to indicate the top surface of the sample along with the location, date and depth of sampling.

b) Tube Samples

Undisturbed tube samples may also be obtained by means of 100mm diameter sampling tubes with a cutting edge. The sampler shall be slightly oiled or greased inside and outside to reduce friction. The sampler shall be pushed into the soil and while doing so soil around the tube shall be carefully removed. In case it is not possible to push the sampler it may be driven by light blows from a "monkey".

6.6.4 In case it is not possible to collect undisturbed samples in the pit, in-situ density of soil shall be determined by sand replacement method. The specification, equipments, accessories etc required for the test and the procedure of testing shall be in accordance with IS: 2720, Part-XXVIII. No separate payment shall be made for this test.

6.6.5 After the completion of the test, sampling and visual examination, the pit shall be suitably backfilled as directed by the engineer-in-charge. Unless otherwise specified excavated soil shall be used for this purpose.

6.7 Vane Shear Test

Field vane shear test shall be performed inside the borehole to determine the shear strength of cohesive soils, especially of soft and sensitive clays which are highly susceptible to sampling disturbance. This test shall be conducted by advancing a four winged vane of suitable size (75mm or 100mm diameter as per the soil condition) into the soil upto desired depth and measuring the torque required to rotate the vane. The specification for equipments & accessories required, the test procedure and field observations etc shall be as per IS: 4434. This test may also be conducted by direct penetration from

the ground surface. If the cuttings at the test depth in the bore hole show any presence of gravel, sand, shells, decomposed wood etc which are likely to influence the test results substantially, the test at that particular depth may be omitted with the permission of the engineer-in-charge. However the test shall be conducted at a depth where these obstructions cease to occur. On completion of the test the results shall be reported in an approved proforma as specified in IS: 4434, Appendix-A.

6.8 Static Cone Penetration Test

Static cone penetration test shall be conducted to know the soil stratification and to estimate the various physical and engineering properties of soil. The cone penetrometer shall be advanced by pushing and the static force required for unit penetration shall be determined. The test shall be conducted using a 200kN capacity mechanically operated equipment upto the specified depth or refusal whichever is earlier. For this test, 'refusal' means meeting a very hard strata which cannot be penetrated at the rate of at least 0.3cm/sec even when the equipment is loaded to its full capacity. The specification for the equipment and accessories required for performing the test, test procedure, field observation and reporting of results shall conform to IS : 4968, Part-III. At the ground level, preboring upto 0.5m depth shall be permitted if the overlying strata is very hard. No extra payment shall be made on account of this preboring. Continuous record of the penetration resistance shall be maintained.

6.9 Dynamic Cone Penetration Test

Dynamic cone penetration test shall be conducted using bentonite slurry by driving a standard size cone attached to the bottom of a string of drill rods. The test shall be conducted upto the specified depth or refusal whichever is earlier. Refusal shall be considered when the blow count exceeds 150 for 300mm penetration. The specification for the equipment and accessories required for performing the test, test procedure, field observations and reporting of results shall conform to IS:4968, Part-II. The driving system shall comprise of a 65 kg weight having a free fall of 0.75m. The cone

shall be of 65mm diameter provided with vents for continuous flow of bentonite slurry through the cone and rods in order to avoid friction between the rods and soil. On completion of the test, the results shall be presented as a continuous record of number of blows required for every 300mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot.

6.10 Plate Load Test

6.10.1 Plate load test shall be conducted to determine the bearing capacity and load/settlement characteristics of soil at shallow depth by loading a plane and levelled steel plate kept at the desired depth and measuring the settlement under different loads until a desired settlement takes place or failure occurs. The specification for equipment and accessories required for conducting the test, the test procedure, field observations and reporting of results etc shall conform to IS: 1888. The location and depth of the test shall be as given in the drawing or as indicated by the engineer-in-charge. Undisturbed tube samples as specified in clause 6.6.3 (b) shall be collected at 1m and 2.5m depths from the ground level for carrying out laboratory tests.

6.10.2 The size of pit shall not be less than five times the plate size and the depth shall be as specified. All provisions regarding excavation and visual examination of pit under clause 6.6.1 and 6.6.2 shall apply here also.

6.10.3 If the ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. Dewatering shall be at the cost of the contractor.

6.10.4 Unless otherwise specified the reaction method of loading shall be adopted. Settlement shall be recorded from dial gauges placed at four diametrically opposite ends of the test plate. The test plate shall be of 600mm x 600mm size and atleast 25mm thick. The bottom of the pit shall be levelled before placing the plate in position for conducting the test.

6.10.5 A seating load of 7kN/sqm shall be applied and after the dial gauge readings are stabilized, the load shall be released and the initial readings of the dial gauges be recorded after they indicate constant reading. The load shall be increased in stages. These stages shall be 20, 40, 70, 100, 150, 200, 250, 300, 400, 500, 600 and 800kN per sqm or as directed by the engineer-in-charge. Under each loading stage, record of 'time vs settlement' shall be kept as specified in IS:1888.

6.10.6 In case of cohesive soils, each load increment shall be maintained until the settlement is less than 0.02mm/minute or 6 hours whichever is later. Dial gauge readings for settlement shall generally be taken at 1, 2.25, 4, 6.25, 9, 16, 25, 60, 90 and 120 minutes from the start of each stage of loading. Thereafter the readings shall be taken at hourly interval upto a further 4 hours and at two hours interval thereafter for another 6 hours.

6.10.7 Other than cohesive soils (for all other type of soils), each stage loading shall be maintained for a minimum duration of one hour or till the settlement rate reduces to 0. 02mm/minute whichever is later. No extrapolation of settlement rate from periods less than one hour shall be permitted. The final loading shall be maintained for 24 hours. During unloading, reading of dial gauge shall be recorded for each stage of unloading.

6.10.8 Loading shall be carried out in stages as specified above till one of the following conditions occur.

a) Failure of soil under the plate i.e. the settlement of the plate at constant load becomes progressive and reaches a value of 40 mm or more.

b) Load intensity of 800 kN/sqm is reached without failure of the soil.

6.10.9 Backfilling of the pit shall be carried out as per the directions of the engineer-in-charge. Unless otherwise specified the excavated soil shall be used for this purpose.

6.11 Cyclic Plate Load Test

This test shall be carried out to determine the dynamic soil properties required for the analysis of foundation subjected to dynamic loads. This test shall be conducted on similar lines as the ordinary plate load test with an addition that unloading shall also be done before each stage of loading. Test set up, load increment and maximum load intensity etc shall be as per Clause- 6.10.

6.11.1 After each stage of loading, the load shall be removed in a minimum of two stages and as directed by the engineer-in-charge. After each stage of reduction of load, dial gauge readings and settlements shall be taken for atleast one hour until the readings stabilize. Thereafter the next loading stage shall commence. Recording and analysis of test data shall be as per IS: 5249.

6.12 Field California Bearing Ratio Test

This test shall be carried out to obtain the properties of soil required for the design of roads. The equipments and accessories required for carrying out the test, test procedure, recording of observations and presentation of results shall conform to IS: 2720 part XXXI. The test locations and depth shall be as specified in the drawings or as directed by the engineer-in-charge.

6.13 Electrical Resistivity Test

This test shall be conducted to determine the electrical resistivity of soil required for designing safety grounding system for the entire power plant area. The specification for the equipments and other accessories required for performing the test, test procedure and reporting of field observations shall conform to IS:3043. The test shall be conducted using Wenner's four electrode method as specified in IS:1892, Appendix-B2. Unless otherwise specified, at each test location the test shall be conducted along two perpendicular lines parallel to the co- ordinate axes. On each line, the spacing of electrodes shall be kept at 1m, 2m, 5m and 10m. Testing shall be done during the driest season prevalent in the area to the extent possible. In no circumstances shall the testing be done during or

immediately after the rainy season or persistent rains or in the vicinity of any existing water body such as ponds, streams etc.

6.14 Seism ic Refraction Test

6.14.1 This test shall be carried out to establish the rock and soil profiles of varying density. The dynam ic shear modulus of the soil shall also be obtained from the results of this test. The specification for the equipments and other accessories, procedure for carrying out the test, recording and anal ysis o f results and their presentation shall conform to IS: 1892.

6.14. 2 This test shall be carried out by inducing shock waves into the soil by striking a plate placed on the ground surface with a hammer. The shock waves shall be picked up through geophones placed on the ground surface at regular interval s in line with the plate along a straight line. The tim e elap sed before the waves reach the geophones shall be recorded to an accuracy of one m illisecond or better.

6.14.3 The distance between the shoc k poi nt and the geophones shall be increased to cover a wider area. Alternatively, m ultiple geophones shall be used sim ultaneously using multiple channel seism ograph to record the arrival ti me an d in tensity of waves reaching the geophones. The spacing of geophone s shall be 5m. As the distance between geophones and the shock pr oducing poi nt are increased, the time lapse for the waves pass ing through different underlying strata and reaching the geophone shall be recorded. The wave forms shall be recorded for each test using multiple channel seismograph.

6.14.4 The test shall be conducted along t raverses in two ort hogonal directions as specified in t he drawing or as directed by the engineer-in-charge. During t esting, prope r care shall be taken to avoid disturbance caused due to the m ovement of vehicles or othe r working operations around the test location. The type of wave (compression or shear) shall be an alysed properly using the data recorded during the test.

6.15 Cross Hole Shear Test

This test shall be generally carried out in accordance with IS: 13372 to establish the dynamic elastic properties of soil and rock. In this test, the seismic waves are to be picked up in two adjacent receiver boreholes. The spacing of boreholes shall be determined so as to obtain good results. The boreholes shall be uncased in the portion carrying the geophones. However it should be kept filled with water or drilling mud in order to ensure perfect contact between the borehole wall and the geophone. In case of cased hole preferably a low velocity material such as a high impact PVC should be used for casing and it is essential that it should be well grouted behind in order to make an intimate contact with the soil. The charge shall be installed within the depth as specified and the waves shall be picked up from the geophones installed at required depths in receiver boreholes. Knowing the travel time from shot hole to receiver hole and corresponding distance, the velocity of the waves is determined which enables to estimate dynamic elastic modulus, shear modulus and Poisson's ratio. In each receiver borehole multiple geophones shall be provided at 2m interval (with starting depth as 3m below ground level) to cover the depth and various strata as specified. Intensity of the waves shall be recorded by multiple channel seismograph.

6.16 Pressuremeter Test

6.16.1 This test shall be conducted in bore holes at desired depth to obtain the in-situ stress-strain characteristics and strength parameters of soil/rock layer by measuring the deformation of the probe at different pressures of the volumemeter. The location and depth of the test shall be as given in the drawing or as per the directions of the engineer-in-charge.

6.16.2 All precautions shall be taken to ensure a smooth bore hole of required diameter with minimum disturbance to the surrounding soil. In soft, loose and sensitive soils, the bore hole shall be predrilled deeper than the testing depth for enough so that the cuttings settling at the bottom of the bore hole shall not interfere with the test.

6.16.3 The equipment shall be calibrated for pressure losses (membrane correction/air calibration) and volume or radius changes (line calibration/thick wall rigid steel cylinder test) before starting of test and at regular intervals as per the manufacturer's specification.

6.16.4 Maximum value of pressure correction shall not be more than 50% of limit pressure. The total volume loses in the system shall not exceed 0.5% of the static probe volume per 100kPa. Volume correction may he neglected in soil if it is less than 0.1% of probe volume per 100 kPa.

6.16.5 The test shall be performed by expanding a cylindrical probe to obtain a pressure vs volume or pressure vs radius curve as specified in IS:1892. The probe may be of Ax, Bx or Nx size. However the size of the borehole shall be compatible to the size of pressuremeter probe. Hose pipe connecting the probe with the surface unit shall be of flexible tubing of single or coaxial type. The equipment should be able to reach a maximum pressure of 5000kPa for testing in soil and 8000kPa for testing in rock. The accuracy of measuring device shall be such that a change of 0.2% of static probe volume or 0.1% of probe radius is measurable as specified in IS:1892.

6.16.6 The probe shall be lowered down to the required depth as soon as the boring is completed so as to limit the expansion of soil due to release of stresses. The probe shall be held by a clamping device ensuring that it is not located at the interface of two different soil/rock layers.

6.16.7 The pressure shall be increased in atleast 20 equal stages as directed by the engineer-in-charge. At each stage the pressure shall be maintained for a period of atleast 60 seconds and volume reading shall be taken for 7 to 14 minutes. The volume of water sent into the probe during this period shall be measured upto an accuracy of 0.01cum. In case the water level in the volumemeter drops rapidly, it is necessary to close the volumemeter valve quickly so that the reservoir does not empty and allow air or gas into the tubing.

6.16.8 The test shall be carried out in stages till one of the following conditions occur.

a) The volume of the probe is doubled
b) Ultimate failure of soil/rock occurs
c) Load intensity of 5000kPa for soil and 8000kPa for rock is reached without failure.

6.16.9 If the shape of uncorrected pressure vs volume curve drastically varies from the ideal test curve, the test shall be repeated at no extra cost to the owner/ BHEL at a different depth as decided by the engineer-in-charge.

6.16.9 On completion of the test, all results mentioned in Clause- 9.2 shall be reported.

7.0 FIELD INVESTIGATION - ROCK

7.1 Rock Drilling

Drilling in rock shall be done at specified locations or as per the directions of the engineer-in-charge. Before commencing drilling, it shall be proved that characteristics of rock has been met with as mentioned in clause 6.1.1(b). The starting depth of drilling in rock as mentioned in clause 6.1.1(b) shall be certified by the engineer-in-charge. The portion drilled in rock shall be back filled with 1part of cement : 3 part of sand (1:3) grout unless otherwise specified and as directed by the engineer-in-charge.

7.1.1 Equipment

a) Core drilling shall be done by rotary motion using diamond bit. The feed or thrust to the drilling bit shall be actuated by hydraulic system. The rotary core drilling equipment and procedure for drilling shall conform to IS: 6926. The equipment shall be provided with necessary facilities to regulate the spindle speed, bit pressure and water pressure during core drilling to get a good core recovery.

b) Drilling shall be carried out with Nx size diamond tipped drill bits or impregnated diamond bits depending on the type of rock encountered. Double tube swivel core barrel of Type B conforming to IS: 6926 shall be used to ensure a good core recovery and to pick

up cores from all layers of rock. Suitable core catchers shall be used to ensure continuous and good core recovery.

7.1.2 Procedure

a) The drilling fluid shall be clean water. Circulation of drilling fluid shall be started before the core barrel reaches the bottom of the hole to prevent cuttings or sludge from entering the core barrel at the start of coring. Drilling fluid shall be circulated continuously down the hollow rods and the sludge conveying the rock cuttings to the surface shall be collected.

b) When drilling through soft/weathered/fractured rock, water circulation must be reduced so as to avoid shattering/breaking of core.

c) The rotational speed of the bit (spindle speed), the amount of downward pressure applied on the bit (bit pressure) and water pressure shall be suitably adjusted and properly monitored so that the core is collected with least disturbance and to avoid shearing of the core from its base. Bit speed, bit pressure, water pressure for the type of bit for various rock types shall be as per Appendix A of IS:6926.

d) No drill run shall exceed 0.75m in length. This can be increased to 1.5m provided the core recovery observed is more than 80% in two successive 0.75m drill runs and on approval from the engineer-in-charge. If the core recovery is less than 20% then SPT shall be performed before commencing the next drill run as explained in Clause- 6.2.

e) If at any time blocking of the bit or grinding of the core is observed, the core barrel shall be immediately withdrawn from the borehole regardless of the length of drill run completed.

7.1.3 Observations

a) The colour of return water at regular intervals, the depth at which any change of colour of return water is observed, the depth of

occurrence and amount of flow of hot water if encountered shall be recorded.

b) The depths through which a uniform rate of penetration was maintained, the depth at which a marked change in rate of penetration or sudden fall of drill rod occurs, the depth at which any blockage of drill bit causing core loss if any etc shall be recorded.

c) Any heavy vibration or torque noticed during drilling should be recorded together with the depth of occurrence.

d) Special conditions like the depth at which grouting was done during drilling, presence of artesian conditions, loss of drilling fluid, observation of gas discharge with return water etc shall also be observed and recorded.

e) During drilling operation, observation on return water, rate of penetration etc shall be recorded in a proforma as given in IS: 5313, Appendix-A.

7.1.4 Core Samples

a) Core samples shall be extracted by the application of a continuous pressure at one end of the core with the barrel held horizontally without vibration. Friable cores shall be extracted from the barrel directly into a suitable sized half round plastic channel section. Care shall be taken to maintain the direction of extrusion of sample same as that while coring to avoid stress reversal.

b) Immediately after withdrawal from the core barrel, the cores shall be placed in a tray and transferred into boxes specially prepared for the purpose. The boxes shall be made from seasoned timber or any other durable material and shall be indexed on top of the lid as per IS:4078. The cores shall be numbered serially and arranged in the boxes in a sequential order. The description of the core samples shall be recorded as per IS: 4464. Where no core is recovered, it shall be recorded as specified in the continuous record of core recovery and RQD in the corelog as per IS:11315, Part-II.

c) The basic information for the description of rocks shall cover i) degree of weathering ii) discontinuity spacing iii) strength iv) colour v) grain size vi) structural condition, the mineralogy of the grains and cementing material vii) rock name, special features like major joint planes, features/laminations, faults etc.

7.2 Standard Penetration Test

The relevant hardness of rocks shall be tested in boreholes after every drill run of 0.75m in rock if core recovery observed is less than 20% or as directed by the engineer-in-charge. The testing equipment and arrangement shall be conforming to IS: 2131. The number of blows for each 75mm penetration to a total penetration of 450mm shall be recorded. Penetration for every 50 blows shall be recorded and the test shall be stopped at a total of 100 blows.

7.3 Plate Load Test

The test shall be conducted as described under Clause- 6.10 for soil subject to the following changes.

The test plate shall be of size 45cm x 45cm and at least 25mm thick. The maximum load shall be 1500 kN/sqm to be applied in stages of 25, 50, 100,150,200, 300, 400, 600, 800, 1000, 1200, 1400 and 1500 kN per sqm. Under each load the time Vs settlement shall be recorded and plotted.

7.4 Pressuremeter Test

This test shall be conducted as described under Clause- 6.16 for soil subject to the following changes. The test shall be carried out till one of the following condition occurs.
a) The volume of the probe is doubled
b) Ultimate failure of rock
c) Load intensity of 8000 kN/sqm is reached without failure.

7.5 Cross Hole Shear Test

This test shall be conducted as described under Clause- 6.15 for soil.

7.6 Permeability Test

Permeability test shall be conducted in bed rock inside the bore hole by pumping in water under pressure to determine the percolation capacity of the rock strata. This test shall be conducted in uncased and ungrouted sections of the drill hole. Clear and clean water shall be used for the purpose of both drilling and testing. The specification for the equipments and other accessories, test procedure etc shall conform to IS: 5529, Part-II. The length of the test section shall be either 1.5m or 3m as per field conditions and as per the directions of the engineer-in-charge. The level of water table (if any) in the bore hole shall be recorded and the drill hole shall be cleaned before the start of the test. Depending upon the depth of the test section, single or double packer method shall be adopted. Care shall be taken to maintain water tightness of all the joints and connections during testing.

a) Single Packer method

This method shall be adopted when the bottom elevation of the test section is the same as the bottom of the drill hole. The packer shall be fixed at the top level of test section such that only the test section lies below the packer. Water shall then be pumped through a pipe into the test section under a required pressure and maintaining it till a constant quantity of water intake is observed. The amount of water percolating through the hole shall be recorded at every 5 minute interval. The test shall be repeated by increasing the pressure at regular intervals upto a pressure limit as specified in IS: 5529, Part-II. The details and observations shall be recorded in a proforma as recommended in IS: 5529, Part-II, Appendix-B.

b) Double Packer method

This method shall be adopted when the permeability of an isolated section inside a drill hole is to be determined. Packers shall be fixed both at the top and bottom of the test section such that their spacing is exactly equal to the length of the test section. The test shall then be conducted as specified in Clause- 7.6(a).

8.0 LABORATORY INVESTIGATION

8.1 Essential Requirements

a) All laboratory tests shall be conducted in an approved laboratory using approved apparatus complying with the requirements and specifications of Indian standards or other approved standards for this class of work. It shall be checked that the apparatus are in good working condition before starting the laboratory tests. Calibration of all the instruments and their accessories shall be done carefully and precisely.

b) Depending on the type of sub strata encountered, appropriate laboratory tests shall be conducted on soil and rock samples collected in the field. Laboratory tests shall be scheduled and performed by a qualified and experienced personnel who are thoroughly conversant with the work. Tests indicated in the schedule of items shall be performed on soil, rock and water samples as per relevant IS codes. One copy of all the laboratory test data records shall be submitted to the owner progressively every week. Laboratory tests shall be carried out concurrently with field investigation since initial laboratory test results could be useful in planning the later part of field work. **A schedule of laboratory tests shall be established by the contractor and the same shall be submitted and got approved by the engineer-in-charge before starting of laboratory tests.**

c) All samples whether undisturbed or disturbed shall be extracted, prepared and examined by a competent personnel properly trained and experienced in soil sampling, examination, testing and in using the apparatus as per the specified standards.

d) Undisturbed soil samples retained in liners or seamless tube samplers shall be taken out without causing any disturbance to the samples using suitably designed extruder just prior to actual testing. If the extruder is horizontal, proper support shall be provided to prevent the sample from breaking. For screw type extruders the pushing head shall be free from the screw shaft so that no torque is applied to the soil sample in contact with the pushing head. For soft clay samples, the sample tube shall be cut by means of a high speed

hacksaw to speci fied test l ength and placed over t he mould before pushing the sample into it with a suitable piston.

e) While extracting a sam ple from a liner or tube care shall be taken to see that its direction of move ment is the same as that during sampling to avoid stress reversal.

f) On all undisturbed soil samples tested for bulk density, water content, grain size distributi on, liquid lim it and plastic lim it tests shall also be performed.

g) On all rock samples tested for unconfined com pression test, bulk density and water content tests shall also be performed.

h) After com pletion of all tests, a summary of t est re sults fo r ea ch soil and rock sampl e shall be presen ted in a proforma as enclosed in **Annexure-A & B** resp ectively. Chem ical test results on soil and water samples shall be furnished in a tabular form separately.

8.2 Tests

Tests as indicated in this spec ification and as called for by the engineer-in-charge sha ll be conducted. The te sts shall include the following.

a) Tests on Undisturbed and Disturbed Soil Samples

- Visual and engineering classification
- Sieve analysis and hydrometer analysis
- Liquid, plastic and shrinkage limits
- Specific gravity
- Chemical analysis
- Swell pressure and free swell index determination
- Proctor compaction
- California bearing ratio

b) Test on Undisturbed Soil Samples

- Bulk density and moisture content
- Relative density (for sand)
- Unconfined compression test
- Box shear test
- Triaxial shear tests (dependi ng on the type of soil and field conditions on undisturbed or remoulded samples)

  i)Unconsolidated undrained

  ii) Consolidated undrained test with the measurement of pore water pressure

  iii)Consolidated drained

- One dimensional consolidation test

c) Test on Rock Samples

- Visual classification
- Water absorption, porosity and density
- Specific gravity
- Hardness
- Slake durability
- Unconfined compression test (both at saturated and at in-situ water content)
- Point load strength index
- Deformability test (both on saturated and dry samples)

c) Chemical Analysis of Sub-soil and Ground Water

8.3 Salient Test Requirements

a) Remoulded soil specimen whenever desired shall be fully reworked at field density and natural moisture content. For conducting CBR test and triaxial test for dyke /road material the sample shall be remoulded to 95% of standard proctor density.

b)Triaxial shear test shall be conducted on undisturbed soil samples saturated by the application of backpressure. Only if the water table is at sufficient depths such that chances of its rising to the base of the footing are meagre or nil, the triaxial tests shall be performed on the specimens at natural moisture content. Each test shall be carried out on a set of three test specimens from one sample at cell pressures equal to 100, 200 and 300kN/sqm or as required depending on the soil conditions.

c) Effective stress triaxial shear test shall be consolidated undrained with pore water pressure measurement. The test shall be conducted at cell pressures of 100, 200 and 300kN/sqm ensuring complete consoIidation at each stage.

d) Direct shear test shall be conducted on undisturbed soil samples. The three normal vertical stresses for each test shall be 100, 200 and 300 kN/sqm or as required depending on the soil conditions.

e) Consolidation test shall have loading stages of 10, 25, 50, 75, 100, 200, 400 and 800 kN/sqm. Rebound curve shall be recorded for all the samples by unloading the specimen at the in-situ stress of the specimen. Additional rebound curves shall also be recorded whenever desired by the engineer-in-charge.

f) Chemical analysis of sub-soil shall include determination of pH value, carbonate, sulphate (both SO_3 and SO_4), chloride and nitrate contents, organic matter, salinity and any other chemicals harmful to the foundation material. The contents in soil shall be indicated as percentage.

g) Chemical analysis of sub-soil water sample shall include the determination of the properties such as colour, odour, turbidity, pH value and chemical contents such as carbonate, sulphate (both SO_3 and SO_4), chloride, nitrate, organic matter and any other chemicals harmful to the foundation material. The contents such as sulphate etc shall be indicated as ppm by weight.

h) The laboratory CBR test shall be performed on undisturbed or on remoulded sample as per the drawing or as directed by the engineer-in-charge in soaked and unsoaked conditions.

9.0 REPORT

9.1 General

a) On completion of all the field and laboratory works, the contractor shall submit a draft report containing geological information of the region, procedure adopted for investigation, field observations, summarised test data, conclusion and recommendations. The report shall include detailed borelogs, sub-soil sections, field test results, laboratory observations and test results in both tabular as well as graphical forms, practical and theoretical considerations for the interpretation of test results, the supporting calculations for the conclusions drawn etc. Initially, the contractor shall submit three copies of the report in draft form for the owner/BHEL's review.

b) After review of the draft report, the employer's comments will be intimated to the contractor. The contractor shall incorporate the comments and after getting the amended draft report approved, five copies of the detailed final report shall be submitted alongwith one set of reproducible of the graphs, tables etc. Any expenditure on account of redrafting, finalising the report etc shall be deemed to have been included in the quoted rates.

c) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundation of different type of structures envisaged in the area under investigation. The contractor shall acquaint himself about the type of structures, foundation loads and other information required from the engineer-in-charge.

9.2 Data to be Furnished

The report shall also include but not be limited to the following.

a) A Plot Plan/Geotechnical Investigation Layout showing the location and reduced levels of a ll fiel d test s e.g . bore holes, trial pits, plate load tests etc properly drawn to scale and dimensioned with reference to the established grid lines.

b) Geological information of th e area such as geom orphology, geological structure, lithology, stratigraphy and tectonic faults, seismicity of the region and site , core recovery and rock quality designation etc.

c) Past observations and historical da ta if available for the area or for other areas with sim ilar soil profile for sim ilar structures in the surrounding areas.

d) A true cross section of all indi vidual boreholes and trial pit s with reduced levels and co-ordinates showing t he classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted and sam ples co llected at different depths and the rock stratum if met with.

e) A set of longitudinal and tran sverse soil/rock pr ofiles connecting various bore holes in or der to give a clear pict ure of the variation of the subsoil strata as per IS: 6065.

f) Water level contours and rock level contours

g) Plot of standard penetration te st 'N' values (both uncorrected and corrected) with depth for identified areas.

h) Results of all field tests in tabular as well as in graphical forms.

i) Results of all laboratory tests summarised (i) for each sam ple as well as (ii) a consolidated table giving t he layer-wise soil and rock properties . All the relevant ch arts, tables, graphs, figures, supporti ng

calculations, conclusions and photog raphs of representative rock cores and trial pits shall be furnished.

j) For all triaxial shear tests, stre ss vs strain diag rams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated . The value of m odulus of elasticity 'E' shall be furnished for all tests along with relevant calculations.

k) For all consolidation tests the following curves shall be furnished.

e vs log P
e vs P and
Compression vs log t or square root of t (depending upon shape of the plot for proper determination of coefficient of consolidation)

The point showing initial condition (eo, Po) of the soil shall be marked on the curves.

l) Values of co mpression i ndex, coefficient of volume compressibility etc shall be furnis hed. The procedure adopted for calculating the compression index from the field curve and settlement of soil str ata shall be cle arly sp ecified. The ti me required for 50% and 90% prim ary consolidation al ong with secondary settlement if significant shall also be calculated.

m) For pressuremeter tests, the following shall be furnished.

Calibration record i ncluding descrip tion of m embrane and sheath on probes, dimensions of thick walled cylinder, length of flexible tubing, calibration curves and temperature etc.

Drilling record including bore hole num ber, method of making borehole, log with soil type and cond ition, depth of water table in the borehole, weather and temperature etc.

Test record including type of test, date and time, depth of centre point of probe, volum e readings at 30 and 60 second elapsed time and corresponding pressure readings and notes on any deviation from standard test procedure etc.

Field pressuremeter, creep and air calibration curves indicating Po, Pf and Pl. Corrected pressuremeter and creep curves indicating Po, Pf, Pl along with calculation for the corrections.

n) Values of cohesion, angle of internal friction, pressuremeter modulus, shear modulus and co-efficient of sub-grade reaction along with sample calculations. Calculation for allowable bearing pressures and corresponding total settlements for shallow foundations and load carrying capacity calculation of piles in various modes etc.

o) Analysis and discussion of test results.

p) Photographs showing details of field tests, soil/rock samples, trial pits etc.

Recommendations

Recommendations shall be given areawise duly considering the type of soil/rock, structure, foundation type and ground water table etc in the area. The recommendations shall include but not be limited to the following.

a) Type of foundation to be adopted for various structures duly considering the sub strata characteristics, water table, total settlement permissible for the structures and equipments, minimum depth and width of foundation etc.

b) For shallow foundations the following shall be furnished with comprehensive supporting calculations.

i) Net safe bearing pressure for isolated square/rectangular footings and continuous strip footings of sizes 1, 2, 3, 4 & 5m at different founding depths of 1, 2, 3, 4 & 5m below ground level considering both shear failure and settlement criteria giving reasons for the type of shear failure adopted in the calculation.

ii) Net safe bearing pressure for raft foundation of widths greater than 6m at 2 , 3, 4 & 5m below ground level considering both shear failure and settlement criteria.

iii) Modulus of sub-grade reaction and modulus of elasticity from plate load test results along with time-settlement curves and load-settlement curves in both natural and log-log graph.

c) If piling is envisaged the following shall be furnished with comprehensive supporting calculations.

i) Type of pile and reasons for recommending the same duly considering the sub strata characteristics.

ii) Suitable founding strata for the pile.

iii) Estimated length of pile for 800kN (450mm dia.), 1050kN (500mm dia.), 1500kN (600mm dia.) and 4500kN (1070mm dia.) capacities. End bearing and frictional resistance shall be indicated separately. Safe lateral and tensile load carrying capacities of pile with supporting calculations.

iv) Magnitude of negative skin friction if any.

d) Coefficient of permeability of various sub-soil and rock strata based on in-situ permeability tests.

e) Cone resistance, frictional resistance, total resistance and settlement analysis for different size of foundations.

f) Electrical resistivity of sub-soil based on electrical resistivity tests including electrode spacing vs cumulative resistivity curves.

g) Dynamic soil properties such as dynamic shear modulus and Poisson's ratio etc from cross-hole shear and seismic refraction tests and coefficient of elastic uniform compression from cyclic plate load tests.

h) Suitability of the soil for construction of roads and embankments, their stable slopes for shallow and deep excavations, active and passive earth pressures, earth pressure at rest and modulus of elasticity as a function of depths for the design of underground structures etc.

i) Suitability of locally available soils at site for filling and back filling purposes.

j) If expansive soil is met with, then recommendation on removal or retainment of the same under the structures/roads etc shall be given. In the latter case, detailed specifications of any special treatment required including specification for materials to be used, construction method, equipments to be deployed etc shall be furnished.

k) Protective measures based on chemical nature of soil and ground water with due regard to the potential deleterious effects on concrete, steel and other building materials etc. Remedial measures for sulphate attack and acidity shall be dealt in detail.

l) Susceptibility of sub soil strata to liquefaction in the event of earthquake. If so, recommendation for remedial measures.

m) Identification of any other potential geotechnical problems and their remedial measures.

n) Description of measures required for erosion control.

o) Identification of corrective measures required for the improvement of sub surface conditions such as removal of poor sub soil/material and in-situ densification etc. If ground improvement is recommended then its detailed specification, specification for the materials to be used, construction method, equipments to be deployed etc shall be furnished.

10.0 RATES & MEASUREMENTS

10.1 RATES

a) The item of work in the schedule of quantities describes the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rates shall include all the activities covered in the description of the items as well as for

all necessary operations in deta ils described in the technical specification.

b) No claims shall be entertai ned if the details shown on the released for construction drawings differ in any w ay (e.g. location and depth of tests, num ber of te sts etc) from those shown on the tender drawings.

c) The unit rates quoted shall in clude m inor details which are obviously and fairly intended a nd which m ay not have been included i n these documents but ar e essential for the satisfactory completion of the work.

d) The bidders quoted rates shall be inclusive of providi ng all equipments, men, materials, sk illed and unskilled labours, making observations, establis hing the ground level and coordinates at location of each bore hole, test p it etc b y carrying levels fro m one established bench mark and distan ces from one set of grid lines furnished by the engineer-in-c harge. Also no extra payments shall be made for conducting the standard penetration t ests, collection, packing and transportation of all the samples and cores, recording of all results and submitting them in approved formats etc.

e) The quoted rates for trial pits/pla te load tests/ cyclic plate load tests shall be inclusive of dewatering and backfilling etc.

f) The quoted rates for drill ing in rock shall satisfy the requirements as furnished in specification.

g) The rates quoted for conducting pum p out test shall be inclusive of boring a well of 400mm diameter, providi ng and installation of perforated GI/MS pipes and observation pipes etc .

h)The rates quoted for conducting cross hole shear test shall be inclusive of necessary bori ng, pr oviding PVC pipes, grouting, geo-phones, backfilling the holes after completion of testing etc.

i)The rates quoted for laboratory te sts shall include preparation of samples, performin g tests, re cording, a nalysis and subm ission of data etc.

j) The bidder shall submit a scheme showing the arrangement and equipment proposed to be used for conducting the site work along with rates. However the minimum number of staff and equipments to be deployed/mobilised for site works shall be as per **Annexure-C & D** respectively.

10.2 MEASUREMENTS

a) All measurements shall be in SI Units.

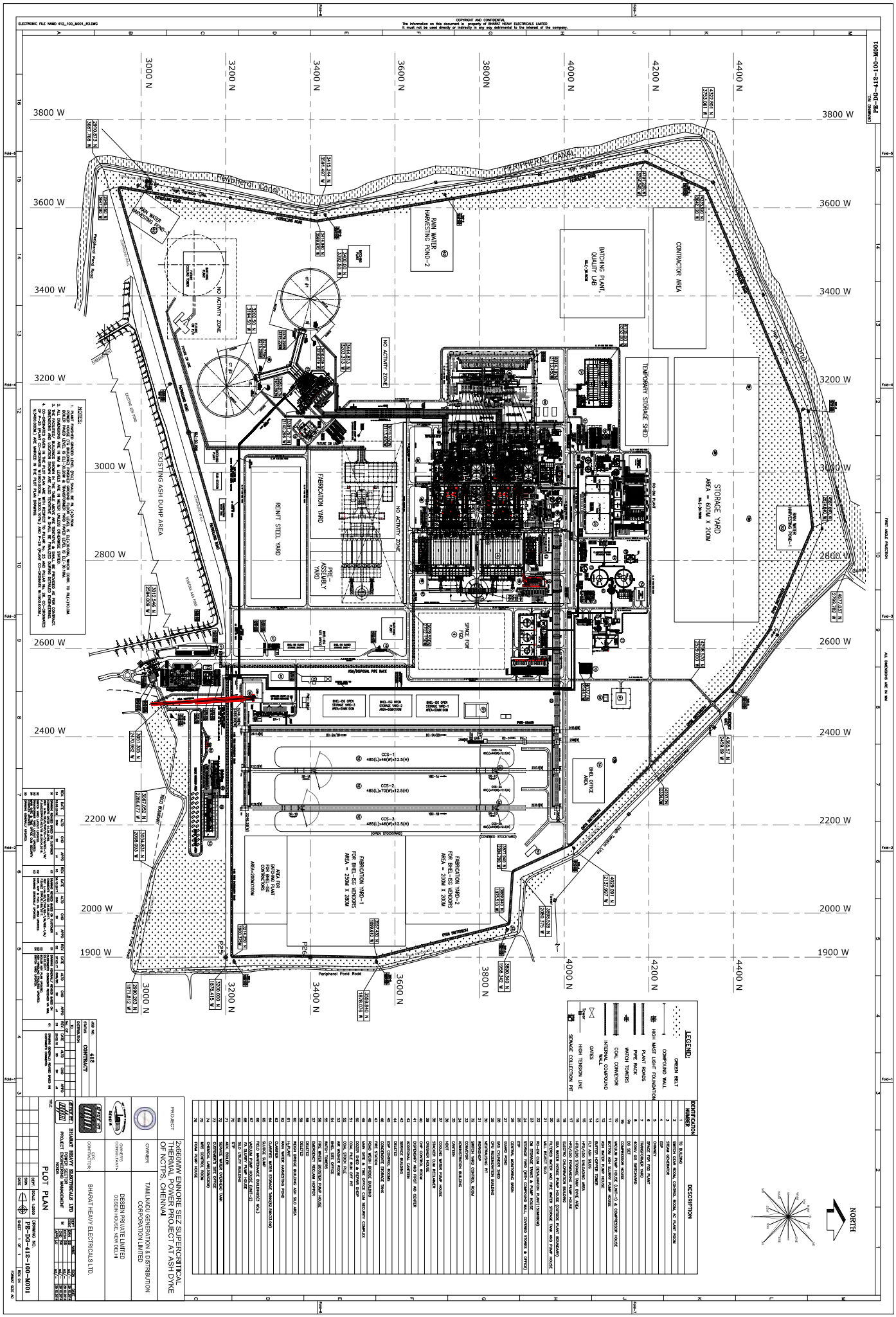
b) Length shall be measured in metres (m) correct to two places of decimals. Areas shall be worked out in square meters(Sqm) and volume in cubic meters(Cum) rounded off to two decimals.

c) Certain tests have to be conducted in the bore holes and trial pits etc. Such bore holes and trails pits etc shall be measured once only and not again just because the tests are conducted therein.

d) The depth of penetration due to SPT at the bottom of bore hole shall not be considered for the measurement of bore hole depth.

e) Pits shall be measured in Cum.

f) Coring in rock with diamond bit shall be measured in length(metre) correct to two places of decimal for the actual cored length satisfying the criteria of specification.



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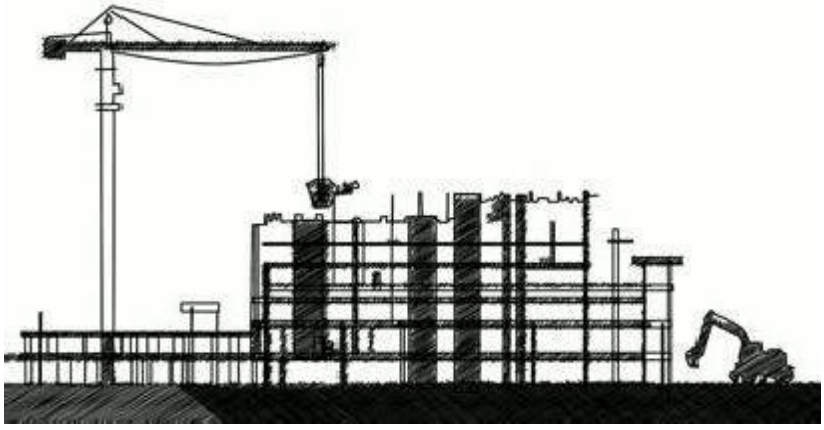
HEALTH, SAFETY and ENVIRONMENT PLAN

for

SITE OPERATIONS

by

SUB-CONTRACTORS



POWER SECTOR

HSE PLAN FOR SITE OPRATIONS BY BHEL'S SUBCONTRACTORS

AT A GLANCE

BEFORE START

SIGNING OF MOU
Agree to comply to HSE requirement- Statutory and BHEL's

PLAN

HSE ORGANISATION	
Manpower • 1 (one) safety officer for every 500 workers or part thereof • 1(one) safety-steward/ supervisor for every 100 workers **Qualification** As per Cl. 7.1	**HSE Roles and responsibilities** • Site In-charge- As per clause 7.2.1 • Safety officer- As per clause 7.2.2

HSE Planning
for Man, Machinery/Equipment/Tools & Tackles

PROVIDE

HSE INFRASTUCTURE	
• PPEs • Drinking Water • Washing Facilities • Latrines and Urinals • Provision of shelter for rest • Medical facilities	• Canteen facilities • Labour Colony • Emergency Vehicle • Pest Control • Scrapyard • Illumination

TRAIN

HSE TRAINING , AWARENESS & PROMOTION	
Training • Induction training • Height work and other critical areas • Tool Box talk & Pep Talk	**Awareness & Promotion** • Signage • Poster • Banner • Competition • Awards

COMMUNICATE

HSE COMMUNICATION	
Incident Reporting • Accident- Fatal & Major • Property damage • Near Miss	**Event Reporting** • Celebrations • Training • Medical camp

EXECUTE SAFELY

OPERATIONAL CONTROL PROCEDURES

PERMIT TO WORK

Height work (above 2 metres), Hot Work, Heavy Lifting, Confined Space, Radiography, excavation (More than 4 metres)

SAFETY DURING WORK EXECUTION	
• Welding • Rigging • Cylinder- storage & Movement • Demolition work • T&Ps • Chemical Handling • Electrical works	• Fire • Scaffolding • Height work • Working Platform • Excavation • Ladder • Lifting • Hoisting appliance
HOUSE KEEPING	
WASTE MANGEMENT	
TRAFFIC MANAGEMENT	
ENVIRONMENTAL CONTROL	
EMERGENCY PREPAREDNESS AND RESPONSE PLAN	

CHECKS

HSE AUDITS & INSPECTION	
• Daily Checks • Inspection of PPEs • Inspection of T& Ps • Inspection of Cranes & Winches	• Inspection of Height work • Inspection of Welding and Gas cutting • Inspection of elevators etc.

HSE PERFORMANCE EVALUATION PARAMETERS

NON CONFORMANCE

PENALTY for NON CONFORMANCE

Refer Clause 16

Incremental penalty

For repeated violation by the same person, the penalty would be double of the previous penalty

For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

REVISION HISTORY SHEET

Date	Revision No.	Details of Changes	Reason	Prepared	Reviewed	Approved
12.08.2014	00	First Issue	First Issue	S. B. Jayant, Dy Manager-FQA & Safety	A. K. Sinha, GM-FQA & Safety	Anuj Bhatnagar, ED-FQA & Safety
20.01.2020	01	Formats added: **HSEP:14-F30 – Monthly HSE Planning & Review** (Page 11, Clause 8.0 - updated) HSEP:14-F13E-Excavation Inspection Format (part of F30)) HSEP:14-F32B – Job Safety Analysis Format (part of F30) **HSEP:14-F31A – Daily HSE Reporting** (Page 18, Clause 10.3 – added) **HSEP:14-F33 – HSE Performance Evaluation** (Page 31, Clause 13 – revised)	IOM No. **PSHQHSE/MONREP/02** Dated 08-Jan-2020	Rohit Kumar	Santosh Nair, GM (MSX & HSE)	

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1.0 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.

1.3 Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy relevant statutory guidelines must be followed.

1.4 In case the customer has any specific requirement, the same is to be fulfilled.

2.0 SCOPE

The document is applicable for BHEL's Subcontractors at all installation / servicing activities of BHEL Power Sector as per the relevant contractual obligations.

3.0 OBJECTIVES AND TARGETS

The HSE Plan reflects that BHEL places high priority upon the Occupational Health, Safety and Environment at workplaces.

- Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
- Ensure protection of environment of the work site.
- Comply at all times with the relevant statutory and contractual HSE requirements.
- Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
- Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.
- Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
- Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
- Establish effective communication on HSE matters with all relevant parties involved in the Project works.
- Ensure that all work planning takes into account all persons that may be affected by the work.
- Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
- Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
- Ensure continual improvements in HSE performance
- Ensure conservation of resources and reduction of wastage.
- Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
- Ensure timely implementation of correction, corrective action and preventive action.

HSE TARGETS

EXPLOSION	**ZERO**
FATALITY	**ZERO**
LOST TIME INJURY	**ZERO**
FIRE	**ZERO**
VEHICLE INCIDENTS	**ZERO**
ENVIRONMENTAL INCIDENTS	**ZERO**

4.0 BHEL POWER SECTOR HEALTH, SAFETY & ENVIRONMENT POLICY

Health, Safety & Environment Policy of BHEL

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, contractors 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.

` **sd/-**

CMD, BHEL

5.0 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 w h i l e executing the Contract Number _____

M/s_____shall ensure that safe work practices as per the HSE plan. Spirit and content therein shall be reached to 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.

Signed by authorized representative of M/s ----------

Name :

Place & Date:

6.0 TERMS AND DEFINITIONS

6.1 DEFINITIONS

6.1.1 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.

6.1.2 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".

6.1.3 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 labours. 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.

6.1.4 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.

6.1.5 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.

6.1.6 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.

6.1.7 TYPE OF INCIDENTS & THEIR REPORTING:

The three categories of Incident are as follows:

Non-Reportable Cases:
An incident, where the injured person is given medical help and discharged for work without counting any lost time.

Reportable Cases:
In this case the injured person is disable for 48 hours or more and is not able to perform his duty.

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.

6.1.8 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:

$$\frac{\text{Number of Reportable LTI}}{\text{Total Man Hours Worked}} \times 1{,}000{,}000$$

6.1.9 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:

$$\frac{\text{Days lost due to LTI}}{\text{Total Man Hours Worked}} \times 1{,}000{,}000$$

6.1.10 INCIDENCE RATE

Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as:

$$\frac{\text{Number of LTI} \times 1000}{\text{Average number of manpower deployed}}$$

7.0 HSE ORGANISATION

Number of safety officers:
The subcontractor must deploy one safety officer for every 500 workers or part thereof in each package. In addition, there must be one safety-steward/safety-supervisor for every 100 workers.

Deployment: The subcontractor should deploy sufficient safety officers and safety-steward/Safety-supervisor, as per requirement given above, since initial stage and add more in proportion to the added strength in work force. Any delay in deployment will attract a penalty of Rs.30,000/- per man month for the delayed period.

7.1 QUALIFICATION FOR HSE PERSONNEL

Sl.no	Designation	Qualification	Experience
1	Safety officer (Construction Agency)	Degree or Diploma in Engineering with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years for degree holder and five years for diploma holder in the field of Construction of power plant/ major industries

2	Safety-Steward/ Safety-Supervisor	Degree or diploma in any discipline with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years

7.2 RESPONSIBILITIES

7.2.1 SITE IN -CHARGE OF SUBCONTRACTOR

- Shall sign Memorandum of Understanding (MoU) for compliance to BHEL's HSE Plan for Site Operations as per clause 5.0
- Shall engage qualified safety officer(s) and steward (s) as per clause 7.0
- Shall adhere to the rules and regulations mentioned in this code, practice very strictly in his area of work in consultation with his concerned engineer and the safety coordinator.
- Shall screen all workmen for health and competence requirement before engaging for the job and periodically thereafter as required.
- Shall not engage any employee below 18 years.
- Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job. Shall ensure that no working men/women carry excessive weight more than stipulated in Factory Rule Regulation R57.
- Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent person.
- Shall ensure that provisions stipulated in contract Labour Regulation Act 1970, Chapter V C.9, canteen, rest rooms/washing facilities to contracted employees at site.
- Shall adhere to the instructions laid down in Operation Control Procedures (OCPs) available with the site management.
- Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
- Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.
- Shall report all incidents (Fatal/Major/Minor/Near Miss) to the Site engineer /HSE officer of BHEL.
- Shall ensure that Horseplay is strictly forbidden.
- Shall ensure that adequate illumination is arranged during night work.
- Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard to self and to others.
- Shall ensure display of adequate signage/posters on HSE.
- Shall ensure that mobile phone is not used by workers while working.
- Shall ensure conductance of HSE audit, mockdrill, medical camps, induction training and training on HSE at site.
- Shall ensure full co-operation during HQ/External /Customer HSE audits.

- Shall ensure submission of look-ahead plan for procurement of HSE equipment's and PPEs as per work schedule.
- Shall ensure good housekeeping.
- Shall ensure adequate valid fire extinguishers are provided at the work site.
- Shall ensure availability of sufficient number of toilets /restrooms and adequate drinking water at work site and labour colony.
- Shall ensure adequate emergency preparedness.
- Shall be member of site HSE committee and attend all meetings of the committee
- Power source for hand lamps shall be maximum of 24 v.
- Temporary fencing should be done for open edges if Hand – railings and Toe-guards are not available.

7.2.2 HEALTH, SAFETY AND ENVIRONMENT OFFICER OF SUBCONTRACTOR

- Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, P&M and other tools and tackles.
- Facilitate inclusion of safety elements into Work Method Statement.
- Highlight the requirements of safety through Tool-box / other meetings.
- Help concerned HOS to prepare Job Specific instructions for critical jobs.
- Conduct investigation of all incident/dangerous occurrences & recommend appropriate safety measures.
- Advice & co-ordinate for implementation of HSE permit systems, OCPs & MPs.
- Convene HSE meeting & minute the proceeding for circulation & follow-up action.
- Plan procurement of PPE & Safety devices and inspect their healthiness.
- Report to PS Region/HQ on all matters pertaining to status of safety and promotional program at site level.
- Facilitate administration of First Aid
- Facilitate screening of workmen and safety induction.
- Conduct fire Drill and facilitate emergency preparedness
- Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
- Apprise PS– Region on safety related problems.
- Notify site personnel non-conformance to safety norms observed during site visits / site inspections.
- 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.
- To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
- Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.
- Shall work as interface between various agencies such customer, package-in-charges, subcontractors on HSE matters

8.0 PLANNING BY SUBCONTRACTOR

Monthly planning and review of HSE activities shall be carried out by subcontractor as per format No. HSEP:14-F30 jointly along with BHEL.

8.1 MOBILISATION OF MACHINERY/EQUIPMENT/TOOLS BY SUBCONTRACTOR

- 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.

- The machinery and equipment to be embraced for this purpose shall include but not limited to the following:

  - Mobile cranes.
  - Side Booms.
  - Forklifts.
  - Grinding machine.
  - Drilling machine.
  - Air compressors.
  - Welding machine.
  - Generator sets.
  - Dump Trucks.
  - Excavators.
  - Dozers
  - Grit Blasting Equipment.
  - Hand tools.

- 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.

8.2 MOBILISATION OF MANPOWER BY SUBCONTRACTOR

- The subcontractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner.
- 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.
- 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.
- Appropriate accommodation to be arranged for all workmen in hygienic condition.

8.3 PROVISION OF PPEs

- Personnel Protective Equipment (PPEs), in adequate numbers, will be made available at site & their regular use by all concerned will be ensured
- The following matrix recommends usage of minimum PPEs against the respective job.

Sl. No	Type of work	PPEs
1	Concrete and asphalt mixing	Nose mask, hand glove, apron and gum boot
2	Welders/Grinders/ Gas cutters	Welding/face screen, apron, hand gloves, nose mask and ear muffs if noise level exceeds 90dB. Helmet fitted with welding shield is preferred for welders
3	Stone/ concrete breakers	Ear muffs, safety goggles, hand gloves
4	Electrical Work	Rubber hand glove, Electrical Resistance shoes
5	Insulation Work	Respiratory mask, Hand gloves, safety goggles
6	Work at height	Double lanyard full body harness, Fall arrestor (specific cases)
7	Grit/Sand blasting	Blast suit, blast helmet, respirator, leather gloves
8	Painting	Plastic gloves, Respirators (particularly for spray painting)
9	Radiography	As per BARC guidelines

- The PPEs shall conform to the relevant standards as below and bear ISI mark.

Relevant is-codes for personal protection

IS: 2925 – 1984	Industrial Safety Helmets.
IS: 4770 – 1968	Rubber gloves for electrical purposes.
IS: 6994 – 1973 (Part-I)	Industrial Safety Gloves (Leather &Cotton Gloves).
IS: 1989 – 1986 (Part-I-II)	Leather safety boots and shoes.
IS: 5557 – 1969	Industrial and Safety rubber knee boots.
IS: 6519 – 1971	Code of practice for selections care and repair of Safety footwear.
IS: 11226 – 1985	Leather Safety footwear having direct molding sole.
IS: 5983 – 1978	Eye protectors.
IS: 9167 – 1979	Ear protectors.
IS: 1179-1967	Eye & Face protection during welding
IS: 3521 – 1983	Industrial Safety Belts and Harness
IS:8519 -1977	Guide for selection of industrial Safety equipment for body protection
IS:9473-2002,14166-1994,14746-1999	Respiratory Protective Devices

The list is not exhaustive. The safety officer may demand additional PPEs based on specific requirement.

- 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
- Besides the PPEs mentioned above, the persons shall use helmet and safety shoe. The visitors shall use Helmet and any other PPEs as deemed appropriate for the area of work.

Colour scheme for Helmets:

1. Workmen: Yellow
2. Safety staff: Green or white with green band
3. Electrician: Red
4. Others including visitors: White

- All the PPEs shall be checked for its quality before issue and the same shall be periodically checked. The users shall be advised to check the PPEs themselves for any defect before putting on. The defective ones shall be repaired/ replaced.
- The issuing agency shall maintain register for issue and receipt of PPEs.
- The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the front.
- The body harnesses shall be serial numbered.

8.4 ARRANGEMENT OF INFRASTRUCTURE

8.4.1 DRINKING WATER

- Drinking water shall be provided and maintained at suitable places at different elevations.
- Container should be labeled as " Drinking Water"
- Cleaning of the storage tank shall be ensured atleast once in 3 months indicating date of cleaning and next due date.
- Potability of water should be tested as per IS10500 at least once in a year.

8.4.2 WASHING FACILITIES

- In every workplace, adequate and suitable facilities for washing shall be provided and maintained.
- 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.
- 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.

8.4.3 LATRINES AND URINALS

- Latrines and urinals shall be provided in every work place.
- Urinals shall also be provided at different elevations.
- They shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times, by appointing designated person.
- Separate facilities shall be provided for the use of male and female worker if any.

8.4.4 PROVISION OF SHELTER DURING REST

Proper Shed & Shelter shall be provided for rest during break

8.4.5 MEDICAL FACILITIES

8.4.5.1 MEDICAL CENTRE (As per Schedule V, X and XI of BOCW central Rules, 1998)

- A medical centre shall be ensured/identified at site with basic facilities for handling medical emergencies. The medical center can be jointly developed on proportionate sharing basis with permission from BHEL
- A qualified medical professional, not less than MBBS, shall be deployed at the medical centre
- The medical centre shall be equipped with one ambulance, with trained driver and oxygen cylinder.
- Medical waste shall be disposed as per prevailing legislation (Bio-Medical Waste –Management and Handling Rules, 1998)

8.4.5.2 FIRST AIDER

- Ensure availability of Qualified First-aider throughout the working hours.
- Every injury shall be treated, recorded and reported.
- Refresher course on first aid shall be conducted as necessary.
- List of Qualified first aiders and their contact numbers should be displayed at conspicuous places.

8.4.5.3 FIRST AID BOX (as per schedule III of BOCW)

- 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.
- 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.
- 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.
- The first aid box shall be distinctly marked with a Green Cross on white background.
- Details of contents of first aid box is given in Annexure No. 01
- Monthly inspection of First Aid Box shall be carried out by the owner as per format no. HSEP:14-F01
- The subcontractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.

8.4.5.4 HEALTH CHECK UP (As per schedule VII and Form XI)

The persons engaged at the site shall undergo health checkup as per the format no. HSEP:14-F02 before induction. The persons engaged in the following works shall undergo health checkup at least once in a year:

a. Height workers
b. Drivers/crane operators/riggers

c. Confined space workers
d. Shot/sand blaster
e. Welding and NDE personnel

8.4.6 PROVISION OF CANTEEN FACILITY

- Canteen facilities shall be provided for the workmen of the project inside the project site.
- Proper cleaning and hygienic condition shall be maintained.
- Proper care should be taken to prevent biological contamination.
- Adequate drinking water should be available at canteen.
- Fire extinguisher shall be provided inside canteen.
- Regular health check-up and medication to the canteen workers shall be ensured.

8.4.7 PROVISION OF ACCOMODATION/LABOUR COLONY

- The subcontractor shall arrange for the accommodation of workmen at nearby localities or by making a labour colony.
- Regular housekeeping of the labour colony shall be ensured.
- Proper sanitation and hygienic conditions to be maintained.
- Drinking water and electricity to be provided at the labour colony.
- Bathing/ washing bay
- Room ventilation and electrification.

8.4.8 PROVISION OF EMERGENCY VEHICLE

- Dedicated emergency vehicle shall be made available at workplace by each subcontractor to handle any emergency

8.4.9 PEST CONTROL

Regular pest control should be carried out at all offices, mainly laboratories, canteen, labour colony and stores.

8.4.10 SCRAPYARD

- In consultation with customer, scrapyard shall be developed to store metal scrap, wooden scrap, waste, hazardous waste.
- Scrap/Waste shall be segregated as Bio-degradable and non-bio-degradable and stored separately.

8.4.11 ILLUMINATION

- 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.

- Adequate and suitable light shall be provided at all work places & their approaches including passage ways as per IS: 3646 (Part-II). Some recommended values are given below:

S. No.	Location	Illumination (Lux)
A.	**Construction Area**	
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 rough measurements etc.	300
7.	Fine work like precision assembly, precision measurements etc.	700
8.	Sheet metal works	200
9.	Electrical and instrument labs	450
B.	**Office**	
1.	Outdoor area like entrance and exit roads	20
2.	Entrance halls	150
3.	Corridors and lift cars	70
4.	Lift landing	150
5.	Stairs	100
6.	Office rooms, conference rooms, library reading tables	300
7.	Drawing table	450
8.	Manual telephone exchange	200

- Lamp (hand held) shall not be powered by mains supply but either by 24V or dry cells.
- Lamps shall be protected by suitable guards where necessary to prevent danger, in case of breakage of lamp.
- Emergency lighting provision for night work shall be made to minimise danger in case of main supply failure.

If the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instructions issued by the authorized BHEL official, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor

9.0 HSE TRAINING& AWARENESS

9.1 HSE INDUCTION TRAINING

All persons entering into project site shall be given HSE induction training by the HSE officer of BHEL /subcontractor before being assigned to work.

In-house induction training subjects shall include but not limited to:

- Briefing of the Project details.
- Safety objectives and targets.
- Site HSE rules.
- Site HSE hazards and aspects.
- First aid facility.
- Emergency Contact No.
- Incident reporting.
- Fire prevention and emergency response.
- Rules to be followed in the labour colony (if applicable)

- 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.)
- They must arrive fully dressed in safety wear & gear to attend the induction.
- Any one failing to conform to this safety wear& gear requirement shall not qualify to attend.
- On completing attending subcontractor's in-house HSE induction, each employee shall sign an induction training form (format no. HSEP:14-F03) to declare that he had understood the content and shall abide to follow and comply with safe work practices. They may only then be qualified to be issued with a personal I.D. card, for access to the work site.

9.2 HSE TOOLBOX TALK

- HSE tool Box talk shall be conducted by frontline foreman/supervisor of subcontractor to specific work groups prior to the start of work. The agenda shall consist of the followings:
  - 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.
- Record of Tool box talk shall be maintained as per format no. HSEP:14-F04
- Tool box talk to be conducted at least once a week for the specific work.

9.3 TRAINING ON HEIGHT WORK

Training on height work shall be imparted to all workers working at height by in-house/external faculty at least twice in a year. The training shall include following topics:

- Use of PPEs
- Use of fall arrester, retractable fall arrester, life line, safety nets etc.
- Safe climbing through monkey ladders.
- Inspection of PPEs.
- Medical fitness requirements.
- Mock drill on rescue at height.
- Dos & Don'ts during height work.

9.4 HSE TRAINING DURING PROJECT EXECUTION

- Other HSE training shall be arranged by BHEL/ subcontractor as per the need of the project execution and recommendation of HSE committee of site.
- The topics of the HSE training shall be as follows but not limited to:
  - Hazards identification and risk analysis (HIRA)
  - Work Permit System
  - Incident investigation and reporting
  - Fire fighting
  - First aid
  - Fire-warden training
  - EMS and OHSMS
  - T & Ps fitness and operation

- Electrical safety
- Welding, NDE & Radiological safety
- Storage, preservation & material handling.

- A matrix shall be maintained to keep an up-to-date record of attendance of training sessions carried out.

9.5 HSE PROMOTION-SIGNAGE, POSTERS, COMPETITION, AWARDS ETC

9.5.1 Display of HSE posters and banners

- Site shall arrange appropriate posters, banners, slogans in local/Hindi/English languages at work place

9.5.2 Display of HSE signage

- Appropriate HSE signage shall be displayed at the work area to aware workmen and passersby about the work going on and do's and don'ts to be followed

9.5.3 Competition on HSE and award

- Site will arrange different competition (slogan, poster, essay etc.) on HSE time to time (Safety day, BHEL day, World Environment Day etc.) and winners will be suitably awarded.

9.5.4 HSE awareness programme

- Subcontractor shall arrange HSE awareness programme periodically on different topics including medical awareness for all personnel working at site

10.0 HSE COMMUNICATION

10.1 INCIDENT REPORTING

- The subcontractor shall submit report of all incidents, fires and property damage etc to the Engineer immediately after such occurrence, but in any case not later than 24 hours of the occurrence. Such reports shall be furnished in the manner prescribed by BHEL. (Refer HSE procedure for incident investigation, analysis and reporting for details)
- In addition, periodic reports on safety shall also be submitted by the subcontractor to BHEL from time to time as prescribed by the Engineer. Compiled monthly reports of all kinds of incidents, fire and property damage to be submitted to BHEL safety officer as per prescribed formats.
- HSE incidents of site shall be reported to BHEL site Management as per Procedure for Incident Investigation and Reporting in format no. HSEP:14-F15. Corrective action shall be immediately implemented at the work place and compliance shall be verified by BHEL HSE officer and until then, work shall be put on hold by Construction Manager.

10.2 HSE EVENT REPORTING

- 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
- Celebration of important days like National Safety Day, World Environment Day etc. shall also be reported as mentioned above.

10.3 DAILY HSE ACTIVITY REPORTING

Daily HSE activities shall be reported by subcontractor to BHEL as per Format No. HSEP:14-F31A

11.0 OPERATIONAL CONTROL

All applicable OCPs (Operational control procedures) will be followed by subcontractor as per BHEL instructions. This will be done as part of normal scope of work. List of such OCPs is given below. In case any other OCP is found to be applicable during the execution of work at site, then subcontractor will follow this as well, within quoted rate. These OCPs (applicable ones) will be made available to subcontractor during work execution at site. However for reference purpose, these are kept with Safety Officer of BHEL at the Power Sector Regional HQ, or available in downloadable format in the website, which may be refereed by subcontractor, if they so desire.

LIST OF OCPs

Safe handling of chemicals	Safety in use of cranes	Hydraulic test
Electrical safety	Storage and handling of gas cylinders	Spray insulation
Energy conservation	Manual arc welding	Trial run of rotary equipment
Safe welding and gas cutting operation	Safe use of helmets	Stress relieving
Fire safety	Good house keeping	Material preservation
Safety in use of hand tools	Working at height	Cable laying/tray work
First aid	Safe excavation	Transformer charging
Food safety at canteen	Safe filling of hydrogen in cylinder	Electrical maintenance
Illumination	Vehicle maintenance	Safe handling of battery system
Handling and erection of heavy metals	Safe radiography	Computer operation
Safe acid cleaning	Waste disposal	Storage in open yard
Safe alkali boil out	Working at night	For sanitary maintenance
Safe oil flushing	Blasting	Batching
Steam blowing	DG set	Piling rig operation
Safe working in confined area	Handling & storage of mineral wool	Gas distribution test
Safe operation of passenger lift, material hoists & cages	Drilling, reaming and grinding(machining)	Cleaning of hotwell / deaerator
Electro-resistance heating	Compressor operation	O&M of control of AC plant & system
Air compressor	Passivation	Safe Loading of Unit
Safe EDTA Cleaning	Safe Chemical cleaning of Pre boiler system	Safe Boiler Light up
Safe Rolling and Synchronization		

11.1 HSE ACTIVITIES

HSE activities shall be conducted at site based on the HSEMSM developed by Power Sector and issued to site by Regions.
While planning for any activity the following documents shall be referred for infrastructural requirements to establish control measures:

1) HSE Procedure for Register of OHS Hazards and Risks
2) HSE Procedure for Register of Environmental Aspects and Impacts
3) HSE Procedure for Register of Regulations

4) Operational Control Procedures
5) HSE Procedure for Emergency Preparedness and Response Plan
6) Contract documents

11.2 WORK PERMIT SYSTEM

- The following activities shall come under Work Permit System
  a. Height working above 2 metres
  b. Hot working at height
  c. Confined space
  d. Radiography
  e. Excavation more than 4 meter depth
  f. Heavy lifting above 50 ton
  Refer Annexure 05 for Work permit formats.
- "HSE Procedure for Work Permit System" shall be followed while implementing permit system. Where customer is having separate Work Permit System the same shall be followed.
- Permit applicant shall apply for work permit of particular work activity at particular location before starting of the work with Job Hazard Analysis.
- Permit signatory shall check that all the control measures necessary for the activity are in place and issue the permit to the permit holder.
- Permit holder shall implement and maintain all control measures during the period of permit .He will close the permit after completion of the work. The closed permit shall be archived in HSE Department of site.

11.3 SAFETY DURING WORK EXECUTION

Respective OCPS are to be followed and adherence to the same would be contractually binding

11.3.1 WELDING SAFETY

All safety precautions shall be taken for welding and cutting operations as per IS-818. All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.

11.3.2 RIGGING

Rigging equipment shall not be loaded in excess of its recommended safe working load. Rigging equipment, when not in use, shall be removed from the original work area so as not to present a hazard to employees.

11.3.3 CYLINDERS STORAGE AND MOVEMENT

All gas cylinders shall be stored in upright position. Suitable trolley shall be used. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced. No of cylinders shall not exceed the specified quantity as per OCP
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.

When cylinders are transported by powered vehicle they shall be secured in a vertical position.

11.3.4 DEMOLITION WORK

Before any demolition work is commenced and also during the process of the work the following shall be ensured:

- All roads and open areas adjacent to the work site shall either be closed or suitably protected.
- 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.
- 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.

11.3.5 T&Ps

All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test/calibration certificates bearing endorsement from competent authority of BHEL..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.

11.3.6 CHEMICAL HANDLING

Displaying safe handling procedures for all chemicals such as lube oil, acid, alkali, sealing compounds etc , at work place.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.

11.3.7 ELECTRICAL SAFETY

- Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts.
- Fulfilling safety requirements at all power tapping points.
- High/ Low pressure welders to be identified with separate colour clothings. No welders will be deployed without passing appropriate tests and holding valid welding certificates. Approved welding procedure should be displayed at work place.
- The subcontractor shall not use any hand lamp energized by Electric power with supply voltage of more than 24 volts in confined spaces like inside water boxes, turbine casings, condensers etc.
- All portable electric tools used by the subcontractor shall have safe plugging system to source of power and be appropriately earthed. Only electricians licensed by appropriate statutory authority shall be employed by the subcontractor to carry out all types of electrical works. Details of earth resource ad their test date to be given to BHEL safety officer as per the prescribed formats of BHEL
- The subcontractor shall use only properly insulated and armored cables which conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.

- BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the cost of the subcontractor.
- All electrical appliances used in the work shall be in good working condition and shall be properly earthed.
- No maintenance work shall be carried out on live equipment.
- The subcontractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installations.
- Area wise Electrical safety inspection is to be carried out on monthly basis as per "Electrical Safety Inspection checklist' and the report is to be submitted to BHEL safety officer
- 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
- The subcontractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltages used in critical areas.

11.3.8 FIRE SAFETY

- Providing appropriate fire fighting equipment at designated work place and nominate a fire officer/warden adequately trained for his job.
- Subcontractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporary structure in labor colony etc. Such fire protection equipment shall be easy and kept open at all times.
- 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.
- 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.
- 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.
- Emergency contacts nos must be displayed at prominent locations
- 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.

11.3.9 SCAFFOLDING

- Suitable scaffolds shall be provided for workman for all works that cannot safely be done from the ground, or from solid construction except in the case of short duration of work which can be done safely from ladders.
- When a ladder is used, it shall be of rigid construction made of steel. The steps shall have a minimum width of 45 cm and a maximum rise of 30 cm. Suitable handholds of good quality wood or steel shall be provided and the ladder shall be given an inclination not steeper then ¼ horizontal and 1 vertical.
- Scaffolding or staging more than 3.6 m above the ground floor, swung or suspended from an overhead support or erected with stationery support shall have a guard rail properly bolted, braced or otherwise secured, at least 90 cm above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from saver, from swaying, from the building or structure.

11.3.10 **WORK AT HEIGHT**:

- Guardrails and toe-board/barricades and sound platform conforming to IS:4912-1978 should be provided.

- Wherever necessary, life-line (pp or metallic) and fall arrestor along with Polyamide rope or Retractable lifeline should be provided.
- Safety Net as per IS:11057:1984 should be used extensively for prevention/ arrest of men and materials falling from height. The safety nets shall be fire resistant, duly tested and shall be of ISI marked and the nets shall be located as per site requirements to arrest or to reduce the consequences of a possible fall of persons working at different heights.
- 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.
- Use of Rebar steel for making Jhoola and monkey-ladder (Rods welded to vertical or inclined structural members), temporary platform etc. must be avoided.
- Monkey Ladder should be properly made and fitted with cages.
- Jhoola should be made with angles and flats and tested like any lifting tools before use.
- Lanyard must be anchored always and in case of double lanyard, each should be anchored separately.
- In case of pipe-rack, persons should not walk on pipes and walk on platforms only.
- In case of roof work, walking ladder/ platform should be provided along with lifeline and/ or fall arrestor.
- Empty drums must not be used.
- For chimney or structure painting, both hanging platform and men should be anchored separately to a firm structure along with separate fall arrestor. Rope ladder should be discouraged.

11.3.11 WORKING PLATFORM

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 as described above. Every opening in the floor or a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 90 cm.

11.3.12 EXCAVATION

Wherever there are open excavation in ground, they shall be fenced off by suitable railing and danger signals installed at night so as to prevent persons slipping into the excavations.

11.3.13 LADDER SAFETY

Safe means of access shall be provided to all working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m in the length while the width between side rails in rung ladder shall in no case be less than app. 29.2 cm for ladder upto and including 3 m in length. For longer ladders this width shall be increased at least ¼'' for each additional foot of length.

A sketch of the ladders and scaffolds proposed to be used shall be prepared and approval of the Engineer obtained prior to Construction.

11.3.14 LIFTING SAFETY

- It will be the responsibility of the subcontractor to ensure safe lifting of the equipment, taking due precaution to avoid any incident and damage to other equipment and personnel.

- All requisite tests and inspection of handling equipment, tools & tackle shall be periodically done by the subcontractor by engaging only the Competent Persons as per law.
- Defective equipment or uncertified shall be removed from service.
- Any equipment shall not be loaded in excess of its recommended safe working load.

11.3.15 HOISTING APPLIANCE

- Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances should be provided with efficient safe guards.
- Hoisting appliance should be provided with such means as will reduce to the minimum the risk of any part of a suspended load becoming incidentally displaced.
- When workers employed on electrical installations which are already energized, insulating mats, wearing apparel, such as gloves, sleeves and boots as may be necessary should be provided.
- The worker should not wear any rings, watches and carry keys or other materials which are good conductor of electricity.

11.4 ENVIRONMENTAL CONTROL

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. 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.

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).

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

All subcontractors shall be responsible for the cleanliness of their own areas.

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.
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, keeping good relation with local populace etc.
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.

11.5 HOUSEKEEPING

- Keeping the work area 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 has to be done by

subcontractor within quoted rate, on daily basis by an identified group. 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 contractor's bill. Such decisions of BHEL shall be binding on the subcontractor

- Proper housekeeping to be maintained at work place and the following are to be taken care of on daily basis.
- All surplus earth and debris are removed/disposed off from the working areas to identified locations.
- Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the working areas are removed to identified locations.
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations. 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 location.
- Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.
- Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.
- Labour 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.
- Fabricated steel structures, pipes & piping materials shall be stacked properly.
- 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.
- Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas

11.6 WASTE MANAGEMENT

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.

11.6.1 BINS AT WORK PLACE

- Sufficient rubbish bins shall be provided close to workplaces.
- Bins should be painted yellow and numbered.
- Sufficient nos. of drip trays shall be provided to collect oil and grease.
- Sufficient qty. of broomsticks with handle shall be provided.
- Adequate strength of employees should be deployed to ensure daily monitoring and service for waste management.

11.6.2 STORAGE AND COLLECTION

- Different types of rubbish/waste should be collected and stored separately.
- Paper, oily rags, smoking material, flammable, metal pieces should be collected in separate bins with close fitting lids.
- Rubbish should not be left or allowed to accumulate on construction and other work places.
- Do not burn construction rubbish near working site.

11.6.3 SEGREGATION

- Earmark the scrap area for different types of waste.
- Store wastes away from building.
- Oil spill absorbed by non-combustible absorbent should be kept in separate bin.
- Clinical and first aid waste stored and incinerated separately.

11.6.4 DISPOSAL

- Sufficient containers and scrap disposal area should be allocated.
- All scrap bin and containers should be conveniently located.
- Provide self-closing containers for flammable/spontaneously combustible material.
- Keep drainage channels free from choking.
- Make schedule for collection and disposal of waste.

11.6.5 WARNING AND SIGNS

- Appropriate sign to be displayed at scrap storage area
- No toxic, corrosive or flammable substance to be discarded into public sewage system.
- Waste disposal shall be in accordance with best practice.
- Comply with all the requirements of Pollution Control Board (PCB) for storage and disposal of hazardous waste.

11.7 TRAFFIC MANAGEMENT SYSTEM

11.7.1 SAFE WORKPLACE TRANSPORT SYSTEM

- 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.
- 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.
- For internal traffic, lines marked on roads / access routes and between buildings shall clearly indicate where vehicles are to pass.
- Temporary obstacles shall be brought to the attention of drivers by warning signs or hazard cones.
- Speed limits shall be clearly displayed. Speed ramps preceded by a warning signs or marker are necessary.
- 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.
- Safest route shall be provided between places where vehicles have to call or deliver.
- Avoid vulnerable areas/items such as fuel or chemicals tanks or pipes, open or unprotected edges and structures likely to collapse

- Safe areas shall be provided for loading and unloading.
- Avoid sharp or blind bends. If this is not possible hazards should be indicated e.g. blind corner.
- Ensure road crossings are minimum and clearly signed.
- Entrance and gateways shall be wide enough to accommodate a second vehicle without causing obstruction.
- Set sensible speed limits which are clearly sign posted.
- Where necessary ramps should be used to retard speed. This shall be preceded by a warning sign or mark on the road.
- Forklift trucks shall not pass over road hump unless of a type capable of doing so.
- Overhead electric cable, pipes containing flammable hazardous chemical shall be shielded by using goal posts height gauge posts or barriers.
- 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.

11.7.2 TRAFFIC ROUTE FOR PEDESTRIANS

- Where traffic routes are used by both pedestrians and vehicles road shall be wide enough to allow vehicles and pedestrians safely.
- 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.
- Where pedestrian and vehicle routes cross, appropriate crossing shall be provided.
- Where crowd is likely to use roadway e.g. at the end of shift, stop vehicles from using them at such times.
- Provide high visibility clothing for people permitted in delivery area.

11.7.3 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:

- o A high level of stability.
- o A safe means of access/egress.
- o Suitable and effective service and parking brakes.
- o Windscreens with wipers and external mirrors giving optimum all round visibility.
- o Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
- o Provision of seat belts.
- o Guards on dangerous parts.
- o Driver protection - to prevent injury from overturning and from falling objects/materials.
- o Driver protection from adverse weather.
- o No vehicle shall be parked below HT/LT power lines.
- o Valid Pollution Under Control certification for all vehicles

11.7.4 DAILY CHECK BY DRIVER

- There should also be daily safety checks containing below mentioned points by the driver before the vehicle is used.
  - Brakes.
  - Tires.
  - Steering.
  - Mirrors.
  - Windscreen waters.
  - Wipers.
  - Warning signals.
  - Specific safety system i.e. control interlocks
- Management should ensure that drivers carry out these checks.

11.7.5 TRANSPORTATION OF PERSONNEL AND MATERIALS BY VEHICLES

- 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.
- 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.
- All overhangs shall be made clearly visible and restricted to acceptable limits
- Load shall be checked before moving off and after traveling a suitable distance.
- 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.
- Warning signs shall be displayed during transportation of material.
  All vehicles used by BHEL shall be in worthy condition and in conformance to the Land Transport requirement.

11.7.6 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.

11.8 EMERGENCY PREPAREDNESS AND RESPONSE

- Emergency preparedness and response capability of site shall be developed as per Emergency Preparedness and Response plan issued by Regional HQ
- Availability of adequate number of first aiders and fire warden shall be ensured with BHEL and its subcontractors
- 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.
- Assembly point shall be earmarked and access to the same from different location shall be shown
- Fire exit shall be identified and pathway shall be clear for emergency escape.

- Appropriate type and number of fire extinguisher shall be deployed as per Fire extinguisher deployment plan and validity shall be ensured periodically through inspection
- 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.
- First aid center shall be developed at site with trained medical personnel and ambulance
- Emergency contact numbers (format given in EPRP) of the site shall be displayed at prominent locations.
- Tie up with fire brigade shall be done in case customer is not having fire station.
- Tie up with hospital shall be done in case customer is not having hospital.
- Disaster Management group shall be formed at site
- Mock drill shall be arranged at regular intervals. Monthly report of the above to be given to BHEL safety Officer as per prescribed BHEL formats
- Mock drill shall be conducted on different emergencies periodically to find out gaps in emergency preparedness and taking necessary corrective action

12.0 HSE INSPECTION

Inspection on HSE for different activities being carried out at site shall be done to ensure compliance to HSEMS 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 etc. 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.

12.1 DAILY HSE CHECKS

Both the Site Supervisors and safety 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:

- Personal Safety wears & gear compliance.
- Complying with site safety rules and permit-to-work (PTW).
- Positions and postures of workers.
- 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.

12.2 INSPECTION OF PPE

- PPEs shall be inspected by HSE officer at random once in a week as per format no. HSEP:14-F06 for its compliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.
- The applicable PPEs for carrying out particular activities are listed below.

12.3 INSPECTION OF T&Ps

- A master list of T&Ps shall be maintained by each subcontractor.
- All T&Ps being used at site shall be inspected by HSE officer once in a month as per format no. HSEP:14-F07 for its healthiness and maintenance.
- 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.
- The validity of T&P shall be monitored as per "Status of T&Ps" format no. HSEP:14-F08

12.4 INSPECTION OF CRANES AND WINCHES

- 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.
- Cranes and Winches shall be inspected by HSE officer once in a month as per format no. HSEP:14-F09 for healthiness, maintenance and validity of third party inspection.
- The date of third party inspection and next due date shall be painted on cranes and winches.
- The operators/drivers shall be authorized by sub-contractor based on their competency and experience and shall carry the I-card.
- 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.

12.5 INSPECTION ON HEIGHT WORKING

- Inspection on height working shall be conducted daily by supervisors before start of work to ensure safe working condition including provision of
    - Fall arrestor
    - Lifelines
    - Safety nets
    - Fencing and barricading
    - Warning signage
    - Covering of opening
    - Proper scaffolding with access and egress.
    - Illumination
- Inspection on height working shall be conducted once in a week by HSE officer as per format no. HSEP:14-F10.
- Medical fitness of height worker shall be ensured.
- Height working shall not be allowed during adverse weather.

12.6 INSPECTION ON WELDING AND GAS CUTTING OPERATION

- Supervisor shall ensure that no flammable items are available in near vicinity during welding and gas cutting activity.
- Gas cylinders shall be kept upright.
- Use of Flash back arrestor shall be ensured at both ends.

- Inspection during welding and gas cutting operations shall be carried out by HSE officer once a month as per format no. HSEP:14-F11.
- Use of fire blanket to be ensured to avoid falling of splatters during welding or gas cutting operation at height.
- Availability of fire extinguisher at vicinity shall be ensured.

12.7 INSPECTION ON ELECTRICAL INSTALLATION / APPLIANCES

- Ensure proper earthing in electrical installation
- Use ELCB at electrical booth
- Electrical installation shall be properly covered at top where required
- Use appropriate PPEs while working
- Use portable electrical light < 24 V in confined space and potentially wet area.
- Monthly inspection shall be carried out as per format no. HSEP:14-F12.

12.8 INSPECTION OF ELEVATOR

- Elevators shall be inspected by concerned supervisors once in a week as per format no. HSEP:14-F13.
- All elevators shall be inspected by competent person and validity shall be ensured.
- The date of third party inspection and next due date shall be painted on elevator.

12.9 INSPECTION OF EXCAVATION

Excavation activities shall be inspected as per Format HSEP:14-F13A

13.0 HSE PERFORMANCE

- Contractor shall be assessed on monthly basis for HSE Compliance by BHEL Safety In-charge at site.
  The HSE compliance shall be based on Online HSE Evaluation System of BHEL as per Format No. HSEP:14-F33.
- BHEL shall reserve the right to use this assessment for evaluating bidder's capacity for future tenders
- Suitable HSE reward system shall be developed at site level to promote HSE compliance amongst workmen by the subcontractor.
  To decide HSE reward, performance towards HSE shall be evaluated for workmen and it shall be awarded regularly in public gathering.
- 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.

14.0 HSE PENALTIES

- As per contractual provision HSE penalties shall be imposed on subcontractors for non- compliance on HSE requirement as per format no. HSEP:14-F14. The list in the format is only indicative. For any other violation, not listed in the format, the minimum penalty amount is to be decided as per BOCW act.
- 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.
- The penalty amount shall be recovered by Site Finance department from subcontractors from the RA/Final bill.

15.0 OTHER REQUIREMENTS

- In case of any delay in completion of a job due to mishaps attributable to lapses by the subcontractor, BHEL shall have the right to recover cost of such delay from the payments due to the subcontractor, after notifying the subcontractor suitably.
- 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 at the risk and cost of the subcontractor after giving a notice of not less than 7 days indicating the steps that would be taken by BHEL.
- 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.
- 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.
- 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.
- 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.
- The subcontractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard.
- 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.

- 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.

16. NON COMPLIANCE

NONCONFORMITY OF SAFETY RULES AND SAFETY APPLIANCES WILL BE VIEWED SERIOUSLY AND BHEL HAS RIGHT TO IMPOSE FINES ON THE SUBCONTRACTOR AS UNDER FOR EVERY INSTANCE OF VIOLATION NOTICED:

SN	Violation of Safety Norms	Fine (in Rs)
01	Not Wearing Safety Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03	Not wearing safety shoe	200/-*
04	Not keeping gas cylinders vertically	200/-
05	Not using flash back arrestors	100/-
06	Not wearing gloves	50/- *
07.	Grinding Without Goggles	50/- *
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slinging properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

- Legend:-

  *: per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

  #: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

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. The amount will be deducted from running bills of the subcontractor. The amount collected above will be utilized for giving award to the employees who could avoid incident by following safety rules. Also the amount will be spent for purchasing the safety appliances and supporting the safety activity at site.

17.0 HSE AUDIT/INSPECTION

- Regular HSE Audit/inspection shall be carried out by Subcontractor as per Site HSE audit calendar.
- HSE checklist **(Annexure 02)** shall be used for carrying out audit/inspection and report shall be submitted to BHEL site management
- All non-conformities and observations on HSE identified during internal or external HSE audit shall be disposed off by site in a time bound manner and reported back the implementation status
- Corrective action and Preventive action on HSE issues raised by certification body issued by Regional HQs shall be implemented by site and reported to Site management.

18.0 MONTHLY HSE REVIEW MEETING

- Site shall hold HSE review meeting every month to discuss and resolve HSE issues of site and improve HSE performance. It will also discuss the incidents occurred since previous meeting,its root cause and Corrective action and Preventive action. The agenda is given below:
  - Implementation of earlier MOM
  - HSE performance
  - HSE inspection
  - HSE audit and CAPA
  - HSE training
  - Health check-up camp
  - HSE planning for the erection and commissioning and installation activities in the coming month
  - HSE reward and promotional activities
- The meeting shall be chaired by Construction Manager, convened by HSE coordinator and attended by all HOS, Site Incharge of Subcontractors and HSE officer of Subcontractors.
- MOM on the discussion will be circulated to the concerned for implementation.

19.0 FORMATS USED (Details available in Annexure-04)

SL. No.	Format Name	Format No.	Rev No.
01	Inspection of First Aid Box	HSEP:14-F01	00
02	Health Check Up	HSEP:14-F02	00
03	HSE Induction Training	HSEP:14-F03	00
04	Tool Box Talk	HSEP:14-F04	00
05	Monthly Site HSE Report	As specified by BHEL	00
06	Inspection of PPE	HSEP:14-F06	00

07	Inspection of T&Ps	HSEP:14-F07	00
08	Status of T&Ps	HSEP:14-F08	00
09	Inspection of Cranes and Winches	HSEP:14-F09	00
10	Inspection on Height Working	HSEP:14-F10	00
11	Inspection on Welding & Gas Cutting	HSEP:14-F11	00
12	Inspection on Electrical Installation	HSEP:14-F12	00
13	Inspection on Elevator	HSEP:14-F13	00
14	HSE Penalty	HSEP:14-F14	00
15	Accident /incident / property damage /fire incident report	HSEP:14-F15	00

20.0 ANNEXURES

ANNEXURE 01

As per Contract Labour (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 labour 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 Labour 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 labour 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 labour 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 02

HSE AUDIT/INSPECTION CHECKLIST CUM COMPLIANCE REPORT

PROJECT:_____ SUBCONTRACTOR:_____

DATE : _____ OWNER :_____

INSPECTION BY:_____

Note : write 'NA' wherever the items is not applicable

Item	Yes	No	Remarks	Action
HOUSEKEEPING				
Waste containers provided and used				
Passageways and walkways clear				
General neatness of working area				
Other				
PERSONNELPROTECTIVEEQUIPTMENTS				
Goggles; shields				
Face protection				
Hearing protection				
Respiratory masks etc.				
Safety belts				
Other				
EXCAVATIONS / OPENINGS				
Openings properly covered or barricaded				
Excavations shored				
Excavations barricaded				
Overnight lighting provided				
Other				
WELDING, CUTTING				
Gas cylinders chained upright				
Cable and hoses not obstructing				
Fire extinguisher (s) accessible				
Others				
SCAFFOLDING				
Fully decked platforms				
Guard and intermediate rails in place				
Toe boards in place				
Adequate shoring				
Adequate access				
Others				
LADDER				
Extension side rails 1 m above				
Top of landing				
Properly secured				

Angle + 70^0 from horizontal				
Other				
HOISTS, CRANES AND DERRICKS				
Condition of cables and sheaf OK				
Condition of slings, chains, hooks OK				
Inspection & maintenance log maintained				
Outriggers used				
Signals observed and understood				
Qualified operators				
Others				
MACHINERY, TOOLS & EQUIPMENT				
Proper instruction				
Safety devices				
Proper cords				
Inspection and maintenance				
Other				
VEHICLE AND TRAFFIC				
Rules and regulations observed				
Inspection and maintenance				
Licensed drivers				
Other				
TEMPORARY FACILITIES				
Emergency instructions posted				
Fire extinguishers provided				
Fire-aid equipment available				
General neatness				
Others				
FIRE PREVENTION				
Personnel instructed				
Fire extinguishers checked				
No smoking in prohibited areas.				
Hydrants				
Clearance				
Others				
ELECTRICAL				
Proper wiring				
ELCB's provided				
Ground fault circuit interrupters				
Protection against damage				
Prevention of tripping hazards				
Other				
HANDLING & STORAGE OF MATERIALS				
Properly stored or stacked				
Passageways clear				
Other				
FLAMMABLE GASES AND LIQUIDS				
Containers clearly identified				
Proper storage				
Fire extinguisher nearby				

Other				
WORKING AT HEIGHT				
Safety nets				
Safety belts				
Safety helmets				
Anchoring of safety belt to the life line rope				
ENVIRONMENT				
Lubricant waste/engine oils properly dispose.				
Waste from Canteen, offices, sanitation etc. disposed properly.				
Disposal of surplus earth, stripping materials, expired batteries, oily rags and combustible materials done properly.				
HEALTH CHECKS				
Hygienic conditions at labor camps O.K.				
Availability of first-aid facilities				
Proper sanitation at site, office & labor camps.				
Arrangement of medical facilities.				
Measures for dealing with illness.				
Availability of potable drinking water for workmen & staff.				
Provision of crèches for children.				

ANNEXURE 03

REFERENCES

- Contract documents
- Relevant legislations
- HSEMSM
- Relevant Indian standards as listed below (illustrative only):

SL NO	CODE NAME	TITLE
(1)	IS : 818-1888 (Reaffirmed 2003)	Code of Practice for safety and health requirements in Electric and Gas Welding and Cutting operations.
(2)	IS: 1179-1967 (Reaffirmed 2003)	Specification for Equipment for Eye & Face protection during welding.
(3)	IS : 1989 (Part 2):1986 (Reaffirmed 1997)	Specification for Leather Safety Boots & Shoes
(4)	IS:2925 – 1984 (Reaffirmed 2010)	Specification for Industrial Safety Helmets
(5)	IS:3521 : 1999 (Reaffirmed 2002)	Industrial Safety Belts & Harnesses-Specification
(6)	IS:3646(Part II) – 1966 (Reaffirmed 2003)	Code of Practice for Interior Illumination
(7)	IS:3696 (Part I) – 1987 (Reaffirmed 2002)	Safety Code for Scaffolds and Ladders
(8)	IS: 3696(Part 2) : 1991 (Reaffirmed 2002)	Scaffolds and Ladders-Code of Safety
(9)	IS:3786 – 1983 (Reaffirmed 2002)	Method for Computation of Frequency and Severity Rates for Industrial Injuries and Classification of Industrial Incidents
(10)	IS:4770 : 1991 (Reaffirmed 2006)	Rubber Gloves – Electricals purposes-Specification
(11)	IS:4912 : 1978 (Reaffirmed 2002)	Safety Requirements for Floor and Wall Openings, Railings and Toe Boards
(12)	IS: 5983 – 1980 (Reaffirmed 2002)	Specification for Eye-Protectors
(13)	IS:6519 – 1971 (Reaffirmed 1997)	Code of Practice for Selection, Care and Repair of Safety Footwear
(14)	IS:9167:1979	Specification for Ear-Protectors
(15)	IS:6994(Part I)-1973 (Re affirmed 1996)	Specification for Industrial Safety Gloves Leather and Cotton Gloves
(16)	IS:8519 – 1977 (Reaffirmed 1983)	Guide for Selection of Industrial Safety Equipment for Body Protection.
(17)	IS 11006 : 2011	Flash Back(Flame Arrestor) Specification

(18)	IS:8520 – 1977 (Reaffirmed 2002)	Guide for Selection of Industrial Safety Equipment for Eye, Face and Ear Protection.
(19)	IS:9473:2002	Respiratory Protective Devices-Filtering Half Masks to protect against Particles-Specification.
(20)	IS:9944:1992 (Reaffirmed 2003)	Natural and Man-made Fiber Rope Slings-Recommendations on Safe working loads.
(21)	IS:11057 – 1884 (Reaffirmed 2001)	Specification for Industrial Safety Nets
(22)	IS:12254:1993 (Reaffirmed 2002)	Polyvinyl Chloride (PVC) Industrial Boots-Specification
(23)	IS:13367(Part 1):1992 (Reaffirmed 20030	Safe Use of Cranes-Code of Practice
(24)	IS:14166:1994 (Reaffirmed 2002)	Respiratory Protective Devices-Full Face Masks Specification
(25)	IS:14746 : 1999 (Reaffirmed 2003)	Respiratory Protective Devices-Half Masks and Quarter Masks - Specification
(26)	IS : 15397 :2003 (Reaffirmed 2008)	Portable Extinguisher Mechanical Foam Type(Stored Pressure)-Specification
(27)	IS: 19011:2002	Guidelines for Quality and/or Environmental Management Systems Auditing

ANNEXURE 04 : SAFETY FORMATS
&
ANNEXURE 05 : WORK PERMIT FORMATS

	POWER SECTOR	FORMAT NO: HSEP:14-F01 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF FIRST AID BOX	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Number of employees on the site: -_____

Sl.No.	**Item**	**No. Available**	**Remarks**
1	No. of small sterilized dressings		
2	No of medium sized sterilized dressings		
3	No of large sized sterilized dressings.		
4	No of large sized sterilized burn dressings		
5	No of (15 grams) packets sterilized cotton wool		
6	No of pieces of sterilized eye pads in separate sealed packets.		
7	No of roller bandages 10 cm wide.		
8	No of roller bandages 5 cm wide.		
9	Whether tourniquet available		
10	Whether supply of Suitable splints available.		
11	No of packets of safety pins.		
12	Whether kidney tray available		
13	Whether sufficient number of eye wash bottles, filled with distilled water or suitable liquid, clearly indicated by a distinctive sign which shall be visible at all times, available.		
14	Whether 4%-xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops available.		
15	Whether (60ml) bottle containing a two percent alcoholic solution of iodine available		
16	Whether (two hundred ml) bottle of mercurochrome (2 per cent) solution in water available.		

Sl.No.	Item	No. Available	Remarks
17	Whether 120ml bottle containing Sal volatile having the dose and mode of administration indicated on the label, available.		
18	Whether roll of adhesive plaster (6 cmX1 meter) available		
19	No of rolls of adhesive plaster (2 cmX1 meter)		
20	Whether snake bite lancet available.		
21	Whether (30 grams) bottle of potassium permanganate crystals available.		
22	Whether a pair scissors available		
23	Whether copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India available.		
24	Whether bottle containing 100 tablets (each of 5 grains) of aspirin available		
25	Whether Ointment for burns available		
26	Whether bottle of a suitable surgical anti-septic solution available		

Signature of Subcontractor's Site I/C:

	POWER SECTOR	FORMAT NO: HSEP:14-F02 REV NO.: 00 PAGE NO. 1 OF 02
	HEALTH CHECK UP	

Name of Site :	
Name of Sub-Contractor :	
Name of Employee :	

NAME:

History Of Past Illness	H/O Epilepsy
	H/O Drug Allergy
	H/O Diabetics/ Hypertension
	H/O Unconsciousness
Personal History	

EXAMINATION		**OBSERVATION**	
General Physical Examination			
Height	:		
Weight	:		
BMI	:		
Built And nourishment	:		
Pallor	:		
Temperature	:		
Chest Expansion	:	Inspiration	Expansion
Lymph Node Enlargement	:		
Ear, Nose, Throat	:		
Ear	:		
Nose	:		
Throat	:		

EXAMINATION		OBSERVATION	
Cardiovascular System Examination :			
Inspection	:		
Palpation	:	Pulse	BP
Auscultation (Heart Sounds)	:		
Respiratory System	:		
Inspection	:	Respiratory Rate	
Palpation:	:		
Percussion	:		
Auscultation (Breath Sounds)	:		
Examination of Abdomen	:		
Inspection	:		
Palpation	:		
Auscultation (Bowel Sounds)	:		
Any Other	:		
Clinical Impression			

Signature of the examining doctor

	POWER SECTOR **HSE INDUCTION TRAINING**	FORMAT NO: HSEP:14-F03 REV NO.: 00 PAGE NO. 01 OF 01

Name of Site :	
Name of Sub-Contractor :	
Date :	
Name of Training Co-ordinator	

Sl No.	**Name**	**Designation**	**Organisation**	**Signature**

Signature of Training co-ordinator :

	POWER SECTOR	FORMAT NO: HSEP:14-F04 REV NO.: 00 PAGE NO. 01 OF 01
	TOOL-BOX TALK	

Name of Site :	
Sub-Contractors Name :	
Date :	

Topic	**Name of person delivered Tool Box Talk**	**No. of Participants attended**	**Remarks**

Signature of Site I/C of Subcontractor :

	POWER SECTOR **PERSONAL PROTECTIVE EQUIPMENTS**	FORMAT NO: HSEP:14-F06 REV NO.: 00 PAGE NO. 01 OF 01

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Item	**Issued this Month**	**Nos. Issued up to the Month**	**Percentage of usage at site**
Safety Helmet			
Safety Shoes			
Full Body Harness			
Fall Arrestor			
Safety Nets			
Other PPEs.			

Signature of Site I/C of Subcontractor :

	POWER SECTOR **INSPECTION OF T&Ps**	FORMAT NO: HSEP:14-F07 REV NO.: 00 PAGE NO. 01 OF 01

Name of Site :	
Name of Sub-Contractor :	
Date of Inspection :	

Sl.No.	Description	Remarks	
1.0	Name of equipment		
2.0	Basic Information of equipment		
2.1	Specification		
2.2	Sr. No. of equipment		
2.3	Make		
2.4	Year of manufacture		
3.0	Major repairs / overhauls(Furnish details of work carried out)		Date(s) of major repair/overhaul
3.1			
3.2			
3.3	Repairs carried out at site		
4.0	Any performance test conducted	Yes/No	
5.0	Document Submitted	Yes/No	
6.0	Manufacturer's test / guarantee certificate	Available/ Not available	
7.0	Performance test	Done/ Not Done	
8.0	Acceptance Norms		
9.0	Committee Observations		
10.0	Date of next review (if accepted)		

Signature-Site Safety Officer (BHEL)	**Signature-Subcontractor/ Subcontractor's Safety Officer**

	POWER SECTOR **STATUS OF T&Ps**	FORMAT NO: HSEP:14-F08 REV NO.: 00 PAGE NO. 01 OF 01

Name of Site	
Name of Sub-Contractor	
Date of Inspection	

Item	**Nos. Deployed**	**Identification No.**	**Nos. Tested by competent person**	**Validity of Test Certificate**
Winches				
Chain Blocks				
Wire Rope Slings				
Man Cages				
D-Shackles				
Air Compressors				
Crawler Cranes				
Mobile Cranes				
Hydra Cranes				
Others				

Signature of Site I/C of subcontractor:

	POWER SECTOR **INSPECTION OF CRANES AND WINCHES**	FORMAT NO: HSEP:14-F09 REV NO.: 00 PAGE NO. 01 OF 03

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Crane Reg. No (Make/Model) _____

Name of Driver/Operator _____

Sl.no.	Description	Observation	Measures
1	Valid Driving license		
2	Hook & Hook Latch		
3	Over Hoist limit switch		
4	Boom limit switch		
5	Boom Angle Indicator		
6	Boom limit cutoff switch		
7	Condition of Boom		
8	Condition of ropes		
9	Number of load lines		
10	Size and condition of the slings		
11	Stability of the cranes		
12	Soil Condition		
13	Swing Break And Lock		
14	Proper Break And Lock		
15	Hoist Break And Lock		
16	Boom Break And Lock		
17	Main Clutch		
18	Leakage in Hydraulic Cylinders		
19	Out riggers filly extendable		
20	Tyre pressure		
21	Condition of Battery And Lamps		

Sl.no.	Description	Observation	Measures
22	Guards of moving and rotating parts		
23	Load chart provided		
24	Number and position of pedant ropes		
25	Reverse Horn		
26	Load Test Details		
27	Operator's fitness		
28	Pollution under control certificate		
29	Fire extinguisher of appropriate type.		
30	Training of the operator		

WINCH

Sl. No.	Description	YES	NO	NA	Remarks
1	Has the copy of Third Party Inspection certificate been provided in winch machine shed?				
2	Is winch machine operator experienced enough to operate the winch machine?				
3	Is the winch machine operated by someone other than the winch machine operator?				
4	Is there guard provided in all moving parts like wheel and motor's shaft?				
5	Will it protect against unforeseen operational contingencies?				
6	Are brakes, clutch and locking arrangement working properly?				
7	Has it been ensured that the guard does not constitute a hazard by itself?				
8	Are the cranks and the connecting rods protected by guardrails?				
9	Is there provision for fully covered shed with wooden plank roof?				

Sl. No.	Description	YES	NO	NA	Remarks
10	Is wire rope free from any kind of damage or wear and tear?				
11	Is split pin provided for the protection of clutch and brake locking arrangement?				
12	Is pulley inspected by competent person and certified before use?				
13	Is pulley free from any wear and tear visually?				
14	Is winch rope barricaded with clipsheet for the protection of rope and person?				
15	Is the wire rope lubricated by cardium oil?				
16	Is there any friction in wire rope which may damage the wire rope rather than the rolling parts?				
17	Is there any oil leakage in the hydraulic system of the winch machine?				
18	Has it been ensured that the guard will not cause discomfort or inconvenience to operator?				
	Total Number of NO:				
	Total Number of NA:				
	% Compliance :				

Signature of Site I/C of subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:14-F10 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF HEIGHT WORKING	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Sl. No.	**Descriptions**	**Observation (Yes/No)**	**Remarks**
1	All the workers have been explained safe work method?		
2	An established communication system has been established and explained to the workers.		
3	Adequate illumination has been ensured.		
4	Work area inspected prior to the start of the work.		
5	Area below the work place barricaded, particularly below hot work.		
6	Workers provided with bags /box to carry bolts, nuts and hand tools		
7	Arrangement for fastening hand tools made.		
8	All work platforms ensured to be of adequate strength and ergonomically suitable.		
9	Fabricated makeshift arrangements are checked for quality and type of material welding, anchoring etc.		
10.	Work at more than one elevation at the same segment is restricted.		
	ACCESS/EGRESS		
1	Walkways provided with handrail, mid-rail and toe guard?		
2	All checkered plates, gratings properly welded/ bolted?		
3	Are ladders inspected and they are in good condition?		
4	Are ladders spliced?		
5	Are ladders properly secured to prevent slipping, sliding or falling?		
6	Do side rails extend 36” above top landing?		
7	Are built up ladders constructed of sound materials?		

	POWER SECTOR	FORMAT NO: HSEP:14-F10 REV NO.: 00 PAGE NO. 02 OF 02
	INSPECTION OF HEIGHT WORKING	

Sl. No.	Descriptions	Observation (Yes/No)	Remarks
8	Are rugs and cleats not over 12” on center?		
9	Metal ladders not used around electrical hazards.		
10	Proper maintenance and storage.		
11	Ladders placed at right slope.		
12	Ladders / staircases welded/ bolted properly.		
13	Any obstruction in the stairs.		
14	Are landing provided with handrails, knee rails, toe boards etc.?		
15	Whether ramp is provided with proper slope.		
16	Proper hand rails / guards provided in ramps.		
	Housekeeping		
1	Walkways, aisles & all overhead workplaces cleared of loose material.		
2	Flammable materials, if any, are cleared.		
3	All the de shuttering materials are removed after de shuttering is done.		
4	Platforms and walkways free from oil/grease or other slippery material.		
5	Collected scrap are brought down or lowered down and not dropped from height.		
	PPE And Safety Devices		
1	Use of safety helmet, safety belts ensured for all workers		
2	Anchoring points provided at all places of work.		
3	Common lifeline provided wherever linear movement at height is required.		
4	Safety nets are use wherever required.		
5	Proper fall arrest system is deployed at critical workplaces.		
6	Crawler boards/Safety system or works on fragile roof are used.		

Signature of Site I/C of subcontractor :

	POWER SECTOR **INSPECTION OF WELDING AND GAS CUTTING**	FORMAT NO: HSEP:14-F11 REV NO.: 00 PAGE NO. 1 OF 02

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Welding				
Sl.no.	Description	Yes	No	Remarks
1	Is electric connection given through 30 mA ELCB/RCCB to welding m/c?			
2	Is electric cable fitted properly in junction box on m/c?			
3	Is electrical cable free from joints?			
4	Are the joints attached firmly & insulated with tape?			
5	Is double earthing given to body of m/c?			
6	Is the physical condition of the m/c good?			
7	Is ON/OFF switch connected to the m/c is working and in good condition?			
8	Are indication lamps on m/c working?			
9	Is the electrode holder in good condition?			
10	Are the cables of the welding m/c lugged & tight properly?			
11	Are return lead connected properly (Rod, Angle, Channels shall not be used)			
	Total No of NO			
	Total No of YES			

	POWER SECTOR **INSPECTION OF WELDING AND GAS CUTTING**	FORMAT NO: HSEP:14-F11 REV NO.: 00 PAGE NO. 2 OF 02

Gas Cutting				
Sl. no	Description	Yes	No	Remarks
1	Are Cylinders kept on trolleys?			
2	Physical condition of Gas cylinders Good?			
3	Is there Oil/Grease on valve of the cylinder?			
4	Are pressure regulators in good condition?			
5	Condition of hose pipe OK?			
6	Are hose pipe clamped with hose clip?			
7	Is flash back arrestor & NRV fitted on torch both for O2 and LPG cylinder?			
8	Is nozzle of the torch cleaned?			
	Total Number of NO			
	Total No of YES			
	% Compliance			

Signature of Site I/C of subcontractor :

	POWER SECTOR **INSPECTION OF ELECTRICAL INSTALLATION**	FORMAT NO: HSEP:14-F12 REV NO.: 00 PAGE NO. 01 OF 02

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection:	

Sr. No.	**Contents**	**Yes/No**	**Remarks**
A	**Cable**		
1.	Whether the condition of cable is checked?		
2.	Are cables received from other sites checked for insulation resistance before putting them into use?		
3.	Are all main cables taken either underground / overhead?		
4.	Are welding cables routed properly above the ground?		
5.	Are welding and electrical cables overlapping?		
6.	Is any improper joining of cables/wires prevailing at site?		
B	**DBs/SDBs**		
1.	Is earth conductor continued up to DB / SDB?		
2.	Whether DBs and extension boards are protected from rain / water?		
3.	Is there any overloading of DBs / SDBs?		
4.	Are correct / proper fuses & CBs provided at main boards and sub-boards?		
5.	Is energized wiring in junction boxes, CB panels & similar places covered all times?		
C	**ELCB**		
1.	Whether the connections are routed through ELCB?		
2.	Is ELCB sensitivity maintained at 30 mA?		

Sr. No.	Contents	Yes/No	Remarks
3.	Are the ELCB numbered and tested periodically & test results recorded in a logbook countersigned by a competent person?		
D	**Grounding**		
1.	Is natural earthing ensured at the source of power (main DB at Generator or Transformer)?		
2.	Whether the continuity and tightness of the earth conductor are checked?		
3.	Mention the gauge of the earth conductor used at the site.		
4.	Mention the value of Earth Resistance.		
E	**Electrically operated Machines or Accessories**.		
1.	Whether the plug top is provided everywhere.		
2.	Are all metal parts of electrical equipment and light fittings / accessories grounded?		
3.	Is there any shed or cover for welding machines?		
4.	Are halogen lamps fixed at proper places?		
5.	Are portable power tools maintained as per norms?		
6.	Any other information:		

Signature of Site I/C of subcontractor :

	POWER SECTOR **INSPECTION OF ELEVATOR**	FORMAT NO: HSEP:14-F13 REV NO.: 00 PAGE NO. 01 OF 01

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Sr. No.	**Description**	**Remarks**
1.0	Name of equipment	
2.0	Basic Information of equipment	
2.1	Specification	
2.2	Sr. No. of equipment	
2.3	Make	
2.4	Year of manufacture	
3.0	Major repairs/overhauls(Furnish details of work carried out)	Date(s) of major repair/overhaul
3.1		
3.2		
3.3	Repairs carried out at site	
4.0	Any performance test conducted	Yes/No
5.0	Document Submitted	Yes/No
6.0	Manufacturer's test / guarantee certificate	Available/ Not available
7.0	Performance test	Done/ Not Done
8.0	Acceptance Norms	
9.0	Committee Observations	
10.0	Date of next review (if accepted)	

Signature-Subcontractor/ Subcontractor's Safety Officer	**Signature-Site Safety Officer (BHEL)**

	POWER SECTOR	FORMAT NO: **HSEP:14-F13E** REV NO.: 00 PAGE NO. 01 OF 01
	Inspection of Excavation	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Sl.no.	Description	Yes	No	Remarks
1	Precautions taken for Underground Electrical Cable			
2	Precautions taken for Under / Above ground sewer/ Drinking Water Line			
3	Precautions taken for Underground Telecommunication Line			
4	Precautions taken for Underground Product/Utility Line			
5	Precautions taken for Underground Fire Water Line			
6	Shoring / Shuttering / Sheet piling done to prevent collapse of excavation walls. Strength of Excavation wall ensured at all times			
7	Slope Cutting / Angle Maintained			
8	Hard Barricading & Edge Protection provided			
9	Separate Safe Access for Man and Vehicle			
10	Lighting arrangement			
11	Banksman Provided			
12	Required basic PPEs provided			
13	Excavated soil / Construction Material / equipment kept away from the edge.			
14	First aid in attendance.			
15	Other:			
	Total No of YES			

Signature-Subcontractor/ Subcontractor's Safety Officer **Signature-Site Safety Officer (BHEL)**

Sub: MEMO for Penalty for non-compliances in Safety

Following lapse (tick marked) was observed and penalty is imposed as stated at the bottom of this memo. It is requested that such occurrences be please avoided in future.

Safety Area

SN	Violation of Safety Norms	Fine (in Rs)
01	Not Wearing Safety Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03	Not wearing safety shoe	200/-*
04	Not keeping gas cylinders vertically	200/-
05	Not using flash back arrestors	100/-
06	Not wearing gloves	50/- *
07.	Grinding Without Goggles	50/- *
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slinging properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

Legend: -

*: per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

#: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

Details (if any) related to non- compliance (Name of persons, Nature of deficiency, etc.)

_____

Penalty imposed:

1, Rate as per above chart_____

2. No. of Persons/ machine/ event/ labour _____

3. Total Penalty= 1. X 2. =_____

Signature:

Witnessed by: (Sub- Contractor representative) (BHEL Personnel)

Name_____ Name_____

Distribution: 1 Copy: to Sub- contractor,
1 Copy to Site Construction Manager (BHEL)

बी एच ई एल BHEL	**POWER SECTOR- HQ** **Incident Report** (To be submitted within 24 hours of time of incident)	FORMAT NO: HSEP:14-F15 REV NO.: 00 PAGE NO. 01 OF 01

Type of incident: Fatal/Major/ Minor/Fire/Property Damage/Near-miss

1	NAME OF SITE		3	ACTIVITY AREA	
2	SCOPE OF WORK		4	NAME OF CONTRACTOR	
			5	NAME & DESIGNATION OF BHEL ACTIVITY I/C	
6	DATE & TIME OF ACCIDENT		7	DATE RESUMED	
8	NO. OF WORK-DAYS LOST BY VICTIM (If duty not resumed, give estimated figure)				
9	NO. OF MANHOURS LOST BY OTHERS				
10	PERSONAL DETAILS OF INJURED AND / OR DETAILS OF MATERIALS / EQUIPMENT / PROPERTY DAMAGED				

NAME				NAME OF MATERIAL / EQUIPMENT / PROPERTY	
PERIOD OF EMPLOYMENT					
AGE	YRS	SEX	MALE/ FEMALE	ESTIMATED COST	ACTUAL COST
MARITAL STATUS	SINGLE / MARRIED				
OCCUPATION				NATURE OF DAMAGE	
PART OF BODY INJURED					
NATURE OF INJURY					
AGENCY (OBJECT / EQUIPMENT / SUBSTANCE) MOST RESPONSIBLE FOR CAUSING ACCIDENT / INJURY / DAMAGE					
12	PERSON (NAME & DESIGNATION) WITH MOST CONTROL OVER AGENCY (OBJECT / EQUIPMENT / SUBSTANCE) CAUSING ACCIDENT INJURY / DAMAGE				
13	DESCRIBE CLEARLY HOW THE ACCIDENT OCCURRED (USE ADDITIONAL SHEET, IF REQUIRED				
ANALYSIS					
14	WHAT ACTS AND / OR CONDITIONS CONTRIBUTED MOST DIRECTLY TO THIS ACCIDENT				
15	WHAT ARE THE BASIC REASON FOR THE EXISTENCE OF THESE ACTS AND / OR CONDITION ?				
16	WHAT CORRECTIVE ACTIONS HAVE BEEN TAKEN TO PREVENT ACCIDENT RECURRENCE ?				
	DATE :			SIGNATURE OF SITE HSE COORDINATOR	
17	COMMENTS OF HEAD / SOX				
	DATE:			SIGNATURE OF HEAD/SOX	

	POWER SECTOR	FORMAT NO: **HSEP:14-F30** REV NO.: 00 PAGE NO. 01 OF 3
	Format for Monthly HSE Planning & Review	

Note: This is a template and can be modified in consultation with BHEL			
Name of the Site		**Name of the Subcontractor**	
Scope of Work		**Date**	
PART- A: PLAN OF HSE ACTIVITIES FOR THE MONTH OF……			**PART-B: REVIEW ON ……**
SN.	**Description of HSE Activity & Formats**	**Plan & Targets for the month**	**Review**
1	Availability of First Aid Box at Required Places and Inspection thereof as per Format: F01	Areas 1. … …	
2	Health check-up as per Format: F02	Health check-up for Nos 1. New inductees 2. Drivers & Operators 3. Workers in following high risk areas: a. …	
3	Induction training of newly joined workers as per Format: F03	Minimum No. of workers:	
4	Toolbox talks (TBT) conducted before start of work as per Format: F04	Locations of TBTs & No. of workers **1.** …	
5	PPE usage and issue as per Format: F06		
6	Inspection of T&Ps as per Format: F07	List of T&Ps to be inspected 1.	
7	Identification & Inspection Status of T&Ps as per Format: F08		
8	Inspection of Cranes & Winches as per Format: F09	List of Cranes & Winches & Nos. 1. …	
9	Inspection of Height Working as per Format: F10	Areas: 1. …	
10	Inspection of Welding & Gas Cutting operations as per Format: F11	Areas: 1. …	
11	Inspection of Electrical Installations as per Format: F12	Locations: 1. …	
12	Inspection of Elevators (as applicable) as per Format: F13	Locations: 1. …	
13	Inspection of Excavation as per Format: F13E	**Locations:** **1. …**	

SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
14	Job Safety Analysis as per Format F32B	**Activities:** **1. …**	
15	Regular Job Specific Training (Re-training) for workers involved in hazardous activities	Topics/ Hazards & No. of workers **1.** …	
16	Mass housekeeping (HK) drive in work areas	Areas **1.** …	
17	Vertigo Test of Height workers	Minimum No. of workers:	
18	Deployment of qualified HSE Officers as per contract	Location(s) & Nos. **1.** …	
19	Deployment of qualified HSE Stewards as per contract	Location(s) & Nos. **1.** …	
20	Deployment of Safety tools & Equipment (Safety Nets, Lifelines, Fall arrestors, Man-cages, flashback arrestors, scaffolding etc.)	Tool/ Equipment & Location **1.** …	
21	Safety Walks by site in charge of agency (4 -Weekly once)	Dates:	
22	Safety walks by departmental head (8-Weekly twice)	Dates:	
23	Availability/ deployment of Safety posters/ placards/ signage at strategic locations	Locations: Nos. **1.** …	
24	Provision of clean drinking water sources for workers	Locations: Nos. **1.** …	
25	Provision of toilets for workers (separate for male & female workers)	Locations: Nos. **1.** …	
26	Rest sheds for workers during lunchtime, rain, dust storm etc.	Locations: Nos. **1.** …	
27	Availability of following in Labor colony	**1. Clean drinking water** **2. Toilets** **3. Cleanliness & Hygiene** **4. Grass cutting,** **5. Fogging** **6. Electrical Inspection …**	

SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
28	Availability of dust/ waste bins at various locations	Locations: **1.** …	
29	Availability of Ambulance (individual/ joint) in each shift	Ambulance No.	
30	Availability of emergency vehicle in each shift	Emergency vehicle	
31	Deployment/ Availability of tested Fire Extinguishers	Locations & Nos. **1.** …	
32	Tree plantation	Locations & Nos. **1.** …	
33	Waste disposal & Scrap Bins	Locations **1.** …	
34	Illumination checks	Locations **1.** …	
35	Safety award function: 1. Display of good practices Award presentation	Minimum 1 per month	
36	**Submission of Daily Reports as per Format No.F31A**	**Daily Reports (Night & Day Shifts)**	

PLAN		**REVIEW**	
Agency Name: Sign: Date:	**BHEL** Name: Sign: Date:	**Agency** Name: Sign: Date:	**BHEL** Name: Sign: Date:

	POWER SECTOR	FORMAT NO: **HSEP:14-F31** A REV NO.: 00 PAGE NO. 01 OF 1
	Format for Daily HSE Reporting	

Note: Following format to be submitted (preferably) in excel/ soft copy by subcontractor daily at the end of each shift. Any photographs/ records to be attached

Site									**Subcontractor**																		
Year							**Month**													**Day**							
SHIFT	Submitted By	Work Area(s)	Staff	Man-Power	Safety Officers	Safety Stewards	Tool Box (Topics and No. of Participants)	Induction Training (No. of Participants)	Vertigo Test (Numbers Tested)	On-the-Job Training (Topic & participants)	Work Permits	Job Safety Analyses conducted	Height Work Inspection	Other Hazardous Activities Inspection	T&P Inspection (Names & Nos. Inspected)	Safety Walk (Designation, Areas)	HSE Meeting	Safety Reward (Details)	Housekeeping/ Dust Suppression/ Tree Plantation Activities (Locations/Details)	Lost time Accident	Restricted Work Case	Medical Treatment Case	First Aid Case	Near miss	Property Damage/ Fire	Non-Compliances Submitted by BHEL	Complied by Agency	Any other Remarks/ Inputs
Day																											
Night															NA		NA	NA	NA								

	POWER SECTOR **Job Safety Analysis Format**	FORMAT NO: **HSEP:14-F32B** REV NO.: 00 PAGE NO. 01 OF 1

Name of the Site	
Name of the Subcontractor	
Activity, Area	

HAZARDS	**PRECAUTIONS**

(Name)	**Submitted By (Agency HSE)**		**Reviewed By (BHEL Execution)**		**Approved By (BHEL HSE)**	
(Sign)						
(Date)						

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
1a	Induction training for new workers conducted through audio-visual medium & documented ?	M	1	Induction Training Records
1b	Tool box talk conducted regularly as per plan, and documented?	M	1	Toolbox Talk Records
1c	Contractor in charge and safety in charge attended safety meetings?	M	2	Minutes of Meeting
1d	Whether observations in safety meetings are complied before next meeting?	M	2	-do-
1e	Preparation and submission of Monthly HSE report within stipulated time	M	1	Report submission date
1f	Preparation and submission of Incident/near-miss report and RCA Report (as applicable) within stipulated time	M	1	Incident/ Near Miss Records
1g	Carrying out Inspections and submission of Inspection reports within stipulated time	M	1	Inspection Records
1h	Regular Job Specific Training ensured for High Risk Workers (through audio-visual medium) as per plan	M	1	Training & Attendance Records
2a	Whether the contractor is registered under BOCW	M	2	BOCW Registration Certificate
2b	Availability of Qualified safety officer (1 for every 500 labour)	M	2	Safety Officer qualification & experience records
2c	Availability of Qualified safety supervisor (1 for every 100 labour)	M	2	Safety Officer qualification & experience records
2d	All the workers are provided and using safety helmets and safety shoes/gum boots	M	2	PPE Issue Records, Inspection/ non-conformity records
2e	Housekeeping done on regular basis and scrap removal at site	M	1	Housekeeping records, Inspection/ non-conformity records
2f	Usage of Goggles/Face shields and Hand gloves for gas cutter and grinders		1	PPE Issue Records, Inspection/ non-conformity records
2g	Wall openings & floor openings are guarded?		1	Inspection/ non-conformity records
2h	Adequate illumination provided in all working area?		1	Inspection/ non-conformity records
2i	Safety posters, sign boards and emergency contact numbers in all prominent location are displayed?		1	Inspection/ non-conformity records
2j	Availability of automatic reverse horns, Main horn, hook latches for Vehicles, mobile cranes, Hydras		1	Inspection/ non-conformity records
2k	Ban of carrying mobile phones to work place is implemented for workers		1	Inspection/ non-conformity records
2l	Availability of Tags & Inspection Certificates for Cranes of all capacities		1	Master T&P List with internal & external test details
2l.2	Availability of Tags & Inspection Certificates for Winches of all capacities		1	Master T&P List with internal & external test details
2l.3	Availability of Tags & Inspection Certificates, color coding for Chain pulley blocks		1	Master T&P List with internal & external test details
2l.4	Availability of Tags & Inspection Certificates for Vehicles - Trailers, Dozers, Dumpers, Excavators. Mixers etc.		1	Master T&P List with internal & external test details
2l.5	Availability of Tags & Inspection Certificates for Welding machines, grinders, Drilling machines, etc.		1	Master T&P List with internal & external test details
2l.6	Availability of Tags & Inspection Certificates, colour coding for Wire rope slings etc.		1	Master T&P List with internal & external test details
2l.7	Availability of Tags & Inspection Certificates for Batching plants		1	Master T&P List with internal & external test details

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
2m.1	Use of Lifting Permit as per requirement		1	Permit Records
2m.2	Use of Height Permit as per requirement		1	Permit Records
2m.3	Use of Hot Work Permit as per requirement		1	Permit Records
2m.4	Use of Excavation permit as per requirement		1	Permit Records
2m.5	Use of Confined space work permit as per requirement		1	Permit Records
2m.6	Use of Grating removal and safety net removal permit as per requirement		1	Permit Records
2m.7	Use of Lockout-Tag out permit as per requirement		1	Permit Records
2m.8	Use of Radiography permit as per requirement		1	Permit Records
2m.9	Use of Night/ Holiday Work Permit as per requirement		1	Permit Records
2m.10	Use of Any other Applicable Permit as per requirement		1	Permit Records
3a	Material safety data sheet(MSDS) available for all chemicals and displayed in usage and storage area?		1	Inspection/ non-conformity records
3b	Spillages of oil/concrete and other chemical is controlled and cleaned by proper method in case of spill?		1	Inspection/ non-conformity records
3c	Availability of adequate number of urinals in workplace and in elevations and maintained	M	1	
3d	Availability of rest rooms for workers at site	M	1	
3e	Availability of Drinking water facility at work spot		1	
3f	Hygienic Labour colony is provided for workers.		1	
4a	Is heavy/complex critical lifting permit obtained for heavy, complex materials before handling/erection activity?		1	Work Permit records
4b	Whether area below lifting activities barricaded		1	Inspection/ non-conformity records
4c	Availability of experienced rigging foreman		1	Experience details of rigging foreman
4d	Is agency is following proper storage and handling procedure as per manufacturer standard for all hazardous material?		1	Procedure for storage & handling
4e	Are oxygen and acetylene cylinders are transported to work place from storage area in trolleys		1	
5a	Whether all deep excavation has been protected by barrier		1	Inspection/ non-conformity records
5b	Sloping/benching & shoring provided for excavation as per requirement?		1	-do-
5c	Proper access and egress provided for excavations?		1	-do-
5d	Blasting is done in controlled manner?		2	-do-
6a	Whether Electrical booth is equipped with Co_2 fire extinguishers and fire buckets filled with sand?		2	Inspection/ non-conformity records
6b	Availability of Illumination lamp in electric booth?		1	-do-
6c	whether Caution Boards have been displayed?		1	-do-
6d	Usage of Metal Plug top for all hand power tools ?		1	-do-
6e	Usage of Insulated welding cables.		1	-do-
6f	Electrical Booth/Distribution Board to be covered by proper Canopy.		1	-do-
6g	Availability of functional & individual 30ma ELCB / RCCB and MCB for protection and conducting periodical check-up?		1	-do-
6h	Double earthing for panel boards and all machinery & proper earth pit with regular inspection available?		1	-do-
6i	Whether Electrician is qualified and experienced		1	Qualification & Experience records of electrician
6j	Availability and usage of Rubber hand gloves by electrician?		1	Inspection/ non-conformity records

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
7a	Whether Scaffolding pipes made with steel or aluminum, are being used and checked periodically by experienced/ certified scaffolder?		2	Inspection/ non-conformity records
7b	8mm Stainless Steel wire rope with plastic cladding is provided for life line (Vertical / Horizontal) during height work?		2	-do-
7c	Availability of emergency lighting in case of power failure		1	-do-
7d	Whether all the openings are covered with Safety Nets made of fire proof Nylon?		1	-do-
7e	Whether MS pipe rails around staircases & platforms in usage are provided with top, middle rails and toe guard ?		1	-do-
7f	Whether Ladder with vertical life line /Fall arrestor is available to climb?		1	-do-
7g	Whether all workers deployed for working at height have been issued height pass after undergoing vertigo test?		1	Height Pass records
7h	Whether all workers deployed for height work / climbing ladder are provided and using Double lanyard safety belt?		1	PPE Issue records, inspection/ non-conformity reports
7i	Is all hand tools/Small material used by height workers is tied firmly to prevent fall?		1	-do-
8a	Flash back arrestors for all gas cutting sets is available on Torch side and cylinder side		1	Inspection/ non-conformity records
8b	Oxygen/Acetylene/LPG cylinders not in use have caps in place and stored separately?		1	-do-
8c	Availability of Face screen, Hand gloves, and Apron, for welders		1	-do-
8d	Protection from falling hot molten metal during metal cutting / welding at height by providing GI sheet below the cutting area especially in fire prone areas		1	-do-
9a	Pre-employment medical check-up done for all workers and submitted?		1	Medical check records
9b	Availability of first aid center, with MBBS doctor(Own or Sharing basis)	**M**	2	Attendance records
9c	Availability of Ambulance facility 24 hours (Own or sharing basis)	**M**	2	-do-
9d	Is First aid trained personnel's are available and their names are displayed at site?	**M**	1	-do-
9e	Availability of Emergency vehicle at site		1	
9f	Periodical medical check-up is conducted for all the workers and submitted?		1	Medical check records
9g	Availability of sufficient number of first aid box as per standard list and maintaining record		1	Inspection records
10a	Availability of Fire extinguishers, buckets at all vulnerable points		2	Fire extinguisher records
10b	Periodic fire mock drill conducted?		1	Fire, Mock drill records
10c	Are all flammable materials are stored separately?		1	
10d	Periodic grass cutting is done in material storage area?		1	
10e	Availability of 24V DC lighting in confined space work area		1	
10f	Availability of exhaust fan in confined space work area		1	

Note:

- **M: Mandatory; O: Optional**. Points other than mandatory can be excluded with appropriate justification (scope etc.) by BHEL
- Additionally: 30 Marks for each Fatal Accident and 10 mark for each major accident shall be deducted.

SAFETY WORK CLEARANCE	Permit no.
Project:	Emergency Contact Nos:
Subcontractor:	

BURNING/WELDING /HOT WORK PERMIT

Area :_____ Date:_____ Time:_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign:_____

Name of Work Performing Contractor: _____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work: _____

_____

Work Execution Date:_____ Time Valid from:_____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Proper Access/Exit available		
2.	Proper ventilation and /or lighting provided.		
3.	Proper and safe scaffolding, platform, ladder provided.		
4.	Welding machine located in a clean and dry area.		
5.	Welding machine grounded at the equipment and proper leakage current protection device (ELCB) provided for welding machine.		
6.	Emergency STOP buttons are in working condition. Welder /Helper knows how to operate it.		
7.	Welding machine input/output cables, welding holder and weld return clamp (Holder) are insulated and in good condition.		
8.	Welder & Fitter trained to connect ground/work return clamps (Holder) to work place prior to energization of welding machine.		
9.	Gas cylinders are stacked vertically and not below the welding / cutting area. Regulator key is available with cylinder.		
10.	Pressure gauges/Flash back arrestor provided and in working condition.		
11.	Personal Protective equipment Minimum applicable: safety helmet, safety goggles, welding helmet, safety shoes, leather gloves, long sleeve and nose mask -provided		
12.	In case of pits, water removed from the pit and wood/rubber insulation provided.		
13.	Safety signboards are in place.		
14.	Adequate and Suitable nos. of fire fighting extinguisher provided.		
15.	Nearby combustible material removed. Housekeeping done.		
16.	Other		

Name of Contractor Safety Officer:_____ Sign:_____ Date:_____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name:_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Safety Representative:_____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority:_____ Sign:_____ Date:_____ Time:_____

Permit Cancellation:

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority:_____ Sign:_____ Date:_____ Time:_____

Name of Site Engr. (Permit Requesting Authority):_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Site Engr. (Permit Issuing Authority):_____ Sign:_____ Date:_____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site **Second Copy – BHEL SAFETY** **Third Copy : Contractor**

SAFETY WORK CLEARANCE	Permit no.
Project:	**Emergency Contact Nos:**
Subcontractor:	

LIFTING ACTIVITY PERMIT

Area :_____ Date:_____ Time:_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign: Name of Work

Performing Contractor: _____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work: _____

_____

Work Execution Date:_____ Time Valid from:_____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Crane used for lifting activity tested, certified and approved for rated lifting		
2.	All lifting tackles, gears/appliances are tested and certified for lifting works.		
3.	Crane operator is trained and competent for lifting operation.		
4.	Lifting sling/ belt is protected against sharp edge of the jobs to be lifted.		
5.	Access and exit marked and without obstruction.		
6.	Lifting arrangement adequate.		
7.	Unwanted rubbish material removed from work platform.		
8.	Minimum 2 guidelines have been provided for balancing and guiding jobs to be lifted.		
9.	Periphery area of crane booms as well as lifting job is barricaded and unauthorized/no-entry sign board posted.		
10.	Rigger and signal man is trained and competent for lifting work.		
11.	No lifting activity to be carried out during lightening, heavy wind/rain.		
12.	If scaffolding to be used during lift, scaffolding with valid tag available for use.		
13.	Double lanyards safety harness/belt checked an in working condition.		
14.	Safety shoes (non-slip), helmet with chin strap available with employees.		
15.	Others.		

Name of Contractor Safety Officer:_____ Sign:_____ Date:_____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name:_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Safety Representative:_____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority:_____ Sign:_____ Date:_____ Time:_____

Permit Cancellation:

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority:_____ Sign:_____ Date:_____ Time:_____

Name of Site Engr. (Permit Requesting Authority):_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Site Engr. (Permit Issuing Authority):_____ Sign:_____ Date:_____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site **Second Copy – BHEL SAFETY** **Third Copy : Contractor**

SAFETY WORK CLEARANCE	Permit no.
Project:	**Emergency Contact Nos:**
Subcontractor:	

WORKING AT HEIGHT PERMIT

Area :_____ Date:_____ Time:_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign: Name of Work

Performing Contractor: _____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work: _____

_____

Work Execution Date:_____ Time Valid from:_____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	All workers on job are medically fit for working at height (Person should not have vertigo)		
2.	Scaffolding with valid tag available for use		
3.	Safety harness with life line support/ fall arrester are checked and in working condition		
4.	Safety shoes (non-slip), Helmet with chin strip available with employees		
5.	Safety nets are provided as per design and provided 25 ft. below working area & extending 8 ft beyond.		
6.	Horizontal life lines are provided to cater to design specification of 2300kg per person.		
7.	Ladders have been inspected and provided as per BHEL standard/contract.		
8.	All lifting / tightening tools, hand tools/equipment checked and in good condition		
9.	Access and exit marked and without obstruction.		
10.	Lighting arrangement adequate.		
11.	Unwanted and rubbish material removed from working platform.		
12.	Electrical cable, welding Hose/Compressed air hose properly secured and lay down without obstruction.		
13.	Signboards provided on working platforms		
14.	Hazards in the vicinity are identified and communicated to the worker.		
15.	Other		

Name of Contractor Safety Officer:_____ Sign:_____ Date:_____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name:_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Safety Representative:_____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority:_____ Sign:_____ Date:_____ Time:_____

Permit Cancellation:

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority:_____ Sign:_____ Date:_____ Time:_____

Name of Site Engr. (Permit Requesting Authority):_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Site Engr. (Permit Issuing Authority):_____ Sign:_____ Date:_____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site **Second Copy – BHEL SAFETY** **Third Copy : Contractor**

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BHEL

Project		**Vendor**			**Package/Unit**	
SL	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents`**
#'1.01	Cumulative number of days in the month, the nominated Quality Officer or his authorised nominee was not available	QUALITY	1.5		Quality Officer or his authorised nominee should be available for all the days of working at site	Daily Log Book entry/Incident Registers/letter references
#1.02	Number of instances of non- compliance wrt FQP, Standard Drawings, Specifications, E&C Manuals etc.	QUALITY	1.5		No deviation from FQP, Standard Drawings, Specifications, E&C Manuals etc. is allowed without BHEL Engineer's approval.	Daily Log Book entry/Incident Registers/letter references
#1.03	Percentage submission of test certificates for batches of welding electrodes, cement, sand, aggregate, consumable, Paints etc. as applicable for this month OR In case of MM & MH package, monthly checks for Storage/Preservation of material.	QUALITY	1		Submission of 100% Test certificates for materials as per FQP is mandatory. MM & MH package: Storage/Preservation as per manual/procedure.	Daily Log Book entry/Incident Registers/letter references
#1.04	Number of incidences of improper storage & preservation (not in accordance to the guidelines of BHEL MUs or approved FQP) of materials, consumables (viz. gases, welding electrodes & fluxes, fuel etc.) & bought-out items (paints, fasteners etc.) under the custody of the contractor	QUALITY	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter ref erences
#1.05	Rework/ Rejection instances in a month necessitated due to deviation from Standard Drawings /Specifications /Manuals /E&C procedures /FQPs or due to Poor Workmanship by contractor	QUALITY	2		Reworks/ Rejection should be as minimum as possible. Total number of reworks/ rejections due to reasons attributable to contractor.	Daily Log Book entry/Incident Registers/letter references
#1.06	Delay in preparation & submission of signed protocols / log sheets / site register / NDT test reports as per approved FQP/ Qualified Welder List along with photocopies of Welder ID cards / Welder Performance Evaluation records etc. in the month OR in case of MM / MH package reconciliation statement / verification report.	QUALITY	1		Within 2 days of measurements taken or within first 3 working days of next month, as advised by BHEL Engineer	Daily Log Book entry/Incident Registers/letter references
#1.07	Number of instances for Major equipment/product failure due to negligence/improper work/poor workmanship by contractor	QUALITY	1		No such event should happen	Daily Log Book entry/Incident Registers/letter references
#1.08	Total number of complaints received in the month on the quality of finish / aesthetics	QUALITY	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references

Project		**Vendor**			**Package/Unit**	
SL	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents`**
#2.01	Cumulative number of days of delay in submission of Plan FOR THE MONTH supported by deployment plan of Major T&Ps and Manpower (as per Form F-14) and relevant construction/layout drawings - like A4 plan / elevation views of plan status for structures / pressure parts/Civil Works, Piping isometrics for piping, Layout / PID / System reference sketch, Unloading / storage plans etc.as applicable.	PERFORMANCE	5		Number of days delayed from second working day of the month	Daily Log Book entry/Incident Registers/letter references
#2.02	Percentage of timely submission of Daily Reports for Progress of work, Resources, Consumables etc.	PERFORMANCE	1.5		Percentage of timely submission of daily reports/ Scheduled date is successive next day for each day	Daily Log Book entry/Incident Registers/letter references
#2.03	Number of days delayed for submission of FQP log sheets / protocols / Monthly Progress Reports for the work executed during the month under measurement	PERFORMANCE	1.5		Number of days delayed/Scheduled date is first 2 working days of next month	Daily Log Book entry/Incident Registers/letter references
#2.04	Shortfall attributable to contractor w.r.t. Plan as per Form-14 for the subject month	PERFORMANCE	35		Percentage of shortfall to be calculated w.r.t. Total planned target for the month as per part-A of F-14. If more than one work has been planned in a month then Weightages of works shall be assigned at the time of plan to arrive at plan vs achievement calculation.	Progress review formats
#2.05	Number of days delayed in submission of Running bills with complete supporting documents (including updated reconciliation statement of BHEL issued material) for the month	PERFORMANCE	2		Number of days delayed / Scheduled date is 7th day of next month	Daily Log Book entry/Incident Registers/letter references
#2.06	Number of times the Top Management of contractor did not respond to critical issues of site, for the month	PERFORMANCE	1		Total number of instances	Daily Log Book entry/Incident Registers/letter references
#2.07	Cumulative number of days in the month the works were stopped / refused on interpretation of contract clauses/scope due to tendency of taking undue advantage by interpreting contract clauses in their favour	PERFORMANCE	2		Cumulative number of days lost	Daily Log Book entry/Incident Registers/letter references
#2.08	Number of times rework was refused by contractor	PERFORMANCE	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references

Project		**Vendor**			**Package/Unit**	
SL	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents`**
#2.09	Cumulative number of days in the month recording / logging was not done in daily log / history register / hindrance register / soft form in a PC maintained at BHEL Site Office	PERFORMANCE	1		Cumulative number of days recording or logging was not done / all days of the month	Daily Log Book entry/Incident Registers/letter references
#3.01	Number of days of non-availability of required Manpower including supporting staff as per plan submitted in F-14 for the month.	RESOURCES	7		Cumulative number of days Sufficient Manpower was not available as per Plan in F-14	Daily Log Book entry/Incident Registers/letter references
#3.02	Number of days of non-availability of required T&P as per plan submitted in F-14 for the month.	RESOURCES	7		Cumulative number of days Sufficient T&P was not available as per Plan in F-14	Daily Log Book entry/Incident Registers/letter references
#3.03	Cumulative number of major instances in the month hampering / affecting progress of work due to breakdown or non-availability of major T&P and MME for the work, under the scope of Contractor	RESOURCES	3		Cumulative number of instances	Daily Log Book entry/Incident Registers/letter references
#3.04	Cumulative number of major instances in the month hampering / affecting progress of work due to non-availability of Consumables/ use of improper consumables under the scope of contractor	RESOURCES	3		Cumulative number of instances	Daily Log Book entry/Incident Registers/letter references
#4.01	Number of non-compliances during the month for Statutory requirements like validity of Labour Licence, Insurance Policy, Labour Insurance, PF, BOCW Compliance etc. and any other applicable laws/ Regulation, Electrical Licence, T&P fitness certificate, Contractors' All Risk Policy etc. as applicable	SITE INFRASTRUCTURE & SERVICE	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references
#4.02	Cumulative number of days in a month poor illumination is reported at storage area, erection area, pre-assembly area and other designated areas by BHEL site.	SITE INFRASTRUCTURE & SERVICE	0.5		Total number of non-compliances/random checks	Daily Log Book entry/Incident Registers/letter references
#4.03	Cumulative number of days of non-availability of well-maintained toilets facilities for workers (separate for men and women) and non-availability of potable drinking water stations for workers in specified areas.	SITE INFRASTRUCTURE & SERVICE	1		Total number of non-compliances/random checks	Daily Log Book entry/Incident Registers/letter references

Project		**Vendor**			**Package/Unit**	
SL	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents`**
#4.04	Total number of instances in the month, Housekeeping NOT attended to in spite of instructions by BHEL -i.e. removal / disposal of surplus earth / debris / scrap / unused / surplus cable drums / other electrical items / surplus steel items / packing materials, thrown out scrap like weld butts, cotton waste etc. from the working area to identified locations	SITE INFRASTRUCTURE & SERVICE	2		Total number of non-compliances/random checks	Daily Log Book entry/Incident Registers/letter references
#4.05	Total number of instances in a month, Site Office with reasonably good facilities including enough nos. of computers and printers etc. for use by office and supporting staff was not made available/maintained.	SITE INFRASTRUCTURE & SERVICE	0.5		No discrepancy during regular or surprise visits	Photograph and report of the Engineer
#5.01	Number of days delayed in making labour payments for the last month	SITE FINANCE	2		Number of days delayed / Scheduled date is 7th day of next month	Daily Log Book entry/Incident Registers/letter references
#5.02	Number of complaints from labour/ sub supplier/ sub-contractor for non-receipt of payments from contractor	SITE FINANCE	1.5		Total number of complaints or reporting	Daily Log Book entry/Incident Registers/letter references
#5.03	Number of times the site operations were hampered for want of funds at the disposal of site-in-charge.	SITE FINANCE	1.5		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references
#6.01	Cumulative number of days in a month the nominated Safety Officer was not available	HSE & SA	1		Safety Officer should be available for all the days	Daily Log Book entry/Incident Registers/letter references
#6.02	Shortfall in number of weekly safety meetings in the month conducted or attended by the Safety Officer	HSE & SA	0.5		Safety meetings to be held every week	Copy of Minutes of meeting
#6.03	Level of compliance w.r.t decisions taken in previous Safety meetings	HSE & SA	0.5		Number of consolidated issues discussed in Safety meetings	Copy of Minutes of meeting, Non-compliance intimation documents from BHEL site
#6.04	Delay in submission of monthly report on safety (including electrical safety for equipment & personnel etc.) in the prescribed form	HSE & SA	1		Number of days delayed/Scheduled date is third working day of next month	Daily Log Book entry/Incident Registers/letter references
#6.05	Number of days taken for lodging FIRs from date of occurrence/notice of incident of theft / accident etc.	HSE & SA	0.5		Number of days delayed/Scheduled date is within 24 Hrs of occurrence/notice of incidence	Copy of FIR lodged by Contractor

Project		**Vendor**			**Package/Unit**	
SL	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents`**
#6.06	Number of times written(email, letters etc.) warning issued for non-availability/ use of improper Fall protection and rescue arrangement as lifeline, fall arrestors, safety net, hand-railings, covered floors, man-basket, rescue basket & kit etc. by the contractor	HSE & SA	2		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references
#6.07	Number of times punitive fines imposed for unsafe practices as per contract like non-availability/use of PPEs as safety shoes, helmets, goggles, gloves, lifeline, safety belts etc.	HSE & SA	1		Total number of non-compliances	Non-compliance intimation documents from BHEL site
#6.08	Percentage compliance to Emergency preparedness and response plan: Portable Fire-extinguishers, Buckets, Fire-wardens, display of emergency numbers, mock-drills, Hazard Identification and Risk Assessment(HIRA) etc.	HSE & SA	1		Compliance should be 100% as per HSE Plan or as finalized in Safety Meetings	Non-compliance intimation documents from BHEL site
#6.09	Number of times the agency has defaulted on display of safety posters / safety slogans / safety barriers/emergency numbers etc. in identified areas	HSE & SA	0.5		Total number of instances	Non-compliance intimation documents from BHEL site
#6.10	Non compliances observed during HSE and Safety Audit	HSE & SA	0.5		Total number of non-compliances	Non-compliance intimation documents from BHEL site, Audit Reports
#6.11	Cumulative number of days in the month, non-availability of First Aid Kit, First Aider & Emergency Vehicles/Ambulance.	HSE & SA	0.5		Cumulative number of days	Non-compliance intimation documents from BHEL site
#6.12	Number of days taken for submission of Root Cause analysis (RCA) for the accident from the cut-off date intimated by BHEL for submission of RCA	HSE & SA	0.5		Number of days delayed/Scheduled date is cut-off date intimated by BHEL	Daily Log Book entry/Incident Registers/letter references
#6.13	Non conductance of training (induction, job specific, height work etc.), tool box meeting and health check-up as per Contract requirements	HSE & SA	0.5		Number of incidences of non-conductance during the month	Daily Log Book entry/Incident Registers/letter references
		Total	**100**			

Project		**Vendor**			**Package/Unit**	
SL	**Parameter for Measurement**	**Classification**	**Max Score**	**Score Obtained**	**Measurement Key/Scheduled date**	**Supporting Documents`**
Less Deduction in Score Due to Major Accidents (Fatal, Permanent Disability or bodily injury by which person injured is prevented to resume to work within 48 hours or more after accident,, Major Damage to Equipment etc.) @ 3 points/ accident						
Less Deduction in Score Due to Minor Accidents(All Others) @ 1 point/ accident						
Less Deduction in Score Due to not Maintaining of Labour Colony (if applicable) as per BHEL HSE policy @2 points in a month on verification any day						
				Final Score		

Performance Score Summary for the Month	**Total Score**	**Score Obtained**
QUALITY	10	
PERFORMANCE	50	
RESOURCES	20	
SITE INFRASTRUCTURE & SERVICE	5	
SITE FINANCE	5	
HSE & SA	10	
OTHERS (deductions if any)	0	
TOTAL	**100**	

Name and Signature of BHEL Package In-charge

Name and Signature of Contractor

PSSR	MONTHLY PLAN & REVIEW WITH CONTRACTOR	Page **1** of **6**

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART- A: PLAN/ REVIEW OF WORK FOR THE MONTH OF …….. Date of Plan/ Review……

SN.	Description of Work	Unit of Measur-ement	Unit Rate	Planned (QTY Planned for the month as per Part –C of last month)		Cumulative Shortfall attributable to contractor upto last month (Refer Note 1)		Achieved		Shortfall attributable to BHEL w.r.t Plan (as per Col. 3 of Part-D)		Cumulative Shortfall attributable to Contractor upto & including this month		REMARKS (Reasons for Shortfall attributable to Contractor. Supporting documents to be kept as record.)
(a)	(b)	(c)	(d)	A		B		C		D		E=A+B-C-D		
				Phy.	Financial	Phy	Financial	Phy.	Financial	Phy.	Financial	Phy.	Financial	
	Value of Other Items not mentioned above but planned to be executed in this month													
Total					ΣA		ΣB		ΣC		ΣD		ΣE	

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART- A: Contd…….

Note 1: **In addition to the work planned as per Col. 'A', Contractor shall also make full efforts to minimize the 'Cumulative shortfall attributable to contractor upto the month' as mentioned in Col. 'B' by enhancing its resources, so as to achieve the completion of activities as per agreed schedule. In case contractor is not able to execute the entire shortfall, then BHEL 'Engineer in-charge', shall decide the priority of work to be executed and it shall be binding on the contractor.**

Note 2: Percentage Shortfall attributable to contractor w.r.t. **"**Plan - Shortfall attributable to BHEL**"** for the month = [(ΣE-ΣB)/(ΣA-ΣD)]x100
In case, (ΣE-ΣB) is negative, then it shall be treated as zero percent."

Note 3: Form 14 should include all items being planned in the current month, and all items against which shortfall was attributable to contractor till previous month. However, for practical reason, if it is not possible to mention some of the items in Form-14 being planned to be executed in this month, then also value of such items shall necessarily be included in calculation of Total Value.

Note 4: In case reason for shortfall attributable to contractor is w.r.t. T&P and Manpower, it should be in conformity with Part B1 and B2.

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

PSSR	MONTHLY PLAN & REVIEW WITH CONTRACTOR	Page **3** of **6**

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – B-1: PLAN/REVIEW OF DEPLOYMENT OF MAJOR T&Ps FOR THE MONTH OF ……..…….. Date of Plan/ Review……

CONTRACTOR'S SCOPE: -

SN.	PLAN				DEPLOYMENT STATUS			
	Major T&P to be deployed as per work planned for the month	QTY	Deployment Period (in days)	Weightage assigned to planned T&P (in fraction such that ΣC =1)	Actual Deployed Quantity	Actual Deployment Period (in days)	Weighted T&P Deployed	REMARKS (Works affected due to non-deployment of T&Ps)
		A	B	C	D	E	F=(C x D x E) / (A x B)	

Note: In case, E>B, it shall be considered as E=B. Similarly, in case D>A, it shall be considered as D=A.
Percentage of T&P Deployed = ΣF x 100

BHEL SCOPE: -

SN.	PLAN			DEPLOYMENT STATUS		
	Major T&P to be deployed as per work planned for the month	QTY	Deployment Period (in days)	Actual Deployed Quantity	Actual Deployment Period (in days)	REMARKS (Works affected due to non-deployment of T&Ps)

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – B-2: PLAN/ REVIEW OF DEPLOYMENT OF MANPOWER FOR THE MONTH OF ……..…….. Date of Plan/ Review……

CONTRACTOR'S SCOPE: -

SN.	Area of Work	Category of Labour	No. of Labour required as per category	Deployment Period (in days)	No. of Labour actually deployed	Actual Deployment Period (in days)	REMARKS (Works affected due to non-availability of labour)
			A	B	C	D	

Percentage of Manpower Deployed=100 x Σ(CxD)/Σ(AxB)

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

PSSR	MONTHLY PLAN & REVIEW WITH CONTRACTOR	Page **5** of **6**

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – C: PLAN(PHYSICAL) FOR THE NEXT MONTH i.e. ……..…….. Date of Plan ……

SN.	Description of work	Original Planned Quantity	Planned Quantity (excluding shortfalls attributable to contractor till date)	Unit of Measu-rement	T&Ps Required				Manpower Required		REMARKS (Reasons for difference in Original Planned Quantity w.r.t. Planned quantity to be given)
					Contractor Scope		BHEL Scope		Category of Labour	No. of Labour required as per Category	
					Major T&P to be deployed as per work planned for the month	Quantity	Major T&P to be deployed as per work planned for the month	Quantity			

Note 1: Planned quantity should be based on available/ expected fronts/ inputs in the next month

Note 2: "Original Planned Quantity" shall be as per latest jointly agreed programme between BHEL and Contractor before commencement of work or at the time of latest Time Extension, as the case may be.

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – D: REASONS FOR SHORTFALL ATTRIBUTABLE TO BHEL IN RESPECT OF PLAN FOR THE MONTH……

SN.	Description of Work (from Part-A)	Quantities Affected		Reasons for Shortfall attributable to BHEL	Agency responsible for reasons for Shortfall	Remarks (Supporting Documents in respect of agency responsible)
		(Physical Quantity)	Unit of Measu-rement			
1	2	3	4	5	6	7

Note1: Reasons for shortfall shall include non-availability of fronts/ drawings/ materials/ T&P (BHEL Scope)/ clearances etc. and other hindrances for which contractor is not responsible.

Note2: Agency responsible may be BHEL Site/ MUs/ Design Centre/ BHEL Customer/ other Contractors etc.

BHEL
(Sign with name, designation and date)

Form WAM 23

PROFORMA OF BANK GUARANTEE (in lieu of EARNEST MONEY if permissible under Works Policy)

(On non-Judicial paper of appropriate value)
(Para 4.7.6 of Works Accounts Manual)

Bank Guarantee No……
Date……

To
(Employer's Name and Address)
……..

Dear Sirs,

In accordance with the terms and conditions of Invitation for Bids/Notice Inviting Tender No……[1] (Tender Conditions), M/s. ……[2] having its registered office at ……[3] (hereinafter referred to as the 'Tenderer'), is submitting its bid for the work of……[4] invited by Bharat Heavy Electricals Limited (hereinafter referred to as the 'Employer' which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns) incorporated under the Companies Act, 1956 and having its registered office at *BHEL House, Siri Fort, Asiad, New Delhi – 110049* through its unit at *Bharat Heavy Electricals Limited, Power Sector Southern Region, Tek Towers, No.11, Old Mahabalipuram Road, Okkiyam Thoraipakkam, Chennai – 600097.*

The Tender Conditions provide that the Tenderer shall pay a sum of Rs ……[5] as Earnest Money Deposit in the form therein mentioned. The form of payment of Earnest Money Deposit includes Bank Guarantee executed by a Scheduled Bank.

In lieu of the stipulations contained in the aforesaid Tender Conditions that an irrevocable and unconditional Bank Guarantee against Earnest Money Deposit for an amount of .....[6] is required to be submitted by the Tenderer as a condition precedent for participation in the said Tender and the Tenderer having approached us for giving the said Guarantee,

we, the .....(Name & address of the Bank) ..... having our Head Office at ……..(hereinafter referred to as the Bank) being the Guarantor under this Guarantee, hereby irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer without any demur, merely on your first demand any sum or sums of Rs.....[6] (in words Rupees.....) without any reservation, protest, and recourse and without the beneficiary needing to prove or demonstrate reasons for its such demand.

Any such demand made on the Bank shall be conclusive as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. _____.[6]

We undertake to pay to the Employer any money so demanded notwithstanding any dispute or disputes raised by the Tenderer in any suit or proceeding pending before any Court or Tribunal, Arbitrator or any other authority, our liability under this present being absolute and unequivocal.

The payment so made by us under this Guarantee shall be a valid discharge of our liability for payment hereunder and the Tenderer shall have no claim against us for making such payment.

We …….. Bank further agree that the Employer shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said Tender or to extend the time of submission of from time to time or to postpone

for any time or from time to time any of the powers exercisable by the Employer against the said Tenderer and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said Tenderer or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said Tenderer or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Tenderer and notwithstanding any security or other guarantee that the Employer may have in relation to the Tenderer's liabilities.

This Guarantee shall be irrevocable and shall remain in force upto and including…….[7] and shall be extended from time to time for such period as may be desired by the Employer.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Tenderer but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms hereof. However, unless a demand or claim under this Guarantee is made on us in writing on or before the ……[8] we shall be discharged from all liabilities under this Guarantee.

We, …… Bank lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.
Notwithstanding anything to the contrary contained hereinabove:

a) The liability of the Bank under this Guarantee shall not exceed……[6]
b) This Guarantee shall be valid up to ……[7]
c) Unless the Bank is served a written claim or demand on or before _____[8] all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

For and on behalf of
(Name of the Bank)

(Signature of Authorised signatory)

Date…….
Place of Issue…….

[1] Details of the Invitation to Bid/Notice Inviting Tender (Tender Ref. No. Eg. - BHEL PSSR SCT XXXX)
[2] Name of Tenderer
[3] REGISTERED Office Address of the Tenderer
[4] Details of the Work i.e Tender Description
[5] EMD Amount as mentioned in Notice Inviting Tender
[6] BG Amount in words and Figures (BG Amount shall be Minimum of EMD amount less Rs. 2 Lakhs)
[7] Validity Date
[8] Date of Expiry of Claim Period (Claim Period shall be minimum of 3 Months after the validity date of Bank Guarantee)

Note:
1. The BG should be on Non-Judicial Stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the State(s) where the BG is submitted or is to be acted upon or the rate prevailing in the State where the BG was executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Vendor/Contractor/Supplier /Bank issuing the guarantee.

2. In Case of Bank Guarantees submitted by Foreign Vendors-
   a. From Nationalized/Public Sector / Private Sector/ Foreign Banks (BG issued by Branches in India) can be accepted subject to the condition that the Bank Guarantee should be enforceable in the town/city or at nearest branch where the Unit is located i.e. Demand can be presented at the Branch located in the town/city or at nearest branch where the Unit is located.
   b. From Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor Country's Bank)
      b.1 In such cases, in the Tender Enquiry/ Contract itself, it may be clearly specified that Bank Guarantee issued by any of the Consortium Banks only will be accepted by BHEL. As such, Foreign Vendor needs to make necessary arrangements for issuance of Counter- Guarantee by Foreign Bank in favour of the Indian Bank's (BHEL's Consortium Bank) branch in India. It is advisable that all charges for issuance of Bank Guarantee/ counter- Guarantee should be borne by the Foreign Vendor. The tender stipulation should clearly specify these requirements.
      b.2 In case, Foreign Vendors intend to provide BG from Overseas Branch of our Consortium Bank (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at sl.no. b.1 will required to be followed.
      b.3 The BG issued may preferably be subject to Uniform Rules for Demand Guarantees (URDG) 758 (as amended from time to time).

PROFORMA OF BANK GUARANTEE (in lieu of SECURITY DEPOSIT)
(On non-Judicial paper of appropriate value)
(Para 4.7.6 of Works Accounts Manual)

Bank Guarantee No……
Date……

To
(Employer's Name and Address)
……..

In consideration of Bharat Heavy Electricals Limited (hereinafter referred to as the 'Employer' which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns) incorporated under the Companies Act, 1956 and having its registered office at *BHEL House, Siri Fort, Asiad, New Delhi – 110049* through its unit at *Bharat Heavy Electricals Limited, Power Sector Southern Region, Tek Towers, No.11, Old Mahabalipuram Road, Okkiyam Thoraipakkam, Chennai - 600097* having agreed to exempt _____[1] (Name of the Vendor / Contractor / Supplier) with its registered office at_____[2] (hereinafter called the said "Contractor" which term includes supplier), from demand under the terms and conditions of the Contract arising vide Letter of Intent (LOI) reference No._____ dated _____[3] valued at Rs. _____[4] (Rupees _____ only)[4] (hereinafter called the said Contract), of Security Deposit for the due fulfilment by the said Contractor of the terms and conditions contained in the said Contract, on production of a Bank Guarantee for Rs. _____[5] (Rupees _____ only),

We, the .....(Name & address of the Bank) ..... having our Head Office at ……..(hereinafter referred to as the Bank), at the request of _____ [Contractor(s)], being the Guarantor under this Guarantee, do hereby irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer, an amount not exceeding Rs._____ without any demur, immediately on demand from the Employer and without any reservation, protest, and recourse and without the Employer needing to prove or demonstrate reasons for its such demand

Any such demand made on the bank, shall be conclusive as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. _____[5].

We undertake to pay to the Employer any money so demanded notwithstanding any dispute or disputes raised by the Contractor(s) in any suit or proceeding pending before any Court or Tribunal or Arbitrator or any other authority, our liability under this present being absolute and unequivocal.

The payment so made by us under this guarantee shall be a valid discharge of our liability for payment hereunder and the Contractor(s) shall have no claim against us for making such payment.

We, further agree that the guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the said Contract and that it shall continue to be enforceable till all the dues of the Employer under or by virtue of the said Contract have been fully paid and its claims satisfied & the Employer certifies that the terms and conditions of the said Contract have been fully and properly carried out by the said contractor(s) or acceptance of the final bill or discharge of this guarantee by the Employer, whichever is earlier. This guarantee shall initially remain in force upto and including _____[6] and shall be extended from time to time for such period as may

be desired by the Employer. Unless a demand or claim under this guarantee is made on us in writing on or before the _____[7], we shall be discharged from all the liability under this guarantee thereafter.

We, _____(indicate the name of the Bank) further agree with the Employer that the Employer shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said Contract or to extend time of performance by the said contractor(s) from time to time or to postpone for any time or from time to time any of the powers exercisable by the Employer against the said contractor(s) and to forbear or enforce any of the terms and conditions relating to the said Contract and we shall not be relieved from our liability by any reason of any such variation or extension being granted to the said contractor(s) or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said contractor(s) or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee that the Employer may have in relation to the Contractor's liabilities.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Contractor but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms thereof. This guarantee will not be discharged due to the change in the constitution of the Bank or the Contractor(s).

We, ……. BANK lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.
Notwithstanding anything to the contrary contained hereinabove:

a) The liability of the Bank under this Guarantee shall not exceed……[5]

b) This Guarantee shall be valid up to ……[6]

c) Unless the Bank is served a written claim or demand on or before _____[7] all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank.

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

Date _____ Day of _____

for_____ (indicate the name of the Bank)

(Signature of Authorised signatory)

[1] NAME OF VENDOR /CONTRACTOR / SUPPLIER
[2] REGISTERED OFFICE ADDRESS OF THE VENDOR /CONTRACTOR / SUPPLIER.
[3] LETTER OF INTENT(LOI) REFERENCE NO. WITH DATE
[4] CONTRACT VALUE (AS MENTIONED IN LOI)
[5] BG AMOUNT IN FIGURES AND WORDS
[6] VALIDITY DATE
[7] DATE OF EXPIRY OF CLAIM PERIOD (CLAIM PERIOD SHALL BE MINIMUM OF 3 MONTHS AFTER VALIDITY DATE)

Note:

1. The BG should be on Non-Judicial Stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the State(s) where the BG is submitted or is to be acted upon or the rate prevailing in the State where the BG was executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Vendor/Contractor/Supplier /Bank issuing the guarantee.
2. In Case of Bank Guarantees submitted by Foreign Vendors-
   a. From Nationalized/Public Sector / Private Sector/ Foreign Banks (BG issued by Branches in India) can be accepted subject to the condition that the Bank Guarantee should be enforceable in the town/city or at nearest branch where the Unit is located i.e. Demand can be presented at the Branch located in the town/city or at nearest branch where the Unit is located.
   b. From Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor Country's Bank)
      b.1 In such cases, in the Tender Enquiry/ Contract itself, it may be clearly specified that Bank Guarantee issued by any of the Consortium Banks only will be accepted by BHEL. As such, Foreign Vendor needs to make necessary arrangements for issuance of Counter- Guarantee by Foreign Bank in favour of the Indian Bank's (BHEL's Consortium Bank) branch in India. It is advisable that all charges for issuance of Bank Guarantee/ counter- Guarantee should be borne by the Foreign Vendor. The tender stipulation should clearly specify these requirements.

      b.2 In case, Foreign Vendors intend to provide BG from Overseas Branch of our Consortium Bank (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at sl.no. b.1 will required to be followed.
      b.3 The BG issued may preferably be subject to Uniform Rules for Demand Guarantees (URDG) 758 (as amended from time to time).

Procedure-2.3

PROCEDURE FOR CONDUCT OF CONCILIATION PROCEEDINGS

1. The proceedings of Conciliation shall broadly be governed by Part-III of the Arbitration and Conciliation Act 1996 or any statutory modification thereof and as provided herein:

2. The party desirous of resorting to Conciliation shall send an invitation/notice in writing to the other party to conciliate specifying all points of Disputes with details of the amount claimed. The party concerned shall not raise any new issue thereafter. Parties shall also not claim any interest on claims/counter-claims from the date of notice invoking Conciliation till the conclusion of the Conciliation proceedings. If BHEL is to initiate Conciliation, then, the invitation to Conciliate shall be extended to the concerned Stakeholder in **Format 7** hereto. Where the stakeholder is to initiate the Conciliation, the notice for initiation of Conciliation shall be sent in **Format-8** hereto.

3. The party receiving the invitation/notice for Conciliation shall within 30 days of receipt of the notice of Conciliation intimate its consent for Conciliation along with its counter-claims, if any.

4. The Conciliation in a matter involving claim or counter-claim (whichever is higher) up to Rs 5 crores shall be carried out by sole Conciliator nominated by BHEL while in a matter involving claim or counter-claim (whichever is higher) of more than Rs 5 crores Conciliation shall be carried out by 3 Conciliators nominated by BHEL. The appointment of Conciliator(s) shall be completed and communicated by the concerned Department/Group of BHEL Unit/Division/Region/Business Group to the other party and the Conciliator(s) within 30 days from the date of acceptance of the invitation to conciliate by the concerned party in the **Format-9**. The details of the Claim, and counter-claim, if any, shall be intimated to the Conciliator(s) simultaneously in **Format-5**.

5. The Parties shall be represented by only their duly authorized in-house executives/officers and neither Party shall be represented by a Lawyer.

6. The first meeting of the IEC shall be convened by the IEC by sending appropriate communication/notice to both the parties as soon as possible but not later than 30 days from the date of his/their appointment. The hearings in the Conciliation proceeding shall ordinarily be concluded within two (2) months and, in exceptional cases where parties have expressed willingness to settle the matter or there exists possibility of settlement in the matter, the proceedings may be extended by the IEC by a maximum of further 2 months with the consent of the Parties subject to cogent reasons being recorded in writing.

7. The IEC shall thereafter formulate recommendations for settlement of the Disputes supported by reasons at the earliest but in any case within 15 days from the date of conclusion of the last hearing. The recommendations so formulated along with the reasons shall be furnished by the IEC to both the Parties at the earliest but in any case within 1 month from the date of conclusion of the last hearing.

8. Response/modifications/suggestions of the Parties on the recommendations of the IEC are to be submitted to the IEC within time limit stipulated by the IEC but not more than 15 days from the date of receipt of the recommendations from the IEC.

9. In the event, upon consideration, further review of the recommendations is considered necessary, whether by BHEL or by the other Party, then, the matter can be remitted back to the IEC with request to reconsider the same in light of the issues projected by either/both the Parties and to submit its recommendations thereon within the following 15 days from the date of remitting of the case by either of the Parties.

10. Upon the recommendations by the Parties, with or without modifications, as considered necessary, the IEC shall be called upon to draw up the Draft Settlement Agreement in terms of the recommendations.

11. When a consensus can be arrived at between the parties only in regard to any one or some of the issues referred for Conciliation the draft Settlement Agreement shall be accordingly formulated in regard to the said Issue(s), and the said Settlement Agreement, if signed, by the parties, shall be valid only for the said issues. As regards the balance issues not settled, the parties may seek to resolve them further as per terms and conditions provided in the contract.

12. In case no settlement can be reached between the parties, the IEC shall by a written declaration, pronounce that the Conciliation between the parties has failed and is accordingly terminated.

13. Unless the Conciliation proceedings are terminated in terms of para 22 (b), (c) & (d) herein below, the IEC shall forward his/its recommendations as to possible terms of settlement within one (1) month from the date of last hearing. The date of first hearing of Conciliation shall be the starting date for calculating the period of 2 months.

14. In case of 3 members IEC, 2 members of IEC present will constitute a valid quorum for IEC and meeting can take place to proceed in the matter after

seeking consent from the member who is not available. If necessary, videoconferencing may be arranged for facilitating participation of the members. However, the IEC recommendations will be signed by all members. Where there is more than one (1) Conciliator, as a general rule they shall act jointly. In the event of differences between the Members of IEC, the decision/recommendations of the majority of the Members of IEC shall prevail and be construed as the recommendation of the IEC.

15. The Draft Settlement Agreement prepared by the IEC in terms of the consensus arrived at during the Conciliation proceedings between the Parties shall be given by the IEC to both the parties for putting up for approval of their respective Competent Authority.

16. Before submitting the draft settlement agreement to BHEL's Competent Authority viz. the Board Level Committee on Alternative Dispute Resolution (BLCADR) for approval, concurrence of the other party's Competent Authority to the draft settlement agreement shall be obtained by the other party and informed to BHEL within 15 days of receipt of the final draft settlement agreement by it. Upon approval by the Competent Authority, the Settlement Agreement would thereafter be signed by the authorized representatives of both the Parties and authenticated by the members of the IEC.

17. In case the Draft Settlement Agreement is rejected by the Competent Authority of BHEL or the other Party, the Conciliation proceedings would stand terminated.

18. A Settlement Agreement shall contain a statement to the effect that each of the person(s) signing thereto (i) is fully authorized by the respective Party(ies) he/she represents, (ii) has fully understood the contents of the same and (iii) is signing on the same out of complete freewill and consent, without any pressure, undue influence.

19. The Settlement Agreement shall thereafter have the same legal status and effect as an arbitration award on agreed terms on the substance of the dispute rendered by an arbitral tribunal passed under section 30 of the Arbitration and Conciliation Act, 1996.

20. Acceptance of the Draft Settlement Agreement/recommendations of the Conciliator and/or signing of the Settlement Agreement by BHEL shall however, be subject to withdrawal/closure of any arbitral and/or judicial proceedings initiated by the concerned Party in regard to such settled issues.

21. Unless otherwise provided for in the agreement, contract or the Memorandum of Understanding, as the case may be, in the event of likelihood of prolonged

absence of the Conciliator or any member of IEC, for any reason/incapacity, the Competent Authority/Head of Unit/Division/Region/Business Group of BHEL may substitute the Conciliator or such member at any stage of the proceedings. Upon appointment of the substitute Conciliator(s), such reconstituted IEC may, with the consent of the Parties, proceed with further Conciliation into the matter either de-novo or from the stage already reached by the previous IEC before the substitution.

22. The proceedings of Conciliation under this Scheme may be terminated as follows:

a. On the date of signing of the Settlement agreement by the Parties; or,

b. By a written declaration of the IEC, after consultation with the parties, to the effect that further efforts at conciliation are no longer justified, on the date of the declaration; or,

c. By a written declaration of the Parties addressed to the IEC to the effect that the Conciliation proceedings are terminated, on the date of the declaration; or,

d. By a written declaration of a Party to the other Party and the IEC, if appointed, to the effect that the Conciliation proceedings are terminated, on the date of the declaration; or,

e. On rejection of the Draft Settlement Agreement by the Competent Authority of BHEL or the other Party.

23. The Conciliator(s) shall be entitled to following fees and facilities:

Sl No	**Particulars**	**Amount**
1	Sitting fees	Each Member shall be paid a Lump Sum fee of Rs 75,000/- for the whole case payable in terms of paragraph No. 27 herein below.
2	Towards drafting of settlement agreement	In cases involving claim and/or counter-claim of up to Rs 5crores. Rs 50,000/- (Sole Conciliator) In cases involving claim and/or counter-claim of exceeding Rs 5 crores but less than Rs 10 crores. Rs 75,000 (per Conciliator)

Sl No	Particulars	Amount
		In cases involving claim and/or counter-claim of more than Rs 10 crores. Rs 1,00,000/- (per Conciliator) Note: The aforesaid fees for the drafting of the Settlement Agreement shall be paid on the, Signing of the Settlement Agreement after approval of the Competent Authority or Rejection of the proposed Settlement Agreement by the Competent Authority of BHEL.
3	Secretarial expenses	Rs 10,000/- (one time) for the whole case for Conciliation by a Sole Member IEC. Where Conciliation is by multi member Conciliators –Rs 30,000/- (one time)- to be paid to the IEC
4	Travel and transportation and stay at outstation Retired Senior Officials of other Public Sector Undertakings (pay scale wise equivalent to or more than E-8 level of BHEL)	As per entitlement of the equivalent officer (pay scale wise) in BHEL.
	Others	As per the extant entitlement of whole time Functional Directors in BHEL. Ordinarily, the IEC Member(s) would be entitled to travel by air Economy Class.
5	Venue for meeting	Unless otherwise agreed in the agreement, contract or the Memorandum of Understanding, as the case may be, the venue/seat of proceedings shall be the location of the concerned Unit / Division / Region /

Sl No	Particulars	Amount
		Business Group of BHEL. Without prejudice to the seat/venue of the Conciliation being at the location of concerned BHEL Unit / Division / Region / Business Group, the IEC after consulting the Parties may decide to hold the proceedings at any other place/venue to facilitate the proceedings. Unless, Parties agree to conduct Conciliation at BHEL premises, the venue is to be arranged by either Party alternately.

24. The parties will bear their own costs including cost of presenting their cases/evidence/witness(es)/expert(s) on their behalf. The parties agree to rely upon documentary evidence in support of their claims and not to bring any oral evidence in IEC proceedings.

25. If any witness(es) or expert(s) is/are, with the consent of the parties, called upon to appear at the instance of the IEC in connection with the matter, then, the costs towards such witness(es)/expert(s) shall be determined by the IEC with the consent of the Parties and the cost so determined shall be borne equally by the Parties.

26. The other expenditures/costs in connection with the Conciliation proceedings as well as the IEC's fees and expenses shall be shared by the Parties equally.

27. Out of the lump sum fees of Rs 75,000/- for Sitting Fees, 50% shall be payable after the first meeting of the IEC and the remaining 50% of the Sitting Fees shall be payable only after termination of the conciliation proceedings in terms of para 22 hereinabove.

28. The travelling, transportation and stay at outstation shall be arranged by concerned Unit as per entitlements as per Serial No. 4 of the Table at para 23 above, and in case such arrangements are not made by the BHEL Unit, the same shall be reimbursed to the IEC on actuals limited to their entitlement as per Serial No. 4 of the Table at Para 23 above against supporting documents. The IEC Member(s) shall submit necessary invoice for claiming the fees/reimbursements.

29. The Parties shall keep confidential all matters relating to the conciliation proceedings. Confidentiality shall extend also to the settlement agreement,

except where its disclosure is necessary for purposes of its implementation and enforcement or as required by or under a law or as per directions of a Court/Governmental authority/ regulatory body, as the case may be.

30. The Parties shall not rely upon or introduce as evidence in any further arbitral or judicial proceedings, whether or not such proceedings relate to the Disputes that is the subject of the Conciliation proceedings:

a. Views expressed or suggestions made by the other party in respect of a possible settlement of the Disputes;

b. admissions made by the other party in the course of the Conciliator proceedings;

c. proposals made by the Conciliator;

d. The fact that the other Party had indicated his willingness to accept a proposal for settlement made by the Conciliator.

31. The Parties shall not present the Conciliator(s) as witness in any Alternative Dispute Resolution or Judicial proceedings in respect of a Disputes that is/was the subject of that particular Conciliation proceeding.

32. None of the Conciliators shall act as an arbitrator or as a representative or counsel of a Party in any arbitral or judicial proceeding in respect of a Disputes that is/was the subject of that particular Conciliation proceeding.

33. The Parties shall not initiate, during the Conciliation proceedings, any arbitral or judicial proceedings in respect of a Disputes that is the subject matter of the Conciliation proceedings except that a Party may initiate arbitral or judicial proceedings where, in his opinion, such proceedings are necessary for preserving his rights including for preventing expiry of period of limitation. Unless terminated as per the provisions of this Scheme, the Conciliation proceedings shall continue notwithstanding the commencement of the arbitral or judicial proceedings and the arbitral or judicial proceedings shall be primarily for the purpose of preserving rights including preventing expiry of period of limitation.

34. The official language of Conciliation proceedings under this Scheme shall be English unless the Parties agree to some other language.

FORMAT-5

STATEMENT OF CLAIMS/COUNTER CLAIMS TO BE SUBMITTED TO THE IEC BY BOTH THE PARTIES

1. Chronology of the Disputes

2. Brief of the Contract/MoU/Agreement/LOI/LOA

3. Brief history of the Disputes:

4. Issues:

5. Details of Clam(s)/Counter Claim(s):

Sl. No.	**Description of claim(s)/Counter Claim**	**Amount (in INR)Or currency applicable in the contract**	**Relevant contract clause**

6. Basis/Ground of claim(s)/counter claim(s) (along with relevant clause of contract)

Note– *The Statement of Claims/ Counter Claims may ideally be restricted to maximum limit of 20 pages. Relevant documents may be compiled and submitted along with the statement of Claims/ Counter Claims. The statement of Claims/ Counter Claims is to be submitted to all IEC members and to the other party by post as well as by email.*

FORMAT-7

FORMAT FOR NOTICE INVOKING CONCILIATION CLAUSE BY BHEL FOR REFERRING THE DISPUTES TO CONCILIATION THROUGH IEC

To,

M/s. (Stakeholder's name)

Subject: **NOTICE FOR INVOCATION OF THE CONCILIATION CLAUSE OF THE CONTRACT BY BHEL**

Ref: Contract No/MoU/Agreement/LOI/LOA& date _____.

Dear Sir/Madam,

As you are aware, with reference to above referred Contract/MoU/Agreement/LOI/LOA, certain disputes have arisen, which, in-spite of several rounds of mutual discussions and various correspondences have remained unresolved. The brief particulars of our claims which arise out of the above- referred Contract/MoU/Agreement/LOI/LOA are reproduced hereunder:

Sl. No.	Claim description	Amount involved

As you are aware, there is a provision in the captioned Contract/MoU/Agreement/LOI/ LOA for referring disputes to conciliation.

In terms of Clause ---------of Procedure i.e., Annexure ------ to the Contract/MoU /Agreement / LOI / LOA, we hereby seek your consent to refer the matter to Conciliation by Independent Experts Committee to be appointed by BHEL. You are invited to provide your consent in writing to proceed with conciliation into the above mentioned disputes within a period of 30 days from the date of this letter along with details of counter-claims, if any, which you might have with regard to the subject Contract/ MoU/ Agreement/ LOI/ LOA.

Please note that upon receipt of your consent in writing within 30 days of the date of receipt of this letter by you, BHEL shall appoint suitable person(s) from the BHEL Panel of Conciliators.

This letter is being issued without prejudice to our rights and contentions available under the contract and law.

Thanking you
Yours faithfully

Representative of BHEL

Note: The Format may be suitably modified, as required, based on facts and circumstances of the case.

FORMAT-8

FORMAT FOR NOTICE INVOKING CONCILIATION CLAUSE BY A STAKEHOLDER FOR REFERRING THE DISPUTES TO CONCILIATION THROUGH IEC

To,
BHEL (Head of the Unit/Division/Region/Business Group)

Subject: **NOTICE FOR INVOCATION OF THE CONCILIATION CLAUSE OF THE CONTRACT BY A STAKEHOLDER**

Ref: Contract No/MoU/Agreement/LOI/LOA& date _____.

Dear Sir/Madam,

As you are aware, with reference to above referred Contract/MoU/Agreement/LOI/LOA, certain disputes have arisen, which, in-spite of several rounds of mutual discussions and various correspondences have remained unresolved. The brief particulars of our claims which have arisen out of the above-referred Contract/MoU/Agreement/LOI/LOA are enumerated hereunder:

Sl. No.	Claim description	Amount involved

As you are aware, there is a provision in the captioned Contract/MoU/Agreement/LOI/ LOA for referring inter-se disputes of the Parties to conciliation.

We wish to refer the above-said disputes to Conciliation as per the said Clause of the captioned Contract/MoU/Agreement/LOI/ LOA. In terms of Clause ---------of Procedure i.e., Annexure ------ to the Contract/MoU /Agreement / LOI / LOA, we hereby invite BHEL to provide its consent in writing to proceed with conciliation into the above mentioned disputes within a period of 30 days from the date of this letter along with details of counter-claims, if any, which it might have with regard to the subject Contract/ MoU/ Agreement/ LOI/ LOA and to appoint suitable person(s) as Conciliator(s) from the BHEL Panel of Conciliators.

This letter is being issued without prejudice to our rights and contentions available under the contract and law.

Thanking you
Yours faithfully

Representative of the Stakeholder

Note: The Format may be suitably modified, as required, based on facts and circumstances of the case.

FORMAT-9

FORMAT FOR INTIMATION TO THE STAKEHOLDER ABOUT APPOINTMENT OF CONCILIATOR/IEC

To,

M/s. (Stakeholder's name)

Subject: **INTIMATION BY BHEL TO THE STAKEHOLDER AND CONCILIATOR(S) ABOUT APPOINTMENT OF CONCILIATOR/IEC**

Ref: Contract No/MoU/Agreement/LOI/LOA& date _____.

Sir,

This is with reference to letter dated ---------- regarding reference of the disputes arising in connection with the subject Contract No /MoU/Agreement/LOI/LOA to conciliation and appointment of Conciliator(s).

In pursuance of the said letter, the said disputes are assigned to conciliation and the following persons are nominated as Conciliator(s) for conciliating and assisting the Parties to amicably resolve the disputes in terms of the Arbitration & Conciliation Act, 1996 and the Procedure ---- to the subject Contract ...../MoU/Agreement/LOI/LOA, if possible.

Name and contact details of Conciliator(s)

a) .....

b) .....

c) .....

You are requested to submit the Statement of Claims or Counter-Claims (strike off whichever is inapplicable) before the Conciliator(s) in Format 5 (enclosed herewith) as per the time limit as prescribed by the Conciliator(s).

Yours faithfully,

Representative of BHEL

CC: To Conciliator(s)… for Kind Information please.
Encl: As above

Note: The Format may be suitably modified, as required, based on facts and circumstances of the case.

Annexure

C1

DATE:31/05/2019

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 01/06/2019 to 31/5/2021 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (BEYOND USEFUL LIFE)
I.	CRANES:-			
1	Portal Gantry Crane 500T	15	20100.00	19980.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	11370.00	11320.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	56290.00	55940.00
4	PORTAL CRANE, 360T	15	14070.00	13980.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	55460.00	55110.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	68610.00	68180.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	33510.00	33300.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	20940.00	20810.00
9	MANITOWOC M-250T TRUCK CRANE	15	30160.00	29970.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	31660.00	31470.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	26390.00	26220.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	36110.00	36110.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	15130.00	15030.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	18850.00	18850.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	16750.00	16650.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	21780.00	21640.00
15	CRAWLER CRANE SUMITOMO, 150T	15	10890.00	10820.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	13400.00	13320.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	10830.00	10780.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	10720.00	10650.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	8880.00	8820.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	10050.00	9990.00
20	CRAWLER CRANE 100 T (KH 500)	15	10050.00	9990.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	5410.00	5390.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6140.00	6110.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5370.00	5340.00
24	Mobile Crane, 55MT (TIL)	12	4410.00	4390.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3030.00	3010.00
26	MOBILE CRANE, 20MT (TIL)	10	2270.00	2260.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2270.00	2260.00
28	MOBILE CRANE ESCORTS- 14MT	10	710.00	710.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	390.00	380.00
30	ELECTRIC GANTRY CRANE 3T	5	430.00	430.00
31	ELECTRIC GANTRY CRANE 5T	5	540.00	540.00
32	ELECTRIC GANTRY CRANE 30T	5	3640.00	3620.00
33	FORK LIFT 5T	5	650.00	650.00
34	FORK LIFT 3T	5	540.00	540.00

Annexure C2 DATE 31/05/2019

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 01/06/2019 to 31/5/2021 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (BEYOND USEFUL LIFE)
I.	CRANES:-			
1	Portal Gantry Crane 500T	15	22340.00	22200.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	12630.00	12570.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	62550.00	62160.00
4	PORTAL CRANE, 360T	15	15630.00	15540.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	61620.00	61240.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	76230.00	75760.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	37230.00	37000.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	23270.00	23120.00
9	MANITOWOC M-250T TRUCK CRANE	15	33510.00	33300.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	35180.00	34960.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	29320.00	29130.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	40120.00	40120.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	16810.00	16700.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	20950.00	20950.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	18610.00	18500.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	24200.00	24050.00
15	CRAWLER CRANE SUMITOMO, 150T	15	12100.00	12020.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	14890.00	14800.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	12030.00	11970.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	11910.00	11840.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	9860.00	9800.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	11170.00	11100.00
20	CRAWLER CRANE 100 T (KH 500)	15	11170.00	11100.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	6010.00	5980.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6830.00	6790.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5970.00	5940.00
24	Mobile Crane, 55MT (TIL)	12	4900.00	4880.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3370.00	3350.00
26	MOBILE CRANE, 20MT (TIL)	10	2520.00	2510.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2520.00	2510.00
28	MOBILE CRANE ESCORTS- 14MT	10	790.00	790.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	430.00	430.00
30	ELECTRIC GANTRY CRANE 3T	5	480.00	480.00
31	ELECTRIC GANTRY CRANE 5T	5	600.00	600.00
32	ELECTRIC GANTRY CRANE 30T	5	4040.00	4030.00
33	FORK LIFT 5T	5	720.00	720.00
34	FORK LIFT 3T	5	600.00	600.00

ANNEXURE-T I
DT: 31/05/2019

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 01/06/2019 to 31/5/2021
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	20930
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	310
3	MULTI SHEAVE PULLEY BLOCK 100T	630
4	MULTI SHEAVE PULLEY BLOCK 150T	1260
5	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
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	16380
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	8190
3	WELDING GENERATOR 320/300 A	300
4	WELDING RECTIFIER 400A/300A	300
5	WELDING RECTIFIER 600A	400
6	DIESEL WELDING GENERATOR 400A/300A	400
7	TRANSFORMER,600A	300
8	TRANSFORMER 300/400A	200
III	SERVICE PLANTS & ALLIED EQUIPT.	0
1	500KVA DIESEL GENERATOR	3800
2	TRANSFORMER OIL FILTERATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	6370
3	-DO- , WITH STORAGE TANK	7280
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	910
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON	1360
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON	1820
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON	3640
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750	1270
9	Low Vacuum de-hydration unit	630
10	DIESEL GENERATING SET,250 KVA	1770
11	DIESEL GENERATING SET,25 KVA	500
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

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 01/06/2019 to 31/5/2021
17	AIR COMPRESSORS 250/300/330/360/350 CFM	2730
18	AIR COMPRESSORS 140/150/190/210 CFM	910
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	1820
20	Industrial Blower 2000CFM	1270
21	Air Leak Test Blower (Flow: 40000 m^3/Hr)	1160
22	Air Blower (Flow: 20000 m^3/Hr)	940
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	630
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1630
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	1800
4	-do- Gun with nose Assembly only	540
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	36980
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	800
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1090
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1270
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1330
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2230
7	BOLT STRETCHING DEVICE	910
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	3640
9	ULTRASONIC FLAW DETECTOR	2730
10	MPI TEST KIT	360
11	GAS LEAK DETECTOR	270
12	VIBRATION/SOUND LEVEL METER IRD-306	360
13	VIBRATION/SOUND LEVEL METER IRD-308	360
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1450
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2540
16	SHOCK PULSE METER	630
17	HV.DC TEST KIT UPTO 50 KV	540
18	HV.DC TEST KIT ABOVE 50 KV	1000
19	HV.AC TEST KIT UPTO 50KV	810
20	HV.AC TEST KIT ABOVE 50KV	2910
21	MOTORISED MEGGER 2.5KV	400
22	MOTORISED MEGGAR 5KV	450
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	450
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1090
25	WAVEFORM ANALYSER	910
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1630
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1090
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	910
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

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 01/06/2019 to 31/5/2021
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 DIAGONISTIC REPAIR KIT	2000
56	SECONDARY INJECTION RELAY TEST KIT	5270
57	MICRO OHM METER	1450
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 μΩ TO 20KΩ	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
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

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 01/06/2019 to 31/5/2021
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

ANNEXURE-T II

DT: 31/05/2019

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 01/06/2019 to 31/5/2021
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	23250
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	350
3	MULTI SHEAVE PULLEY BLOCK 100T	700
4	MULTI SHEAVE PULLEY BLOCK 150T	1400
5	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
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	18190
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	9090
3	WELDING GENERATOR 320/300 A	330
4	WELDING RECTIFIER 400A/300A	330
5	WELDING RECTIFIER 600A	440
6	DIESEL WELDING GENERATOR 400A/300A	440
7	TRANSFORMER,600A	330
8	TRANSFORMER 300/400A	220
III	SERVICE PLANTS & ALLIED EQUIPT.	
1	500KVA DIESEL GENERATOR	4220
2	TRANSFORMER OIL FILTERATION EQUIPMENT 6000LPH	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	1510
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON	2020
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON	4040
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750	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

ANNEXURE-T II
DT: 31/05/2019

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 01/06/2019 to 31/5/2021
17	AIR COMPRESSORS 250/300/330/360/350 CFM	3030
18	AIR COMPRESSORS 140/150/190/210 CFM	1010
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 m^3/Hr)	1290
22	Air Blower (Flow: 20000 m^3/Hr)	1040
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	700
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1810
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	2000
4	-do- Gun with nose Assembly only	600
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	41090
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	880
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1210
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1410
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1480
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2480
7	BOLT STRETCHING DEVICE	1010
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	4040
9	ULTRASONIC FLAW DETECTOR	3030
10	MPI TEST KIT	400
11	GAS LEAK DETECTOR	300
12	VIBRATION/SOUND LEVEL METER IRD-306	400
13	VIBRATION/SOUND LEVEL METER IRD-308	400
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1610
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2830
16	SHOCK PULSE METER	700
17	HV.DC TEST KIT UPTO 50 KV	600
18	HV.DC TEST KIT ABOVE 50 KV	1110
19	HV.AC TEST KIT UPTO 50KV	900
20	HV.AC TEST KIT ABOVE 50KV	3230
21	MOTORISED MEGGER 2.5KV	440
22	MOTORISED MEGGAR 5KV	500
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	500
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1210

ANNEXURE-T II
DT: 31/05/2019

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 01/06/2019 to 31/5/2021
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
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 DIAGONISTIC REPAIR KIT	2220
56	SECONDARY INJECTION RELAY TEST KIT	5860
57	MICRO OHM METER	1610
58	DIGITAL MICRO OHM METER	3590
59	PMI Machine OLYMPUS make	3730
60	Mobile Lighting Mast -	960
61	10KVA RESISTANCE BRAZING MACHINE	160
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH	510

ANNEXURE-T II

DT: 31/05/2019

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 01/06/2019 to 31/5/2021
63	HYDROGEN GAS LEAK DETECTOR	60
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE	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	520
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR	480
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL	2010
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1400
75	5KV Insulation Tester	500
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